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Nutrients and Leaf Plucking Effect on Growth and Yield of Cabbage

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Authors' contributions

This work was carried out in collaboration between all authors. Authors TM and KK planned the experiment and lead the research. Authors TM, KK and AP designed and carried out the research. Authors MEH and MA performed the statistical analysis. Author AP carried out the research on field. Authors AP, FA and SA collected the data. Authors AP, MA and MEH wrote the manuscript. Authors AP, FA and SA managed the literature searches. All authors provided critical feedback and helped in shape the research, analysis and manuscript. All authors read and approved the final manuscript.

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ABSTRACT

The experiment was carried out at the Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka during September 2016 to December 2016 to find out the growth, yield and economic benefit of cabbage as influenced by nutrients and leaf plucking. The research comprises of two factors: Factor A: NPK nutrients (four levels) as- N_0 = control, N_1 = $N_{120}P_{30}K_{100}$kg ha^{-1}, N_2 = $N_{140}P_{40}K_{120}$kg ha^{-1}, N_3 = $N_{160}P_{50}K_{140}$kg ha^{-1}and Factor B: leaf plucking (three levels) as- L_0 = No leaf plucked, L_1 = 4-leaves plucked and L_2 = 6-leaves plucked. The experiment was set up in randomized complete block design (RCBD) with three replications. In case of nutrients, the highest gross yield (90.53 t ha^{-1}) and marketable yield (68.95 t ha^{-1}) were obtained from N_3, while the lowest gross yield (60.26 t ha^{-1}) and marketable yield (44.24 t ha^{-1}) from N_0. For dissimilar levels of leaf plucking, the highest gross yield (80.64 t ha^{-1}) and marketable yield (62.08 t ha^{-1}) were

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recorded from L_1, whereas the lowest gross yield (74.13 t ha^{-1}) and marketable yield (56.96 t ha^{-1}) from L_0. Due to combined effect, the highest gross yield (94.38 t ha^{-1}) and marketable yield (71.91 t ha^{-1}) were recorded from N_3L_1, whereas the lowest gross yield (58.75 t ha^{-1}) and marketable yield (41.15 t ha^{-1}) from N_0L_0. From the economic point of view, the highest benefit cost ratio (BCR) was2.35 noted from N_3L_1 and the lowest (1.63) from N_0L_0. It is evident that the N_3L_1 gave the best performance for the growth, yield and economic benefit of cabbage. So, $N_{140}\,P_{50}\,K_{120}$kg ha^{-1} with 4-leaves plucked may be considered as an optimum dose for cabbage production.

Keywords: Benefit Cost Ratio (BCR); cabbage; leaf plucking; NPK nutrients; yield.

1. INTRODUCTION

Cabbage (*Brassica oleracea* var. *capitata* L.) is one of the most significant and nutritious winter leafy vegetables which belongs to the family Cruciferae. It is a biennial crop that is grown as an annual, unless it is grown for seed production [1,2]. It can grow simply under wide range of environmental condition in all temperate, tropical and sub-tropical regions, but cool moist climate is most suitable [3]. The origin of cabbage is the Western Europe and North shores of the Mediterranean Sea [4]. The edible portion of cabbage plant is head which is formed by the fleshy leaves overlapping one another. It has been reported that 100 g of green edible portion of cabbage contains 92% water, 24 kilocalories of food energy, 1.5 g of protein, 4.8 g of carbohydrate, 40 mg of calcium, 0.6 mg of iron, 600 IU of carotene, 0.05 mg of riboflavin, 0.3 mg of niacin and 60 mg of vitamin C [5]. It has been documented as a very necessary vegetable to the farmers in providing income and nutrition worldwide [6]. Cultivation of cabbage is mainly done in winter season in Bangladesh. It is cultivated in 16.6 thousand hectares with a production of 220 thousand metric tons and the average yield is about 9 t ha^{-1} [7]. Now, India is the second largest manufacturer of cabbage in the world, next to China, accounting for 16.55 per cent of the world area and 12.79 per cent of the world production [8]. Cabbage can play a critical role in elevating the nutritional status of Bangladesh, as it is rich in vitamins and minerals such as ascorbic acid, contains appreciable quantities of thiamin, riboflavin, calcium and iron [9]. Among the vegetables, it covers about 5% production under vegetable crops in Bangladesh [10]. However, low yield in Bangladesh may be attributed to a number of reasons viz. lack of quality seeds, nutrients unavailability, disease and insect infestation, improper or limited irrigation facilities etc.

