Research Article:

COMPARISON ON PLANT GROWTH, YIELD AND QUALITY OF BROCCOLI (*Brassica oleracea* L. var. *italica* Plenck) VARIETIES IN SINDHULI AND KAILALI DISTRICTS OF NEPAL

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ABSTRACT

Broccoli (*Brassica oleracea* L. var. *italica* Plenck) is a highly valued vegetable in Nepal. Head size and quality of broccoli largely depend on temperature and genetic potentiality. Hence, location specific varietal selection is crucial. Two experiments were conducted to evaluate the growth, yield and postharvest quality of broccoli varieties in Sindhuli and Kailali districts of Nepal during October, 2024 to February, 2025. The experiment was laid out in Randomized Complete Block Design with four replications. The five broccoli varieties studied were Calabrese, Chitwan Local, Centauro, Everest Green and Green Pia. Results revealed that in Sindhuli significantly the maximum plant height (75.27 cm), number of leaves (13.44), earliest head initiation (43.50 days) and maturity (58.5 days) were observed in Calabrese; however, head diameter (19.17 cm) and yield (21 mt/ha) were maximum in Everest Green which was at par with Centauro (19.45 mt/ha). In Kailali, maximum number of leaves (11.7) and leaf area (327.72 cm^2) were observed in Chitwan Local; highest plant height, earliest head initiation (41.5 days) and maturity (53.75 days) in Calabrese; maximum head diameter (17 cm) in Green Pia and yield (19 mt/ha) was maximum in Everest Green which was statistically at par with Green Pia and Centauro. TSS, TA% and pH differed in Sindhuli but remained similar in Kailali. Green Pia had the longest shelf life in both the locations. Thus, Everest Green and Centauro in Sindhuli, while any variety among Everest Green, Centauro and Green Pia in Kailali proved to be promising to maximize the yield.

सारांश

ब्रोकाउली नेपालको एक महत्त्वपूर्ण तरकारी हो। ब्रोकाउलीको फूलको आकार र गुणस्तर धेरै हदसम्म तापक्रम र आनुवंशिक क्षमतामा निर्भर गर्दछ। त्यसैले, स्थानविशेष जात चयन महत्त्वपूर्ण छ । कार्तिक, २०८१ देखि माघ, २०८१ सम्म नेपालको सिन्धुली र कैलाली जिल्लाहरूमा ब्रोकाउलीका जातहरूको वृद्धि, उत्पादन र फसल पछिको गुणस्तर मूल्याङ्कन गर्न दुई अध्ययनहरू गरिएको थियो। यो अध्ययन अनियमित पूर्ण ब्लक डिजाइनमा चार पटक दोहोर्याइ राखिएको थियो। अध्ययन गरिएका पाँच ब्रोकाउलीका जातहरू क्यालाब्रेस, चितवन लोकल, सेन्टाउरो, एभरेस्ट ग्रीन र ग्रीन पिया थिए । नतिजाहरूले सिन्धुलीमा उल्लेखनीय रूपमा अधिकतम बिरुवाको उचाइ (७५.२७ से.मी), पातहरूको संख्या (१३.४४), फूलको सुरुवात (४३.५० दिन) र परिपक्वता (५८.५ दिन) क्यालाब्रेसमा अवलोकन गरिएको थियो। यद्यपि, एभरेस्ट ग्रीनमा अधिकतम फूलको व्यास (१९.१७ से.मी) र उत्पादन (२१ मेट्रिक टन/हेक्टर) थियो जुन तथ्याङ्कीय रूपमा सेन्टाउरोसँग (१९.४५ मेट्रिक टन/हेक्टर) समान थियो । कैलालीमा, अधिकतम पातहरूको संख्या (११.७) र पातको क्षेत्रफल (३२७.७२ वर्ग से.मी) चितवन लोकलले देखायो । क्यालाब्रेसमा सबैभन्दा बढी बिरुवाको उचाइ, सबैभन्दा पहिले फूलको सुरुवात (४१.५ दिन) र परिपक्वता (५३.७५ दिन) अवलोकन गरियो ।

