Response of Late Cauliflower (*Brassica Oleracea* L. Var. *Botrytis*) Cultivars to Different Sources of Nitrogen at Chitwan, Nepal

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Abstract

The experiment was conducted at horticultural farm of IAAS, Rampur from November, 2012 to March, 2013 to evaluate the efficacy of the different sources of nitrogen (inorganic-urea and organic-FYM) on the performance of late varieties of cauliflower. The experiment was laid out in two factor factorial randomized complete block design (RCBD) with three replications. The experiment comprised of 12 different treatment combinations: three different sources of nitrogen (100% N through urea, 50% N through urea + 50% N through FYM, and 100% N through FYM) and four varieties (Snow Mystique, Snow Crown, Snow Dome and Madhuri) of cauliflower. Various growth attributing characters: plant height, number of leaves per plant and curd height were observed better in performance through 50% N-Urea+50%N-FYM with Madhuri variety compared to other treatments. Snow Dome took the longest period to 50% curd initiation (74.22 days) and 100% curd imitation (79.44 days). Similarly, Snow Crown took the shortest period to 50% curd initiation (49.56days) and 100% curd imitation (55.56 days). The maximum curd height (7.52cm), curd diameter (16.66cm), maximum plant height at harvest (58.28 cm), highest number of leaves per plant (13.93) and the highest economic yield (24.82tha^{-1}) were recorded from 50%N-Urea+50%N-FYM. The highest plant height at harvest (59.52cm), highest numbers of leaves per plant (15.06), maximum curd height (7.52 cm), curd diameter (17.20 cm) and highest economic yield (27.78 tha-^{1}) was recorded from Madhuri compared to other varieties.The higher yield of Madhuri was because of better vegetative growth which resulted in higher length, diameter and weight of curd. Fifty percent substitution of nitrogen requirement through FYM produced better performance in terms of morphological traits and yield parameters as compared to other combination of FYM and urea. It can be suggested that the open pollinated variety Madhuri can be grown with the combination of 50% N from FYM and 50% N from Urea in the late season under Chitwan condition.

Keywords: *Curd initiation days, curd height, economic yield*

Introduction

Cauliflower (*Brassica oleracea* var. *botrytis* L.), queen of winter vegetables, is an important winter vegetable widely grown in Terai and mid hills of Nepal (APP, 1995). It is one of the highly preferred vegetable crops and can be successfully grown from the terai to high hills in normal and offseason period with appropriate technologies and varieties as requirement. In Chitwan, it covers an area of 623 ha with a total production of 8847 mt and average productivity of 14 mtha^{-1} (MOAD, 2014/015). Farmers generally grow cauliflowers in normal and offseason for fetching high income. Plant growth is adversely affected due to deficiency of nitrogen and it is constituent of enzymes, chlorophyll and proteins (Reddy and Reddy, 2002). Variety selection and crop management practices are the main factors that contribute to growing profitable cauliflower (Zerkoune, 2000).

The detrimental impact on the soil, environment and human health and rapid increase in prices of chemical fertilizers urged the farmer for adoption of integrated plant nutrients that improves the soil fertility and sustainable crop production (Sentiyangla *et al.*, 2010).

Consumers are ready to pay any price for organic product considering human health and environment. Productivity of cauliflower depends on use of balanced fertilizer.

Neither the chemical fertilizer alone nor the organic manure is able to sustain the crop productivity and soil fertility (Vithwel *et al.*, 2013). Adjusting the planting date of crops and altering the production season may be viable method for reducing pesticide use. Continuous use of inorganic fertilizer alone causes the soil condition to deteriorate and lowers the productivity of soil. Farm Yard Manure not only supplies a variety of macro and micronutrients to the soil, but also improves the physico-chemical and biological properties of the soil which helps to maintain the soil productivity and soil health. Use of FYM alone cannot satisfy the nutrient requirement of the crop. This is mainly due to low nutrient analysis and the slow decomposition rate of manure. Thus, proper ratio between FYM and chemical fertilizers sources should be worked out to derive the best possible advantages of inputs.

