International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 22s, 2025
https://theaspd.com/index.php

Cauliflower Quality Optimization: Harnessing Organic and Inorganic Fertilizers

Alka Arya[1], Jitendra Kumar[2], Sobaran Singh[1], Sarvesh Kumar[1] and Sapna Jarial[3]
[1]Department of soil science, college of agriculture, G.B. Pant University of agriculture and technology, Pantnagar, Uttarakhand, –263145, India
[2]Department of Horticulture, College of Agriculture, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, –263145, India
[3]Department of Agricultural Economics & Extension, School of Agriculture, Lovely Professional University, Phagwara,

Abstract
The experiment intended to determine the impact of various doses of organic and inorganic fertilizer on the quality of cauliflower. The trial was conducted in a Randomized Block Design (RBD) at the Crop Research Centre of G.B. Pant University of Agriculture and Technology in Pantnagar, Uttarakhand, with ten treatments and three replications. The treatments included Control (T1), general recommended dose of N:P:K (100:60:60 kg ha-1) (T2), and increasing doses of N:P:K with or without farmyard manure (FYM) - T3 to T8, and two levels of FYM alone (T9 and T10). Results showed that quality parameters of cauliflower, such as ascorbic acid, protein content, total phenols, and flavonoids in different treatments, were significantly higher than the control. Furthermore, cauliflower cultivated with integrated nutrient systems or organic systems demonstrated higher antioxidant qualities than those cultivated with chemical fertilizers alone. These results suggest that organic fertilizers can enhance the nutritional quality of cauliflower and serve as an alternative to mineral fertilizers.
Keywords: *Cauliflower, General recommended dose, Ascorbic acid, Total phenols, Flavonoids*

1. INTRODUCTION

In the quest for food and nutrition security, vegetables hold a vital position. These nutrient-dense foods are an indispensable component of human nutrition due to their rich profile of essential vitamins, minerals, dietary fibers, and phytochemical compounds. Incorporating vegetables into our diets is important for promoting a healthy and balanced lifestyle, as their nutrient content can improve health and prevent chronic ailments (Moni, 2023).They are usually consumed in association with protein and starch-rich foods(Manzeke-Kangara et al., 2023). A diverse range of vegetables are consumed and included in the diet to get all the health benefits (Noopur et al., 2023). Cole crops, including cabbage, cauliflower, broccoli, Brussels sprout, kale and others, are popular, nutritious, and affordable winter season vegetables in India. Among these, cauliflower, is a vegetable of “Brassicaceae” family. Cauliflower is dietary fiber-rich, have essential nutrients such as phosphorus, potassium, magnesium, manganese, choline, and vitamins including B, C, and K. Moreover, cauliflower contains a variety of antioxidants, including isothiocyanates, carotenoids, glucosinolates and flavonoids, which have an important function in supporting human health (Bairwa et al., 2023).

Edible cauliflower is “ascorbic acid-rich (74.61mg/100g), water (92%), carbohydrates (40.14g/100g), protein (27.77g/100g), fat (5.36g/100g), and fiber (8.55g/100g)” (Bhargava and Srivastava, 2023). It has an abundance of phenolic compounds, such as, quercetin, pyrogallol, and kaempferol. These compounds have potent antioxidant properties that may provide numerous health benefits (Ainebyona et al., 2023). Apart from its high nutritional value, cauliflower also contains sulfur in a concentration of 635.96mg/100g in raw form. This vegetable is packed with vitamins that offers health advantages for both people and animals, notably vitamin C, which is known to give protection against some forms of cancer, assist decrease blood cholesterol, and function as powerful antioxidants. Nonetheless, the macronutrient content of cauliflower can differ depending on the specific nutrient solutions utilized during growth. Therefore, understanding the impact of various growing conditions and nutrient regimes on the nutritional composition of cauliflower is critical to optimize its dietary value (Yadav et al., 2023).
Fertilizers are a crucial component of agricultural production, and balanced nutrient use is essential for maintaining soil health and sustaining agricultural productivity. Crop-specific fertilizer requirements vary due to differential production potential and the ability of crops to mine nutrients from native and

fertilizer sources. The optimal amount of fertilizer required for a crop is dependent on various factors such as the initial nutrient status of the soil, yield, and fertilizer and crop management practices. Cauliflower is a nutrient-intensive crop that extracts a significant amount of macronutrients from the soil. To improve cauliflower production, several researchers in India have recommended the use of heavy manuring to enhance soil fertility and nutrient availability (Bhowal et al., 2020; Kumar et al., 2020).