अधिकतम फूलको व्यास (१७ सेमी) ग्रीन पियामा र अधिकतम उत्पादन (१९ मेट्रिक टन/हेक्टर) एभरेस्ट ग्रीनमा थियो जुन तथ्याङ्कीय रूपमा ग्रीन पिया र सेन्टाउरोसँग समान थियो । सिन्धुलीमा कुल घुलनशील ठोस पदार्थ, विलयमान अम्ल र पिएच फरक देखियो तर कैलालीमा समान रह्यो । दुबै स्थानहरूमा फसल पछिको स्वःजीवन ग्रीन पियामा सबैभन्दा लामो देखियो। यसरी, सिन्धुलीमा एभरेस्ट ग्रीन र सेन्टाउरो, जबकि कैलालीमा एभरेस्ट ग्रीन, सेन्टाउरो र ग्रीन पिया मध्ये कुनै पनि जातले अधिकतम उत्पादन दिने साबित भयो।

Keywords: Genotype, head size, sprouting broccoli, varietal selection and quality

INTRODUCTION

Broccoli (*Brassica oleracea* L. var. *italica* Plenck, 2n=18), belongs to the family Brassicaceae (Plenck, 1794) and is popularly known for its high nutritive value. It is highly remunerative and is a widely grown cool season vegetable in tropics and subtropics (FAO, 2018). Owing to its numerous health benefits, it is commonly recommended by dieticians and highly valued by the consumers (Khirwar & Shukla, 2025). Broccoli is a rich source of vitamins C, K, and A. It also contains minerals like potassium, calcium, and iron. The glucosinolates contained in broccoli help to fight against cancer. Anti-inflammatory, antioxidant, and fiber-rich properties of broccoli support heart and gut health as well as boost the immune system (Barber et al., 2020; Jacques et al., 2013). The high content of vitamin A promotes eye health and prevents cataracts (Rasmussen & Johnson, 2013).

The edible part of broccoli is the terminal head including fleshy stalk and are consumed either as salad or cooked. Mainly, two types of broccoli are grown in Nepal i.e. heading type and sprouting type (Piya et al., 2008). Green sprouting types are also called Italian types or Calabrese. Heading types form larger and compact heads as in cauliflower; whereas sprouting broccoli produce a smaller central head. After harvesting of the central head, sprouting types produce many smaller heads with long slender flower stalks called as spears arising from axils of leaves and contributing to around 50% of yield per plant (Bose et al., 1986). Sprouting types allow multiple harvesting and are preferred for kitchen gardening or rooftop farming whereas heading types are commercially cultivated (Dahal et al., 2022).

The head size of broccoli depends on temperature. Temperature also determines the time of transition of the plant from vegetative to head formation phase (Fellows et al., 1997), thus affects the duration of the vegetative phase. Yield is higher when the crop receives a temperature range 15-25°C during the vegetative to head harvesting stage. Long time exposure to higher temperature lowers the yield and quality (Kaluzewicz et al., 2009). In Nepal broccoli is cultivated in 3,529 ha with the production and productivity of 44,227 mt and 12.53 mt/ha respectively (MoALD, 2025). Nepal is far behind in terms of broccoli production as compared to China, which is a leading country in the world for broccoli production. The average productivity of broccoli in China is 19.60 mt/ha (FAO, 2025). Sindhuli and Kailali districts have lower productivity than the national average (MoALD, 2025).