Integrated use of organic and inorganic fertilizers can improve crop productivity and sustain soil health and fertility (Satyanarayana *et al.*, 2002). There is higher positive effect on microbial mass from the use of organic and chemical fertilizer compared to addition of organic fertilizer alone which result better soil health (Dutta *et al.,* 2003).The concept of integrated nutrient management system has been adopted to conserve and improve the soil fertility as a further response to economic recession (Quamruzzaman, 2006). Integrated use of inorganic fertilizer and organic manure increase important yield attributes like plant height, number of primary branches per plant, and total soluble solid contents (Patil *et al.,* 2004). The growth and yield of cauliflower are remarkably influenced by organic and inorganic fertilizer management, for which an integrated approach benefits yield sustainability and maintains soil fertility (Noor *et al.,* 2007*).*

Nitrogen is a major nutrient to be considered for sustainable production as it is essential for optimum growth of plant and higher yield. Farmers are applying inorganic nitrogen without proper knowledge which causes the higher pest infestation to the crop. There are many varieties available in the market but farmers have no proper knowledge regarding varietal selection in appropriate place at right time. Several hybrids and open pollinated varieties of cauliflower have been introduced in Nepal but performance of these varieties in different agro-climatic conditions and socio-economic strata has not been evaluated. For achieving higher yield, right variety selection with proper dose of nutrients and plant protection measures is essential. Late season cauliflower production extends the time of supply thereby increasing the scope for generating higher returns for growers (Subedi *et al.,* 1996).

Methodology

The field experiment was conducted at the vegetable farm of the Institute of Agriculture and Animal Science (IAAS), Rampur, Chitwan, Nepal during November, 2012 to March, 2013. The experiment was laid out in two factors Factorial Randomized Complete Block Design (RCBD) with three replications. The first factor was combination of three different sources of nitrogen (100% N through urea, 50% N through urea+50% through FYM, and 100% N through FYM). The second factor was four varieties (Snow Mystique, Snow Crown, Snow Dome and Madhuri). There were a total of 36 plots. Individual net experimental plot area comprised of 3m×2.25m (6.75m^2) with 25 plants. Seedlings were transplanted at an spacing of 60 cm x 45 cm in each plot.

The recommended dose of nitrogen, phosphorous, potash was supplied by using urea, single super phosphate (SSP), and muriate of potash (MOP) at the rate of 150:60:60 kg NPKha^{-1}. The laboratory analysis of FYM and soil samples of the experimental plots before transplanting of seedlings was done in the laboratory of Soil Science Division, NARC, Khumaltar, Lalitpur, Nepal. Required quantity of FYM and chemical fertilizer (urea) were calculated on the basis of total amount of nitrogen present in them. All the collected data of growth parameters under observation were subjected to analysis of variance and Duncan's Multiple Range Test (DMRT) for mean separation using MSTAT-C.

Table 1. Laboratory analysis of FYM and soil before seedling transplanting

Manure	Nutrient content percentage			Organic Matter	pH	Soil Texture
	Total Nitrogen	Phosphorus	Potash			
FYM	1.05 (%)	0.219 %	0.8 (%)	-	-	-
Soil	1.14 (%) high	Available Phosphorus 85.68kg/ha (high)	Available Potassium 165.99 kg/ha (Medium)	2.04% Medium	5.57 (acidic)	Sandy loam

Source: Central Soil Science Laboratory, NARC, Khumaltar, Lalitpur, Nepal

The soil was rated according to the rating chart of soil value to determine the fertility status of the soil as given by Khatri Chhetri (1991) and Jaishy (2000).