Mineral nutrition is vital in determining crop quality, and it is true that chronic use of chemical fertilizers resulted significant soil organic matter reduction and extensive soil fertility depletion (Bhowal et al., 2020).These issues are commonly associated with nutrient imbalances caused by excessive fertilizer use, as well as the widening gap between the nutrients applied through fertilizers and those actually utilized by crops. Extracting limited native soil nutrients for plant development and production might worsen soil erosion. As such, it is critical to adopt sustainable agricultural practices that aim to maintain soil health and productivity while minimizing environmental damage (Bhowal et al., 2020) .

Using chemical fertilisers and organic manures preserve agricultural yields and soil health, integrated nutrient management may solve these issues (Bhowal et al., 2020). The continuous use of inorganic nutrients can have negative impacts on soil physicochemical properties, ultimately affecting crop yields. To maintain crop yields while reducing dependence on inorganic fertilizers, it is crucial to incorporate the use of organic manures, biofertilizers, and other organic inputs. This research examined how varying concentrations of organic and inorganic fertilisers affected cauliflower quality. Thus, the present research examined how varying concentrations of organic and inorganic fertilisers affected cauliflower quality.

2. MATERIALS AND METHODS

2.1 Experimental site

The fields were located in Pantnagar, Uttarakhand. The site geo location coordinates were 29°N latitude, 79°29' E longitudes, and situated at an elevation of 243.84m above msl.

2.2 Research design

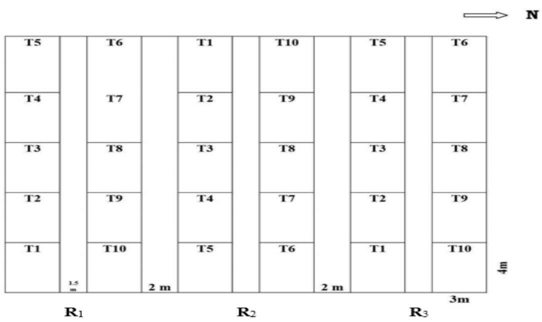
A Randomized block design (RBD) was employed as the research design to evaluate the effects of 10 different treatments, with each treatment being replicated three times. Table 1 delivers the details of each treatment, while Figure 1 illustrates the experimental layout.

Table 1. Detail of treatments

Treatment	Details
T_1	Control treatment
T_2 NPK**	General Recommended dose 100:60:60
T_3 NPK**	145:80:102
T_4 NPK**	190:103:128
T_5 NPK**+FYM*	118:74:93 +10
T_6 NPK**+FYM*	103:70:85 +20
T_7 NPK**+FYM*	160:95:118+10
T_8 NPK**+FYM*	146:90:110 +20
T_9 FYM*	10
T_{10} FYM*	20

*t/ha ** kg/ha

Figure 1: Field trial layout



In the final week of September, cauliflower seeds were sown in 3x1-meter beds. Seedlings of uniform height (approximately 15-20 cm) that were one month old were selected and transplanted with 60x50 cm spacing in 4x3 meter plots. The full dosages of nitrogen, phosphate, and potash were administered as a base dose, whereas fifty percent of the nitrogen dose was applied after one month after transplanting. For nitrogen- urea, phosphorus- single super phosphate(SSP), and muriate of potash(MOP) as potash source were utilized. For organic source, well decomposed farm yard manure (FYM) was utilized. Further, cultural operations were undertaken in accordance with the recommended practices. Curd samples were taken from each plot, air-dried first, then paper-bagged and 48 hours at 60 degrees Celsius in the oven. Cauliflower quality characteristics were determined using these samples.

