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**Research Article****GROWTH, YIELD AND POST-HARVEST QUALITY OF LATE SEASON CAULIFLOWER GROWN AT TWO ECOLOGICAL ZONES OF NEPAL****H. N. Giri<sup>1</sup>, M. D. Sharma<sup>1</sup>, R. B. Thapa<sup>1</sup>, K. R. Pande<sup>1</sup>, and B. B. Khatri<sup>2</sup>**<sup>1</sup> Agriculture and Forestry University, Rampur, Chitwan, Nepal<sup>2</sup> Nepal Agriculture Research Council, Kathmandu, Nepal**ABSTRACT**

Eleven late season cauliflower (*Brassica oleracea* L. *Botrytis*) cultivars were grown in varietal trail consisting of four separate replicated plantings with RCB design at Rampur, Chitwan and Puranchaur, Kaski during the winter season of 2016-2017. These newly introduced varieties were- Amazing, Artica, Freedom, Ravella, Titan, Bishop, Casper, Indam 9803, NS 106, Snow-mystique and Snowball 16. The main objective of this research was to identify the short duration genotypes of late season cauliflower to mitigate the negative effects of high temperature. The recorded parameters were plant height, canopy diameter, curd yield, post-harvest quality, period of curd initiation and curd maturity. The maximum plant height was recorded in Bishop (73.1 cm) at Rampur while the lowest height was recorded in Snowball 16 (47.5 cm) at Puranchaur. Similarly, the maximum plant canopy was recorded in NS 106 (76.2 cm) at Rampur while the lowest in Snowball 16 (48.2 cm) at Puranchaur. Whereas the maximum curd yield (55.7 t/ha.) was found in Bishop at Rampur, but the lowest curd yield (19t/ha) was found in Snowball16 at Puranchaur. In the case of maturity period, Bishop and Freedom at Rampur were having shorter period (81 days) while Snowball 16 at Puranchaur had longest period (124 days). The varieties at Rampur showed the higher pH than Puranchaur whereas the highest TSS was recorded in Snowball 16 at Rampur. It was thus clear that plant growth parameters, yield and post-harvest quality of major late season varieties of cauliflower were differed significantly in Terai and Mid-hill region of Nepal. Newly introduced varieties Bishop and NS 106 produced the highest plant height and canopy diameter. Bishop along with NS 106 was recognized as short duration varieties which can minimize the negative effects of high temperature during late season.

**Key words:** Cauliflower, late season, biological yield, curd yield, post-harvest.

**INTRODUCTION**

Cauliflower (*Brassica oleracea* L. var. *botrytis*) is a popular winter season vegetable crop grown throughout the world. It is also the most important vegetable crop in Nepal in terms of area while the total cultivated area is about 3298,816 ha that is 13% of the total area under vegetable crops. Cauliflower has the highest share in terms of production which is 550,004.8 tons followed by cabbage i.e. 484,036.8 tons (MoAD, 2015). Curd is the edible part of the cauliflower and major nutrients available are vitamins, protein and minerals. Regular consumption of curds can save from cancers and heart diseases and also helps to maintain the healthy level of cholesterol and immune system in human body (Keck, 2004).

Climatic factors are the major influencing factors on growth and development of curds in cauliflower. Production of cauliflower would be beneficial during winter season than late winter due to higher in temperature above 24°C (Rahman et al., 2007). In comparison to other cole crops, cauliflower is always responsive to climatic factors. According to Swiader et al., (1992) and Baloch (1994), 14-20°C is the optimum temperature for curd formation in cauliflower. Initiation of the curds depends upon the genetic characteristics of the varieties (Saini, 1996). Early varieties require high temperature for curd formation (Chatterjee, 1993). Bose and Som (1993) reported that early cultivars require 20-25°C air temperature while the late cultivars require 10-16°C for curd formation. Several types of defects for marketing appears above the optimum range of temperature. The curds becomes poor quality and there is no formation of curds above 25°C (Swiader et al., 1992). Production of loose curds, development of riceyness and fuzzy curds would be noted during curd development of cauliflower due to higher temperature in late season (Fujime, 1983 and Swiader et al., 1992).

