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Research Article

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Performance of Grafted Bitter Gourd (*Momordica charantia* L.) at Different Pruning and Nitrogen Levels in Nawalparasi East, Nepal

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Abstract

Pruning and level of nitrogen influence the growth and yield of bitter gourd. A field experiment was conducted to assess the effect of different pruning and nitrogen levels on the growth and productivity of bitter gourd from March to July 2022 in Nawalparasi East, Nepal. The field experiment was laid out in a split-plot design with three replications. The treatment comprised three levels of pruning (No pruning, second generation (2G) pruning, and third generation (3G) pruning) in main plots and three different doses of nitrogen (100, 150, and 200 kg ha-1) in sub-plots. Observations on growth, floral, and yield parameters were recorded, analyzed, and presented. The research result revealed that 3G pruning with 200 kg ha-1 nitrogen level produced the highest fruit yield (16242.56 kg ha-1) at the fourth harvest. The yield trend showed higher fruit yield at higher nitrogen levels and 3G pruning at all dates of harvest. The increased fruit yield at higher nitrogen levels was because of more number of fruits per plant as well as longer fruit length and larger fruit diameter. The higher productivity in 3G pruning was mainly due to more fruit per plant at the fourth harvest. The results indicate a higher yield of bitter gourd at a higher level of nitrogen with 3G pruning.

Keywords : Bitter gourd, pruning, 3G cutting, nitrogen, grafting

Introduction:

Bitter gourd (*Momordica charantia* L.), popular with names such as karela, bitter melon, wild cucumber, and bitter apple is one of the key market vegetables in Eastern and South Asia (Krawinkel & Keding, 2006). Chan et al. (1984) stated the presence of β-momorcharin in bitter gourd. Horax et al., (2005) also recorded some presence of antioxidants like phenols in bitter gourd, which are said to reduce the rate of occurrence of cardiovascular diseases, and cancer, and reduce blood pressure. Dutta et al. (1981) reported that bitter gourd also contains other phytochemicals like Vicine, which is hypoglycemic, and Polypeptide-p which is a hypoglycemic peptide called plant insulin (Khanna et al., 1981). Lack of improved varieties, infestation of insects and diseases, haphazard application of fertilizers, and lack of sufficient and timely irrigation are some of the major reasons for the lower yield of bitter gourd (Nasreen et al., 2013). There is a lack of knowledge on the grafting of vegetables among farmers, which can be effective in solving problems like wilting during the peak fruiting period (Rakholiya et. al., 2003).

The process of increasing the production in plants by enhancing the development of female flowers through pruning of the tip of first and second-generation branches is called 3G cutting (Chaurasiya et. al., 2020). It is the process of stimulating the growth of third-generation branches of plants by removing primary (first-generation) and secondary (second-generation) branches (Singh et al., 2021). Similarly, the process of promoting the growth of the secondary branch by removing the primary branch is called 2G cutting. 3G cutting is done to multiply the number of pistillate flowers on a plant as third-generation branches yield more female flowers than male blooms (Verma et. al., 2023). The development of aerial parts is favored by nitrogen fertilization which promotes the flowering and fruiting of crops (El-Gengaihi et al., 2007). The production and quality of bitter gourd can be improved through proper nutrient management (Nasreen et al., 2013). This research was conducted to observe the effectiveness of pruning and nitrogen levels in increasing the productivity of bitter gourd, especially in Nawalparasi East and other similar locations. The information obtained from the research helps farmers follow similar practices, which will ultimately increase their productivity and benefit the country as a whole.

Materials and methods:

Experimental site

The field experiment was carried out during the spring season from March to June 2022 in the farmer's field at Danda, Kawasoti, Nawalparasi East, situated at 27° 38′ 25.05″ N and 84° 7′ 28.6″ E geographical coordinates and about 180 m above the sea level. The average annual temperature in the area was 23.5 °C. The minimum and maximum temperatures in the area during the cropping period were 15.1 and 34.2 °C, respectively. The average annual precipitation of Kawasoti was 2,541 mm. The highest relative humidity (RH %) reached 80%, while the lowest RH was 50% during the cropping period. The soil type of the research site was sandy loam and the soil pH of the site was 6.5.

Experimental design

The study was conducted using a split-plot design, and it was replicated three times. The main plot factor was pruning, constituting three levels: P1 (No pruning), P2 (2G cutting) and P3 (3G cutting). Similarly, nitrogen levels were taken as the subplot factor, constituting three levels: N1 (100 kg ha^{-1}), N2 (150 kg ha^{-1}), and N3 (200 kg ha^{-1}). The individual plot size was 4 m × 3 m (12 m^2). The spacing between rows was 50 cm whereas the spacing within rows was 25 cm.