The market price of broccoli is always higher than cauliflower and cabbage even in the normal winter season. Despite its high nutrition and monitory value, very few formal studies have been carried out in Nepal (Piya et al., 2010). Due to climate change crops have to encounter various biotic and abiotic stresses (Pandey et al., 2015). Various genotypes need to be maintained suitable for climatic diversity of Nepal (Upadhya & Joshi, 2003). Highest percentage of hybrid seeds of cole crops (86.41%) was imported in Nepal (Kafle & Joshi, 2018). It is essential to test the costly hybrids being imported in Nepal (Subedi & KC, 2004) whereas open pollinated varieties although inexpensive, their production is low (Pixley & Banziger, 2004). Hybrid

varieties available nowadays are heat and moisture tolerant. Proper varietal selection is critical to obtain high yields and desirable head quality (Lestrange et al., 2003). Performance of a crop or variety depends on its genetic potential and the climatic conditions of the place (Prashanti et al., 2022). Nepalese farmers are still unable to select high yielding broccoli varieties suitable for their locality as well as face various postharvest problems like quick yellowing of broccoli heads leading to shorter shelf life. There is an urgent need to lower the yield gap of broccoli in Nepal, select the promising variety with better quality and fulfill the market demand. Hence, an experiment to evaluate the growth, yield and quality of broccoli varieties was conducted at two different locations of Nepal i.e. Marin of Sindhuli and Tikapur of Kailali district.

RESEARCH METHODS

Experimental site and location

The field experiment was conducted at two locations of Nepal i.e. Marin rural municipality, Sindhuli and Tikapur municipality, Kailali, Nepal during October 2024 to February 2025. Geographically, Marin is located at 27° 14′ 53″ N and 85° 42′ 0″ E with an elevation of 299 masl while Tikapur lies at 28°31′30″N and 81°07′15″ E with an elevation of 159 masl. The experimental fields under the College of Natural Resource Management, Sindhuli and Kailali were used in the study, which are the constituent colleges of AFU, Nepal.

Soil properties of the experimental field

Soil samples were collected from the experimental fields of both sites before transplanting seedlings and were tested at nearby soil and fertilizer testing labs at Hetauda and Kanchanpur.

Table 1. Physico-chemical properties of soil at research field in Sindhuli and Kailali, 2024/25

Parameters	Observed results		Methods of testing
	Sindhuli	Kailali	
Soil texture	Sandy loam	Silty loam	Hydrometer
pH	5.1 (Acidic)	7.28 (N)	pH meter
Organic matter (%)	2.02 (L)	2.55 (M)	Walkley-black
Total nitrogen (%)	0.10 (L)	0.13 (M)	Kjeldhal digestion
Available phosphorus (kg/ha)	22.00 (L)	125.46 (H)	Modified Olsen bicarbonate
Available potassium (kg/ha)	38.00 (VL)	141.38 (M)	Flame photometer

Note: N: Neutral, VL: Very low, L: Low, M: Medium, H: High

Weather parameters of the research sites

During the experiment the maximum mean monthly temperature was 24.72°C and 25.03°C in October while the minimum was 16.8°C and 16.65 °C in January at Marin, Sindhuli and Tikapur, Kailali respectively. In case of relative humidity Marin was relatively humid as compared to Tikapur. The maximum mean monthly RH was 85.09% and 77.08% in October while the minimum was 38.8% and 37.63% in February at Marin and Tikapur respectively. Temperature and humidity were measured using digital thermo-hygrometer at both the locations.

