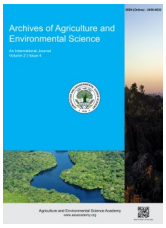
Archives of Agriculture and Environmental Science 9(1): 23-28 (2024)
https://doi.org/10.26832/24566632.2024.090104

e-ISSN: 2456-6632

This content is available online at AESA

Archives of Agriculture and Environmental Science

Journal homepage: journals.aesacademy.org/index.php/aaes



ORIGINAL RESEARCH ARTICLE

Evaluation of broccoli (*Brassica oleracea* var. *italica* L.) varieties with respect to growth and yield in Chitwan, Nepal

Pratima Bagale*, Arjun Kumar Shrestha, Hom Nath Giri and Pradip Regmi

Agriculture and Forestry University (AFU), Rampur, Chitwan, NEPAL
*Corresponding author's E-mail: bagalepratima3@gmail

ARTICLE HISTORY

Received: 28 December 2023
Revised received: 16 February 2024
Accepted: 05 March 2024

Keywords

Canopy
Economic yield
Head diameter
Head initiation
Head maturity

ABSTRACT

A field experiment was carried out during October, 2021 to March, 2022 with an objective to evaluate growth and yield parameters of broccoli (*Brassica oleracea* var. *italica* L.) varieties in the Horticulture Farm of Agriculture and Forestry University, Rampur, Chitwan, Nepal. The experiment was laid out in Randomized Complete Block Design (RCBD) with four replications. The treatments were six broccoli varieties *viz.* two open pollinated (Calabrese and Green Sprouting) and four hybrid varieties (Centauro, Century, Delight, Everest Green). Data were collected for biometrical, phonological, yield and yield attributing characteristics. Results revealed significance for growth and yield parameters. Calabrese had the tallest plant (100.60 cm), the highest leaf number per plant (15.75), the longest leaf (73.90 cm), higher canopy diameter (101.75 cm) and earliness in head initiation (54.50 days) as well as head maturity (60.25 days). Highest head diameter (30.13 cm) and economic yield (22.52 mt/ha) was observed in Century. Thus, Century was found more profitable for commercial production in the environment conditions of Chitwan, Nepal.

Citation of this article: Bagale, P., Shrestha, A. K., Giri, H. N., & Regmi, P. (2024). Evaluation of broccoli (*Brassica oleracea* var. *italica* L.) varieties with respect to growth and yield in Chitwan, Nepal. *Archives of Agriculture and Environmental Science*, *9*(1), 23-28, https://dx.doi.org/10.26832/24566632.2024.090104

INTRODUCTION

Vegetables are important in daily diet of people for providing several nutritional benefits. Broccoli (*Brassica oleracea* var. *italica* L.) is also known as Calabrese or green sprouting broccoli, Italian broccoli, asparagus broccoli belongs to the family Brassicaceae. Broccoli is highly preferred and most widely grown vegetables in tropics and subtropics due to its nutritional and economic benefits (FAOSTAT, 2018). Broccoli is an important vegetable crop with high nutritional and good rate of return on investment (Yoldas *et al*., 2008). Nutritionally, broccoli is an excellent source of vitamin A, vitamin C, protein, carbohydrates and minerals: calcium, iron, phosphorous, potassium and sodium (Lister and Bradstock, 2003). Broccoli has been accepted as profitable crop by the farmers of Nepal. However, availability of authentic varieties is very less. There are two types of broccolis, the heading type closely resembles cauliflower and forms a large central head. Sprouting or Italian broccoli types form one central sprout and many small florets and these types are suitable for multi-harvesting. Because of these characteristics, heading type is the primary choice of commercial growers and sprouting is liked by subsistence farmers due to longer availability in kitchen gardening (Dahal *et al*., 2022). In Nepal, the total area under broccoli production is 2665 ha with the production and productivity of 30,523 mt and 11.45 mt/ha respectively whereas, in Chitwan district broccoli covers the total area of 227 ha with the production and productivity of 3405 mt and 15 mt/ha respectively (MoALD, 2023).