Cultural practices

Grafting of bitter gourd seedlings was prepared on the sponge gourd stock on three different dates i.e. 22nd, 24th, and 25th of March. Sponge gourd is used as rootstock because it is locally believed to be comparatively more resistant to disease and pests than bitter gourd. Also, sponge gourd is observed to suffer less wilting than bitter gourd. The grafted plants were kept in a healing chamber for about 10 days and kept in a nursery for hardening. A week prior to transplanting, land preparation was done. Around 700 kg of Farm Yard Manure (FYM) was incorporated during final land preparation in the area of 1.35 katha (0.045 ha). Urea was taken as the source of nitrogen. Half dose of nitrogen fertilizer in each treatment and full doses of phosphorus and potassium fertilizers were applied as basal applications where Diammonium phosphate (DAP) and Muriate of potash (MOP) were used @ 120 kg ha^{-1} and 60 kg ha^{-1}, respectively. The remaining dose of nitrogen fertilizer was applied one month after transplantation. In total 100, 150, and 200 kg ha^{-1} of N, 55.2 kg ha-^{1} of P2O5, and 36 kg ha^{-1} of K2O were used in the area of 450 m^2.

Data Observation

Length of the main stem, number of nodes on the main stem, and primary and secondary branches per vine were recorded at 30 days after transplantation (DAT). The number of days taken for 50% female and male flowering, male and female flowers number, and the ratio of male: female flowers were recorded at 28, 30, and 35 DAT.

$$\text{Male: female flower ratio} = \frac{\text{number of male flowers}}{\text{numbers of female flowers at given DAT}}$$

Yield parameters like fruit length (cm), fruit diameter (cm), number of fruits per plant, and fruit yield (kg ha^{-1}) were recorded.

Total Yield = yield of individual plant * total number of plants

Statistical Analysis

Data entry was done by using MS Excel while data analysis was done using R Studio. Mean separation was done by the use of Duncan's Multiple Range Test (DMRT) at a 5% level of significance. Analysis of variance (ANOVA) was done to determine the significance of differences between means of treatment.

Results and Discussion:

Growth of Bitter Gourd at 30 DAT

Length of stem (cm)

The mean length of stem was 191.22 cm at 30 DAT. Length of stem (cm) was significantly influenced by pruning but not by nitrogen levels (Table 1). The length of stem was significantly longer in the plot without pruning as compared with 2G and 3G cutting. The plant height was taller in no pruning, possibly due to the continuity of apical dominance in such plants, unlike the plants with 2G and 3G pruning where the apical portion was removed. Mir et al. (2019) reported that pruning resulted lower stem length (83.75 cm, 146.71 cm, 176.25 cm) in cucumbers compared to control (90.50cm, 152.86 cm, 181.50 cm) at 30, 40, and 50 Days after sowing (DAS), respectively which is supposed to be due to creation of shocking periods as a result of pruning in plants which hindered the normal growth of plant.

No. of nodes/plant

The interaction between pruning and nitrogen levels was non-significant in the number of nodes per plant (Table 1). The mean number of nodes per plant was 29.20 at 30 DAT. However, number of nodes per plant was significantly influenced by pruning but not by nitrogen levels at 30 DAT. The maximum number of nodes was found in plants with no pruning (33.77) and the minimum number of nodes was found in plants with 3G cutting (26.63) which was at par with 2G cutting (27.19). More nodes in plants with no pruning is possibly due to their greater length of stem.

Table 1 : Growth of grafted Bitter Gourd at 30 DAT as influenced by pruning and nitrogen levels at Danda, Nawalparasi East, Nepal, 2022

Treatment	Length of stem (cm)	No. of nodes/ plant	No. of Primary Branch/ plant	No. of Secondary Branch/ plant
Pruning				
No pruning	217.25[a]	33.77[a]	16.91	1.30[b]
2G cutting	178.80[b]	27.19[b]	16.83	2.66[b]
3G Cutting	177.61[b]	26.63[b]	18.27	5.52[a]
SEM1 (±)	13.02	2.29	0.46	1.24
LSD (0.05)	15.72	2.60	2.60	2.80
CV (a)%	6.3	9.2	11.5	67.8
F-test	**	**	NS	*
Nitrogen Levels				
100 kg ha-1	191.31	29.22	16.72	2.86
150 kg ha-1	189.97	29.17	18.02	2.91
200 kg ha-1	192.39	29.22	17.27	3.72
SEM2 (±)	0.69	0.02	0.37	0.27
LSD (0.05)	5.31	1.60	1.60	0.75
CV (b)%	2.7	3.3	9	23.2
F-test	NS	NS	NS	NS
Interaction				
F-test	*	NS	NS	NS
Grand Mean	191.22	29.20	17.34	3.16