Quality parameters of cauliflower:

Ascorbic acid was measured in curd, total phenolics and flavonoids. After the collection, sample was left to dry under shade and after some time kept in oven for drying. Mortar and pestle crushed samples into powder.

Ascorbic acid (mg/100g)

The “2,6-dichlorophenol-indophenol visual titration method” (Mondal et al., 2023), was used . The formula was:

$$\text{"Ascorbic acid content}\left(\frac{\text{mg}}{100}\text{g}\right) = \frac{\text{Titre} \times \text{Dye factor} \times \text{Volume made up} \times 1000}{\text{Volume of aliquot taken} \times \text{Weight of sample taken}} \times 10\text{"}$$

Protein content (%)

Micro-Kjeldhal was used to calculate protein percentage. The following formula determined the sample's nitrogen content:

$$\text{"Nitrogen (\%)} = \frac{\text{Sampletitre} - \text{Blanktitre} \times 100 \times \text{N} \times 14}{\text{Weight of sample (g)} \times 1000}\text{"}$$

For protein content determination the formula was:

$$\text{"Protein (\%)} = 6.25 \times \text{Nitrogen (\%)"}$$

2.3 Determination of total phenolics and flavonoids content Preparation of sample

To determine the antioxidant activity, a 1.5 g sample was accurately weighed and extracted using 85% methanol that used 6N HCl, the pH was adjusted to 2.0. The extraction procedure required 30 minutes of continual stirring using a magnetic stirrer. The supernatant was decanted with care, and the remaining residue was treated to two further extractions to guarantee complete phenolic and flavonoid elimination. Afterward, the three supernatants were combined and subjected to centrifugation at a speed of 6000 rpm for a duration of 15 minutes. The resultant supernatant was collected and purified using “Whatman No. 1 filter paper” to produce 50 ml of crude extract. For future study of phenolic and flavonoid activity, the extract was kept at -20 degrees Celsius.

Total phenol content (mg GAE/100g): To calculate the total phenol content, was used (Bhowal et al., 2020). This involved the use of “Folin-ciocalteu reagent”.

Principle: The polyphenols present in the plant extract react with the Folin-ciocalteu reagent; form a blue chromophore made up of a phosphotungstic-phosphomolybdenum complex. Blue color's intensity is measured at a wavelength of 750 nm.

Reagent Preparations:

Standard Gallic acid (GA) solution (100 mg percent)

Stock solution: A solution was created by dissolving 100 mg of gallic acid in 100 ml of distilled water.

Working solution: The volume of a 1 ml stock solution was adjusted to 20 ml using D/W.

Folin- ciocalteu (FC) reagent (50%): In a ratio of 1:1, the sample was diluted with distilled water.

Sodium carbonate (7.5%): To prepare a solution, 7.5 grams of sodium carbonate (Na_2CO_3) dispersed in 100 ml of distilled water.

Procedure:

Sample: “The sample was measured and diluted to a final amount of 1.5 ml using distilled water. The diluted sample was then mixed with 0.5 ml of Folin-ciocalteu reagent and 10 ml of 7.5% Na_2CO_3 for 60 minutes at 37°C. The intensity of the blue color produced was measured at a wavelength of 750 nm, and a blank sample was used as a reference”.

Standard: Standard gallic acid solutions were made, with concentrations ranging from 5-20 μg. From these standard solutions, aliquots of 0.1, 0.2, 0.3, and 0.4 ml were extracted, and their contents were adjusted to 5 ml using distilled water. The standard solutions were then handled similarly to the sample.

Blank: To make the blank, 1.5 ml of distilled water was collected and treated in the same manner as the sample.

Calculations:

Total Phenol (mg GAE/100g):

$$\frac{\text{Standard concentration}}{\text{Standard O. D.}} \times \frac{\text{Standard O. D.}}{\text{Aliquot taken}} \times \frac{\text{Volume made up}}{\text{Sample taken}} \times \frac{100}{1000}$$

Total flavonoid content (mg RE/100g):

The amount of total flavonoids was estimated according to the procedures of Zhishen et al. (Bhowal et al., 2020)

Reagent Preparation:

Rutin standard solution (10 mg %): Dissolution of 10 mg rutin in 100 ml methanol.