Different genotypes of diverse crop have been created and maintained because of benefits from diverse climate across the country (Upadhaya and Joshi, 2003). However, market remains unregulated as nearly 90% of the total seed requirements is accounted by the informal seed system (Nepal, 2013). In Nepal, due to open border with India, unregistered hybrid seed are freely traded in large quantities via a vast network of agro-vets (LI-BIRD, 2017). According to agriculture scientists, more than 90% of vegetable seeds used in the country today are imported

(Kafle and Joshi, 2018). Numerous biotic and abiotic stresses are likely to cause the degradation of hybrid varieties (Panthee *et al*., 2020). The first stage in the transition to sustainable agricultural and food systems is improving effectiveness in the utilization of agricultural inputs (FAO, 2019). Bhargava and Srivastava (2019) reported that in developing nations, the creation of high-yielding pollinated varieties is increasing, and numerous governments are funding the creation of these seeds and encouraging farmers to utilize them.

Farmers may more easily afford open-pollinated varieties since they require fewer inputs (such as fertilizer and insecticides) and are less expensive (Pixley and Banzige, 2001) but the production is low due to numerous factors. The performance of a crop or variety is mostly determined by its genetic composition, but it also depends on prevailing climatic conditions in which it is grown (Prashanthi *et al*., 2022). There are just eleven F_1 hybrid varieties of broccoli recognized in Nepal, (NPVSDC, 2018). However, there is no officially recommended and released high yielding broccoli variety in Nepal for the production during mid-season across the country to meet the demand of increasing population with the vailable resources. To address such issues, this research was performed to evaluate growth and yield attributes of broccoli varieties with an objective to identify the better performing broccoli varieties in the study area.

MATERIALS AND METHODS

Experimental site and location

An experimental trial was conducted during winter-spring season from October 2021 to March 2022 in the Chitwan district of Bagmati Province of Nepal. The study was carried out at Horticulture Farm of Agriculture and Forestry University, Rampur, Chitwan, Nepal situated in the Bagmati, Province. Geographically, it is located at 27°37' N latitude and 84°25' E longitude with an elevation of around 256 meters above sea level (Subedi *et al*., 2020).

Soil properties of experimental field

The soil samples were collected from each plot for chemical analysis before the transplanting of seedlings. The air dried and filtered soil was taken into Soil and Fertilizer Testing Laboratory, Gandaki Province to measure the total nitrogen, phosphorus, potassium, organic matter, soil pH and soil texture. The experimental field was slightly alkaline (soil pH: 6.4), medium nitrogen, potassium and phosphorus content, high organic matter content and sandy clay loam.

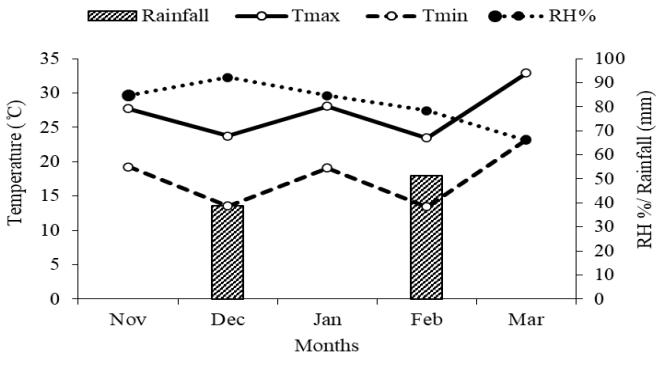


Figure 1. *Weather condition during broccoli growing period (November 2021 to March 2022) at Rampur, Chitwan.*

Agro-meteorological information of the research site

The maximum air temperature ranges from 27.73°C - 32.94°C, minimum air temperature ranges from 13.45°C - 23.26)C, RH of 66 - 92.21 % and total rainfall of 90.13 mm during the growing period of broccoli. The average temperature and RH of room condition during study of postharvest quality were 13.45°C and 84.75 % respectively during the study period Figure 1.