*Means accompanied by the same letter(s) within a column are not statistically different at 5% by DMRT, CV (Coefficient of variation), SEM (±) (Standard error of mean difference), LSD (Least significant difference), * significant at 5% (P<0.05), ** significant at 1% (P<0.01), *** significant at 0.1% (P<0.001), NS (Non-significant)*

No. of Primary Branch/ plant

The average number of primary branches per plant at 30 DAT was 17.34 (Table 1). Neither pruning nor nitrogen level significantly influenced the number of primary branches per plant.

Number of secondary branches per plant

The interaction between pruning and nitrogen levels had no significant effect on number of secondary branches per plant (Table 1). The mean number of secondary branches per plant was 3.16 at 30 DAT. The number of secondary branches per plant was significantly influenced by pruning but not by nitrogen levels at 30 DAT. The number of secondary branches per plant was highest in plants with 3G cutting (5.52) and lowest in plants with no pruning (1.30) which was at par with that of 2G cutting (2.66). More number of secondary branches per plant in plants with 3G cutting is possibly due to the ceasing of apical dominance due to pruning (Arora and Malik, 1998).

The length of stem due to the interaction between pruning levels and nitrogen levels was significant at 30 DAT (Table 2). The interaction between no pruning and nitrogen level 150 kg ha^{-1} recorded the maximum length of stem (218.41 cm) which was statistically at par with 100 kg ha^{-1} (217.83 cm) and 200 kg ha^{-1} (215.50 cm) nitrogen levels.

Table 2 : Length of stem (cm) at 30 DAT as influenced by the interaction of pruning and nitrogen levels at Danda, Nawalparasi East, Nepal, 2022

Treatments	Length of stem (cm)		
	Pruning		
	No pruning	2G pruning	3G pruning
Nitrogen Levels			
100 kg ha^{-1}	217.83[a]	172.50[d]	183.58[bc]
150 kg ha^{-1}	218.41[a]	176.92[cd]	174.58[cd]
200 kg ha^{-1}	215.50[a]	187.00[b]	174.67[cd]
LSD (0.05)		9.19*	
CV (%)		2.70	
SEM (±)		0.69	

*Means accompanied by the same letter(s) within a column are not statistically different at 5% by DMRT, CV (Coefficient of variation), SEM (±) (Standard error of mean difference), LSD (Least significant difference), * significant at 5% (P<0.05), ** significant at 1% (P<0.01), *** significant at 0.1% (P<0.001), NS (Non-significant)*

Days to 50% male and female flowering

The interaction between pruning and nitrogen levels did not yield statistically significant results concerning the time it took for 50% male and female flowering (as shown in Table 3). The mean number of days for 50% of male and female flowering were 27.16 days and 27.82 days, respectively (Table 3). Days to 50% male and female flowering were significantly influenced by pruning but not by nitrogen levels (Table 3). Maximum days to 50% male flowering were recorded in 3G cutting (27.56 days) which was statistically similar with 2G cutting (27.50 days). Similarly, maximum days to 50% female flowering were recorded in 3G cutting (28.36 days) which was statistically equivalent with 2G cutting (28.25). The minimum days to 50% male flowering (26.44 days) and female flowering (26.83 days) were recorded with no pruning. Pruned plants took longer days for 50% male and female flowering. Utobo et al. (2010) observed in cucumber that plants without pruning achieved 50% flowering in a shorter time (26 days) compared to pruned plants. Chapagain et al. (2022) suggested that the variation in the time to reach 50% flowering for both male and female flowers might be attributed to the adjustment of hormone levels and the redistribution of nutrients in plants resulting from the pruning of main shoots and branches.