The late season varieties of cauliflower from November to March has been long duration for curd maturity, lower yield and poor post-harvest quality. Temperature is higher in late winter or early spring season and therefore, the cauliflower curds become unattractive and poor quality. Fluctuation of the temperature during curd development and maturation phase of the cauliflower would be unfavorable for quality curd

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production (Bose and Som, 1993). Activities of insects become higher in late winter season and the cabbage butterfly damages the crop as a major pest in Nepal (Joshi, 1994). Identification and evaluation of short duration genotypes of cauliflower with high yielding varieties during late season can mitigate the negative effects of higher temperature and its impacts on incidence of insect as well as production of poor quality curds. Thus, a field research was conducted to identify the short duration varieties of cauliflower to deal with negative effects of increased temperature in late winter season.

### MATERIAL AND METHODS

An experiment was conducted at two locations in Horticulture Farm, Rampur and Puranchaur, Kaski during winter season of 2016-2017. Altogether, eleven late season varieties of the cauliflower were selected for evaluation in this study. The experiment was conducted using RCBD with four replications. The individual net experimental plot was comprised of 3 m×2.5 m (7.5 m<sup>2</sup>) with 25 plants. Row to row distance was 60 cm and plant to plant distance was 50 cm. The varieties used in this experiment are presented in Table 1.

**Table 1. Details of late season varieties of the cauliflower grown at Rampur, Chitwan and Puranchaur, Kaski (2016-2017)**

Varieties	Export of the seeds	Type
Amazing	Territorial seed company, USA	Open pollinated
Artica	Stokes seeds, New York, USA	Hybrid
Freedom	Park seed, USA	Hybrid
Ravella	Osborne seed, USA	Hybrid
Titan	Osborne seed, USA	Hybrid
Bishop	Rijk Zwaan, Netherlands	Hybrid
Casper	Rijk Zwaan, Netherlands	Hybrid
Indam 9803	Indo-American hybrid seed, India	Hybrid
NS 106	Namdhari seeds Pvt. Ltd., India	Hybrid
Snowmystique	Takii seed, Japan	Hybrid
Snowball 16	Vegetable seed production centre, Dolpa, Nepal	Open pollinated

A well ploughed land and finely prepared beds with incorporation of well decomposed Farm Yard Manure (FYM) or compost manure together with small amount of fertilizer were mixed in the nursery bed for raising the seedlings. The required recommended dose of well decomposed FYM or compost manure @ 30 t/ha and inorganic fertilizers @ 200:120:80 kg NPK per ha was mixed and weighed by electronic sensitive balance and incorporated in the research field homogenously at the time of field preparation. The seedlings were transplanted four weeks after the seed sowing and irrigation was provided by using water cane immediately after transplanting to avoid transplanting shock. Regular water application and subsequent irrigations were given as per need of the crop. First hand weeding was done at 15 days after transplanting to keep away the weeds. The second weeding was done 30 days after the first weeding followed by hoeing and earthing-up.

The growth parameters viz. plant height (the highest point of the plant above the soil surface) and canopy diameter of the plants (cm) were recorded from randomly selected five plants in each plot at 25, 40 and 55 days after transplanting. At the time of final harvest, plant height (cm), canopy diameter (cm), curd height (cm), curd diameter (cm), curd yield (ton/ha) and biological yield (ton/ha) were measured from those randomly selected five plants of each plot in both research sites. Similarly, period for first curd initiation and final maturity were recorded from the whole plant populations excluding the border plants in each plot. Statistical tool Genstat 15<sup>th</sup> edition was used for general analysis of variance; grand mean and standard error of mean. Means were compared using Duncan's Multiple Range Test (DMRT) at 0.05 and 0.01 levels of significance (Gomez and Gomez, 1984).

### Soil and weather condition

The soil samples from both experimental sites were analyzed in the soil lab. The fields were slightly acidic with 5.6 and 5.8 soil pH at Rampur and Puranchaur respectively. Soil texture was sandy loam had 4.2% organic matter, medium nitrogen (0.19%), medium phosphorus (42 kg/ha) and medium potash (118 kg/ha) in Rampur. Similarly, soil texture was sandy loam had 2.1% organic matter, medium nitrogen (0.11%), medium phosphorus (51 kg/ha) and medium potash (112 kg/ha) in Puranchaur. The daily average weather data viz. temperature and relative humidity (RH) were taken from National Maize Research Program, Rampur and Puranchaur meteorological station Puranchaur, Kaski during the growing period of cauliflower. The percentage of RH and mean temperature were calculated at ten days interval during the first day of December, 2016 to second week of March, 2017. The maximum mean temperature and RH was up to 22°C & 95% at Rampur and 17.5°C & 78% at Puranchaur respectively. Similarly, the minimum mean temperature and RH was up to 14°C & 77% at Rampur and 10.6°C & 54% at Puranchaur respectively. There was negligible rainfall at both research sites during this period. Details of mean temperature and relative humidity during the first day of December, 2016 to second week of March, 2017 has been shown in Figure 1.