Experimental design and treatments

The experiment was laid out in Randomized Complete Block Design (RCBD). Each plot contained five rows of plants with five plants in each row. Five plants were randomly chosen from each plot as sample from the middle nine avoiding border for collection of data. Variety was assigned as treatment that were replicated four times for the experiment. So, there were altogether 24 plots for the experimental trial. The area of individual plot was 7.5 m^2. Row to row distance was maintained at 60 cm and plant to plant distance was also continued at 50 cm. The varieties used in this experiment are listed in Table 1. Based on the recommended dose of FYM@500kg/ropani and @19:9:4 kg NPK/ropani, half dose of N and full doses of P, K and boron were applied as basal dose and the remaining half dose of nitrogen was given in two equal split doses 25 DAT and before head initiation at 40 DAT. Uniform seedlings of 22 days old with 3-4 true leaves were transplanted and regular water application was done as per need by the crops. Growth parameters such as plant height, number of leaves per plant, leaf length, stem diameter and canopy diameter were measured from randomly selected five plants of each plot at different growth stages (20 DAT, 35 DAT, 50 DAT and at harvest) of broccoli plants. Similarly, the days required for head initiation (first head initiation, 50% and final head initiation) and curd maturity (final head maturity) were recorded from the whole plants except border plants of each plot. Yield parameters such as head diameter, economic and biological yield was recorded.

Statistical analysis

Collected data was compiled and subjected to analysis of variance by using the MS-Excel. RStudio version 4.2.3 was used for analysis of variance of all parameters. Mean comparison was done using Duncan's Multiple Range Test (DMRT). The significant differences between varieties on growth and yield parameters were determined by using the least significant difference (LSD) test at 5% level of significance

Table 1. *Treatment details of the experiment at Rampur, Chitwan, 2021/22.*

Symbol	Varieties	Variety type
V_1	Calabrese	Open pollinated
V_2	Centauro	Hybrid
V_3	Century	Hybrid
V_4	Delight	Hybrid
V_5	Everest Green	Hybrid
V_6	Green Sprouting	Open pollinated

RESULTS AND DISCUSSION

Plant height (cm)

Significant variations were observed at p<0.05 among the tested varieties for plant height (Table 2). At 20 DAT, Centauro had the tallest plant of 36.61 cm which was statistically similar with that of Calabrese and Everest Green while the lowest plant height was obtained in Delight (32.27 cm). At 50 DAT, Calabrese showed the superior plant height which was statistically at par with Green Sprouting (84.10 cm) and Delight (79.35 cm). Calabrese had the tallest plant at final harvest. Sivakumar *et al.* (2022) found the significant response among broccoli varieties on plant height. Similar results were recorded by Tejaswini *et al.* (2018), Prashanthi *et al.* (2022) as well as Thakur *et al.* (2016). Some varieties recorded the lowest plant height that might be due to its inherent genotypic configuration (Thapa and Rai, 2012).

Number of leaves per plant

Number of leaves per plant were found significant at p<0.05 among the varieties of broccoli (Table 3). Calabrese had the maximum number of leaves (6.30) at 20 DAT which was statistically similar with that of Green Sprouting, Century and Delight. Similarly, at 35 DAT, the maximum number of leaves (7.50) was produced by Calabrese while the minimum was found in Centauro. Prashanthi *et al.* (2022) observed similar differences among varieties in number of leaves which may be due to the variation in their inherent genetic capacity. Varieties adapted to different environmental conditions may exhibit variations in leaf number. Similar results were obtained by Abou El-Magd *et al.* (2006), Thapa and Rai (2012), El-Magd (2013) and Giri *et al.* (2013) among broccoli varieties.

Canopy diameter (cm)

Canopy diameter of broccoli varieties at Rampur, Chitwan, 2021/22 is depicted in Table 4. At 20 DAT, canopy diameter was found non-significant while it differed significantly at p<0.05 among the tested broccoli varieties at 35 DAT, 50 DAT and at final harvest. the Calabrese (62.15 cm) had the maximum canopy diameter while the lowest canopy diameter of was found in Everest Green (53.87 cm). Similarly, the maximum canopy diameter was found in Calabrese (78.57 cm) which was statistically at par with Green Sprouting at 50 DAT. At final harvest, the maximum canopy diameter of 101.75 cm was obtained in Calabrese which was statistically in line with Green Sprouting. The variation among the varieties against plant canopy may be attributed to genetic variability as well as due to changing in the agro-climatic condition. These results are similar with the findings of Kumar *et al.* (2020).

Table 2. Plant height of broccoli varieties at Rampur, Chitwan, 2021/22.