Table 2. Quantity of FYM and urea applied per ha

Treatments	Symbol	Descriptions	Quantity of fertilizers kg per ha
N_1	100% N-Urea	150:60:60 NPK kg ha^{-1} (Recommended dose of fertilizer)	326kg Urea + 375 kg SSP +100 kg MOP
N_2	100% N-FYM	Full dose of nitrogen through FYM	28.46mt FYM + 375 kg SSP+100 kg MOP
N_3	50% N-Urea + 50% N-FYM	1/2 dose of N through FYM + 1/2 dose of N through Urea	14.3mt FYM+163 kg Urea + 375 kg SSP+100 kg MOP

Results and Discussion

Curd initiation days

There were highly significant differences ($p<0.05$) among different varieties on days to curd initiation, 50% curd initiation and 100% curd initiation days after transplanting (Figure:1). Snow Dome variety took the longest period to 50% curd initiation (74.22 days) and 100% curd imitation (79.44 days). Similarly, Snow crown variety took shortest period to 50% curd initiation (49.56 days) and 100% curd initiation (55.56 days). Pandey *et al.* (2000) reported that Snow Crown variety took shorter days to curd initiation compared to Snow Mystique. The effects of different sources of nitrogen on days to curd initiation, 50% and 100% initiation were significant (Figure 2). Days to 50% curd initiation was the longest from 100% N supplied through urea (68.67 days) and the shortest period to 50% curd initiation (60.17 days) from 50% N through Urea+50%N through-FYM. Similarly, the shortest period to 100% curd initiation (66.25days) was recorded from 50% N- Urea+ 50%N-FYM and the longest period to 100% curd initiation (74.08 days) was from 100% N-Urea. The integrated nutrient contributed to enhancement of vegetative growth through mineral nitrogen and slow release of sufficient reserved food material i.e. FYM for curd initiation. As urea releases nutrient fastly, it might have delayed transformation of vegetative phase to curd initiation phase. Similar results were also reported by Bashyal (2008) and Thakur *et al.* (1991). Earliness in days to flowering in okra was observed with the integrated nutrient application (chemical fertilizers, organic manures and biofertilizers) by Prabhu *et al.* (2002).