Aluminium Chloride (10 g %)**:** Dissolution of 10 g $AlCl_3.6H_2O$ in 100 ml distilled water.

Sodium Nitrite (5 g %)**:** 5 gm of NaNO2 dissolved in 100 ml of distilled water.5 grammes of $NaNO_2$ dissolved in 100 ml of distilled water.

Sodium Hydroxide (1N): Dissolution of 4 g NaOH in 100 ml distilled water and standardization with oxalic acid.

Procedure:

Sample**:** Using distilled water, 5ml were added to a known aliquot of the material. After adding 0.3 ml of 5% $NaNO_2$, the $AlCl_3$ solution was added and thoroughly mixed after 5 minutes. 2 ml of 1N NaOH was added and stirred after 6 minutes. To bring the volume up to 10 ml, 2.1 ml of distilled water was then added. At 510 nm, the absorbance of the resulting pink colour was measured against blank.

Standard: A standard series of rutin samples (range 50 to 200 μg) was prepared. Amounts of 0.5, 1.0, 1.5, and 2.0 ml were created as aliquots and treated the same as samples. The quantity of 5 ml using distilled water was prepared.

Blank: Using 5 ml of distilled water, a blank was prepared and handled identically to the sample.

Calculations:

Total flavonoid content (mg RE/100g):

$$"\frac{\text{Standard concentration}}{\text{Standard O. D.}} \times \frac{\text{Standard O. D.}}{\text{Aliquot taken}} \times \frac{\text{Volume made up}}{\text{Sample taken}} \times \frac{100}{1000}"$$

Statistical Analysis

Using ANOVA and a 5 percent level of probability, the obtained data on various factors were statistically examined to determine their degree of significance.

3. Results

Cauliflower quality parameters

Quality parameter of cauliflower i.e., ascorbic acid, protein content, total phenols and flavonoids were significantly influenced by application of different treatments (Table 2, Figure 2).

Table 2: Quality parameters of cauliflower as influence by different doses of organic and inorganic fertilizers

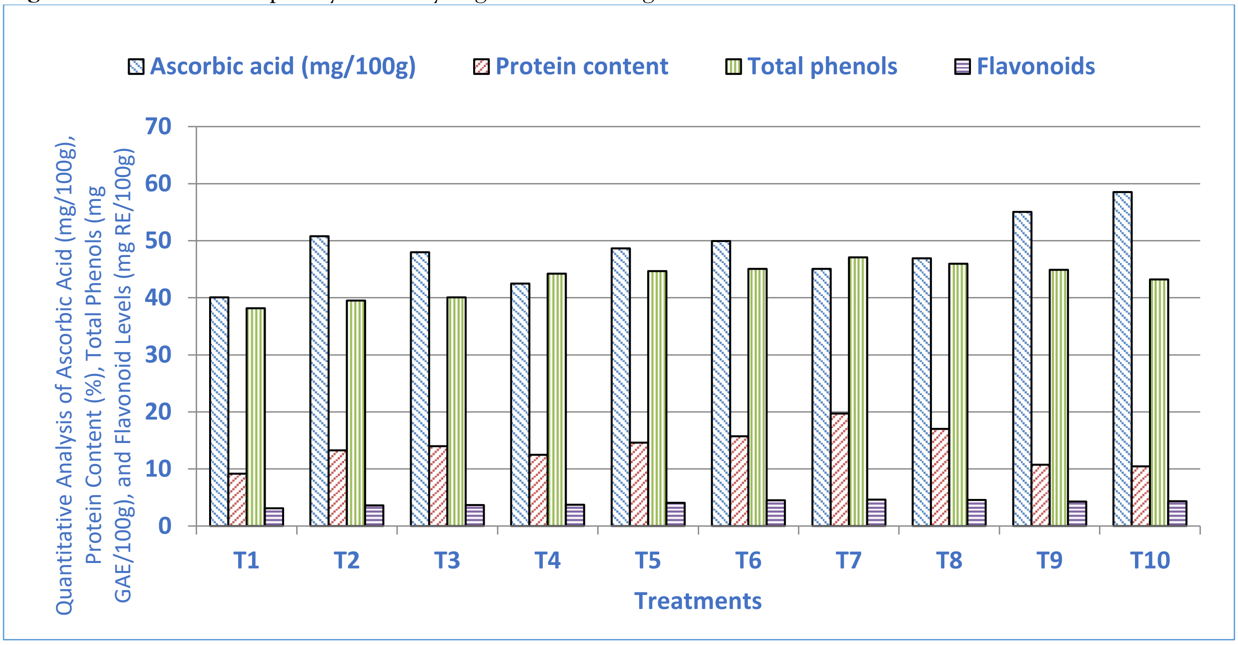
Treatment	**Details**	**Ascorbic acid (mg/100g)**	**Protein content (%)**	**Total phenols (mg GAE/100g)**	**Flavonoids (mg RE/100g)**
T_1	Control treatment	40.08	9.19	38.14	3.12
T_2 NPK**	General Recommended dose 100:60:60	50.76	13.25	39.52	3.63
T_3 NPK**	145:80:102	48.00	14.00	40.05	3.68
T_4 NPK**	190:103:128	42.50	12.50	44.21	3.73
T_5 NPK**+FYM*	118:74:93 +10	48.65	14.63	44.67	4.06
T_6 NPK**+FYM*	103:70:85 +20	49.93	15.75	45.06	4.52
T_7 NPK**+FYM*	160:95:118+10	45.05	19.69	47.08	4.65
T_8 NPK**+FYM*	146:90:110 +20	46.93	17.00	45.98	4.56
T_9 FYM*	10	55.05	10.75	44.9	4.29
T_{10} FYM*	20	58.53	10.44	43.2	4.33
CD at 5%		1.86	0.539	2.00	0.152

