EFFECT OF NITROGEN ON GROWTH AND YIELD OF KNOLKHOL VARIETIES IN CHITWAN

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ABSTRACT

A field experiment was conducted from October 2019 to January 2020 in Chitwan, laid out in completely randomized block design with fifteen combinations: two factors replicated thrice. Three different varieties of first factor were Nepa Ball, Early White Vienna and Local while five different doses of nitrogen of second factor were 100, 75, 50, 25 and 0 kg N ha^{-1}. Significant differences were observed in both varieties and doses of nitrogen with respect to plant height, number of leaves per plant, knob diameter, days to knob initiation and maturation, biological yield, economic yield and harvest index. Varieties and doses of nitrogen were found to interactively affect the knob diameter, days to knob initiation, maturation, yield parameters and BC ratio. Nepa Ball and 100 kg N ha^{-1} were found to be superior with respect to growth, yield, quality parameters and BC ratio. Significantly higher economic yield of 59.87 MT ha^{-1} and 69.85 MT ha^{-1} was obtained with Nepa Ball and 100 kg N ha^{-1} respectively. Knob initiated about 4 days earlier and matured 6 days earlier with Nepa Ball. At 100 kg N ha^{-1}, knob initiated 4-5 days earlier and matured 9 days earlier than control. Nepa Ball and Early White Vienna had higher BC ratio than Local while shelf life and BC ratio were significantly higher with 100 kg N ha^{-1} which was at par with 75 kg N ha^{-1}. The study concluded that Nepa Ball and 75 kg N ha^{-1} would be suitable for Knol Khol production in Chitwan.

Keywords: Doses, knob initiation, knob maturation, knob diameter, BC ratio

Introduction

Knol Khol (*Brassica oleracea* var. *gongylodes* L.) is a short-duration, annual, cool season crop belonging to the family Brassicaceae and is originated from the coastal countries of Mediterranean region (Bose & Som, 2001). Knol Khol is a minor vegetable and is less popular as compared to cabbage, cauliflower and brocolli in Nepal (AITC, 2078). The edible portion of the crop is the bulb like swollen portion of the stem called knob, which arises from thickening of the stem above the cotyledon (Arin, Salk, Deveci & Polat, 2003).

Nitrogen, being one of the most important nutrients for plant production, is a part of chlorophyll molecule, amino acid, proteins, nucleic acid and pigments. Nitrogen supply favors the carbohydrate-to-protein transformation and promotes protoplasm formation due to which plants become succulent (Islam Kabir, Shuvra, Islam & Hera, 2020). The addition of nitrogen enhances vegetative growth whereas plants become stunted with yellow leaves if nitrogen is deficient. The cost of inorganic fertilizers is very high and sometimes it is not available in the market. Consequently, the farmers fail to apply inorganic fertilizer judiciously to the crop field (Haque, Islam, Islam, Ullah & Sarkar, 2000). It is essential to determine the optimum doze of nitrogen application in order to produce maximum yield and optimize product quality (Bashyal, 2011). Various researches have been conducted regarding varietal performance by Chaudhari, Vadodaria, Patel & Patel (2015), Spaldon, Masoodi, Namgial, Angmo & Yangdol (2018) and many others in India and other countries. Similarly, researches regarding nitrogen fertilization through various methods has also been performed (Hange, Barkule, Lohakare, Thalkari, 2002). But, no such researches have been undergone in Nepalese context. This might be due to the minor vegetable tag provided for the Knolkhol. Considered as new vegetable, only two varieties are registered in Nepal (AITC, 2078). Thus, the research has been performed in an attempt to assess the optimum dose of nitrogen for the cultivation and selection of best variety in the context of Chitwan, Nepal.

Methods and Procedures

Climatic and soil conditions. A field experiment was conducted on Knol Khol varieties and doses of nitrogen from October 2019 to January 2020 at Vegetable farm of AFU, Rampur (of Chitwan district, Bagmati Province, geographical location between 27°38´5´´N to 84°20´45´´E, 9 km away from the East-West Mahendra Highway). The area is located in inner Terai region of Nepal and possesses the sub-tropical type of weather condition. The agrometeorological data during the cropping season was recorded from the meteorological station of National Maize Research Program (NMRP), Chitwan (Figure 1).