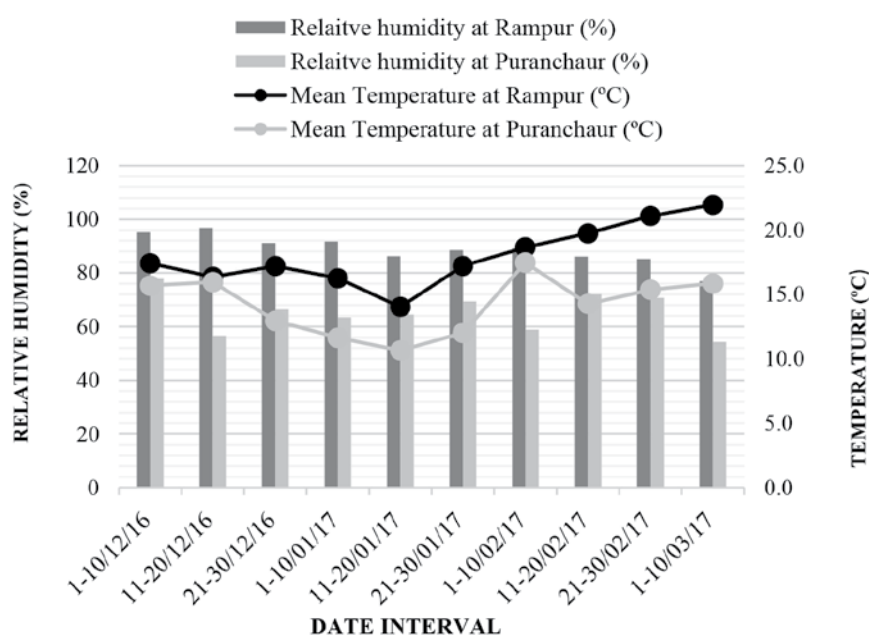


Figure 1: Mean temperature and relative humidity at ten days interval in Rampur, Chitwan and Puranchaur, Kaski (2016-2017)

## RESULTS AND DISCUSSION

### Plant growth

In both research sites, the plant height and canopy diameter of the major varieties were differed significantly ( $P < 0.01$ ). In Rampur, Bishop variety produced maximum plant height whereas in Puranchaur, the maximum plant height was attained by Ravella which was statistically similar to Titan. In overall, the highest plant height was in the variety Bishop at Rampur and the shortest plant height was in Snowball 16 variety at Puranchaur (Table 2). In Rampur, NS 106 had maximum canopy diameter while in Puranchaur, the maximum canopy diameter was in the variety Titan which was statistically similar to Freedom, Ravella, Bishop, Indam 9803, NS 106 and Snow Mystique. In overall, the highest plant canopy was produced by NS 106 from Rampur and the lowest canopy diameter was in the variety Snowball 16 in both locations.

All varieties of cauliflower showed higher plant growth as canopy diameter at lower altitude (Rampur) than at higher altitude (Puranchaur) due to higher temperature up to optimum level which is the influencing factors to obtain such positive result in cauliflower. Similar results were also reported by Rahman et al. (2007). Meena et al. (2010) also reported that the economic yield of the crops and its components characters are polygenic in nature, as it is also influenced by the environmental factors along with management practices. The intra-location variation within the varieties on plant growth parameters is due to the genetic characteristics of the cultivars which were introduced from different countries.