No. of male and female flowers/plant

No. of male flowers/plant

Non-significant result was seen in the interaction between pruning and nitrogen levels in the case of the number of male flowers per plant (Table 4). The mean number of male flowers per plant at 28, 30, and 36 DAT were 6.93, 7.06, and 12.93, respectively (Table 4). Significant influence of the number of male flowers per plant was seen in pruning at 28, 30, and 36 DAT, but not by nitrogen levels except at 36 DAT. The highest number of male flowers per plant was recorded in non-pruned at 28 DAT (9.06), 30 DAT (9.39), and 36 DAT (16.97) whereas it was the lowest in 3G cutting at 28 DAT (4.50), 30 DAT (4.50) and 36 DAT (9.14). Nitrogen level of 200 kg ha-1 gave the maximum number of male flowers per plant at 36 DAT (13.67) and the minimum at 100 kg ha^{-1} (12.50) which was at par with 150 kg ha^{-1} (12.61). Lower

Table 3 : Days to 50% male and female flowering as influenced by pruning and nitrogen levels at Danda, Nawalparasi East, Nepal, 2022

Treatment	Days to 50%	
	Male flowering	Female flowering
Pruning		
No pruning	26.44^{b}	26.83^{b}
2G cutting	27.50^{a}	28.25^{a}
3G Cutting	27.56^{a}	28.36^{a}
SEM1 (±)	0.36	0.49
LSD (0.05)	0.63	1.15
CV (a)%	1.8	3.2
F-test	*	*
Nitrogen Levels		
100 kg ha^{-1}	27.15	27.64
150 kg ha^{-1}	27.18	27.92
200 kg ha^{-1}	27.16	27.89
SEM2 (±)	0.01	0.09
LSD (0.05)	0.39	0.52
CV (b)%	1.4	1.8
F-test	NS	NS
Interaction		
F-test	NS	NS
Grand Mean	27.16	27.82

*Means accompanied by the same letter(s) within a column are not statistically different at 5% by DMRT, CV (Coefficient of variation), SEM (±) (Standard error of mean difference), LSD (Least significant difference), * significant at 5% (P<0.05), ** significant at 1% (P<0.01), *** significant at 0.1% (P<0.001), NS (Non-significant)*

primary branches were removed in pruning, which might have decreased the production of a greater number of male flowers. As a result, a decrease in the total number of male flowers might have been noticed in plants with 2G and 3G cutting. Chapagain et. al. (2022) also reported that pruning modulates the hormonal level in plants, which resulted in the promotion of third-generation branches where higher numbers of pistillate flowers were produced.

No. of female flowers/plant

Non-significant result was seen in the interaction between pruning and nitrogen levels in the case of the number of female flowers per plant (Table 4). The mean number of female flowers per plant was 2.94, 2.98, 4.93, at 28, 30, and 36 DAT, respectively (Table 4). However, significant influence was seen in the number of female flowers per plant in the case of pruning at 28, 30, and 36 DAT, but not in case of nitrogen levels. The total number of female flowers per plant was the highest in 3G pruning at 28 DAT (3.50), 30 DAT (3.50), and 36 DAT (6.61) whereas it was the lowest in no pruning at 28 DAT (2.30), 30 DAT (2.42), and 36 DAT (3.92). The increase in the number of female flowers per plant in plants with 2G and 3G cutting compared to control was probably due to the greater number of primary and secondary branches on them (Mir et al., 2019). According to Chaurasiya et. al. (2020), the growth of third-generation branches was promoted by 3G cutting which increased the number of female flowers. Chapagain et. al. (2022) also reported that pruning modulates the hormonal level in plants, which resulted in the promotion of third-generation branches where higher numbers of pistillate flowers were produced.

Male: Female flowers Ratio

The mean male-to-female flowers ratios were 2.54, 2.53, and 2.94 at 28, 30, and 36 DAT respectively (Table 5). The ratio of male to female flowers was significantly influenced by pruning at 28, 30, and 36 DAT, but not by nitrogen levels. Male to female flower ratio was highest in plants that were not pruned at 28 DAT (3.93), 30 DAT (3.89), and 36 DAT (4.33) whereas it was lowest in 3G cutting at 28 DAT (1.29), 30 DAT (1.29) and 36 DAT (1.38). The total ratio of male to female flowers decreased in pruned plants due to the production of more secondary branches in them which increased the number of pistillate flowers. Saifuddin et. al. (2010), reported that the concentration level of auxin in the lateral buds was increased by pruning of the apical portion of plants which stimulated cell division. This might have influenced the total number of flowers in plants and as a result, the male-to-female flower ratio was affected.