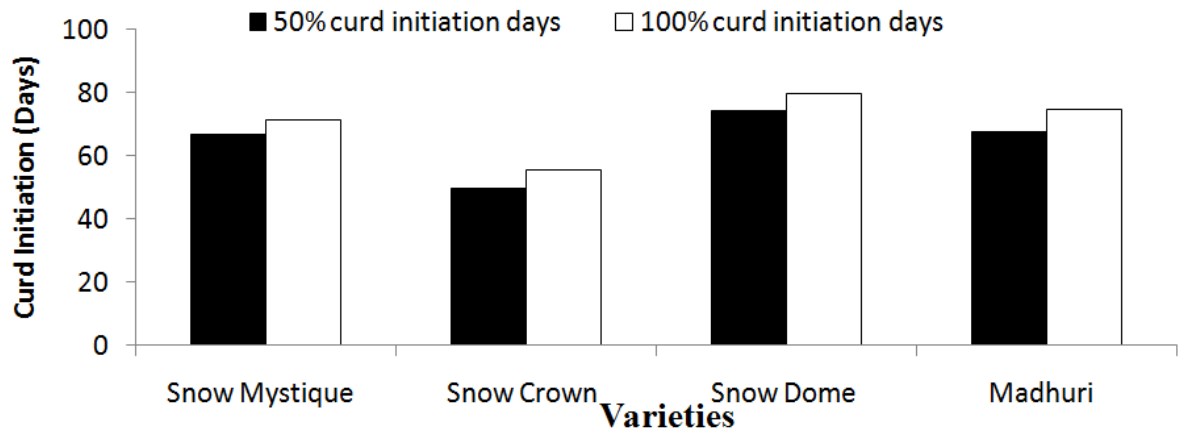

Figure 1 Comparative study of curd initiation (days) of different varieties

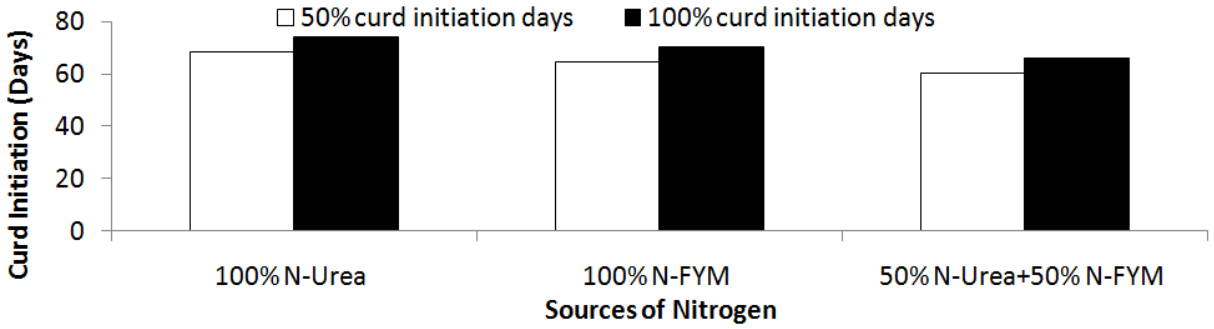

Figure 2 Comparative study of curd initiation (days) of different sources of nitrogen

Plant height at harvest

The significant variation was seen in the effect of different sources of nitrogen and different varieties on plant height of cauliflower at the time of harvest (Table 2). The tallest plant was observed in Madhuri (59.52cm) at harvest, while the shortest in Snow Crown (40.77cm) at harvest. The highest plant height (58.28cm) was from 50%N-Urea+50%N-FYM at harvest and lowest plant height (49.79cm) from 100% N-FYM. Kanwar *et al.* (2002) reported that there was significant increase in plant height in cauliflower when organic manures (vermicompost or FYM) were applied with 50% NPK. These results are due to availability of essential macro and micro nutrients through the organic and chemicals nutrient sources. This effect may also be due to the positive role of FYM on soil physical properties, water holding capacity and aeration. Increase in microbial activity due to manuring gave increment in mineralization of organic nitrogen and, as a result, plant gets all the available nutrients (Gupta *et al.*, 2000). The highest dose of nitrogen might have enhanced cell division and formation of more tissues resulting in luxuriant vegetative growth and thereby increasing plant height (Meyer and Anderson, 2003). Many other investigators reported that, organic manure plus mineral fertilizer increased height (Devi et al., 2003; Rakesh et al., 2006; and Zaki et al., 2009 on broccoli)

Number of leaves per plant at harvest

The highest numbers of leaves per plant (15.06) was recorded from Madhuri and the lowest (10.88) from Snow dome at harvest (Table 2). The highest number (13.93) of leaves per plant at harvest was from 50%N-Urea+50%N-FYM, while the lowest (12.03) was recorded from FYM only (100% N-FYM). Similar results have also been reported by Bhattarai (2013) in broccoli. Kandil and Gad (2009) also recorded greater no. of leaves per plant in

broccoli with the application of FYM and inorganic nitrogen. As supplement of nitrogenous fertilizer increased, number of leaves also increased. Increment in number of leaves by the increase in nitrogenous fertilizer was also reported by Thakur et al. (1991). Shanmugavelu (1989) also reported dwarf cauliflower plant with small young leaves was due to nitrogen deficiency. Surlekov and Rankov (1989) recorded greater number of leaves per plant in chilli with the application of FYM and inorganic nitrogen.

Table 3. Effects of nitrogen sources on plant height, number of leaves per plant and canopy diameter of cauliflower cultivars at Rampur, Chitwan, Nepal, 2012/13

Treatments	Plant height at harvest (cm)	Number of leaves per plant at harvest
Varieties (V)		
Snow Mystique (V1)	59.23[a]	13.72[b]
Snow Crown (V2)	40.77[b]	12.46[b]
Snow Dome (V3)	54.40[a]	10.88[d]
Madhuri (V4)	59.52[a]	15.06[a]
SEM±	2.60	0.35
LSD	7.63**	1.04*
Sources of Nitrogen(N)		
100% N-Urea (N1)	52.37[ab]	13.12[a]
100% N-FYM (N2)	49.79[b]	12.03[b]
50% N-Urea+50% N-FYM (N3)	58.28[a]	13.93[a]
SEM±	2.25	0.31
LSD	6.61*	0.90*
CV %	14.59	8.15
Grand mean	53.48	13.03

Means followed by same letter(s) in a column are not significant at 5% level of significance as determined by DMRT.