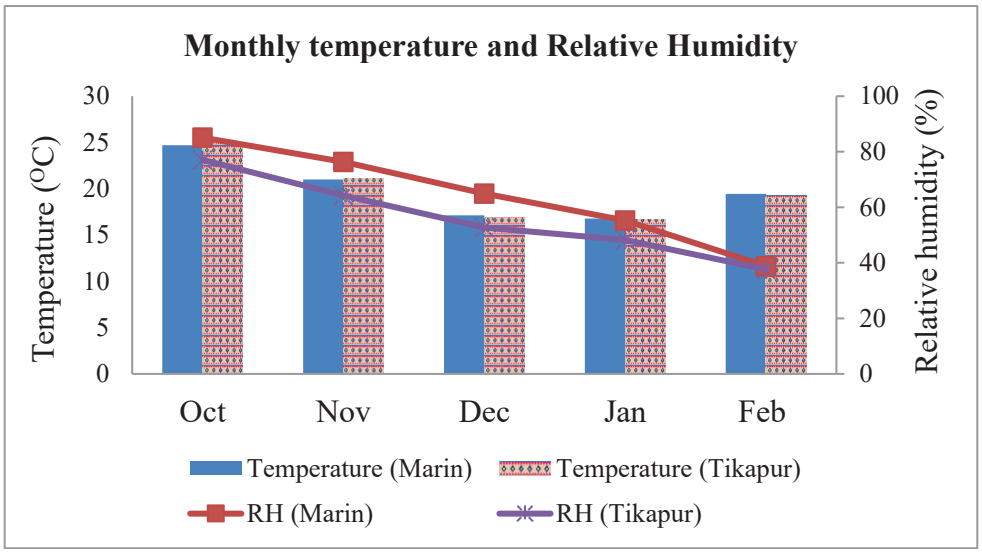

Fig. 1. Weather parameters of the experimental sites during the crop growing period

Experimental design and treatments

The experiment was conducted in Randomized Complete Block Design (RCBD) with five varieties of broccoli which were replicated four times. The area of an individual plot was 7.5 m^2 (3 m × 2.5 m) , having a total 25 plants per plot. Seedlings were transplanted at the spacing of 60 cm × 50 cm. Among the 9 inner plants excluding the border, 5 plants were selected at random as sample plants for data collection. The varieties of broccoli used in the experiment are listed in table 2.

Table 2. Treatment details of the experiment in Sindhuli and Kailali, 2024/25

SN	Varieties	Varieties type
1.	Centauro	Hybrid
2.	Everest Green	Hybrid
3.	Green Pia	Hybrid
4.	Calabrese	Open pollinated
5.	Chitwan Local	Open pollinated

Farm yard manure was applied @ 30 mt/ha and NPK at 200:120:100 kg/ha along with 20 kg Borax/ha. Urea, DAP and MoP fertilizers were used as sources of NPK respectively. Full dose of FYM, phosphorus, potassium, borax, and half dose of nitrogen were applied as a basal dose while the remaining half dose of nitrogen was applied at equal splits at 25 and 40 days after transplanting. Seed sowing was done on October 25, and uniform seedlings of 25 days old with 3-4 true leaves were transplanted at both the locations, i.e., Marin and Tikapur. Similarly, regular management practices like watering and plant protection measures were followed based on the crop requirements. Various crop growth, phenological, yield, and quality parameters were recorded from the sample plants. Data were compiled in Microsoft Excel, and R-studio version 4.2.3 was used for the analysis of variance, and the treatment means were compared using the LSD test at 5% level of significance.

RESULTS AND DISCUSSION

Plant height

Plant height of broccoli varieties in Sindhuli and Kailali is shown in table 3. In Sindhuli, plant height of broccoli varieties at 60 days after transplanting (DAT) was highly significant.

Significantly the maximum plant height (75.27 cm) was observed in Calabrese followed by Chitwan Local (69.38 cm). At 60 DAT, plant height was also found to be significantly different at Kailali. Among the broccoli varieties, Calabrese (74 cm), which is statistically at par with Chitwan Local (72.5 cm), showed the highest plant height, while the lowest plant height was observed on Centauro (56.75 cm), which is similar to Everest Green (58.75 cm) and Green Pia (60.70 cm).