**Table 2. Plant growth parameters of the cauliflower at the time of harvesting in Rampur, Chitwan and Puranchaur, Kaski (2016-2017)**

Varieties	Plant height (cm)		Canopy diameter (cm)	
	Rampur	Puranchaur	Rampur	Puranchaur
Amazing	66.0 <sup>cde</sup>	57.8 <sup>fg</sup>	69.7 <sup>c</sup>	63.7 <sup>d</sup>
Artica	64.7 <sup>de</sup>	56.0 <sup>g</sup>	70.4 <sup>bc</sup>	61.4 <sup>de</sup>
Freedom	70.4 <sup>abcd</sup>	64.3 <sup>de</sup>	74.6 <sup>ab</sup>	64.3 <sup>d</sup>
Ravella	71.8 <sup>abc</sup>	66.5 <sup>bcde</sup>	72.3 <sup>abc</sup>	63.1 <sup>d</sup>
Titan	72.1 <sup>abc</sup>	66.3 <sup>cde</sup>	74.5 <sup>ab</sup>	65.0 <sup>d</sup>
Bishop	73.1 <sup>a</sup>	64.6 <sup>de</sup>	73.8 <sup>abc</sup>	64.2 <sup>d</sup>
Casper	57.2 <sup>fg</sup>	52.3 <sup>gh</sup>	70.0 <sup>c</sup>	58.0 <sup>ef</sup>
Indam 9803	66.0 <sup>cde</sup>	57.0 <sup>fg</sup>	71.6 <sup>bc</sup>	64.3 <sup>d</sup>
NS 106	72.7 <sup>ab</sup>	58.0 <sup>fg</sup>	76.2 <sup>a</sup>	64.3 <sup>d</sup>
Snowball 16	55.3 <sup>g</sup>	47.5 <sup>h</sup>	57.4 <sup>f</sup>	48.2 <sup>g</sup>
Snow Mystique	69.2 <sup>abcd</sup>	62.4 <sup>ef</sup>	70.1 <sup>c</sup>	63.4 <sup>d</sup>
Grand mean	67.17	59.36	71.00	61.85
SEM	2.37	2.78	1.55	2.17
LSD <sub>0.05</sub>	4.94	5.80	3.248	4.53
F-test	**	**	**	**
CV (%)	4.3	5.7	2.7	4.3

Means with same letter do not differ significantly at  $p=0.05$  by DMRT. SEM = Standard error of mean, LSD

Least significant difference and CV = Coefficient of variance

### Curd initiation and curd maturity

The late season varieties of the cauliflower were significantly differed for the first curd initiation ( $p<0.01$ ) at both locations. In Rampur, the shortest period for first curd initiation was found in Freedom and Indam 9803 but it was statistically at par with Bishop (Table 3). In Puranchaur, the shortest period of first curd initiation was found in Indam 9803 but it was statistically similar with NS 106 and Snowmystique (Table 3). In overall, the shortest period of the first curd initiation was found in Freedom and Indam 9803 at Rampur but Snowball 16 was found the longest period of first curd initiation in both locations. The late varieties of the cauliflower were differed significantly for the final maturity of the all curds ( $p<0.01$ ) in both locations. In Rampur, the shortest period of the final curd maturity was in Freedom and Bishop while in Puranchaur, the shortest period for final curd maturity was found in Amazing which was statistically similar to Bishop and Indam 9803 (Table3). In overall the shortest period of final curd maturity was found in Freedom and Bishop Varieties at Rampur but the longest period of final curd maturity was found in Snowball 16 at Puranchaur followed by Rampur.

The period for curd initiation and final maturity of the all curds in both locations were differed due to the genetic characteristics of the cultivars which is similar result with (Saini, 1996) and (Booij, 1990). The periods for curd initiation and curd maturity was longer in Puranchaur than Rampur which was due to greater optimum temperature at Rampur than Puranchaur. Similar results were also reported by Wurr et al. (1996). The days required for final maturity of the curds in Snowball 16 and Snowmystique were 120 and 90 days respectively at Rampur. Similar results were performed by these two varieties in Puranchaur. Other introduced varieties from USA and India performed more or less similar day requirement for final curd maturity at Rampur as mentioned in varietal catalogue but it was longer period in Puranchaur than existing varietal catalogue. It was due to lower temperature in Puranchaur during vegetative growth and development.