Treatment	Plant height (cm)			
	20 DAT	35 DAT	50 DAT	Final harvest
Calabrese	35.92^{a}	53.97^{a}	87.10^{a}	100.60^{a}
Centauro	36.61^{a}	49.95^{b}	75.10^{c}	77.05^{d}
Century	33.41^{bc}	47.45^{b}	68.90^{d}	72.00^{d}
Delight	32.27^{c}	48.14^{b}	79.35^{b}	83.05^{c}
Everest Green	34.81^{ab}	49.95^{b}	76.00^{bc}	83.07^{c}
Green Sprouting	32.69^{bc}	47.79^{b}	84.10^{a}	89.80^{b}
Grand mean	34.29	49.54	78.43	84.25
SEM (±)	0.69	0.89	1.29	1.94
F-test	**	**	***	***
$LSD_{0.05}$	2.07	2.67	3.89	5.84
CV (%)	4.02	3.58	3.29	4.60

Means with same letter in each column are not significantly different at p = 0.05 by DMRT. **Significant at 1% (p<0.01), *** Significant at 0.1% (p<0.001). SEM = Standard error of mean, LSD = Least significant difference, CV = Coefficient of variation and DAT = Days after transplanting.

Table 3. Number of leaves per plant of broccoli varieties at Rampur, Chitwan, 2021/22.

Treatment	Number of leaves per plant			
	20 DAT	35 DAT	50 DAT	Final harvest
Calabrese	6.30^{a}	7.50^{a}	15.6^{a}	15.75^{a}
Centauro	5.05^{c}	5.88^{c}	12.9^{c}	11.90^{b}
Century	5.65^{abc}	6.25^{bc}	13.5^{bc}	14.15^{ab}
Delight	5.60^{abc}	6.45^{bc}	14.7^{abc}	14.15^{ab}
Everest Green	5.20^{bc}	6.30^{bc}	13.9^{abc}	12.62^{b}
Green Sprouting	6.00^{ab}	6.65^{b}	15.1^{ab}	13.65^{ab}
Grand mean	5.63	6.50	14.24	13.69
SEM (±)	0.27	0.21	0.52	0.75
F-test	*	**	*	*
$LSD_{0.05}$	0.83	0.63	1.55	2.26
CV (%)	9.75	6.46	8.90	10.96

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

Table 4. Canopy diameter of broccoli varieties at Rampur, Chitwan, 2021/22.

Treatment	Canopy diameter (cm)			
	20 DAT	35 DAT	50 DAT	Final harvest
Calabrese	39.2	62.2^{a}	78.6^{a}	101.8^{a}
Centauro	38.2	54.7^{b}	69.8^{b}	86.1^{c}
Century	36.9	55.7^{b}	69.0^{b}	85.7^{c}
Delight	34.9	54.2^{b}	74.8^{ab}	88.9^{bc}
Everest Green	36.1	53.9^{b}	74.3^{b}	90.5^{bc}
Green Sprouting	35.1	55.9^{b}	77.6^{a}	94.9^{ab}
Grand mean	36.70	56.07	74.04	91.30
SEM (±)	1.37	1.43	1.96	2.53
F-test	ns	**	*	**
$LSD_{0.05}$	4.15	4.29	5.91	7.63
CV (%)	7.51	5.08	5.29	5.54

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

Table 5. Yield and yield attributing parameters of broccoli varieties at Rampur, Chitwan, 2021/22.

Treatment	Head diameter of primary curd (cm)	Economic yield (mt/ha)	Biological yield (mt/ha)
Calabrese	11.20^{c}	14.45^{c}	59.92^{a}
Centauro	26.28^{b}	19.84^{b}	60.90^{a}
Century	30.13^{a}	22.52^{a}	65.30^{a}
Delight	26.43^{b}	20.74^{b}	50.32^{b}
Everest Green	26.70^{b}	21.40^{ab}	61.60^{a}
Green Sprouting	11.92^{c}	15.58^{c}	61.67^{a}
Grand mean	22.11	19.09	59.95
SEM (±)	0.75	0.53	2.13
F-test	***	***	**
$LSD_{0.05}$	2.25	1.59	6.4
CV (%)	6.78	5.50	7.12

Means with same letter in each column are not significantly different at p= 0.05 by DMRT. ** Significant at 1% (p<0.01), ***Significant at 0.1% (p<0.001). SEM = Standard error of mean, LSD = Least significant difference and CV = Coefficient of variation, DM = Dry matter.