S.Em.±	0.63	0.18	0.67	0.51
CV	2.24	2.29	2.69	2.19

*t/ha ** kg/ha

The results on ascorbic acid indicated that it (Table 2) reduced considerably with the addition of more nutrients. The maximum ascorbic acid concentration (58.53 mg/100g) in curd was obtained at treatment T_{10} (FYM 20 t/ha). The lowest (40.08 mg/100g) ascorbic acid was recorded with control.

Figure 2: Cauliflower quality effect by organic and inorganic fertilisers**.**



Higher dose of nutrients increased protein content in curd (Table 2) significantly. The maximal protein (19.69%) in curd was obtained with the treatment T_7(160:95:118 kg/ha +FYM 10 t/ha). The least protein level (9.19 percent) was found in the control sample.

Figure 3. Photographic view of cauliflower grown under different treatments

T_1

T_4

T_7

Table 2 presents cauliflower antioxidative quality factors. The administration of suggested FYM and NPK has produced a much greater quantity of total phenols and flavonoids than other treatments. Total phenols and flavonoids were considerably lower when only chemical fertilizer was applied compared to other treatments. The highest total phenols (47.08 mg GAE/100g) and flavonoids (4.65 mg RE/100g) contents were obtained with the treatment T_7N:P:K (160:95:118 kg ha^{-1} + FYM 10 t ha^{-1}). The least total phenols (38.14 mg GAE/100g) and flavonoids (3.12 mg RE/100g) were recorded with the control.

4. DISCUSSION

How fertilisers affect cauliflower nutrition (Brassica oleracea L. var. botrytis) has been the subject of several studies. [9,10] have reported that greater nutritional levels in cauliflower lead to a decrease in vitamin C concentration due to increased vegetative development, this causes more water to travel from root zones to plant tips. In addition, the lower content of chemical fertilizers compared to organic fertilizers due to dilution effects may also contribute to this decrease in vitamin C content. Research has shown that organic crops have higher vitamin C levels than conventionally fertilized crops because increased nitrogen exposure enhances protein biosynthesis while decreasing carbohydrate synthesis. As vitamin C is synthesized from carbohydrates, lower nitrogen exposure in organically managed soil leads to higher vitamin C levels.