Length and diameter of fruit (cm)

Length of fruit (cm)

There was no significant effect of interaction between pruning and nitrogen level on the length of fruit (Table 6). The mean length of fruit was 20.14 cm at the first harvest, 22.72 cm at the second harvest, and 27.62 cm

Table 4 : Number of male and female flowers/plant as influenced by pruning and nitrogen levels at Danda, Nawalparasi East, Nepal, 2022

Treatment	No. of male flowers/plant			No. of female flowers/plant		
	28 DAT	30 DAT	36 DAT	28 DAT	30 DAT	36 DAT
Pruning						
No pruning	9.06[a]	9.39[a]	16.97[a]	2.30[c]	2.42[c]	3.92[b]
2G cutting	7.22[b]	7.27[b]	12.67[b]	3.03[b]	3.03[b]	4.25[b]
3G Cutting	4.50[c]	4.50[c]	9.14[c]	3.50[a]	3.50[a]	6.61[a]
SEM1 (±)	1.32	1.41	2.27	0.35	0.31	0.85
LSD (0.05)	0.39	0.41	1.74	0.24	0.27	1.19
CV (a)%	4.4	4.4	10.3	6.3	7	18.4
F-test	***	***	***	***	**	**
Nitrogen Levels						
100 kg ha^{-1}	6.83	7.17	12.50b	3.00	3.03	4.69
150 kg ha^{-1}	6.95	6.95	12.61b	2.89	2.94	4.91
200 kg ha^{-1}	7.00	7.06	13.67a	2.95	2.97	5.17
SEM2 (±)	0.05	0.06	0.37	0.03	0.02	0.14
LSD (0.05)	0.34	0.36	0.76	0.09	0.11	0.57
CV (b)%	4.8	5	5.7	3.1	3.8	11.2
F-test	NS	NS	*	NS	NS	NS
Interaction						
F-test	NS	NS	NS	NS	NS	NS
Grand Mean	6.93	7.06	12.93	2.94	2.98	4.93

*Means accompanied by the same letter(s) within a column are not statistically different at 5% by DMRT, CV (Coefficient of variation), SEM (±) (Standard error of mean difference), LSD (Least significant difference), * significant at 5% (P<0.05), ** significant at 1% (P<0.01), *** significant at 0.1% (P<0.001), NS (Non-significant)*

Table 5 : Male to female flower ratio of grafted bitter gourd at 28, 30, and 36 DAT as influenced by pruning and nitrogen levels at Danda, Nawalparasi East, Nepal, 2022

Treatment	Male: Female flowers Ratio		
	28DAT	30DAT	36DAT
Pruning			
No pruning	3.93[a]	3.89[a]	4.33[a]
2G cutting	2.39[b]	2.40[b]	3.10[b]
3G Cutting	1.29[c]	1.29[c]	1.38[c]
SEM1 (±)	0.77	0.75	0.86
LSD (0.05)	0.19	0.19	0.89
CV (a)%	5.8	6	23.3
F-test	***	***	**
Nitrogen Levels			
100 kg ha^{-1}	2.49	2.52	2.96
150 kg ha^{-1}	2.54	2.49	2.89
200 kg ha^{-1}	2.58	2.56	2.98
SEM2 (±)	0.03	0.02	0.03
LSD (0.05)	0.14	0.15	0.39
CV (b)%	5.5	5.8	13.1
F-test	NS	NS	NS
Interaction			
F-test	NS	NS	NS
Grand Mean	2.54	2.53	2.94

*Means accompanied by the same letter(s) within a column are not statistically different at 5% by DMRT, CV (Coefficient of variation), SEM (±) (Standard error of mean difference), LSD (Least significant difference), * significant at 5% (P<0.05), ** significant at 1% (P<0.01), *** significant at 0.1% (P<0.001), NS (Non-significant)*

Table 6 : Length and diameter of fruit (cm) of grafted bitter gourd at first, second, and third harvest as influenced by pruning and nitrogen levels at Danda, Nawalparasi East, Nepal, 2022

