Growth and Yield of Late Season Cauliflower (Brassica oleracea var. botrytis L.) Varieties in Mid-hill Region of Nepal

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ABSTRACT

Background: Cauliflower production during the late winter season has major problems including the requirement of long duration for its maturity, lower yield and poor postharvest quality, especially in the mid-hill region of Nepal. A field experiment was conducted to access the growth, crop maturity and yield of late-season cauliflower varieties at Puranchaur, Kaski in the mid-hill region of Nepal.

Methods: The experiment was arranged in a randomized complete block design (RCBD) with total eleven late-season cauliflower varieties in which nine were hybrid varieties viz. Freedom, Titan, Ravella, Artica, Bishop, Casper, Indam 9803, NS 106 and Snow Mystique while two were open pollinated varieties viz. Amazing and Snowball 16. The experiment was conducted from November 2016 to March 2017 with four replications.

Result: Significantly shorter period for final curd initiation of 76 days was recorded in NS 106 and Indam 9803 which was statistically similar with Amazing. Significantly shorter period for final curd maturation of 90 days was recorded in Amazing which was statistically similar to Bishop and NS 106. Similarly, the highest curd yield of 50 mt/ha was produced by Bishop at 91 days after transplanting (DAT) while the lowest crud yield of 19 mt/ha was recorded in Snowball 16 at 113 DAT. Finally, it was concluded that Bishop found the best hybrid variety for higher curd yield and short duration for maturation while Amazing performed higher yield than Snowball 16 and early maturing variety in the mid-hill region of Nepal.

Key words: Cauliflower, Curd initiation, Curd maturity, Growth, Late season.

INTRODUCTION

Cauliflower (Brassica oleracea var. botrytis L.) is considered as the high quality and prestigious vegetable crop in urban and rural areas of Nepal which can be grown effectively from inner Terai to the high hills (PANDY and POKHREL, 2000). Curd is the edible part and is consumed as cooking vegetables, curry, raw as salad, pickle and widely used in preparing fried snacks, burgers and sandwiches in restaurants (Ashraf et al., 2017). Cauliflower is rich in sources of vitamins and minerals which can protect against heart disease and also helps to maintain the cholesterol level (Keck, 2004).

Cauliflower is highly sensitive to climatic factors that play an important role in the initiation and growth of the curds. In Nepal, early varieties require a higher temperature than mid and late-season varieties for curd initiation of cauliflower. Fuzzy, riceyness and loosed curds could be produced due to higher temperatures above 20°C in the late winter season (Fujime, 1983, Swiader et al., 1992). Initiation of curds in cauliflower also depends on the genetic characteristics of the varieties (SAINI, 1996). Early varieties of the cauliflower require higher temperature (20-25°C) for curd initiation while late varieties require low temperature (10-16°C) (BOSE and SOM, 1993, CHATTERJEE, 1993).

The commercial hybrid varieties in Nepal were introduced from various countries. According to Krishi Diary (2017), common early cauliflower varieties in Nepal are Pusa Deepali, Silver Cup 60, NS 60, Snow Crown, White Top, White Flash and Sweta. Similarly, popular mid-season varieties in Nepal are NS 90, Snow Queen, Snow King, Department of Horticulture, Agriculture and Forestry University, Rampur, Nepal. 1Nepal Agricultural Research Council, Kathmandu, Nepal. 2Tribhuvan University, Kathmandu, Nepal.

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Kathmandu Local and Jyapucauli while commerciallate-season varieties in Nepal are Kibo Giant, Madhuri, Snowball 16, Snow Mystique and NS 106. Long duration for curd initiation and curd maturity are the major problems faced by the commercial growers such as production of low yield and poor quality curds due to higher temperature during late winter season (BOSE and SOM, 1993). Indeed, the unavailability of suitable varieties for better quality and higher yield is the major challenges tackled by the commercial vegetable growers from the mid-hill region of Nepal (HRD, 2013). Because of the increase in temperature, insect activities also increase during the late winter season. Identification of short duration with high yielding cauliflower varieties during the late winter season can mitigate the negative effects of higher temperature and its impacts on...
incidence of the insect as well as the production of poor quality curds. Therefore, a field experiment was conducted to identify such short matured cauliflower varieties with higher yield to be suitable in the late winter season focusing at Puranchaur, Kaski in Mid-hill region of Nepal.