The demand of cabbage as leafy vegetable is plentiful but the productivity of cabbage per unit area is quite low in Bangladesh due to excessive use of nutrients. Use of imbalanced nutrients in the soils may be harmful and causing our agricultural soil degraded and unproductive [11]. Nutrients may be applied through two sources viz., organic and inorganic sources. It enhances plant growth by providing amendments to the soil via various nutrients ultimately obtaining higher yield of cabbage. It is compulsory to ensure availability of crucial nutrient components for getting higher production and quality yield in any crop [12]. Nitrogen, phosphorus and potassium have profound effect on crop productivity and quality. Nitrogen is an essential plant nutrient, which is involved in physiological processes and enzyme activity [13,14]. It plays a significant role in the building up of protoplasm and protein which induce cell division and initiate meristematic activities of plant when applied in optimum quantity. On the other hand, shortage of nitrogen during early growth may lead to the condition known as “buttoning” in Chinese cabbage when plant becomes stunted with reduce leaf development [15]. Phosphorus is concerned in energy transfer and nutrient movement within the plant. Adequate availability of phosphorus stimulates root development, increases stalk and stem strength and improves flower formation, fruiting and seed production. It also enhances uniform and early crop maturity, increases the nitrogen fixing ability of legumes, improves crop quality and increases resistance to plant diseases [16,17,18]. Potassium also increases better yield and improves quality during translocation of carbohydrate within crops. It exerts balancing role on the effects of both nitrogen and phosphorus, consequently it is especially important in multi-nutrient fertilizer application [19].

Leaf plucking in cabbage is an important factor for higher growth and yield of cabbage production. It means the removal of unfolded leaves or basal leaves without affecting the source-sink balance for proper head development. It is recommended that the

successful cabbage production is possible by the application of basal 4-leaves plucking [20]. The plucked leaves may be positive either as vegetables or fodder as increased total biomass production. As cabbage heading begins, leaves become broader and sessile, and more erect in their posture [21]. After the formation and development of cabbage heads, the basal leaves are occasionally harbor of pathogen and insect which is normally induced decay before the time of harvest. Older or unfolded leaves are also competitive in nutrients requirement with younger leaves in cabbage head. Those impacts on slowly head development and maturation or sometimes cabbage head also indiscriminately infested with insect or fungal infection. The assemblage of layers of leaves over the growing point requires the maintenance of a short stem during the heading period [22]. But the possibility of leaf plucking of cabbage has not been explored earlier in Bangladesh. The present exploration was undertaken to evaluate the performance of nutrients and leaf plucking on growth, yield and economic return of cabbage.

2. MATERIALS AND METHODS

2.1 Experimental Site

The experiment was conducted at the Horticulture Research Farm of Sher-e-Bangla Agricultural University (SAU), Dhaka, Bangladesh during September 2016 to December 2016. Experimental site situated an elevation of 8 meters above the sea level in Agro-ecological zone of "Madhupur Tract" (AEZ-28) [23]. The soil was sandy loam and medium high land in texture having pH 5.46-5.62.