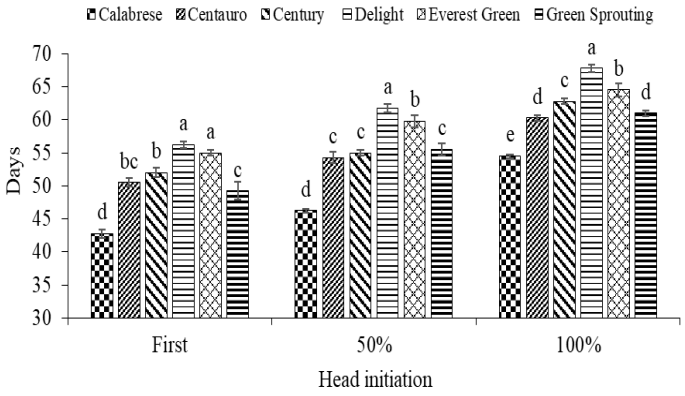


Figure 2. *Days to head initiation of broccoli varieties at Rampur, Chitwan, 2021/22.*

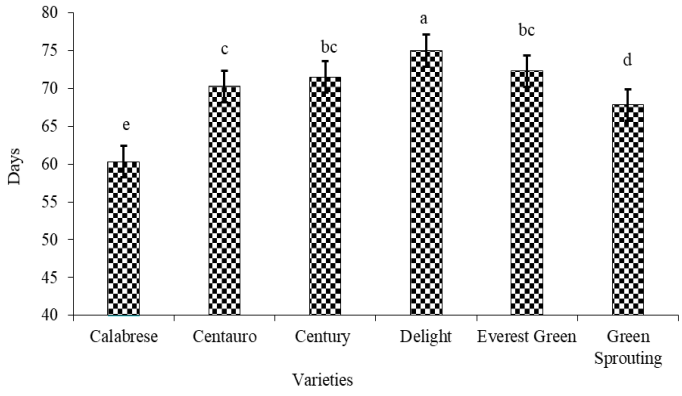


Figure 3. *Days to head maturity of broccoli varieties at Rampur, Chitwan, 2021/22.*

Days to head initiation and head maturity

Days to head initiation and maturity were taken into consideration for determining the phenological character of broccoli varieties. Calabrese took the least days to first (42.75 days), 50% (46.25 days) and 100% (54.50 days) while maximum days to first (56.25 days) head initiation, 50% (61.75 days) and 100% (67.75 days) head initiation occurs in Delight (Figure 2). Similarly, earlier head maturity occurs in Calabrese (60.25 days) followed by Green Sprouting (67.75 days) while it occurs later in Delight (75.00 days) (Figure 3). This shows that the phenological characteristics of plants highly depend on varieties. The variation on days to head initiation among varieties might be due to its genetic makeup of a short vegetative phase which enhance early head initiation and maturity. Similar findings were obtained by Nooprom and Santiprachi (2013) as well as Thapa and Rai (2012) in broccoli.

Yield and yield attributing parameters

Yield and yield attributing parameters were significantly influenced by the varieties (Table 5). Century (30.13 cm) recorded the maximum head diameter of primary curd followed by Centauro (26.28 cm) which was statistically at par with Everest Green (26.70 cm) and Delight (26.43 cm). The lowest head diameter of primary curd was found in Calabrese (11.20 cm). The maximum head yield of 22.52 mt/ha was found in Century which was statistically in line with that of Everest Green (21.40 mt/ha while Calabrese recorded the lowest yield of 14.45 mt/ha.

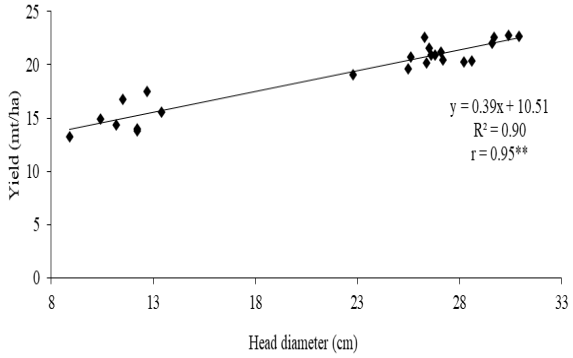


Figure 4. *Correlation between yield and head diameter of broccoli varieties at Rampur, Chitwan, 2021/22.*