Table 3. Plant height of broccoli (*Brassica oleracea* var. *italica*) varieties in Sindhuli and Kailali, 2024/25

Varieties	Plant height at 60 DAT (cm)	
	Sindhuli	Kailali
Centauro	58.97^{c}	56.75^{b}
Everest Green	62.16^{c}	58.75^{b}
Green Pia	60.30^{c}	60.70^{b}
Calabrese	75.27^{a}	74.00^{a}
Chitwan Local	69.38^{b}	72.50^{a}
SEm (±)	1.28	2.033
CV (%)	3.66	1.0
$LSD_{0.05}$	3.68	4.430
F-probability	***	***
Grand mean	65.21	64.54

Note: Means with the same letter(s) within a column are non-significant at p = 0.05 by LSD. ***Significant at 0.1% (p< 0.001), LSD= Least significant difference, CV= Coefficient of variation, DAT = Days after transplanting, SEm= Standard error of mean

Number of leaves per plant

The number of leaves per plant of broccoli varieties in Sindhuli and Kailali is shown in table 4. In Sindhuli, the number of leaves per plant of broccoli varieties at harvest was significant. Significantly the maximum number of leaves (13.44) per plant was obtained in Calabrese which was statistically at par with Chitwan Local (11.75). At Kailali, the number of leaves per plant was significantly different among the varieties of broccoli. At 60 DAT, Chitwan Local had the maximum number of leaves (11.7), which was statistically similar with Green Pia and Calabrese.

Table 4. Number of leaves per plant of broccoli (*Brassica oleracea* var. *italica*) varieties in Sindhuli and Kailali, 2024/25

Varieties	Number of leaves per plant at 60 DAT	
	Sindhuli	Kailali
Centauro	8.65^{b}	9.05^{b}
Everest Green	10.80^{ab}	10.4a^{b}
Green Pia	11.00^{ab}	11.65^{a}
Calabrese	13.44^{a}	11.05^{a}
Chitwan Local	11.75^{a}	11.7^{a}
SEm (±)	0.71	1.32
CV (%)	18.14	10.65
$LSD_{0.05}$	3.04	1.77
F-probability	*	*
Grand mean	11.12	10.77

Note: Means with the same letter(s) within a column are non-significant at p = 0.05 by LSD. *Significant at 5% (p<0.05), LSD= Least significant difference, CV= Coefficient of variation, DAT= Days after transplanting, SEm= Standard error of mean

Leaf area

Leaf area of broccoli varieties in Sindhuli and Kailali is shown in table 5. In Sindhuli, leaf area of different broccoli varieties did not significantly differ, however, the maximum leaf area was observed in Calabrese (447.93 cm^2) while minimum in Everest Green (399.33 cm^2). At 60 DAT, leaf area was significantly influenced by the varieties at Kailali. Chitwan Local recorded the maximum leaf area (327.72 cm^2), which was statistically similar to Calabrese and Centauro. On the other hand, the minimum leaf area was shown by Green Pia (224.99 cm^2), which is statistically at par with Everest Green.

Plant height was found to be significantly different among the varieties of broccoli. Calabrese had the tallest plant height in both locations i.e., Sindhuli and Kailali. Difference in plant height among varieties was also reported by Sivakumar et al. (2022) as well as Prashanti et al. (2022). Variation in plant height among varieties might be due to their inbuilt genetic layout (Thapa & Rai, 2012). Variation in leaf number and leaf area is also attributed to genetic arrangement among varieties. Such variation may also be differentially exhibited by varieties that are adapted to various agro-climatic conditions (Giri et al., 2013; Prashanti et al., 2022).

Table 5. Leaf area of broccoli (*Brassica oleracea* var. *italica*) varieties in Sindhuli and Kailali, 2024/25

Varieties	Leaf area at 60 DAT (cm^2)	
	Sindhuli	Kailali
Centauro	426.07	289.23[ab]
Everest Green	399.33	242.747[b]
Green Pia	424.37	224.99[b]
Calabrese	447.93	288.38[ab]
Chitwan Local	422.51	327.72[a]
SEm (±)	17.65	23.44
CV (%)	11.77	17.22
$LSD_{0.05}$	75.26	72.86
F-probability	Ns	*
Grand mean	424.04	274.62