**Table 3. Days required for curd initiation and final curd maturity of the cauliflower at Rampur, Chitwan and Puranchaur, Kaski (2016-2017)**

Varieties	Days for first curd initiation		Days required for final maturity	
	Rampur	Puranchaur	Rampur	Puranchaur
Amazing	65 <sup>ghi</sup>	70 <sup>def</sup>	84 <sup>jk</sup>	94 <sup>h</sup>
Artica	63 <sup>hij</sup>	71 <sup>de</sup>	85 <sup>j</sup>	101 <sup>def</sup>
Freedom	61 <sup>j</sup>	74 <sup>cd</sup>	81 <sup>l</sup>	99 <sup>f</sup>
Ravella	63 <sup>hij</sup>	76 <sup>c</sup>	84 <sup>jk</sup>	104 <sup>c</sup>
Titan	66 <sup>fgh</sup>	75 <sup>c</sup>	85 <sup>j</sup>	102 <sup>cde</sup>
Bishop	62 <sup>ij</sup>	71 <sup>de</sup>	81 <sup>l</sup>	95 <sup>gh</sup>
Casper	64 <sup>hij</sup>	71 <sup>de</sup>	83 <sup>jkl</sup>	100 <sup>ef</sup>
Indam 9803	61 <sup>j</sup>	68 <sup>efg</sup>	82 <sup>kl</sup>	96 <sup>gh</sup>
NS 106	64 <sup>hij</sup>	69 <sup>ef</sup>	84 <sup>jk</sup>	97 <sup>g</sup>
Snowball 16	86 <sup>b</sup>	94 <sup>a</sup>	109 <sup>b</sup>	124 <sup>a</sup>
Snow Mystique	63 <sup>hij</sup>	70 <sup>ef</sup>	89 <sup>i</sup>	103 <sup>cd</sup>
Grand mean	65.64	73.77	86.48	101.72
SEM	1.07	1.83	0.90	1.32
LSD <sub>0.05</sub>	2.25	3.81	1.89	2.76
F-test	**	**	**	**
CV (%)	2.0	3.0	1.3	1.6

Means with same letter do not differ significantly at  $p=0.05$  by DMRT. SEM = Standard error of mean, LSD = Least significant difference and CV = Coefficient of variance

### Curd height, diameter and yield

In both locations, the curd height of the major late varieties were differed significantly ( $p<0.01$ ). In Rampur, the maximum curd height was found in Bishop but the lowest curd height was found in Amazing variety which was statistically similar to Casper. In Puranchaur, the maximum curd height was found in 9803 and NS 106 which were statistically similar to Artica, Bishop and Snowball 16. The shortest curd height was obtained from the Amazing which was statistically similar to Titan and Casper. In overall, the highest curd height was obtained in Bishop at Rampur and the lowest curd height also was found in Amazing at Rampur (Table 4). In both sites, the curd diameter of the major late season varieties of the cauliflower were differed significantly ( $p<0.05$ ). In Rampur, the maximum curd diameter was found in NS 106 which was statistically similar to Bishop but the lowest curd diameter was found in Titan variety. There was no significant differences on curd diameter among the late season varieties of cauliflower in Puranchaur. In overall, the highest curd diameter was found in Bishop and NS 106 from Rampur but the lowest curd diameter was found in Titan also at Rampur (Table 4). In both sites, the curd yield of the major varieties were tested and found significantly different ( $p<0.01$ ). In Rampur, the highest yield was found from the variety Bishop which was statistically similar to NS 106 but the lowest yield was found in Snowball 16. In Puranchaur, the highest yield was found in Bishop but the lowest yield was found in Snowball 16. In overall, the highest yield was found in Bishop and NS 106 at Rampur but the lowest yield was found in Snowball 16 followed by Amazing at Puranchaur (Table 4).

Amazing and Snowball 16 are open pollinated varieties, which produced low yield as compared to other introduced hybrid varieties which is the first time lead research in Terai and mid hill region of Nepal. Yield containing parameters and the economic yield of the different varieties were significantly different due to the genetic characteristics of the specified cultivars. The yield of the crops and its components characters are polygenic in nature, as it is influenced by the environmental factors and management practices which is similar result as reported by (Meena et al., 2010). Total economic yield was higher in Rampur site as compared to Puranchaur due to the average temperature near to optimum level in Rampur which is similar with results obtained by Rahman et al. (2007). Better yield was also obtained in Rampur than Puranchaur due to better

accumulation of dry matter in that areas and similar results was reported by (Suojala, 2003). Economic yield was influenced by the yield containing parameters of the cauliflower which is similar with result reported by (Sharma et al., 2006). Cauliflower curds produced in Puranchaur were more firm and uniform when compared with trails at Rampur which is genetically hardwired and other environmental factors were involved. Similar results were reported by (Wurr et al., 1996). Total economic yield and yield parameters were lower in Puranchaur when compared with trails at Rampur due to critical temperature exposed along with the lack of efficient utilization of limiting factors like nutrients, light, air and moisture.