* = Significant at 5 % ($p < 0.05$), ** = Significant at 1 % ($p < 0.01$), NS= non significant

Curd height and curd diameter

The maximum curd height (7.52 cm) and curd diameter (17.20 cm) were recorded in Madhuri at harvest (Figure 3). Similarly, at harvest, the maximum curd height (6.93 cm) and curd diameter (16.66 cm) were recorded from 50% N-urea + 50% N-FYM which were significantly higher than those recorded at 100% N-urea and 100% N-FYM. This may be because of increased vegetative growth by the integrated nutrient management which might account for the accumulation of carbohydrates as a result of increased photosynthesis. These results in respect of curd diameter are in complete agreement with the findings of Bhattarai (2013) and Chaterjee *et al.* (2005) in broccoli .These findings were also in accordance with the findings of Nair and Peter (1990) that beneficial effect of combined application of organic and inorganic sources increased fruit number, fruit weight/plant, fruit yield of chilli compared to either organic or inorganic fertilizer applied individually.

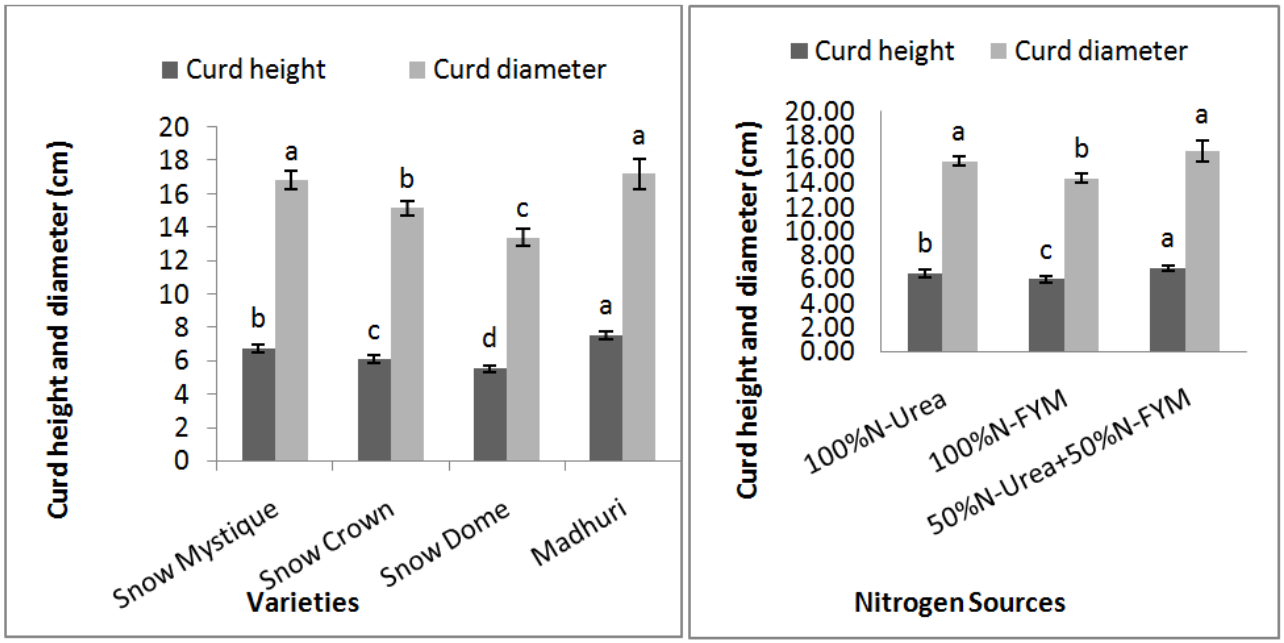

Figure 3 Effect of a) nitrogen sources and b) Varieties on curd height and diameter (cm) of Cauliflower at Rampur, Chitwan, Nepal, 2012/2013

The bars are mean of curd height and diameter± standard errors. Figures followed by same letters within the column are not significant at 5% level of significance as determined by DMRT.