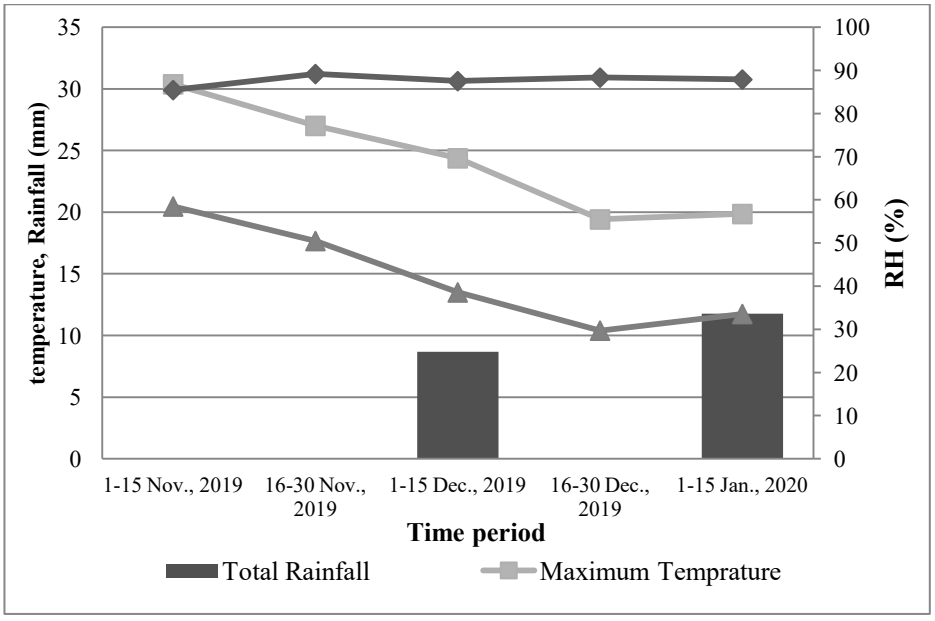

Figure 1. Agro-meteorological data of experimental site during the experimental period at Rampur, Chitwan, 2019/20 (Source: NMRP, 2020)

As per the soil analysis performed at Regional Soil Testing Laboratory of Department of Agriculture, Hetauda, Makawanpur, the soil of the experimental site was loamy type and slightly acidic with medium level of nutrients and organic matter as shown in table 1.

Table 1
Physico-chemical properties of soil at experimental field

Physico-chemical properties of soil	Content	Category	Methods
pH	6.13	Acidic	Digital pH meter
Available nitrogen (%)	0.11	Medium	Kjeldahl distillation (Bremmer, 1965)
Available phosphorus (kg ha^{-1})	61.72	High	Modified Olsen's (Watanabe & Olsen, 1965)
Available potassium (kg ha^{-1})	163.1	Medium	Ammonium acetate extraction method (Pratt, 965)
Organic matter (%)	2.14	Medium	Walkey and Black's Titration Method (Walkey and Black, 1934)
Soil texture		Loam	Hydrometer method (Day, 1965)

The experiment was conducted in Randomized Complete Block Design (RCBD) with two factors, Factor A being the Knol Khol varieties (Nepal Ball, Early White Vienna and Local) and Factor B being the doses of nitrogen (100, 75, 50, 25, 0 kg N ha^{-1}). The treatment combinations are shown in Table 2.

Table 2
Treatment Combinations of Knol khol varieties and doses of nitrogen used in the experiment.

Symbols	Treatment combinations	Symb.	Treatment combinations
$\mathbf{V_1N_1}$	Nepa Ball and 100 kg N ha^{-1}	V_2N_4	Early White Vienna and 25 kg N ha^{-1}
$\mathbf{V_1N_2}$	Nepa Ball and 75 kg N ha^{-1}	V_2N_5	Early White Vienna and 0 kg N ha^{-1}
$\mathbf{V_1N_3}$	Nepa Ball and 50 kg N ha^{-1}	V_3N_1	Knol Khol Local and 100 kg N ha^{-1}
$\mathbf{V_1N_4}$	Nepa Ball and 25 kg N ha^{-1}	V_3N_2	Knol Khol Local and 75 kg N ha^{-1}
$\mathbf{V_1N_5}$	Nepa Ball and 0 kg N ha^{-1}	V_3N_3	Knol Khol Local and 50 kg N ha^{-1}
$\mathbf{V_2N_1}$	Early White Vienna and 100 kg N ha^{-1}	V_3N_4	Knol Khol Local and 25 kg N ha^{-1}
$\mathbf{V_2N_2}$	Early White Vienna and 75 kg N ha^{-1}	V_3N_5	Knol Khol Local and 0 kg N ha^{-1}
$\mathbf{V_2N_3}$	Early White Vienna and 50 kg N ha^{-1}	V_2N_4	Early White Vienna and 25 kg N ha^{-1}

Seeds were sown on 23rd October, 2019 and transplanted 25 days after sowing. Planting of seedlings were done at spacing of 0.2m*0.2m. Organic manure, well rotten FYM was applied in the plot 15 days prior seed sowing at the rate of 20 MT ha^{-1} and fertilizers at dose of 30:30 kg PK ha^{-1}. One third dose of nitrogen, full dose of phosphorus and potassium were applied as basal dose and remaining dose of urea was applied twice in split doses at 30 and 40 days after transplanting. Urea as a source nitrogen was used at the rate of 0, 25, 50, 75 and 100 kg N ha^{-1} as per the treatment. The collected data was compiled by using the Microsoft Excel program and subjected to analysis of variance using GenStat Software package, 18th edition. Mean comparison was done by Duncan's Multiple Range Test (DMRT) at 5% level of significance.