The highest biological yield of 65.30 mt/ha was found in Century which was statistically in line with Green Sprouting (61.67 mt/ha), Everest Green (61.60 mt/ha), Centauro (60.90 mt/ha) and Calabrese (59.92 mt/ha). More number of leaves might have reduced the head size and head yield due to more nutrient absorption by the leaves. Similar findings were observed by Ngullie and Biswas (2014) as well as Tejaswini *et al.* (2018). Sharma *et al.* (2018) reported that the yield of the crops is influenced by the environmental factors and management practices due to its polygenic in nature. The maximum yield might be due to the result from the compact head and higher head diameter of some varieties. Similar results were observed by Thakur *et al.* (2016)

Correlation between yield and other parameters

The positive and significant correlation was observed between yield and head diameter (Figure 4). The yield was strongly correlated with head diameter (r = 95). It was found that 90% (R^2 = 0.90) variation in the yield was accounted by the variation in the head diameter. The maximum yield might be due to the result from the compact head and higher head diameter of some varieties. Similar results were observed by Gogoi *et al.* (2016).

Conclusion

In the study, various varieties exhibited variations in plant growth and yield parameters. Calabrese showed the tallest plant and the highest number of leaves and plant canopy. Furthermore, early head initiation and its maturity was found in Calabrese. Similarly, significantly the highest economic yield was obtained in Century while the higher dry matter percentage was recorded in Calabrese. Thus, the study suggests that Century was superior in terms of yield and yield attributing parameters.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the Directorate of Research and Extension (DOREX), Agriculture and Forestry University, Rampur, Chitwan, Nepal.

Author contributions

Conceptualization, methodology, formal analysis, writing—original draft preparation: P.G.; Data curation, writing—review and editing: P.R.; Supervision, reviewing, funding acquisition, project administration: A.K.S. and H.N.G. All authors have read and agreed to the published version of the manuscript.

Conflict of interest: The authors declare no conflicts of interest regarding publication of this manuscript.

Ethical approval: Not applicable.

Data availability: The data that support the findings of this study are available on request from the corresponding author.

REFERENCES

Abou El-Magd, M. M., El-Bassiony, A. M., & Fawazy, Z. F. (2006). Effect of organic manure with or without chemical fertilizers on growth, yield and quality of some varieties of broccoli plants. *Journal of Applied Sciences Research*, *2*(10), 85635431.

Bhargava, A., & Srivastava, S. (2019). Participatory plant breeding across continents in participatory plant breeding: concept and applications. *Springer*, 109-127.

Dahal, J., Pandey, U., Bhandari, U., Koirala, U., Tiwari, S., & Shrestha, S. (2022). Performance of some broccoli genotypes with respect to morphological, phenological, head and yield traits at three localities of Nepal. *Turkish Journal of Agriculture, Food Science and Technology*, *10*(6), 979-986.

El-Magd, M. M. (2013). Evaluation of some broccoli cultivars on growth, head yield and quality under different planting dates. *Journal of Applied Sciences Research*, *9*(11), 5730-5736.

FAO. (2019). Transition towards sustainable food and agriculture: An analysis of FAO's 2018–2019 work plan.

FAOSTAT. (2018). Food and Agriculture Organization. http://www.fao.org/faostat/en/No. of data/QC.

Giri, R. K., Sharma, M. D., Shakya, S. M., & Kandel, T.P. (2013). Growth and yield response of broccoli cultivars to different rates of nitrogen in western Chitwan, Nepal. *Agriculture Science*, *4*(7), 8-12.

Gogoi, S., Millu, R., Das, P., Bora, N., & Das, B.K. (2016). Effect of sowing dates and spacing on broccoli (*Brassica oleracea* var. *italica*) seed production. *Indian Journal of Agricultural Research*, *50*, 350-353.

Kafle, A. & Joshi, K. (2018). Vegetable seed import scenario in Nepal.

Kumar, S.A., Kumar, P.R., Meena, M.L., Kumar, R.A., Rawat, R.A., & Yadav, S. (2020). Influence of varieties and spacing on growth characters of sprouting broccoli (*Brassica oleracea* L.). *Annals of Plant and Soil Research*, *23*(1), 99-103.