2.2 Experiment Frame Work

The research was consisted of two factors: Factor A: NPK nutrients (four levels) as- N_0 = control, N_1 = N_{120} P_{30} K_{100} kg ha^{-1}, N_2 = N_{140} P_{40} K_{120} kg ha^{-1}, N_3 = N_{160} P_{50} K_{140} kg ha^{-1} and Factor B: leaf plucking (three levels) as- L_0 = No leaf plucked, L_1 = 4-leaves plucked and L_2 = 6-leaves plucked. The two factors experiment was laid out following Randomized Complete Block Design (RCBD) with three replications. The experiment was divided into three equal blocks where each block was divided into 12 plots. Then 12 treatment combinations were allotted at randomly in each block. The size of the each unit plot was 1.8 m × 1.6 m. The distance maintained between two blocks and two plots were 0.5 m and 0.5 m, respectively. The seedlings were transplanted with maintaining distance row to row 60 cm and plant to plant 40 cm.

2.3 Application of manure and ferti+lizers

About 10 t ha^{-1} well decomposed cow dung was applied only control (as No treatment) plot and incorporated adequately to the soil during final land preparation whereas others plot were applied with inorganic fertiliser as per treatment. Doses of inorganic fertilisers (Urea, Triple super phosphate and Muriate of potash) were applied in the experimental plot according to the treatments (Table 1). The whole amount of TSP and half amount of MoP were also applied as basal dose before seedlings transplanting in the main field. 1st top dressing of urea was applied when seedlings established in the main field about 10days after seedling transplanting. 2nd top dressing of urea and rest amount of MoP was applied about 25days after 1st top dressing. Then rest amount of urea was applied as 3rdinstallment about 40 days after transplanting. Each top dressing was followed by manual irrigation.

2.4 Application of Leaf Plucking

Leaf plucking was stunted only when the head grew 12-15cm in diameter. Initially, two bottom leaves were plucked normally which was followed by further leaf plucking as per treatment. Older and unfolded leaves were plucked at

Table 1. Doses of nutrients application in the main field as per treatment

Treatments	Available nutrients (kg ha^{-1})			Fertilizers (kg ha^{-1})			Doses (g $plot^{-1}$)		
	N	P	K	Urea	TSP	MoP	Urea	TSP	MoP
N_1	120	30	100	260.87	150	200	75.13	43.2	57.6
N_2	140	40	120	304.35	200	240	87.65	57.6	70.0
N_3	160	50	140	347.83	250	280	100.00	72.0	80.6

30DAT and 40DAT as per treatment of leaf plucking. The plucked leaves may be useful either as vegetables or fodder as increased total biomass production.

2.5 Cost analysis of Cabbage Production

The cost of production was analysed in order to find out the most economic treatment in respect of NPK nutrients as chemical fertilisers and labour requirement for leaf plucking. All input cost, cost of land and running capital were considered for computing cost of production. The cost and return analysis was done in details according to the procedure of Alam et al. [12]. The benefit cost ratio (BCR) was calculated as follows:

BCR = Gross return per hectare (Tk.) ÷ Cost of production per hectare (Tk.)

2.6 Statistical Analysis

The data obtained for different parameters were statistically analysed by MSTAT-C computer package. The significance of the difference among the treatment combinations means was compared by LSD testat 5% level of probability.

3. RESULTS AND DISCUSSION

3.1 Plant Height (cm)

Considerable variation was found among the different levels of nutrients in respect of plant height of cabbage (Table 2). At 40 DAT and 50 DAT, the tallest plant (34.42cm and 39.86cm, respectively) was recorded from N_3 while the shortest plant (25.76cm and 30.48cm, respectively) from N_0. At harvest, the tallest plant (45.68cm) was observed in N_3 while the shortest plant (34.95cm) was in N_0. Tekasangla et al. [24], Mankar et al. [25], Kumar et al. [26] and Farooque and Mondal [27] also noticed the related findings of the present study. At 50 DAT, the tallest plant (37.79cm) was observed in L_2 while the shortest plant (33.20cm) was in L_0 (Table 3). At harvest, the tallest plant (43.50cm) was in L_2 while the shortest plant (37.06cm) was in L_0 (Table 3).