Results

Plant Growth Parameters. The plant height, stem (knob) diameter, number of leaves per plant, average leaf length, average leaf breadth of Knol Khol significantly differed (at $p<0.05$) among the doses of nitrogen and varieties at 20 DAT, 30 DAT, 40 DAT and final harvest (Figure 2A). At 20, 30, 40 DAT and at harvest, significantly higher plant growth parameters were recorded with Early White Vienna respectively compared to other varieties. Similarly, Plant height of Knol Khol differed significantly at $p<0.05$ among different doses of nitrogen at 20, 30, 40 DAT and final harvest (Figure 2B). At 20, 30, 40 DAT and at final harvest, significantly higher plant height was recorded in 100 kg ha^{-1} nitrogen application. Plant height at 100 kg N ha^{-1} at final harvest was recorded statistically at par with 75 kg N ha^{-1}.The stem (knob) diameter was found to vary significantly at $p<0.05$ due to effect of varieties and doses of nitrogen. Among varieties significantly maximum knob diameter was recorded by Nepa Ball at 20 DAT (2.95 cm), 30 DAT (4.18 cm), 40 DAT (5.45 cm) and at harvest (7.14 cm) which statistically varied with Early White Vienna and Local.

Similarly, among the doses of nitrogen, significantly maximum knob diameter was observed in 100 kg ha^{-1} nitrogen at 20 DAT (2.60 cm), 30 DAT (3.94 cm), 40 DAT (5.35 cm) and final harvest (7.66 cm) which was statistically at par with 75 kg ha^{-1} nitrogen but varied significantly with lower doses of nitrogen.