**MATERIALS AND METHODS**

An experiment was conducted at a farmer’s field in Puranchaur, Kaski, Nepal, situated at 28.32° North latitude and 83.99° East longitude with an elevation of 900 meters above sea level that falls in the mid-hill region of Nepal. This experiment was carried out from November 2016 to March 2017 to access the growth, maturity and yield of the late-season varieties of cauliflower. The weather data, such as maximum temperature, minimum temperature, total rainfall and relative humidity (RH) during the cauliflower growing period from November 2016 to March 2017 was recorded from Puranchaur meteorological station in Puranchaur, Kaski.

**Experiment design and treatments**

The experiment was organized in a randomized complete block design (RCBD); each treatment replicated four times comprised of eleven late-season cauliflower varieties. Out of eleven varieties, nine varieties were hybrid varieties viz. Freedom, Titan, Ravella, Amazing, Artica, Bishop, Casper, Indam 9803, NS 106, Snow Mystique while Snow Mystique was the most popular hybrid late season variety in Nepal. There were two open pollinated varieties viz. Amazing and Snowball 16 in which Snowball 16 was the common open pollinated late season variety in Nepal. The size of the individual plot was 7.5 m² (3 m × 2.5 m) having 25 plants in each plot. Row to row distance was maintained as 60 cm and plant to plant distance was 50 cm.

**Soil properties of the experimental field**

The soil samples from each block with 20 cm depth were taken for chemical analysis before the transplanting of seedlings. The air-dried and sieved samples were taken to test total nitrogen, phosphorus, potassium, organic matter, soil pH and soil texture at Agriculture Technological Centre (ATC), Lalitpur. The experimental field was slightly acidic with 5.8 soil pH; low organic matter content, medium nitrogen, low phosphorus, low potash and sandy loam in texture.

**Field preparation and analysis**

Based on the recommended dose of 30 metric ton farmyard manure (FYM) and 200:120:80 kg NPK per hectare, 22.5 kg FYM, 195 g DAP, 152 g urea and 100 g murate of potash per plot was incorporated in the soil as a basal dose and 98 g urea was supplied 40 DAT as a split dose. The seedlings were transplanted four weeks after the seed sowing and regular water was applied as per need by the crops. Important growth parameters such as plant height and canopy diameter at different growth stages were measured from those randomly selected five plants of each plot. Similarly, the days required for curd initiation (first curd and final curd initiation) and curd maturity (first curd and final curd maturity) were recorded from the whole population, except border plants of each plot. Finally, curd yield and biological yield was recorded from those randomly selected five plants of each plot. Data were recorded and entered into MS-Excel 2016. Statistical tool Genstat 18th edition was used for general analysis of variance (ANOVA), grand mean and standard error of mean . Means were compared using Duncan’s Multiple Range Test (DMRT). The significant differences between varieties were determined by using the least significant difference (LSD) test at 5% level of significance (Gomez and Gomez 1984; Shrestha, 2019).

**RESULTS AND DISCUSSION**

**Weather parameters**

Maximum temperature, minimum temperature, total rainfall and relative humidity during the cauliflower growing period was recorded from November 2016 to March 2017 in Puranchaur, Kaski (Fig 1). A maximum temperature of 25°C was recorded in November 2016 and March 2017 while the minimum temperature of 6°C was observed in January 2017. Similarly, the maximum and minimum relative humidity of 78% and 60% was found in December 2016 and February 2017, respectively. There was negligible rainfall for the whole experiment period, except 146 mm precipitation during March 2017.