Treatment	Length of fruit (cm)			Diameter of fruit (cm)		
	First Harvest	Second Harvest	Third Harvest	First Harvest	Second Harvest	Third Harvest
Pruning						
No pruning	19.04	22.23	27.10	5.17	5.00	5.62
2G cutting	19.49	22.92	27.58	5.15	5.04	5.87
3G Cutting	21.87	23.02	28.18	5.45	5.19	5.87
SEM1 (±)	0.87	0.24	0.31	0.09	0.06	0.08
LSD (0.05)	3.39	2.14	2.13	0.36	0.57	0.54
CV (a)%	12.9	7.2	10	5.3	7.4	7.2
F-test	NS	NS	NS	NS	NS	NS
Nitrogen Levels						
100 kg ha^{-1}	18.74^{b}	21.73^{b}	26.43^{b}	5.19	5.00	5.71b
150 kg ha^{-1}	19.96^{b}	22.61^{ab}	27.02^{b}	5.20	4.98	5.63b
200 kg ha^{-1}	21.71^{a}	23.83^{a}	29.41^{a}	5.38	5.25	6.03a
SEM2 (±)	0.862	0.61	0.91	0.06	0.09	0.12
LSD (0.05)	1.55	1.57	1.18	0.25	0.28	0.26
CV (b)%	7.5	6.7	4.2	4.7	5.3	4.4
F-test	**	*	***	NS	NS	*
Interaction						
F-test	NS	NS	NS	NS	NS	NS
Grand Mean	20.14	22.72	27.62	5.26	5.08	5.79

*Means accompanied by the same letter(s) within a column are not statistically different at 5% by DMRT, CV (Coefficient of variation), SEM (±) (Standard error of mean difference), LSD (Least significant difference), * significant at 5% (P<0.05), ** significant at 1% (P<0.01), *** significant at 0.1% (P<0.001), NS (Non-significant)*

at the third harvest (Table 6). Length of fruit (cm) was not influenced significantly by pruning, but it was by nitrogen levels at all first, second, and third harvests. The minimum length of fruit was seen in 100 kg ha^{-1} nitrogen levels at the first (18.74 cm), second (21.73 cm), and third (26.43 cm) harvests which were statistically equivalent to 150 kg ha^{-1} nitrogen levels at all harvests. Nitrogen level of 200 kg ha^{-1} gave the maximum length of fruit at the first harvest (21.71 cm), second harvest (23.83 cm), and third harvest (29.41 cm). At second harvest length of fruit at 150 kg ha^{-1} nitrogen level (22.61 cm) was statistically at par with 200 kg ha^{-1} (23.83 cm) nitrogen level. Jan et al. (2019) reported that the highest fruit length of 11.06 cm was obtained from the plant fertilized with the maximum dose of nitrogen i.e. 150 kg ha^{-1} while the minimum fruit length (9.17 cm) was obtained from the vines fertilized with the lowest nitrogen level of 50 kg ha^{-1}. The diversion of photosynthates to reproductive organs might be the reason behind the increase in the fruit length (Dudhat and Patel, 2020).

Diameter of fruit (cm)

There was no significant effect of interaction between pruning and nitrogen level on diameter of fruit (Table 6). The mean diameter of fruit was 5.26 cm in the first harvest, 5.08 cm in the second harvest and 5.79 cm in the third harvest (Table 6). Significant influence on the diameter of fruit (cm) was observed in case of nitrogen levels but not in pruning at third harvest. 200 kg ha^{-1} nitrogen level recorded the maximum diameter of fruit at the third harvest (6.03 cm). Nodi (2012) recorded the increase in breadth of fruit along with the increase in nitrogen doses where 161 kg ha^{-1} of nitrogen levels gave maximum diameter of fruit (6.83 cm) and control gave the minimum diameter (6.01 cm) of fruit in tomato.

Number of fruits/plant

The interaction of pruning and nitrogen levels significantly influenced the number of fruits per plant at the fourth harvest (Table 7). The interaction of no pruning and a nitrogen level of 100 kg ha^{-1} resulted in the minimum number of fruits per plant (3.41) which was statistically at par with a nitrogen dose of 150 kg ha^{-1} (3.83) and the interaction between 3G cutting and nitrogen level of 200 kg ha^{-1} resulted in the maximum number of fruits per plant (7.25).

Significant influence of both pruning at fourth harvest, and nitrogen levels at third and fourth harvest was seen in the number of fruits per plant (Table 8). The result also reported that at the third harvest number of fruits per plant at a nitrogen dose

Table 7 : Number of fruits per plant of grafted bitter gourd at fourth harvest as influenced by interaction between pruning and nitrogen levels at Danda, Nawalparasi East, Nepal, 2022

	No. of fruits/ plant		
	Pruning		
	No pruning	2G cutting	3G cutting
Nitrogen Levels			
100 kg ha^{-1}	3.41^{e}	5.41^{bc}	5.16^{bc}
150 kg ha^{-1}	3.83^{de}	4.58^{cd}	5.91^{b}
200 kg ha^{-1}	4.75^{c}	5.25^{bc}	7.25^{a}
LSD (0.05)		0.79*	
CV (%)		8.83	
SEM (±)		0.34	