LI-BIRD. (2017). Farmers' seed systems in Nepal. Review of national legislations; Local Initiatives for Biodiversity, Research and Development, Pokhara, Nepal.

Lister, C., & Bradstock, M. (2003). Antioxidants: A health revolution: all you need to know about Antioxidants. Christchurch, NZ: New Zealand Institute for Crop and Food Research Centre.

MoALD. (2023). Statistical Information on Nepalese Agriculture, 2020/21. Kathmandu, Nepal: Agribusiness Promotion and Market Development Directorate, DOA.

Nepal, G. (2013). National Seed Vision. Ministry of Agricultural Development, Lalitpur, Nepal.

Ngullie, R., & Biswas, P. K. (2014). Performance of different varieties of broccoli under rainfed mid-hill conditions of Mokokchung district of Nagaland. *International Journal of Farm Science*, *4*(2), 76-79.

Nooprom, K., & Santiprachi, Q. (2013). Effects of planting dates and varieties on growth and yield of broccoli during rainy season. *American Journal of Agricultural and Biological Sciences*, *8*(4), 37-361.

NPVSDC. (2018). Annual Progress Report 2074/75 (2017/18). National Potato, Vegetable and Spice Crops Development Center, Kirtipur, Kathmandu, Nepal.

Panthee, D., Gotame, T., Tiwari, S., & Bhandari, H. (2020). The Current status of fruits and vegetables and their Improvements. *Association of Nepalese Agricultural Professionals of Americas*, 245-269.

Pixley, K., & Bänzige, M. (2001). Open-pollinated maize varieties: A backward step or valuable option for farmers? Inbackward step or valuable option for farmers? Harare, Zimbabwe, 22-28.

Prashanthi, C., Prasad, V. M., Topno, S. E., Vani, L., & Singh, Y. K. (2022). Performance of different varieties of broccoli (*Brassica oleracea* var. *italica*) under Prayagraj agro-climatic condition. *International Journal of Environment and Climate Change*, *12*(11), 3003-3009.

Sharma, S., Sharma, S., Singh, Y., & Sekhon, B.S. (2018). Studies of mean performance for yield and its contributing traits in cauliflower (*Brassica oleracea* var. *botrytis* L.) *International Journal of Current Microbiology and Applied Sciences*, *7*(2), 3288-3296.

Sivakumar, V., Srinivasulu, A., Mallikarjuana Rao, K., & Reddy, R. V. S. K. (2022) Performance of broccoli (*Brassica oleracea* var. *italica* L.) genotypes under high altitude Tribal zone of Andhra Pradesh. *Emergent Life Sciences Research*, *8*(1), 84-88.

Subedi, B., Giri, H., Shriwastav, C. P., Khanal, B. R., & Paudel, M. (2020). Effect of different doses of nitrogen and boron on the performance of cauliflower (*Brassica oleracea* var. *botrytis* L.) in Chitwan, Nepal. *Azarian Journal of Agriculture*, *7*(3), 76-83.

Tejaswini, T., Varma, L. R., Verma, P., Prajapathi, R. I., & Vani, F. B. (2018). Performance of different varieties with respect to growth, yield and quality of broccoli (*Brassica oleracea* var. *italica* L.) under North Gujarat Conditions. *International Journal of Current Microbiology and Applied Sciences*, *7*(6), 690-698.

Thakur, S., Thakur, R., & Mehtha, D. K. (2016). Evaluation of different genotypes of broccoli in dry temperate conditions of Kinnur district of Himachal Pradesh in India. *International Journal of Environmental Science and Technology*, *5*, 1673-1679.

Thapa, U., & Rai, R. (2012) Evaluation of Sprouting Broccoli (*Brassicae oleraceae* var. *italica*) genotypes for growth, yield and quality. *International Journal of Agriculture Sciences*, *4*(7), 284-286.

Upadhaya, M. P., & Joshi, B. K. (2003). Plant genetic resources in SAARC countries: Their conservation and management, Nepal chapter, SAARC Agriculture Information Center, 297-422.

Yoldas, F., Ceylan, S., Yagmur, B., & Mordogan, N. (2008). Effect of nitrogen fertilizer on yield quality and nutrient content in broccoli. *Journal of Plant Nutrition*, *31*, 1333-1341.