![Fig 1: The prevailing weather condition in Puranchaur, Kaski during the cauliflower growing period from November 2016 to March 2017.](image-url)
Plant height

Plant height at different growth stages of cauliflower was differed significantly at \( p<0.01 \) among the varieties (Table 1). At 25 days after transplanting (DAT), significantly higher plant height was recorded in Snow Mystique and Indam 9803 than other varieties. Similarly, the lowest plant height was produced by Ravella. At 40 DAT, significantly higher plant height was recorded in Indam 9803 and Snow Mystique while the lowest plant height was produced by Casper. At 55 DAT, significantly higher plant height was produced by Indam 9803 and Titan while the lowest plant height was produced by Casper and Snowball 16. At final harvest, significantly higher plant height was produced by Ravella, Freedom, Titan, Snow Mystique and Bishop followed by Amazing, Indam 9803 and NS 106. The lowest plant height was measured for Snowball 16.

Canopy diameter

Canopy diameter at different growth stages of cauliflower was differed significantly at \( p<0.01 \) among the varieties (Table 2). At 25 DAT, a significantly higher canopy diameter was recorded by Indam 9803, Titan, Amazing, Artica, NS 106 and Snow Mystique. At 40 DAT, a significantly higher canopy diameter was recorded in Indam 9803 than other varieties while the lowest canopy diameter was measured for Casper.

Table 1: Plant height at different growth stages of cauliflower in Puranchaur, Kaski during November 2016 to March 2017.

| Treatments | 25 DAT | 40 DAT | 55 DAT | Final harvest |
|------------|--------|--------|--------|---------------|
| Freedom    | 19.5** | 32.2** | 42.7** | 64.3*         |
| Titan      | 20.1** | 33.2** | 46.0** | 66.3**        |
| Ravella    | 15.8** | 30.9** | 42.8** | 66.5**        |
| Amazing    | 22.0** | 32.8** | 45.2** | 57.8**        |
| Artica     | 21.3** | 31.2** | 42.3** | 56.0**        |
| Bishop     | 19.2** | 29.2** | 44.8** | 64.6**        |
| Indam 9803 | 22.5** | 34.6** | 46.8** | 57.0**        |
| NS 106     | 21.1** | 32.3** | 45.1** | 58.0**        |
| Snow Mystique | 23.1** | 34.5** | 45.3** | 62.4**        |
| Snowball 16 | 21.7bc | 29.6** | 41.6** | 47.5**        |
| Grand mean | 20.62  | 31.92  | 44.06  | 59.36         |
| F-test     | **     | **     | **     |               |
| LSD\(_{0.05}\) | 2.04  | 2.58  | 2.74  | 4.02         |
| CV%        | 6.9    | 5.6   | 4.3   | 4.7          |

Means with same letter in column are not significantly different at \( p=0.05 \) by DMRT. *significant at 5% (p<0.05) and **significant at 1% (p<0.01). LSD = Least significant difference, CV = Coefficient of variance and DAT = Days after transplanting.

Table 2: Canopy diameter at different growth stages of cauliflower in Puranchaur, Kaski during November 2016 to March 2017.

| Treatments | 25 DAT | 40 DAT | 55 DAT | Final harvest |
|------------|--------|--------|--------|---------------|
| Freedom    | 23.8** | 38.3** | 51.1** | 64.3*         |
| Titan      | 27.9** | 41.3** | 53.9** | 63.2**        |
| Ravella    | 19.2** | 31.6** | 49.6** | 63.1**        |
| Amazing    | 27.7** | 40.9** | 48.8** | 60.9**        |
| Artica     | 29.0** | 39.8** | 49.2** | 60.4**        |
| Bishop     | 24.3** | 37.9** | 53.0** | 64.2**        |
| Casper     | 26.3** | 41.0** | 48.2** | 58.0**        |
| Indam 9803 | 29.7** | 44.7** | 54.4** | 65.3**        |
| NS 106     | 28.4** | 42.5** | 55.8** | 64.4**        |
| Snow Mystique | 28.0** | 43.1** | 54.0** | 64.4**        |
| Snowball 16 | 23.5** | 37.6** | 48.2** | 48.5**        |
| Grand mean | 26.22  | 39.39  | 51.53  | 61.54         |
| F-test     | **     | **     | **     |               |
| LSD\(_{0.05}\) | 3.16  | 4.23  | 3.41  | 2.20         |
| CV%        | 3.5    | 2.7   | 4.2   | 3.9          |