Economic yield (ton/ha)

Highly significant response was observed on the effect of different sources of nitrogen and different varieties on economical yield of cauliflower (Figure 4). The highest economical yield (27.78 tha^{-1}) was obtained from Madhuri which was significantly higher than the other varieties. Similarly, the highest economical yield was obtained from 50% N-Urea+50%N-FYM (24.82 tha^{-1}) followed by 100% N-Urea (20.80 tha^{-1}) and 100%N-FYM (14.94 tha^{-1}).

Kumar (2013) have also reported that integration of organic and inorganic fertilizers application significantly increased the yield in broccoli over inorganic fertilizers alone and also over control. Sharma and Singh (2003) in pea and Singh et al., 2005 in cowpea also reported similar findings. The increase in the yield is also due to the supply of additional nutrient through organics as well as inorganic sources resulting in an improvement in the physical and biological properties of soil as reported by Sharma et al., 2005 in broccoli. Nair and Peter (1990) observed the highest yield in hot chillies with the application of 15 ton ha^{-1} FYM and 175:40:25 NPK kg ha^{-1} as compared to control (without FYM). Ullah *et al*. (2008) reported the highest yield (45.5 ton ha^{-1}) with the combined application of 60% organic and 40% inorganic fertilizers in brinjal. The highest fruit yield (13.53 ton ha^{-1}) was observed in sweet pepper with application of FYM 50% and Urea 50% (Ghimire, 2011).