Note: Means with the same letter(s) within a column are non-significant at p = 0.05 by LSD. *Significant at 5% ($p<0.05$), ns = Non-significant, LSD= Least significant difference, CV= Coefficient of variation, DAT = Days after transplanting, SEm= Standard error of mean

Phenological characters

Phenological characters of broccoli varieties in Sindhuli and Kailali are shown in table 6. In Sindhuli, days to head initiation were highly significant among the broccoli varieties. Calabrese showed the earliest days to head initiation (43.5 days) followed by Chitwan Local (47.25 days). Similarly, days to head maturity was also highly significant among the broccoli varieties. The earliest head maturity (58.5 days) was found in Calabrese, followed by Chitwan Local (62.5 days). At Kailali, statistically significant differences were observed among the broccoli varieties for phenological characters. The earliest days to curd initiation were observed in Calabrese (41 days), while the maximum days for curd initiation were observed in Everest Green (48 days), which was statistically at par with Green Pia. On the other hand, the earliest curd maturity was attained by Calabrese (53.75 days), and late maturity was shown by Green Pia (75.5 days).

Days to head initiation as well as head maturity differed among varieties in both locations. This might be because phenology largely depends on genotypic character. Calabrese and Chitwan Local might have a genetic makeup with a short vegetative phase, early transformation to the generative phase, as well as early head maturity. Similar results are reported by Bagale et al. (2024a) as well as Thapa and Rai (2012) in broccoli.

Table 6. Phenological characters of broccoli (*Brassica oleracea* var. *italica*) varieties in Sindhuli and Kailali, 2024/25

Varieties	Phenological characters			
	Days to head initiation		Days to head maturity	
	Sindhuli	Kailali	Sindhuli	Kailali
Centauro	53.75[a]	45.5[b]	80.5[b]	71[b]
Everest Green	51.00[b]	48[a]	78.5[c]	70.5[b]
Green Pia	51.75[ab]	47.5[a]	82.0[a]	75.5[a]
Calabrese	43.50[d]	41.5[c]	58.5[e]	53.75[d]
Chitwan Local	47.25[c]	45[b]	62.5[d]	64.75[c]
SEm (±)	0.51	0.742	0.22	0.516
CV (%)	2.91	1.4	0.87	0.9
$LSD_{0.05}$	2.175	1.616	0.953	1.547
F-probability	***	***	***	***
Grand mean	49.45	45.50	72.4	67.10

Note: Means with the same letter(s) within a column are non-significant at p = 0.05 by LSD. ***Significant at 0.1% (p< 0.001), LSD= Least significant difference, CV= Coefficient of variation, SEm= Standard error of mean

Yield attributes

Yields attributing characters of broccoli varieties in Sindhuli and Kailali are shown in table 7. In Sindhuli, head diameter was highly significant among the broccoli varieties. The largest head diameter was observed in Everest Green (19.17 cm) which was statistically at par with Centaruo (18.03 cm) while Calabrese had the smallest head diameter (9.46 cm) which was statistically at par with Chitwan Local (9.89 cm). Similarly, head yield per hectare was also significant among the varieties. The maximum yield (21 mt/ha) was obtained in Everest Green which was statistically similar with Centauro (19.45 mt/ha) while the minimum yield was obtained in Chitwan Local (12.08 mt/ha) which was statistically at par with Calabrese (13.69 mt/ha). In Kailali, head diameter was statistically different. The highest head diameter was shown by Centauro (17.75 cm), which was statistically at par with Everest Green and Green Pia. Similarly, head yield per hectare was also significant among the varieties in Kailali. The highest yield (19 mt/ha) was obtained from Everest Green which was statistically similar with Cetauro and Green Pia while the lowest yield (12 mt/ha) was obtained from Chitwan Local which was at par with Calabrese.

A greater number of leaves in open pollinated varieties might have reduced the yield by consuming the nutrient by the leaves making the nutrients less available for the head, as reported by Tejaswini et al. (2018) as well as Bagale et al. (2024a). Yield of crops is a complex polygenic trait and is affected by environmental factors and management practices (Sharma et al., 2018). Compact and larger heads might have contributed to the higher yield of hybrids.