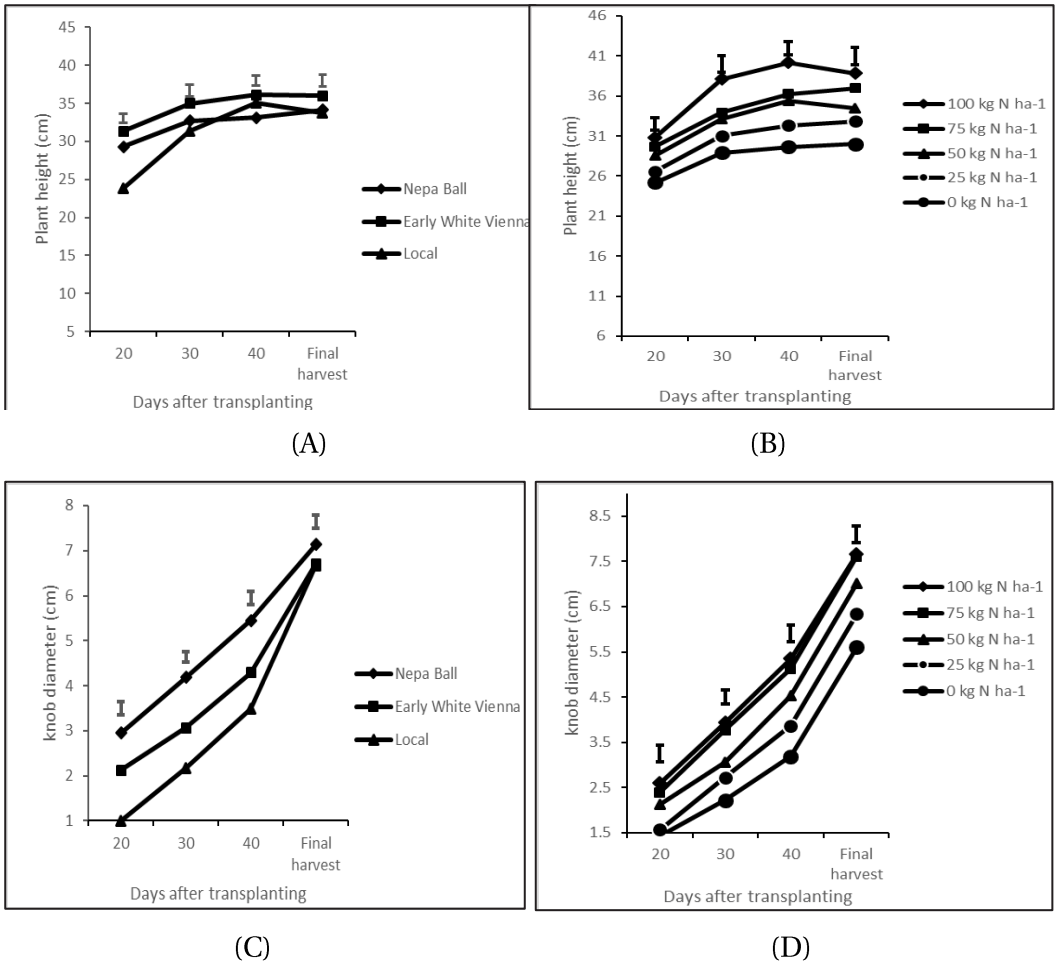

Figure 2: Graph showing the variation in vegetative characters of Knol Khol due to effect of varieties and doses of Nitrogen at different days of transplanting in Rampur, Chitwan 2019/20. (A) Effect of varieties on plant height (B) Effect of doses of nitrogen in plant height (C) Effect of varieties on knob diameter (D) Effect of doses of nitrogen on knob diameter (Bars in the graphs show the LSD values of treatments at different days of transplanting)