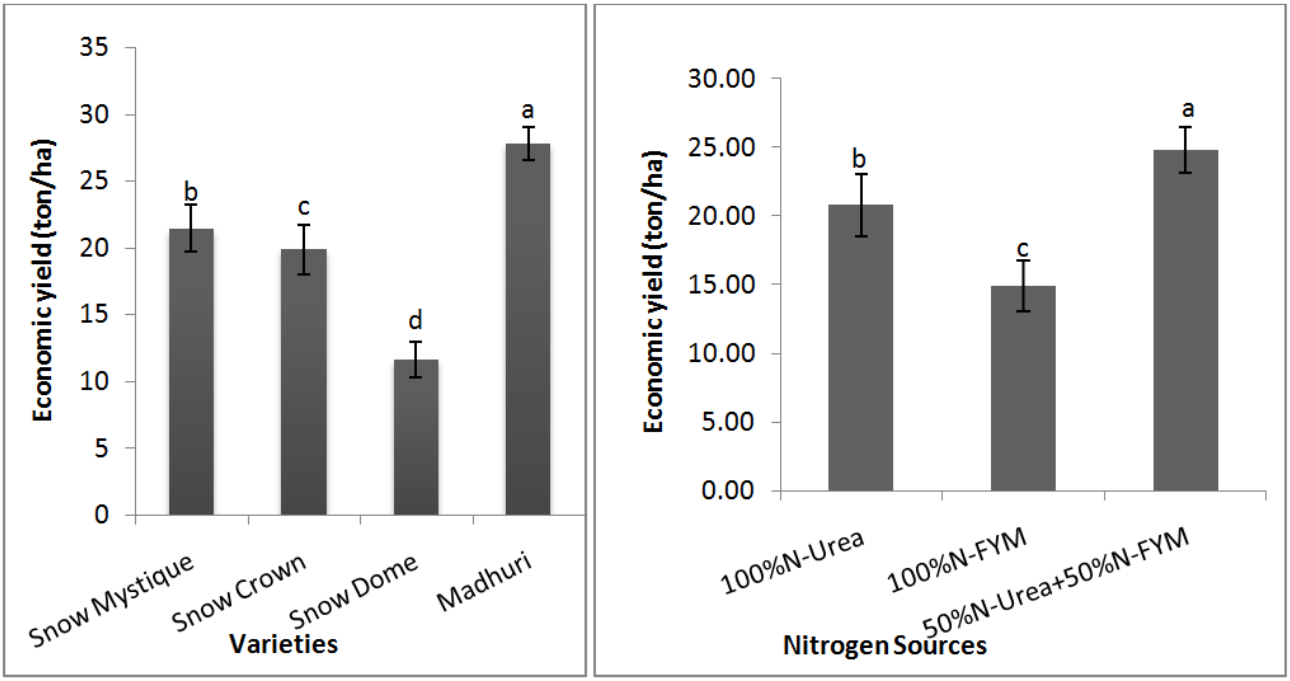

Figure 4 Effect of a) nitrogen sources and b) Varieties on Economic yield of Cauliflower at Rampur, Chitwan, Nepal, 2012/2013

The bars are mean of economic yield± standard errors. Figures followed by same letters within the column are not significant at 5% level of significance as determined by DMRT.

Table 4. Interactive effects of different varieties and different sources of nitrogen on Economic yield of Cauliflower at Rampur, Chitwan, Nepal, 2012/2013.

Treatments	Economical yield (tha^{-1})
Snow Mystique ×100% N-Urea	22.34^{de}
Snow Mystique ×100% N-FYM	15.19^{fg}
Snow Mystique × 50% N-Urea+50% N-FYM	26.79^{b}
Snow Crown×100% N-Urea	20.62^{e}
Snow Crown ×100% N-FYM	13.33^{g}
Snow Crown × 50% N-Urea+50% N-FYM	25.68^{bc}
Snow Dome ×100% N-Urea	10.49^{h}
Snow Dome ×100% N-FYM	7.903^{i}
Snow Dome × 50% N-Urea+50% N-FYM	16.55^{f}
Madhuri ×100% N-Urea	29.75^{a}
Madhuri ×100% N-FYM	23.33^{cd}
Madhuri × 50% N-Urea+50% N-FYM	30.25^{a}
Mean	20.19
SEM±	0.88
LSD0.05	2.56*
CV (%)	7.49

Note: V_1= Snow Mystique, V2= Snow Crown, V3= Snow Dome; V4= Madhuri; N1=100% N-Urea; N2= 100% N-FYM; N3=50% N-Urea+50% N-FYM

The interactive effects of different sources of nitrogen and varieties of cauliflower on economic yield were significant (Table 4). The highest economical yield (30.25 tha^{-1}) was observed from 50%N-Urea+50%N-FYM in Madhuri which was at par with 100% N- Urea in Madhuri variety itself (29.75 t/h). The lowest economical (7.903 tha^{-1})) was obtained from 100% N-FYM in Snow Dome. These findings are similar with the findings of Bhattarai (2013) who reported that the highest total yield (17.262 mt/ha) was recorded by the combined effect of Premium Crop variety and $N_{75\%FYM} + N_{25\%Urea}$. Similar results were also reported by Abou El-Magd *et al*. (2010) and Zaki *et al*. (2009).

Conclusion

The longest period to curd initiation was taken by Snow Dome variety followed by Madhuri, Snow Mystique and Snow Crown respectively. Days to 50% curd initiation was significantly the longest from 100%N-Urea whereas it was the shortest from 50%N-Urea+50%N-FYM. At harvest, the tallest plant and highest number of leaves were observed in Madhuri variety**.** The treatment 50%N-Urea+50%N-FYM produced the tallest plant and the highest number of leaves at harvest. The maximum curd height and curd diameter were recorded from 50% N-urea+50% N-FYM which were significantly higher than those recorded at 100% N-urea and 100% N-FYM. The highest economical yield was obtained from 50% N-Urea+50%N-FYM in Madhuri variety. This showed the interactive advantages of combining the organic (FYM) and inorganic sources (urea) of nutrients. The integrated nutrient management have proved superior rather to use either of the components separately.

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