Means with same letter in column are not significantly different at \( p=0.05 \) by DMRT. *significant at 5% (p<0.05) and **significant at 1% (p<0.01). LSD = Least significant difference and CV = Coefficient of variance.
Curd initiation and curd maturity of cauliflower were differed significantly at p<0.01 among the varieties (Table 3). A significantly shorter period for first curd initiation of 68 days after transplanting was recorded in Indam 9803. A significantly shorter period for final curd initiation of 76 days after transplanting was recorded in Indam 9803, Freedom, Bishop, NS 106 and Amazing. In this experiment, higher plant height and canopy diameter was obtained in Bishop, Freedom, Snow Mystique, Titan and Ravella followed by NS106 and Indam 9803 while other remaining varieties produced lower plant height and canopy diameter at different growth stages of the cauliflower. These variations among the varieties were possibly due to the genetic characteristics of the cultivars which were introduced from various countries. The variation on plant height and canopy diameter of cauliflower varieties were found significantly among the varieties from the beginning of the transplanting to the final harvest. Similar findings were also reported by; Poudel et al. (2017), Pun et al. (2003) and Yadav et al. (2013).

**Curd initiation and curd maturity of cauliflower**

Table 3: Curd initiation and curd maturity of cauliflower in Puranchaur, Kaski during November 2016 to March 2017.

| Treatments | First curd initiation (DAT) | Final curd initiation (DAT) | First curd maturity (DAT) | Final curd maturity (DAT) |
|------------|-----------------------------|-----------------------------|---------------------------|---------------------------|
| Freedom    | 74 ^a                        | 81 ^cd                      | 86 ^cd                    | 92 ^e                     |
| Titan      | 75 ^bc                       | 83 ^c                       | 92 ^b                     | 97 ^c                     |
| Ravella    | 76 ^a                        | 88 ^b                       | 91 ^b                     | 99 ^c                     |
| Amazing    | 70 ^de                       | 77 ^a                       | 84 ^d                     | 90 ^f                     |
| Artica     | 71 ^a                        | 82 ^cd                      | 91 ^b                     | 97 ^c                     |
| Bishop     | 69 ^de                       | 80 ^d                       | 85 ^cd                    | 91 ^ef                    |
| Casper     | 71 ^d                        | 82 ^cd                      | 87 ^c                     | 95 ^d                     |
| Indam 9803 | 68 ^a                        | 76 ^a                       | 86 ^cd                    | 92 ^e                     |
| NS 106     | 69 ^ae                       | 76 ^a                       | 85 ^cd                    | 91 ^ef                    |
| Snow Mystique | 71 ^d                  | 83 ^c                       | 90 ^b                     | 97 ^c                     |
| Snowball 16 | 94 ^a                   | 103 ^a                      | 106 ^a                    | 113 ^a                    |
| Grand mean | 73                          | 83                          | 89                        | 96                        |
| F-test     | **                          | **                          | **                        |                            |
| LSD _0.05  | 1.84                        | 2.41                        | 2.52                      | 1.43                      |
| CV%        | 1.9                        | 2.0                        | 1.9                      | 1.0                      |

Means with same letter in column are not significantly different at p<0.001, LSD = Least significant difference and DAT = Days after transplanting.