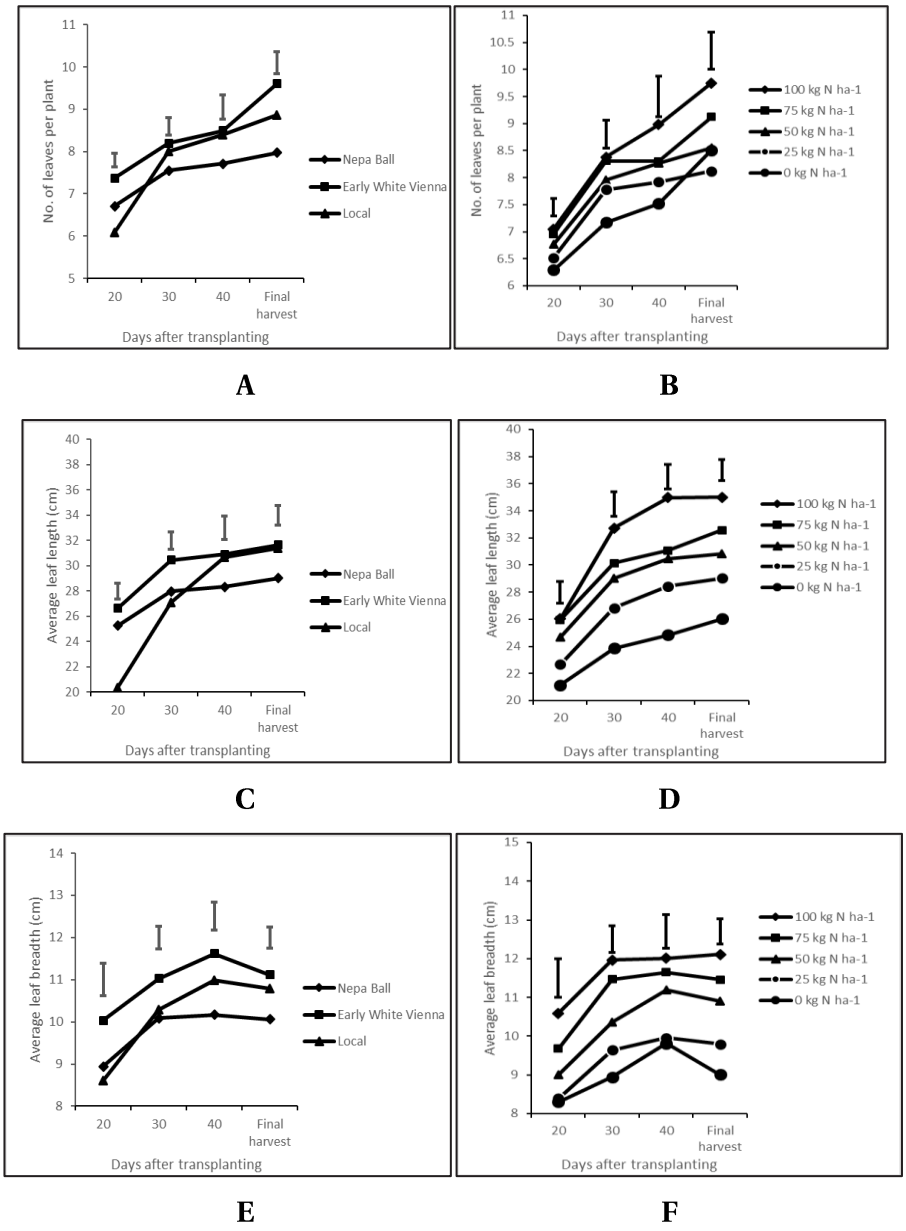

Figure 3: Graph showing the variation in leaf-related vegetative characters of Knol Khol due to effect of varieties and doses of Nitrogen at different days of transplanting in Rampur, Chitwan 2019/20. (A) Effect of varieties on no. of leaves per plant (B) Effect of doses of nitrogen in no. of leaves per plant (C.) Effect of varieties on average leaf length (D) Effect of doses of nitrogen on average leaf length (E)Effect of varieties on average leaf breadth (F) Effect of doses of nitrogen on average leaf breadth (Bars in the graphs show the LSD values of treatments at different days of transplanting)

Knob initiation and maturation

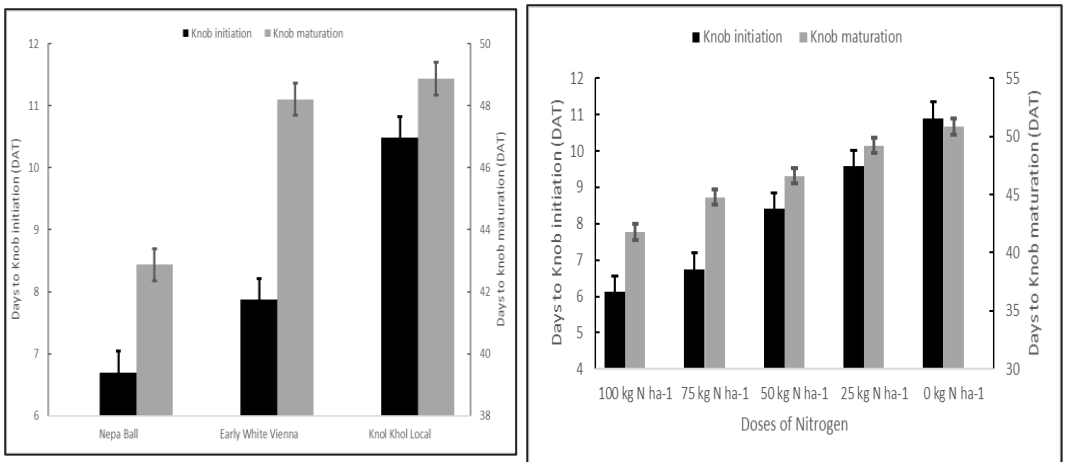

Figure 4: Graph showing effect of varieties (left) and doses of nitrogen (right) to days to Knob initiation and maturation of Knolkhol in Rampur, Chitwan, 2019/20

Varieties and doses of nitrogen were found to have significant impact on days to knob initiation and maturation at $p<0.05$. Among varieties, knob of Nepa Ball initiated significantly earlier i.e. at 6.70 DAT as well as matured significantly earlier i.e. 42.87 DAT, which was significantly different than other varieties. Similarly, among doses of nitrogen, in 100 kg ha^{-1} nitrogen, knob initiation was significantly earlier (6.12 DAT) compared to other doses of nitrogen but at par (6.75 DAT) with 75 kg ha^{-1} nitrogen. Knob maturation was significantly earlier (41.78 DAT) in 100 kg ha^{-1} nitrogen.

Yield. Yield of Knol Khol was significantly influenced by doses of nitrogen and variety (Table 2). Highest biological yield was found at Nepa Ball (59.87 MT ha^{-1}) which was at par with Early White Vienna but varied significantly ($p<0.05$) with Local. Similarly, significantly higher economic yield of 51.45 MT ha^{-1} was recorded by Nepa Ball.

Biological yield was found non-significant at treatment combination of varieties and doses of nitrogen. Economic yield and harvest index were found to be significantly affected by interaction effect of varieties and doses of nitrogen. Maximum economic yield was found in Nepa Ball with 75 kg ha^{-1} of nitrogen application and maximum harvest index was recorded in Nepa Ball with 25 kg ha^{-1} nitrogen application.