Means accompanied by the same letter(s) within a column are not statistically different at 5% by DMRT, CV (Coefficient of variation), SEM (±) (Standard error of mean difference), LSD (Least significant difference), * significant at 5% (P<0.05), ** significant at 1% (P<0.01), *** significant at 0.1% (P<0.001), NS (Non-significant)

Table 8 : Number of fruits per plant of grafted bitter gourd at first, second, third, and fourth harvest as influenced by pruning and nitrogen levels at Danda, Nawalparasi East, Nepal, 2022

Treatment	Number of fruits/plant			
	First Harvest	Second Harvest	Third Harvest	Fourth Harvest
Pruning				
No pruning	0.94	2.19	3.25	4.00^{c}
2G cutting	1.16	2.25	3.43	5.08^{b}
3G Cutting	1.41	2.26	3.98	6.11^{a}
SEM1 (±)	0.14	0.02	0.21	0.60
LSD (0.05)	0.58	0.29	0.72	0.41
CV (a)%	37.7	9.9	15.6	6.2
F-test	NS	NS	NS	***
Nitrogen Levels				
100 kg ha^{-1}	1.08	2.16	3.08^{b}	4.66^{b}
150 kg ha^{-1}	1.25	2.16	3.54^{ab}	4.77^{b}
200 kg ha^{-1}	1.19	2.37	4.03^{a}	5.75^{a}
SEM2 (±)	0.05	0.07	0.27	0.34
LSD (0.05)	0.39	0.30	0.51	0.45
CV (b)%	32.3	13.1	14	8.8
F-test	NS	NS	**	***
Interaction				
F-test	NS	NS	NS	*
Grand Mean	1.18	2.24	3.55	5.06

*Means accompanied by the same letter(s) within a column are not statistically different at 5% by DMRT, CV (Coefficient of variation), SEM (±) (Standard error of mean difference), LSD (Least significant difference), * significant at 5% (P<0.05), ** significant at 1% (P<0.01), *** significant at 0.1% (P<0.001), NS (Non-significant)*

of 150 kg ha^{-1} (3.54) was statistically at par with the nitrogen dose of 200 kg ha^{-1} (5.75). According to Midan et al. (1985) with the increase in nitrogen levels, the number of fruits per plant also increases. Jan et al. (2019) observed that the highest number of fruits per vine was obtained in the plots fertilized with the highest nitrogen dose of 150 kg ha^{-1}, while the lowest number of fruits per vine was observed in control plots.

Yield

The result showed that there was a significant effect of the interaction between pruning and nitrogen level on yield at first, second, and third harvesting (Table 9). The average yield at the first, second, third, and fourth harvests were 514.90 kg ha^{-1}, 652.31 kg ha^{-1}, 5508.42 kg ha^{-1}, and 12069.94 kg ha^{-1} respectively (Table 9). Yield (kg ha^{-1}) was significantly influenced by pruning at the second, third, and fourth harvests, and by nitrogen levels at all first, second, third, and fourth harvests. At the second harvest, the yield was recorded as the highest in 3G cutting (780.88 kg ha^{-1}). This yield of 3G cutting (780.88 kg ha^{-1}) at the second harvest was statistically at par with 2G cutting (664.19 kg ha^{-1}). The yield was maximum on 3G cutting at the third (6623.04 kg ha^{-1}) and fourth (13888.35 kg ha^{-1}) harvest and minimum on no pruning at the third (4498.24 kg ha^{-1}) and fourth (10031.27 kg ha^{-1}) harvest. The yield was maximum on 200 kg ha^{-1} at first (629.71 kg ha^{-1}), second (769.58 kg ha^{-1}), third (6355.28 kg ha^{-1}) and fourth (13854.81 kg ha^{-1}) harvest. The minimum yield was recorded in 100 kg ha^{-1} nitrogen levels at the third (4676.94 kg ha^{-1}) and fourth (10239.67 kg ha^{-1}) harvest. Islam et al. (1997) discovered a similar outcome, indicating that fruit production rises as nitrogen levels increase until they reach a peak. Nasreen et al. (2013) found that the use of nitrogen up to 120 kg ha^{-1} led to an 86% increase in bitter gourd yield in 2010 and a 54% increase in 2011. Jan et al. (2019)

Table 9 : Yield (kg ha-1) at first, second, third, and fourth harvest (kg ha-1) of grafted bitter gourd as influenced by pruning and nitrogen levels at Danda, Nawalparasi East, Nepal, 2022