The interaction between nutrients and leaf plucking treatments affects significantly on plant height (Table 4). At 40 DAT, the tallest plant (34.67cm) was obtained from N_3L_2 which was statistically identical to N_3L_1 while the shortest plant (25.53cm) was in N_0L_0. At 50 DAT, the tallest plant (41.70cm) was observed in N_3L_2 while the shortest plant (27.90cm) was in N_0L_0. At harvest, the tallest plant (48.47cm) was obtained from N_3L_2 whereas the shortest plant (31.60 cm) was in N_0L_0.

3.2 Number of Loose Leaves Plant^{-1}

At 40, 50 DAT, the maximum number of loose leaves plant^{-1} (11.87 and 14.00, respectively) was recorded from N_3 while the lowest (9.20 and 11.20 respectively) was in N_0 (Table 2). At harvest, the maximum (15.74) was recorded from N_3 while the minimum (12.68) was in N_0. At 40 DAT and 50 DAT, the maximum (11.16 and 13.26, respectively) was observed in L_1 while the minimum (10.05 and 11.93) was in L_0 (Table 3). At harvest, the maximum (14.93) was recorded from L_1 while the minimum (13.48) was in L_0.

Different levels of nutrients and leaf plucking showed significant differences due to their interaction effect on the number of loose leaves per plant of cabbage at 40, 50 DAT and at harvest. At 40 DAT, the maximum (12.36) was recorded from N_3L_1 while the minimum (8.76) was in N_0L_0 (Table 4). At 50 DAT, the maximum (14.93) was counted in N_3L_1 whereas the minimum (10.43) was in N_0L_0. At harvest, the maximum (17.03) was obtained from N_3L_1 while the minimum (12.07) was in N_0L_0.

3.3 Days Required to Head Maturity

The maximum days required to head maturity (65.29) was obtained from N_3 while the minimum (60.32) was in N_0 at harvest (Table 2). Different levels of leaf plucking showed a significant variation on days required to head maturity. The maximum days required to head maturity (63.50) was observed in L_1 while the minimum (61.92cm) was in L_0 at harvest (Table 3). The combined effect of nutrients and leaf plucking gives the maximum (66.40) days required to head maturity was recorded from N_3L_2 which was statistically similar to N_3L_1, while N_0L_0 showed the minimum (59.25) days required to head maturity (Table 4).

3.4 Diameter of Stem (cm)

The maximum diameter of stem of cabbage (3.57cm) was observed in N_3 while the minimum (2.56cm) was in N_0 (Table 5). Different levels of leaf plucking showed significant influence on diameter of stem of cabbage. The maximum (3.47cm) was observed in L_1 whereasthe minimum (2.93cm) was in L_0 (Table 6). The combined effect of nutrients and leaf plucking

showed a significant effect on diameter of stem of cabbage. The maximum diameter of stem (3.86cm) was recorded from N_3L_1 while N_0L_0 gave the minimum (2.36cm) diameter of stem (Table 7).

3.5 Diameter of Head (cm)

The highest diameter of head (20.38cm) was recorded from N_3 while the lowest (16.60cm) was in N_0 (Table 5). Similar findings on diameter of head are reported by Hossain et al. [11], Mankar et al. [25] and Naher et al. [28]. The highest (19.05cm) was observed in L_1 whereas the lowest (18.13cm) was recorded from L_0 (Table 6). Combined effect of different levels of nutrients and leaf plucking showed significant effect on diameter of head of cabbage (Table 7). The highest diameter of head (20.93cm) was observed in N_3L_1while the lowest (15.98cm) was in N_0L_0.

3.6 Head Height (cm)

The maximum head height of cabbage (14.17cm) was obtained from N_3 while the minimum (10.65cm) was recorded in N_0 (Table 5). Hossain et al. [11] and Singh et al. [29] reported that the similar views on head height of cabbage of the present experiment. The maximum (13.05cm) was observed in L_1 while the minimum (11.96cm) was found in L_0 (Table 6). Combined effect of nutrients and leaf plucking showed significant effect on head height of cabbage (Table 7). The maximum (14.73cm) was recorded from N_3L_1 which was statistically similar to N_3L_2 (14.40cm), while N_0L_0 gave the minimum (10.16cm).