Table 2
Biological yield, economic yield and harvest index of Knol Khol as influenced by varieties and doses of nitrogen in Rampur, Chitwan, 2019/2020

Treatments	Yield (MT ha^{-1}) and harvest index (HI)		
	Biological yield	Economic yield	Harvest index
Variety (Factor A)			
Nepa Ball	59.87^{a}	51.45^{a}	0.86^{a}
Early White Vienna	58.76^{a}	47.71^{a}	0.81^{b}
Local	51.70^{b}	41.61^{b}	0.79^{b}
Grand mean	56.8	46.9	0.82
SEM (±)	2.16	1.78	0.007
$LSD_{0.05}$	6.26	5.16	0.02
CV (%)	14.7	14.7	3.6
Doses of nitrogen (Factor B)			
100 kg N ha^{-1}	68.85^{a}	56.39^{a}	0.81
75 kg N ha^{-1}	67.79^{a}	55.74^{a}	0.82
50 kg N ha^{-1}	55.86^{b}	46.96^{b}	0.84
25 kg N ha^{-1}	49.88^{b}	41.76^{b}	0.82
0 kg N ha^{-1}	41.51^{c}	33.75^{c}	0.79
Grand mean	56.8	46.9	0.82
SEM (±)	2.79	2.30	0.009
$LSD_{0.05}$	8.08*	6.66*	ns
CV (%)	14.7	14.7	3.6

Means with same letter in column are not significantly different at p = 0.05 by DMRT. *significant at 5% ($p < 0.05$), and ns: not significantly different at 5% ($p > 0.05$). SEM (±) = Standard error of mean, LSD = Least significant difference, CV = Coefficient of variation

Postharvest parameters. No significant difference was observed between varieties on physiological loss in weight (PLW) and shelf life. But significantly higher physiological loss in weight (PLW) was observed with 50 kg ha^{-1} nitrogen and significantly maximum shelf life of 8.55 days was observed with 100 kg ha^{-1}which was at par with that at 75 kg ha^{-1}.

Table 3
Postharvest parameters of Knol Khol as influenced by varieties and doses of nitrogen in Rampur, Chitwan, 2019/2020

Treatments	Postharvest quality parameters	
	PLW (%)	Shelf life (days)
Variety (Factor A)		
Nepa Ball	54.34	8.00
Early White Vienna	53.91	7.80
Local	53.31	7.53
Grand Mean	53.85	7.778
SEM (±)	0.697	0.1433
LSD	NS	NS
CV (%)	5.00	7.1

Doses of nitrogen (Factor B)		
100 kg N ha^{-1}	51.23^{b}	8.55^{a}
75 kg N ha^{-1}	51.12^{b}	8.44^{a}
50 kg N ha^{-1}	54.26^{a}	7.77^{b}
25 kg N ha^{-1}	55.93^{a}	7.33^{b}
0 kg N ha^{-1}	56.74^{a}	6.77^{c}
Grand mean	53.85	7.77
SEM (±)	0.90	0.18
$LSD_{0.05}$	2.60*	0.53*
CV (%)	5.00	7.10

Means with same letter in column are not significantly different at p = 0.05 by DMRT. *significant at 5% (p < 0.05), and ns: not significantly different at 5% (p > 0.05). SEM (±) = Standard error of mean, LSD = Least significant difference, CV = Coefficient of variation

Cost, returns and BC ratio. Varieties and doses of nitrogen significantly vary the net returns and thus BC ratio (P<0.05). Significantly highest BC ratio of 5.61 was recorded with Nepa Ball, which was statistically at par with Early White Vienna compared to lowest BC ratio recorded in Local. Similarly, significantly higher BC ratio was observed with 100 kg ha^{-1} nitrogen which was statistically at par with 75 kg^{-1} nitrogen.

Table 4
Cost, gross returns, net returns and BC ratio of Knol Khol as influenced by varieties and doses of nitrogen in Rampur, Chitwan, 2019/2020

Treatments	Cost, returns and BC ratio			
	Total cost of cultivation (NRs. 000 ha^{-1})	Gross returns (NRs. 000 ha^{-1})	Net returns (NRs. 000 ha^{-1})	BC ratio
Variety (Factor A)				
Nepa Ball	155.50^{a}	1029.00^{a}	873.4^{a}	5.61^{a}
Early White Vienna	150.50^{b}	954.10^{a}	803.6^{a}	5.32^{a}
Local	150.30^{c}	831.3^{b}	681.1^{b}	4.51^{b}
Grand Mean	152.08	938.00	786.00	5.15
SEM (±)	0.009	35.60	35.6	0.23
LSD	0.026	103.20	103.2	0.67
CV	0.00	14.70	17.6	17.6
Doses of nitrogen (Factor B)				
100 kg N ha^{-1}	154.20^{a}	1127.8^{a}	973.0^{a}	6.29^{a}
75 kg N ha^{-1}	153.4^{b}	1113.4^{a}	960.0^{a}	6.25^{a}
50 kg N ha^{-1}	152.1^{c}	939.3^{b}	787.2^{b}	5.18^{b}
25 kg N ha^{-1}	150.7^{d}	835.3^{b}	684.5^{b}	4.52^{b}
0 kg N ha^{-1}	149.4^{e}	674.9^{c}	525.6^{c}	3.50^{c}
Grand mean	152.08	938.00	786.00	5.15
SEM (±)	0.011	46.00	46.0	0.30
$LSD_{0.05}$	0.034	133.20	133.2	0.87
CV, %	0.00	14.70	17.6	17.6