Table 4: Curd yield and biological yield of cauliflower in Puranchaur, Kaski during November 2016 to March 2017.

| Treatments | Curd yield (t/ha) | Biological yield (t/ha) |
|------------|-------------------|-------------------------|
| Freedom    | 40.5 ^cd          | 79.0 ^cd                |
| Titan      | 44.5 ^bc          | 91.6 ^ab                |
| Ravella    | 42.0 ^bc          | 82.5 ^c                 |
| Amazing    | 36.9 ^d           | 72.9 ^d                 |
| Artica     | 46.0 ^ab          | 82.3 ^c                 |
| Bishop     | 50.0 ^a           | 85.6 ^bc                |
| Indam 9803 | 45.1 ^bc          | 82.5 ^c                 |
| NS 106     | 44.9 ^bc          | 85.2 ^bc                |
| Snow Mystique | 45.0 ^bc       | 93.7 ^a                 |
| Snowball 16 | 19.0 ^a         | 42.2 ^bc                |
| Grand mean | 41.73             | 79.69                   |
| F-test     | **                | **                      |
| LSD _0.05  | 4.16              | 6.32                    |
| CV%        | 6.9               | 5.5                     |

Means with same letter in column are not significantly different at p<0.01 by DMRT. *significant at 5% (p<0.05) and **significant at 1% (p<0.01). LSD = Least significant difference, CV = Coefficient of variance and DAT = Days after transplanting.

from the USA and India performed longer duration for curd initiation and curd maturity which was due to variation in weather parameters and management practices. The days to curd initiation and curd maturity of cauliflower in the mid-hill region of Nepal was differed significantly due to the genetic characteristics of cultivars. Similar findings were also reported by Booij, (1990) and Wurr et al. (1996). The longest period for curd initiation and curd maturity was performed by Snowball 16 as a similar finding was also reported by Pandey, (2003).
Curd yield of cauliflower

The curd yield and biological yield of cauliflower were differed significantly at p<0.07 among the varieties (Table 4). A significantly higher curd yield of 50 mt/ha was recorded in Bishop. A significantly higher biological yield of 93.7 mt/ha was produced by Snow Mystique while the lowest curd yield and biological yield was recorded in Snowball 16. In this experiment, hybrid varieties produced higher curd yield and biological yield than open-pollinated varieties. Significant variations in curd yield and biological yield were found among the late-season varieties of cauliflower. A similar finding was also reported by Yadav et al., (2013) and Kumar et al., (2011). The yield of cauliflower is polygenic in nature, as it could be influenced by environmental factors and various management practices (Meena et al., 2010), as a similar finding was also reported by Sharma et al., (2006).

CONCLUSION

The growth and yield of cauliflower along with curd initiation and curd maturity was differed significantly among the late season varieties of cauliflower. Bishop produced the higher yield and matured the curd in short duration than other F1 hybrid varieties. Similarly, Amazing produced the higher yield and matured in early time than other open pollinated variety i.e. Snowball 16. From this experiment, it was concluded that Bishop was the best hybrid variety for higher yield and early maturation while Amazing was the better open pollinated for higher yield and early maturity than Snowball 16 in Mid hill region of Nepal.

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REFERENCES

Ashraf, M.I., Sajad, S., Hussain, B., Sajjad, M., Saeed, M.S., Sattar, S. and Iqbal, M.A. (2017). Physiological attributes of cauliflower (Brassica oleracea var. botrytis L.) as influenced by the application of different levels of nitrogen and hand weeding. International Journal of Pure Applied Bioscience. 5(6): 9-13.

Booj, R. (1990). Cauliflower curd initiation and maturity: Variability within a crop. Journal of Horticultural Science. 65(2): 167-175.

Bose, T.K. and Som, M.G. (1993). Vegetable Crops in India, Naya Prakash, Calcutta. pp. 838.