Treatment	Yield (kg ha^{-1})			
	First Harvest	Second Harvest	Third Harvest	Fourth Harvest
Pruning				
No pruning	458.13	511.87^{b}	4498.24^{c}	10031.27^{c}
2G cutting	472.98	664.19^{ab}	5404.00^{b}	12290.19^{b}
3G Cutting	613.59	780.88^{a}	6623.04^{a}	13888.35^{a}
SEM1 (±)	49.53	77.88	615.58	1118.87
LSD (0.05)	141.56	170.34	738.41	1357.02
CV (a)%	21	20	10.2	8.6
F-test	NS	*	**	**
Nitrogen Levels				
100 kg ha^{-1}	434.58^{b}	548.63^{b}	4676.94^{c}	10239.67^{c}
150 kg ha^{-1}	480.40^{b}	638.73^{b}	5493.03^{b}	12115.33^{b}
200 kg ha^{-1}	629.71^{a}	769.58^{a}	6355.28^{a}	13854.81^{a}
SEM2 (±)	58.90	64.14	484.55	1043.84
LSD (0.05)	142.78	102.24	350.11	591.81
CV (b)%	27	15.3	6.2	4.8
F-test	*	**	***	***
Interaction				
F-test	NS	NS	NS	*
Grand Mean	514.90	652.31	5508.42	12069.94

*Means accompanied by the same letter(s) within a column are not statistically different at 5% by DMRT, CV (Coefficient of variation), SEM (±) (Standard error of mean difference), LSD (Least significant difference), * significant at 5% (P<0.05), ** significant at 1% (P<0.01), *** significant at 0.1% (P<0.001), NS (Non-significant)*

observed that plots receiving the highest nitrogen dose achieved the highest yield at 14748 kg ha^{-1}, whereas the control plots had the lowest fruit yield at 3113 kg ha^{-1}. This increase in fruit production and weight in response to higher fertigation levels can be attributed to enhanced photosynthetic activities, increased protein synthesis, and improved photosynthate translocation, as indicated by Maragal et al. (2018).

Yield during fourth harvest (kg ha^{-1})

A significant influence of the interaction of pruning and nitrogen doses was seen in the fruit yield at the fourth harvest (Table 10). Interaction between 3G cutting and 200 kg ha-1 of nitrogen recorded the maximum yield (16242.56 kg ha^{-1}) whereas the interaction between no pruning and 100 kg ha-1 of nitrogen gave the minimum yield (8371.73 kg ha^{-1}). The observation of Nodi (2012) stated that the maximum yield (52.7 t ha^{-1}) resulted from the interaction of 161 kg ha^{-1} of nitrogen and double stem pruning whereas the minimum yield (32.2 t ha-1) was recorded from the treatment combination of no nitrogen and no stem pruning.

Table 10 : Yield (kg ha-1) of bitter gourd at fourth harvest as influenced by interaction between pruning and nitrogen levels

Treatments	Yield at fourth harvest (kg ha^{-1})		
	Pruning		
	No pruning	2G pruning	3G pruning
Nitrogen Levels			
100 kg ha^{-1}	8371.73^{e}	11085.61^{cd}	11261.66^{c}
150 kg ha^{-1}	10106.72^{d}	12078.44^{c}	14160.81^{b}
200 kg ha^{-1}	11615.35^{c}	13706.51^{b}	16242.56^{a}
LSD (0.05)		1025.04*	
CV (%)		4.8	
SEM (±)		1043.85	

*Means accompanied by the same letter(s) within a column are not statistically different at 5% by DMRT, CV (Coefficient of variation), SEM (±) (Standard error of mean difference), LSD (Least significant difference), * significant at 5% (P<0.05), ** significant at 1% (P<0.01), *** significant at 0.1% (P<0.001), NS (Non-significant)*

Conclusion:

The field research concluded that the yield of bitter gourd was higher at 200 kg ha^{-1} nitrogen level. Similarly, 3G cutting resulted in a higher yield compared to no pruning and 2G cutting. Significant result was seen in the interaction between pruning and nitrogen levels during the fourth harvest where the interaction between 200 kg ha^{-1} nitrogen level and 3G cutting gave the maximum yield and the interaction between 100 kg ha^{-1} nitrogen level and no pruning resulted in the minimum yield.

Declaration of conflict of interest and ethical approval:

R. Kandel was involved in designing the experiment, performing all the field work, data recording, data analysis and writing the manuscript. S. K. Sah was involved in designing the experiment and writing the manuscript along with direct supervision throughout the process. The authors declare no competing interest related to the manuscript.

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