Means with same letter in column are not significantly different at p = 0.05 by DMRT. *significant at 5% (p < 0.05), and ns: not significantly different at 5% (p > 0.05). SEM (±) = Standard error of mean, LSD = Least significant difference, CV = Coefficient of variation

Interaction effect showed significantly maximum BC ratio of (6.76) in variety Nepa Ball at 75 kg ha^{-1} nitrogen and variety Early White Vienna at 100 kg ha^{-1} nitrogen compared to lower BC ratio of (2.11) recorded in Local variety at no application nitrogen which was at par (2.90) with local variety at 25 kg ha^{-1} nitrogen.

Table 5

Interaction effect of varieties and doses of nitrogen on cost of cultivation, gross returns, net returns and BC ratio of Knol Khol in Rampur, Chitwan, 2019/2020

Treatment combinations	Cost, returns and BC ratio			
	Total cost of cultivation (NRs. 000 ha^{-1})	Gross returns (NRs. 000 ha^{-1})	Net returns (NRs. 000 ha^{-1})	BC ratio
Variety and Doses of nitrogen				
Nepa Ball and 100 kg N ha^{-1}	158.23	1036.4^{abc}	878.2^{abc}	5.55^{abc}
Nepa Ball and 75 kg N ha^{-1}	156.87	1217.9^{a}	1061.0^{a}	6.76^{a}
Nepa Ball and 50 kg N ha^{-1}	155.51	897.3^{bcd}	741.8^{bcd}	4.77^{cd}
Nepa Ball and 25 kg N ha^{-1}	154.15	1101.8^{ab}	947.7^{ab}	6.14^{abc}
Nepa Ball and 0 kg N ha^{-1}	152.80	891.4^{bcd}	738.6^{bcd}	4.83^{bcd}
Early White Vienna and 100 kg N ha^{-1}	153.19	1189.5^{a}	1036.3^{a}	6.76^{a}
Early White Vienna and 75 kg N ha^{-1}	151.83	1081.9^{abc}	930.1^{abc}	6.12^{abc}
Early White Vienna and 50 kg N ha^{-1}	150.47	1003.0^{abc}	852.5^{abc}	5.66^{abc}
Early White Vienna and 25 kg N ha^{-1}	149.11	822.3^{cde}	673.2^{cde}	4.51^{cd}
Early White Vienna and 0 kg N ha^{-1}	147.76	673.8^{def}	526.0^{def}	3.56^{de}
Local and 100 kg N ha^{-1}	152.95	1157.3^{ab}	1004.4^{ab}	6.567^{ab}
Local and 75 kg N ha^{-1}	151.59	1040.6^{abc}	889.0^{abc}	5.86^{abc}
Local and 50 kg N ha^{-1}	150.31	917.5^{bcd}	767.2^{bcd}	5.10^{abcd}
Local and 25 kg N ha^{-1}	148.87	581.7^{ef}	432.8^{ef}	2.90^{e}
Local and 0 kg N ha^{-1}	147.52	459.6^{f}	312.1^{f}	2.11^{e}
Grand mean	152.0823	938.00	786.00	5.15
SEM (±)		79.70	79.7	0.52
$LSD_{0.05}$		230.80*	230.8*	1.51*
CV (%)		14.7	17.6	17.6

Means with same letter in column are not significantly different at p = 0.05 by DMRT. *significant at 5% (p < 0.05), and ns: not significantly different at 5% (p > 0.05). SEM (±) = Standard error of mean, LSD = Least significant difference, CV = Coefficient of variation