3.7 Head Weight (kg)

The highest head weight of cabbage (1.92 kg) was recorded from N_3 whereas the lowest (1.20 kg) was in N_0 (Table 5). Similar findings of head weight were observed with Mankar et al. [25]. The results under the present experiment were also fairly supported by Hasan and Solaiman [30]. The highest (1.68 kg) was observed in L_1 while the lowest (1.44 kg) was in L_0 (Table 6). The findings obtained from the experiment were partially conformed to Begum [20]. Due to combined effect of different levels of nutrients and leaf plucking, N_3L_1 produced the highest head weight (2.08 kg) which was statistically similar to N_3L_1 while the lowest (1.09 kg) was in N_0L_0 (Table 7).

Table 2. Effect of nutrients on growth parameters at different growth stages of cabbage

Treatments	Plant height (cm)			Number of loose leaves			Days required for head maturity
	40 DAT	50 DAT	At harvest	40 DAT	50 DAT	At harvest	
N_0	25.76	30.48	34.95	9.20	11.20	12.68	60.32
N_1	29.27	34.77	41.03	10.26	12.18	13.51	62.45
N_2	32.45	37.95	42.42	11.21	12.94	14.43	63.75
N_3	34.42	39.86	45.68	11.87	14.00	15.74	65.29
CV %	5.41	7.67	7.25	11.60	10.58	7.45	4.88
LSD (0.05)	1.91	1.87	2.82	0.64	0.83	0.69	1.47

Table 3. Effect of leaf plucking on growth parameters at different growth stages of cabbage

Treatments	Plant height (cm)			Number of loose leaves			Days required for head maturity
	40 DAT	50 DAT	At harvest	40 DAT	50 DAT	At harvest	
L0	30.38	33.20	37.06	10.05	11.93	13.48	61.92
L1	30.65	36.30	42.50	11.16	13.26	14.93	63.50
L2	30.40	37.79	43.50	10.68	12.55	13.85	63.43
CV %	5.41	7.67	7.25	11.68	10.58	7.45	4.88
LSD (0.05)	NS	2.11	2.44	0.55	0.59	0.60	1.22

Table 4. Combined effect of nutrients and leaf plucking on growth parameters at different stages of cabbage

Treatments	Plant height (cm)			Number of loose leaves			Days required for head maturity
	40 DAT	50 DAT	At harvest	40 DAT	50 DAT	At harvest	
N_0L_0	25.53	27.90	31.60	8.76	10.43	12.07	59.25
N_0L_1	25.96	30.73	35.86	9.76	11.86	13.30	60.91
N_0L_2	25.80	32.80	37.40	9.06	11.30	12.67	60.80
N_1L_0	28.80	31.97	36.73	9.86	11.80	13.03	61.96
N_1L_1	29.66	35.50	42.73	10.70	12.73	14.10	62.93
N_1L_2	29.33	36.86	43.63	10.20	12.03	13.40	62.47
N_2L_0	32.26	35.60	39.16	10.40	12.23	13.93	62.91
N_2L_1	32.56	38.46	43.56	11.83	13.53	15.30	64.25
N_2L_2	32.53	39.80	44.53	11.40	13.06	14.07	64.08
N_3L_0	34.20	37.36	40.76	11.16	13.26	14.90	63.57
N_3L_1	34.40	40.53	47.83	12.36	14.93	17.03	65.90
N_3L_2	34.67	41.70	48.47	12.06	13.80	15.30	66.40
CV %	5.41	7.67	7.25	11.68	10.58	7.45	4.88
LSD (0.05)	3.44	2.23	3.88	1.11	1.11	1.20	1.11

At 40 DAT **At 50 DAT**

Fig. 1. Plots after leaf plucking

Table 5. Effect of nutrients on growth and yield contributing parameters at harvest stage