Table 7. Yield parameters of broccoli (*Brassica oleracea* var. *italica*) varieties in Sindhuli and Kailali, 2024/25

Varieties	Yield parameters			
	Head diameter (cm)		Yield (mt/ha)	
	Sindhuli	Kailali	Sindhuli	Kailali
Centauro	18.03[ab]	17.75[a]	19.45[a]	18.25[a]
Everest Green	19.17[a]	15.75[a]	21.00[a]	19.00[a]
Green Pia	16.37[b]	17.00[a]	16.16[ab]	16.75[a]
Calabrese	9.46[c]	11.75[b]	13.69[b]	12.75[b]
Chitwan Local	9.89[c]	12.00[b]	12.08[b]	12.00[b]

SEm (±)	0.57	1.11	1.14	2.47
CV (%)	11.14	9.4	19.60	9.99
$LSD_{0.05}$	2.29	2.41	4.86	2.42
F-probability	***	***	**	***
Grand mean	14.58	14.85	16.48	15.75

Note: Means with the same letter(s) within a column are non-significant at p = 0.05 by LSD. **Significant at 1% (p<0.01), ***Significant at 0.1% (p< 0.001), LSD= Least significant difference, CV= Coefficient of variation, SEm= Standard error of mean

Quality attributes

Quality parameters of broccoli varieties in Sindhuli and Kailali are presented in table 8. In Sindhuli, TSS, TA% as well as pH were highly significant among the broccoli varieties. Calarese recorded the maximum TSS (6.83˚Bx) than other varieties which was statistically at par with Chitwan Local (6.61˚Bx). Calabrese also recorded maximum TA% (0.44%) which was statistically at par with Chitwan Local (0.42%). The maximum pH (6.3) was obtained in Green Pia which was statistically at par with Everest Green and Centauro while the minimum pH (5.80) was obtained in Chitwan Local which was at par with Calabrese. Post-harvest quality parameters such as TSS, TA, and pH showed non-significant results at Kailali.

Varietal difference in quality attributes of broccoli, like TSS, TA%, pH, and shelf life, may be due to the influence by pre-harvest and post-harvest factors such as season of growth, soil fertility and cultural practices in broccoli (Giri et al., 2020; Kindo & Singh, 2018; Vallejo et al., 2003). The difference in TSS among the varieties might be due to good stomatal conductance and nutrient absorption capacity, providing favorable conditions for carbon metabolism and higher glucose production that contributed to the TSS content. Open-pollinated varieties showed higher TSS and TA% similar results were found in cauliflower (Abbey et al., 2002; Giri et al., 2020). The genetic diversity in response to quality attributes was observed in broccoli (Bagale et al., 2024b; Bhangre et al., 2011; El-Magd, 2013; Prashanthi et al., 2022).

Table 8. Quality parameters of broccoli (*Brassica oleracea* var. *italica*) varieties in Sindhuli and Kailali, 2024/25

Varieties	Quality parameters					
	TSS (˚Brix)		TA (%)		pH	
	Sindhuli	Kailali	Sindhuli	Kailali	Sindhuli	Kailali
Centauro	5.09[b]	4.97	0.17[b]	0.30	6.3[a]	6.0
Everest Green	4.29[b]	4.90	0.10[c]	0.18	6.3[a]	6.2
Green Pia	4.35[b]	4.72	0.09[c]	0.27	6.3[a]	5.9
Calabrese	6.83[a]	4.60	0.44[a]	0.28	5.8[b]	6.0
Chitwan Local	6.61[a]	5.15	0.42[a]	0.36	5.8[b]	6.1
SEm (±)	0.20	0.422	0.012	0.088	0.059	0.248
CV (%)	10.43	14.4	13.89	22.9	0.86	2.7
$LSD_{0.05}$	0.855	-	0.052	-	0.080	-
F-probability	***	ns	***	ns	***	ns
Grand mean	5.43	4.87	0.24	0.28	6.1	6.0