Discussion

Plant growth parameters. Significant variation was observed among varieties with respect to plant height, number of leaves, stem (knob) diameter, leaf length and leaf breadth. Maximum plant height, number of leaves per plant, leaf length and leaf

breadth was observed in variety Early White Vienna whereas maximum stem diameter in Nepa Ball. These results of variation among varieties might be due to pertaining genetic differences affecting the plant vigour. The results are in close conformity with that obtained by Silatar, Patel, Acharya and Vadodaria (2018) and Meena, Shivran, Meena and Singh (2021) in Knol Khol, Giri, Sharma, Shakya, Yibak Dhoj and Kandel (2013) in cauliflower, Ara, Bashar, Begum and Kakon (2007) in tomato. Similarly, plant height was found to be increasing with increasing doses of nitrogen. Nitrogen is an integral part of chlorophyll, which play very integral role in the process of photosynthesis, respiration, energy storage, cell division and enlargement. The results are in accordance with that obtained by Ahmed, Ahmed and Hussain (2003) and Rai, Patel and Dongra (2003) in Knol Khol, Prasad, Bhunia, Naik and Thapa (2009) in chinese cabbage, Bashyal (2011), Chahal, Singh, Dhillon and Kaur (2019) and Ahmad and Horo (2020) in cauliflower.

Days to knob initiation and knob maturation. Varieties showed significant effect on days to knob initiation (DAT). The variety Nepa Ball initiated the knob at the earliest (6.70 DAT) while Local variety was the slowest (10.48 DAT) in initiating knob. Similarly, the variety Nepa Ball was ready to harvest 6 days earlier than other varieties. Differential time of knob initiation and maturation was also observed during the experiment conducted by Nagar (2016) and Patel et al. (2017) in Knol Khol.

High dose of nitrogen favoured earlier knob initiation and harvesting. Higher nitrogen development favoured quick growth and associated with quicker knob initiation and knob maturation in Knol Khol. This may be due to the high availability of nitrogen, which leads to quick conversion of vegetative to reproductive parts. The knob initiation and maturation were earliest at 100 kg N ha^{-1} i.e. 6.12 and 41.78 days after transplanting. Applications of higher nitrogen doses imposed significant influence in knob initiation as shown by Nagar (2016) and Hange, Barkule, Lohakare and Thalkari (2020) in Knol Khol.

Yield parameters. Yield of Knol Khol was significantly increased by varieties. Highest biological and economic yield (59.87 MT ha^{-1} and 51.45 MT ha^{-1}) were found in variety Nepa Ball which differed significantly with Local variety (51.70 and 41.61 MT ha^{-1}) but was at par with Early White Vienna (58.76 and 47.71m t ha^{-1}). Nepa Ball was found to be superior and significantly different than Early White Vienna and Local in terms of harvest index. These results are in conformity with the results obtained from experiment by Nagar (2016), Kumar, Singh, Rana and Shah (2018) and Hange, Barkule, Lohakare and Thalkari (2020) in Knol Khol. Biological and economic yield per hectare were found to increase significantly with increase in nitrogen level. Highest biological yield (68.85 MT ha^{-1}), economic yield (56.39 MT ha^{-1}) were found at 100 kg ha^{-1} nitrogen but no significant difference was observed

with respect to harvest index. This may be due to role of nitrogen in leaf development, photosynthesis and root development resulting in increased food accumulation and nutrient uptake. Similar results were obtained by Bhusan, Sharma and Sharma (2010), Talukder, Banu, Hoque and Hoque (2013), and Nagar (2016) in Knol Khol and Neethu, Tripathi, Narwade and Sreeganesh (2015) in broccoli.

Postharvest quality parameters. Although there was no significant difference among varieties in terms of physiological loss in weight (%) and shelf life (days). Nepa Ball was found to last longer (8.00 days) than Early White Vienna (7.80 days) and Local (7.53). Similarly, shelf life at 100 kg ha^{-1} and 75 kg ha^{-1} nitrogen were at par and varied significantly with that of lower doses of nitrogen. Similar findings were obtained by Nagar (2016) and Hange et al. (2020) in Knol Khol. The differences in physiological loss in weight may be due to lack of temperature management and other post-harvest management (Hange et al., 2020).

Conclusion

The experiment was able to draw some important information and conclusion regarding the Knol Khol varieties and appropriate doses of nitrogen. Nepa Ball was found to be superior than other varieties with respect of vegetative growth, earliness to knob initiation and maturation, knob yield, harvest index and postharvest qualities. Nepa Ball performed better even at low doses of nitrogen. With respect to nitrogen application doses, the crop performed better with the increase in nitrogen levels. The performance of Knol Khol at highest level i.e. 100 kg N ha^{-1} was statistically at par with that at 75 kg N ha^{-1}. Nitrogen level of 75 kg N ha^{-1} would be preferable with respect to growth, yield, postharvest quality and economics of production.

Thus, we can conclude that Nepa Ball can be successfully cultivated at 75 kg N ha^{-1} in order to obtain the optimum yield taking account to all aspects of growth and development. However, the trials should be performed for multiple years and locations in order to assess the precise recommendations.

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