Treatments	Diameter of stem (cm)	Head characteristics				
		Diameter of head (cm)	Head height (cm)	Head weight (kg)	Head thickness (cm)	%Dry matter
N_0	2.56	16.60	10.65	1.20	7.30	6.33
N_1	3.17	18.24	12.26	1.46	9.34	6.76
N_2	3.42	19.47	13.40	1.69	10.35	7.33
N_3	3.57	20.38	14.17	1.92	10.75	8.02
CV %	8.13	9.56	5.39	6.31	8.87	10.93
LSD (0.05)	0.19	0.19	0.32	0.151	0.39	0.37

Table 6. Effect of leaf plucking on growth and yield contributing parameters at harvest stage

Treatments	Diameter of stem (cm)	Head characteristics				
		Diameter of head (cm)	Head height (cm)	Head weight (kg)	Head thickness (cm)	%Dry matter
L_0	2.93	18.13	11.96	1.44	8.60	6.86
L_1	3.47	19.05	13.05	1.68	9.89	7.28
L_2	3.13	18.85	12.85	1.58	9.80	7.19
CV %	8.13	9.56	5.39	6.31	8.87	10.93
LSD (0.05)	0.16	0.17	0.28	0.081	0.34	0.32

Table 7. Combined effect of nutrients and leaf plucking on growth and yield contributing parameters at harvest of cabbage

Treatments	Diameter of stem (cm)	Head characteristics				
		Diameter of head (cm)	Head height (cm)	Head weight (kg)	Head thickness (cm)	%Dry matter
N_0L_0	2.36	15.98	10.16	1.09	6.80	6.13
N_0L_1	2.80	16.91	10.96	1.26	7.63	6.53
N_0L_2	2.50	16.92	10.83	1.24	7.46	6.33
N_1L_0	2.96	17.63	11.73	1.32	8.43	6.43
N_1L_1	3.40	18.59	12.86	1.56	9.83b	6.97
N_1L_2	3.13	18.52	12.20	1.49	9.76b	6.90
N_2L_0	3.06	18.94	12.56	1.56	9.23	7.00
N_2L_1	3.80	19.77	13.66	1.80	10.96	7.53
N_2L_2	3.40	19.72	13.96	1.71	10.86	7.47
N_3L_0	3.33	19.96b	13.40	1.09	9.96	7.90
N_3L_1	3.86	20.93	14.73	2.08	11.15	8.10
N_3L_2	3.50	20.25	14.40	1.89	11.13	8.06
CV %	8.13	9.56	5.39	6.31	8.87	10.93
LSD (0.05)	0.33	0.34	0.56	0.138	0.69	0.69

3.8 Head Thickness (cm)

The highest head thickness (10.75cm) was found from N_3 while the lowest (7.30cm) Naher et al. [28] suggested that the similar results on head thickness of the present study (Table 5). The highest head thickness (9.89cm) was attained from L_1 whereas the lowest (8.60cm) was in L_0 (Table 6). Interaction effect of different levels of nutrients and leaf plucking showed significant differences on thickness of head of cabbage. The highest head thickness (11.15cm) was recorded from N_3L_1 which was statistically identical to N_3L_2 (11.13cm) while the lowest (6.80 cm) was found from N_0L_0 (Table 7).

3.9 Dry Matter Content of Head (%)

The maximum dry matter content (8.02%) was observed from N_3 while the minimum (6.33 %) was in N_0 (Table 5). The maximum dry matter content (7.28 %) was observed in L_1 which was statistically similar to L_2 (7.19 %) whereas the minimum (6.86 %) was found from L_0 (Table 6). Combined effect of nutrients and leaf plucking showed significant effect on % dry matter content of head. The maximum dry matter content (8.10 %) was recorded from N_3L_1 which was statistically identical to N_3L_2 (8.10 %) while the minimum (6.13 %) was in N_0L_0 (Table 7).