Note: Means with the same letter(s) within a column are non-significant at p = 0.05 by LSD. ***Significant at 0.1% (p< 0.001), ns = Non-significant, LSD= Least significant difference, CV= Coefficient of variation, SEm= Standard error of mean, pH= Potential of hydrogen and TSS= Total soluble solids

Shelf life

Shelf life of broccoli varieties under ordinary room storage (21.32 ± 0.44, 64.43 ± 4.25% RH in Sindhuli while 20.12 ± 0.31, 60.33 ± 5.15% RH in Kailali) is presented in table 9. In Sindhuli, the maximum shelf life is obtained in Green Pia (5.25 days), while the minimum shelf life (2.00 days) was observed in Chitwan Local, which was statistically at par with Calabrese. At Kailali, significant differences were observed among the broccoli varieties for shelf life. The highest shelf life was noted on Green Pia (5.75 days), while the lowest was observed on Chitwan Local (2.50 days), which is statistically at par with Calabrese.

Variation in shelf life may be due to genetic traits of genotypes and their interaction with growing environment as well as ambient condition of the storage environment (Sinha et al., 2019). Shorter shelf life of Calabrese and Chitwan Local resulted due to higher physiological loss in weight whereas hybrids had longer shelf life due to compact florets in their heads. It is because compact heads have less surface area and face lower water loss as well as less prone to damage. Similar findings were obtained by Conversa et al. (2020) in broccoli.

Table 9. Shelf life of broccoli (*Brassica oleracea* var. *italica*) varieties under ordinary room storage in Sindhuli and Kailali, 2024/25

Varieties	Shelf life (days)	
	Sindhuli	Kailali
Centauro	3.0[b]	4.2[b]
Everest Green	3.2[b]	3.7[b]
Green Pia	5.2[a]	5.7[a]
Calabrese	2.2[c]	2.5[c]
Chitwan Local	2.0[c]	2.5[c]
SEm (±)	0.13	0.45
CV (%)	12.2	8.0
$LSD_{0.05}$	0.58	0.98
F-probability	***	***
Grand mean	3.1	3.7

Note: Means with the same letter(s) within a column are non-significant at p = 0.05 by LSD. ***Significant at 0.1% (p< 0.001), LSD= Least significant difference, CV= Coefficient of variation, SEm= Standard error of mean

CONCLUSION

There was a significant difference in growth, phenology, yield and quality among the broccoli varieties grown in Marin, Sindhuli. The maximum plant height, number of leaves, earliest head initiation, and maturity were observed in Calabrese; however, head diameter and yield was maximum in Everest Green and were similar to Centauro. In Tikapur, Kailali, plant height was highest in Calabrese, maximum number of leaves and leaf area were observed in Chitwan Local; earliest head initiation and maturity was obtained in Calabrese; head diameter and yield was maximum in Everest Green Pia which was similar to Centauro and Green Pia. TSS, TA, and pH differed in Sindhuli but remained similar in Kailali. Green Pia had the longest shelf life in both locations. Finally, there was no significant difference on yield among the hybrid varieties in both locations i.e. Sindhuli and Kailali.

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AUTHOR CONTRIBUTIONS

Author A: Conceptualization, Supervision, Writing – Review & Editing.
Author B: Investigation, Data Curation, Formal Analysis, Writing – Original Draft, Writing – Review & Editing.
Author C: Investigation, Data Curation, Formal Analysis, Writing – Original Draft.

CONFLICT OF INTEREST

The authors agree in not having any conflict of interest regarding the published material. All the authors had gone through the document prior to the submission to the Journal of Agriculture and Forestry University.

ETHICS APPROVAL

No human participants or animals were involved during the study and prior approvals were obtained where applicable.

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