Chatterjee, R. and Mahanta, S. (2013). Performance of off-season cauliflower (Brassica oleracea var. botrytis L.) under agro shade net as influenced by planting dates and nutrient source. Environment. 1(1): 56-62.

Fujime, Y. (1983). Studies on thermal conditions of curd formation and development in cauliflower and broccoli, with special reference to abnormal curd development. In: Memories of the Faculty of Agriculture Kagawa University, Japan. 40: 117-123.

Gomez, K.A. and Gomez, A.A. (1984). Statistical Procedures for Agricultural Research. 2nd International Rice Research Institute, College, Laguna. pp. 680.

HRD (2013). Annual Report. Horticulture Research Division, Nepal Agricultural Research Council, Kathmandu.

Keck, A.S. (2004). Cruciferous vegetables: Cancer protective mechanisms of glucosinolate hydrolysis products and selenium. Integrative Cancer Therapies. 3: 5-12.

Krishi Diary (2017). Krishi Diary. Government of Nepal, Agriculture Information and Communication Centre.

Kumar, M., Sharma, S.R., Kalia, P. and Saha, P. (2011). Genetic variability and character association for quantitative and quality traits in early maturing Indian cauliflowers. Indian Journal of Horticulture. 68(2): 206-211.

Meena, M.L., Ram, R.B., Lata, R. and Sharma, S.R. (2010). Determining yield components in cabbage (Brassica oleracea var. capitata L.) through correlation and path analysis. International Journal of Science and Nature. 1(1): 27-30.

Pandey, Y.R. (2003). Evaluation of Cauliflower Varieties and their Planting Dates for Commercial Production under Jumla Agro-Ecological Condition. Agricultural Research for Enhancing Livelihood of Nepalese People. In: Proc. 2nd SAS-N convention, 30 July-1 Aug 2003: 207-210.

Pandey, Y.R. and Pokhrel, T.R. (2000). Varietal Evaluation of Late Season Cauliflower. In Proceedings of the Third National Horticultural Research Workshop (pp. 46-49). Horticulture Research Division- NARC, Khumaltar.

Poudel, K., Ansari, A.R. and Shah, M.K. (2017). Varietal Evaluation of Cauliflower for Early Season Production in the Eastern Hills of Nepal. Proceedings of the Ninth National Horticulture Workshop, May 31 to June 1, 2017. pp: 316-319.

Pun, A.B., Pandey, Y.R. and Yadav, Y.P. (2003). Performance of cauliflower varieties under different agro-ecological domains of western hills of Nepal. Agricultural Research for Enhancing livelihood of Nepalese People. In: proc. 2nd SAS-N Convention, 30 July-1 Aug 2003. pp: 235-238.

Saini, G.S. (1996). Text Book of Vegetable Production. Aman Publishing House, India.

Sharma, A., Sharma, S., Pathak, S. and Sood, S. (2006). Genetic variability for curd yield and its component traits in cauliflower (Brassica oleracea var. botrytis L.) under high hills dry temperate conditions. Vegetable Science. 33(1): 82-84.

Shrestha, J. (2019). P-Value: A True Test of Significance in Agricultural Research, https://www.linkedin.com/pulse/p-value-significance-agricultural-research-jiban-shrestha/. DOI: http://doi.org/10.5281/zenodo.4030711.

Swiader, J.M., Ware, G.W. and Collum, J.P. (1992). Producing Vegetable Crops. Interstate Publishes. Inc. Danville, Illinois. pp: 144-149.

Wurz, D.C.E., Fellows, J.R. and Phelps, K. (1996). Investigating trends in vegetable crop response to increasing temperature associated with climate change. Scientia Horticulturae. 66(3): 255-263.

Yadav, M., Prasad, V.M. and Ahirwar, C.S. (2013). Varietal evaluation of cauliflower (Brassica oleracea var. botrytis L.) in Allahabad agro-climatic condition. Trends in Biosciences. 6(1): 99-100.