3.10 Weight of Whole Plant (kg)

Different levels of nutrients showed significant effect on weight of whole plant of cabbage under the present study (Table 8). The highest (2.46 kg) was obtained from N_3 while the lowest (1.39 kg) was in N_0. This result of the present study was partially supported by Mankar et al. [25] and Bojokalfa et al. [31]. The highest (2.09 kg) was recorded from L_1 whereas the lowest (1.88 kg) was in L_0 (Table 9). Combined effect of different levels of nutrients and leaf plucking showed significant variation on weight of whole plant of cabbage (Table 10). The highest (2.60 kg) was observed from N_3L_1 which was statistically similar to N_3L_2 while the lowest (1.30 kg) was in N_0L_0.

3.11 Gross Yield (t ha^{-1})

The highest gross yield (90.53 t ha^{-1}) was obtained from N_3 while the lowest (60.26 t ha^{-1}) was in N_0 (Table 8). Jothi et al. [32] and Rahman [33] stated same views of the present study. It is evident that the highest gross yield (80.64 t ha^{-1}) was observed in L_1 while the lowest (74.13 t ha^{-1}) was in L_0 (Table 9). Begum [20] observed that 4-leaves plucking of cabbage was performed the

Table 8. Effect of nutrients on yield parameters at harvest stage of cabbage

Treatments	Weight of whole plant (kg plant^{-1})	Gross yield (t ha^{-1})	Marketable yield (t ha^{-1})	Economic production (kg plant^{-1})
N_0	1.39	60.26	44.24	1.34
N_1	1.91	75.66	60.79	1.52
N_2	2.20	83.07	64.35	1.74
N_3	2.46	90.53	68.95	1.90
CV %	9.34	9.63	10.27	11.43
LSD (0.05)	0.141	3.56	3.79	0.116

Table 9. Effect of leaf plucking on yield parameters at harvest stage of cabbage

Treatments	Weight of whole plant (kg plant^{-1})	Gross yield (t ha^{-1})	Marketable yield (t ha^{-1})	Economic production (kg plant^{-1})
L_0	1.88c	74.13 c	56.96c	1.53c
L_1	2.09a	80.64 a	62.08a	1.72a
L_2	2.01b	77.36 b	59.71b	1.62b
CV %	9.34	9.63	10.27	11.43
LSD (0.05)	0.072	3.08	2.18	0.082