**Table 4. Curd height, curd diameter and curd yield of the cauliflower in Rampur, Chitwan and Puranchaur, Kaski (2016-2017)**

Varieties	Curd height (cm)		Curd diameter (cm)		Curd yield (ton/ha)	
	Rampur	Puranchaur	Rampur	Puranchaur	Rampur	Puranchaur
Amazing	11.8 <sup>h</sup>	12.0 <sup>gh</sup>	19.0 <sup>de</sup>	20.6 <sup>abcd</sup>	39.87 <sup>de</sup>	36.97 <sup>e</sup>
Artica	13.7 <sup>bcde</sup>	13.8 <sup>bcde</sup>	19.7 <sup>bcde</sup>	20.4 <sup>abcde</sup>	49.94 <sup>abc</sup>	46.05 <sup>bcd</sup>
Freedom	14.2 <sup>bc</sup>	13.0 <sup>defg</sup>	21.2 <sup>abc</sup>	20.2 <sup>abcde</sup>	49.72 <sup>abc</sup>	40.52 <sup>de</sup>
Ravella	13.6 <sup>bcdef</sup>	13.1 <sup>cdefg</sup>	20.0 <sup>abcde</sup>	19.7 <sup>bcde</sup>	45.28 <sup>cde</sup>	42.04 <sup>cde</sup>
Titan	12.6 <sup>fgh</sup>	12.3 <sup>gh</sup>	18.4 <sup>e</sup>	19.4 <sup>cde</sup>	48.16 <sup>abcd</sup>	44.50 <sup>cde</sup>
Bishop	15.4 <sup>a</sup>	13.9 <sup>bcde</sup>	21.7 <sup>a</sup>	20.9 <sup>abcd</sup>	55.72 <sup>a</sup>	50.02 <sup>abc</sup>
Casper	12.2 <sup>gh</sup>	12.3 <sup>gh</sup>	19.7 <sup>bcde</sup>	20.1 <sup>abcde</sup>	47.68 <sup>abcd</sup>	44.68 <sup>cde</sup>
Indam 9803	13.6 <sup>bcdef</sup>	14.0 <sup>bcde</sup>	21.3 <sup>abc</sup>	20.5 <sup>abcd</sup>	53.84 <sup>ab</sup>	45.19 <sup>cde</sup>
NS 106	14.7 <sup>ab</sup>	14.0 <sup>bcde</sup>	21.9 <sup>a</sup>	21.5 <sup>ab</sup>	55.30 <sup>a</sup>	44.97 <sup>cde</sup>
Snowball16	14.2 <sup>bcd</sup>	13.8 <sup>bcde</sup>	20.2 <sup>abcde</sup>	20.3 <sup>abcde</sup>	24.02 <sup>f</sup>	19.00 <sup>f</sup>
S-Mystique	13.4 <sup>cdef</sup>	13.0 <sup>efg</sup>	20.1 <sup>abcde</sup>	21.3 <sup>abc</sup>	44.75 <sup>cde</sup>	45.09 <sup>cde</sup>
Grand mean	13.61	13.23	20.33	20.48	46.75	41.73
SEM	0.45	0.47	0.91	0.65	3.73	2.88
LSD <sub>0.05</sub>	0.94	0.98	1.91	1.36	7.78	6.02
F-test	**	**	*	NS	**	**
CV (%)	4.1	4.4	5.5	3.9	9.8	8.5

Means with same letter do not differ significantly at  $p=0.05$  by DMRT. SEM = Standard error of mean, LSD = Least significant difference and CV = Coefficient of variance

#### Post-harvest quality of the cauliflower

Determination of titrable acid (TA), total soluble solid (TSS) and percentage of hydrogen ions (pH) of the late season varieties of the cauliflower at harvesting time is presented in Table 5. In both research locations, there was no significant differences on titrable acidity (TA) among the major varieties of the cauliflower. In overall, the highest total soluble solid (TSS) was recorded in Snowball 16 at Rampur which was statistically similar to same variety at Puranchaur but the lowest TSS was recorded in Amazing and Indam 9803 also at Rampur (Table 5). In Rampur, there was no significant differences on pH among the late season varieties of the cauliflower. Varieties at Rampur showed the higher pH than Puranchaur. In overall, the variety Titan recorded the lowest pH among the varieties at both locations.

The TSS value was obtained higher in local variety i.e. Snowball 16 than other hybrid varieties in both locations due to its genetic characteristics of the varieties. All the late season varieties of the cauliflower from Terai region had higher TSS than the varieties from hilly region which was due to better accumulation of sugar which is similar with results obtained by (Suojala, 2003). Cauliflower varieties from Terai regions contain more sugar content than hilly region because of high concentration of sulfur containing glucosinolate which is similar with results obtained by Yano et al. (1990).

**Table 5. TA, TSS and pH of the of cauliflower at the time of harvesting at Rampur, Chitwan and Puranchaur, Kaski (2016-2017)**

Varieties	TA		TSS		pH	
	Rampur	Puranchaur	Rampur	Puranchaur	Rampur	Puranchaur
Amazing	0.5	0.5	3.9 <sup>d</sup>	4.5 <sup>cd</sup>	6.5 <sup>abcd</sup>	6.3 <sup>efg</sup>
Artica	0.5	0.5	4.1 <sup>cd</sup>	4.3 <sup>cd</sup>	6.7 <sup>abc</sup>	6.4 <sup>defg</sup>
Freedom	0.6	0.6	4.5 <sup>cd</sup>	4.8 <sup>bc</sup>	6.5 <sup>abcd</sup>	6.3 <sup>fg</sup>
Ravella	0.6	0.5	4.1 <sup>cd</sup>	4.3 <sup>cd</sup>	6.6 <sup>abc</sup>	6.3 <sup>efg</sup>
Titan	0.6	0.5	4.1 <sup>cd</sup>	4.1 <sup>cd</sup>	6.7 <sup>a</sup>	6.3 <sup>g</sup>
Bishop	0.6	0.5	4.2 <sup>cd</sup>	4.5 <sup>cd</sup>	6.6 <sup>abc</sup>	6.3 <sup>efg</sup>
Casper	0.5	0.4	4.4 <sup>cd</sup>	4.5 <sup>cd</sup>	6.7 <sup>ab</sup>	6.5 <sup>cdef</sup>
Indam 9803	0.5	0.4	3.9 <sup>d</sup>	4.3 <sup>cd</sup>	6.5 <sup>abcd</sup>	6.5 <sup>bcde</sup>
Ns 106	0.6	0.5	4.1 <sup>cd</sup>	4.2 <sup>cd</sup>	6.6 <sup>abc</sup>	6.4 <sup>defg</sup>
Snowball 16	0.6	0.6	5.8 <sup>a</sup>	5.5 <sup>ab</sup>	6.6 <sup>abc</sup>	6.6 <sup>abc</sup>
Snow Mystique	0.7	0.5	4.3 <sup>cd</sup>	4.6 <sup>cd</sup>	6.6 <sup>abc</sup>	6.3 <sup>efg</sup>
Grand mean	0.68	0.54	4.36	4.55	6.6	6.43
SEM	0.05	0.04	0.27	0.18	0.06	0.05
LSD <sub>0.05</sub>	0.16	0.13	0.81	0.5	0.17	0.15
F-test	NA	NA	**	**	NA	**
CV (%)	15.3	14.7	11	6.9	1.6	1.4

Means with same letter do not differ significantly at  $p=0.05$  by DMRT. SEM = Standard error of mean, LSD = Least significant difference and CV = Coefficient of variance

### CONCLUSION

The plant growth parameters, yield and post-harvest quality of major late season varieties of cauliflower were differed significantly in Terai and Mid-hill region of Nepal. Newly introduced varieties Bishop and NS 106 produced the highest plant height and canopy diameter. Bishop along with NS 106 was recognized as short duration varieties which can minimize the negative effects during late season. These two varieties were also performed the higher yield at Terai and Mid-hill region of Nepal. Growth parameters along with yield parameters and pH value of these late season varieties of the cauliflower were comparatively higher in Terai than Mid-hill region of Nepal. Other promising varieties along with Bishop and NS 106 were Snowmystique, Freedom and Artica that these varieties need further evaluation for verification to adopt in different regions of Nepal.

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