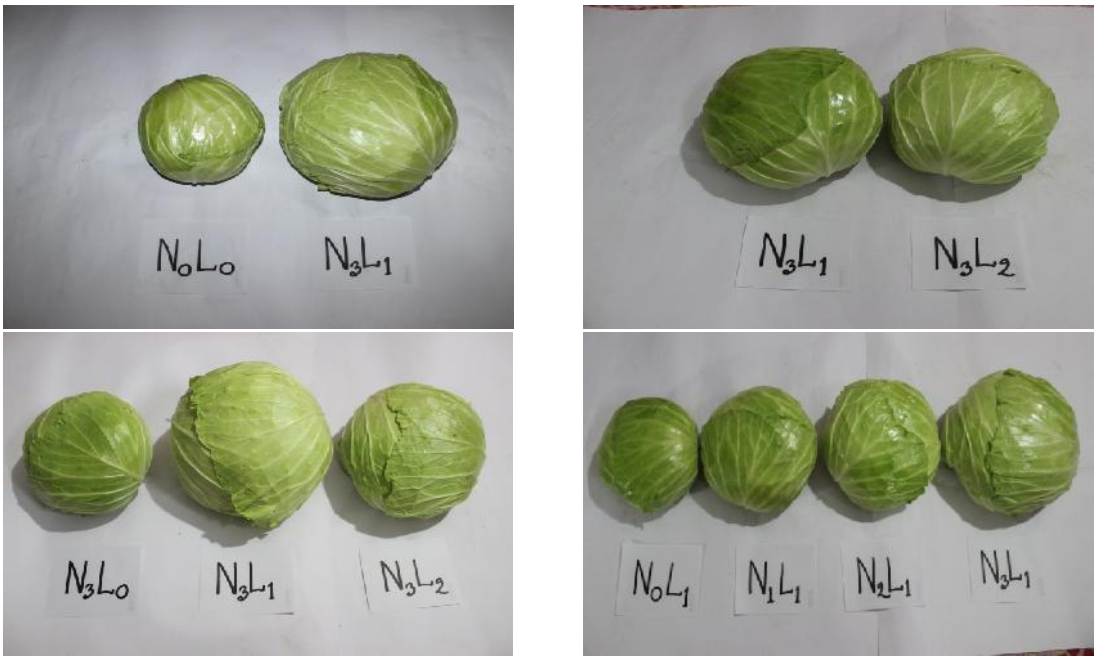

Fig. 2. Some pictures of cabbage head as per treatment at harvest

Table 10. Combined effect of nutrients and leaf plucking on yield parameters at harvest stage

Treatments	Weight of whole plant (kg plant^{-1})	Gross yield (t ha^{-1})	Marketable yield (t ha^{-1})	Economic production (kg plant^{-1})
N_0L_0	1.30	58.75	41.15	1.25
N_0L_1	1.43	62.43	46.98	1.42
N_0L_2	1.44	60.07	44.58	1.35
N_1L_0	1.76	71.32	58.78	1.42
N_1L_1	2.02	79.44	63.06	1.63
N_1L_2	1.96	76.18	60.49	1.50
N_2L_0	2.08	79.27	62.33	1.66
N_2L_1	2.31	86.77	66.32	1.84
N_2L_2	2.21	83.16	64.76	1.73
N_3L_0	2.36	87.15	65.90	1.80
N_3L_1	2.60	94.38	71.91	2.00
N_3L_2	2.42	90.03	68.99	1.90
CV %	9.34	9.63	10.27	11.43
LSD (0.05)	0.049	6.16	6.57	0.038

highest gross yield which is similar to this result of the present study. Combined effect of nutrients and leaf plucking had significant effect on gross yield of cabbage. The highest gross yield (94.38 t ha^{-1}) was observed in N_3L_1 (94.38 t ha^{-1}) while the lowest (58.75 t ha^{-1}) was in N_0L_0 (Table10).

3.12 Marketable Yield (t ha^{-1})

The highest marketable yield (68.95 t ha^{-1}) was observed in N_3 while the lowest (44.24 t ha^{-1}) was in N_0 (Table 8). The results of the present study were partially supported by Singh [29]. The highest (62.08 t ha^{-1}) was obtained from L_1 while the lowest (56.96 t ha^{-1}) was in L_0 (Table 9). The highest (71.91 t ha^{-1}) was observed in N_3L_1 while the lowest (41.15 t ha^{-1}) was in N_0L_0 (Table 10).

3.13 Economic Production (kgplant^{-1})

The highest economic production (1.90 kg plant^{-1}) was recorded from N_3 whereas the lowest (1.34 kg plant^{-1}) was in N_0 (Table 8). The findings of the present study are partially supported with Sharma [34]. The highest economic production (1.72 kg plant^{-1}) was observed in L_1 whereas the lowest (1.53 kg plant^{-1}) was in L_0 (Table 9). The combined effect of different levels of nutrients & leaf plucking had a significant effect on economic production of cabbage. The highest economic production (2.00 kg plant^{-1}) was observed in N_3L_1 which was statistically similar to N_3L_2, while the lowest (1.25 kg plant^{-1}) was in N_0L_0 (Table 10).

4. CONCLUSION

Both crop yield and economic benefit of crop are important for the crop production. Leaf plucking represents higher yield in cabbage plant than without no leaf plucking According to the results of the present experiment, it may be concluded that efficient production of cabbage is increased by the application of nutrients and leaf plucking. Thus, the combined application of nutrients and leaf plucking may be helpful for higher and better qualitative cabbage production in considering crop productivity and economic return of cabbage. On the basis of benefit cost ratio, it may be suggested that N_{160} P_{50} K_{140}kg ha^{-1} nutrients with 4-leaves plucked gave maximum and profitable yield of the cabbage head.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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