Studies have demonstrated that organic treatments with higher rates of farmyard manure (FYM) applications and integrated nutrient management result in better antioxidant capacity compared to cauliflower grown with only chemical fertilizers or without any fertilizers. Identical results were reported by researchers (Kumar and Sengar, 2023; Qi et al., 2023)

Researchers examined how fertilisers affect cauliflower growth, production, and nutritional composition. It was found that by partially substituting mineral fertilizer with biofertilizer, nutritional quality, yield, and soil properties of cauliflower are enhanced (Khadiri et al., 2023) Further research showed that combining 80 percent mineral fertilizer with 80 percent biofertilizer boosts vitamin C content and improves soluble sugar content while lowers nitrate concentration (El Sheikh et al., 2021) . Biofertilization also improves soil organic matter, accessible N, P, and K, and enzyme activities, suggesting that a combination of biofertilizer and a decrease in mineral N-P-K fertilizer may be utilised effectively in cauliflower production without yield penalty.

Other research examined how fertilisers affect cauliflower quality, productivity, and nutrition. The nitrogen amounts applied had little effect on the nutritional content of cauliflower curds and stalks (El Sheikh et al., 2021).Mushroom waste compost and NPK fertilizer have been shown to increase the growth and yield of cauliflower (El Sheikh et al., 2021).Living mulch strategies have also been found to be effective in winter organic cauliflower production(Zargar et al., 2022), while research has been conducted on the response of natural 15N abundance in soil and cauliflower to organic and chemical fertilisers (Zargar et al., 2022)It was found that the application of 50 percent recommended fertiliser dose with organic manures resulted in improved cauliflower growth, production, and quality compared to plants not treated with organic and synthetic fertilisers (Kumar et al., 2020).

5. CONCLUSION

The findings of this investigation indicate that a chemical and organic fertilisers, along with their efficient management, can potentially sustain the productivity of cauliflower. The study highlights that neither chemical fertilizers alone nor organic manures exclusively are sufficient for achieving optimal productivity in cauliflower. Moreover, the study shows that cauliflower grown with integrated nutrient management or organic systems exhibit better antioxidant qualities than those grown with chemical fertilizers only. These findings have important implications for farmers, policy makers and consumers, as they provide insights into sustainable and efficient agricultural practices that can contribute to improved crop productivity and quality.

Funding: None
Institutional Review Board Statement: Not applicable.
Informed Consent Statement: Not applicable.
Data Availability Statement: Not applicable.
Acknowledgement: The authors would like to extend their sincere appreciation to the support at the research facilities of GBPUT.
Conflicts of Interest: None

REFERENCES

1. Ainebyona, P.I., Yekoyada, M., Kigozi, J., Agnes, N. (2023). The Effects of Slice Thickness and Pre-Treatment Concentration on the Quality Characteristics of Solar Dried Pineapple. European Journal of Agriculture and Food Sciences, 5, 47–54. DOI:10.24018/ejfood.2023.5.4.454
2. Bairwa, P.L., Dixit, A., Singh, V. (2023). Influence of Macro and Micronutrients on the Yield and Quality Attributes of Cauliflower (Brassica oleracea var. Botrytis L.) cv."Pusa Sharad." International Journal of Plant & Soil Science, 35, 465–475. DOI:10.9734/ijpss/2023/v35i183311
3. Bhargava, A., & Srivastava, S. (2023). Integrative Approaches to Biotechnology.
4. Bhowal, S.K., Hossain, M.H., & Bashir, M.M. (2020). Integrated nutrient management on the yield and profitability of cauliflower. Bangladesh Agronomy Journal, 23, 45–49. https://doi.org/10.1201/ 9781003324706
5. El Sheikh, D.M., Helal, M.S., & Barakat, H.A. (2021). Improving the nutritional values of wheat and rice crackers by using cauliflowers. Food and Nutrition Sciences, 12, 643–658. DOI:10.4236/fns.2021.126048
6. Khadiri, M., Boubaker, H., Askarne, L., Ezrari, S., Radouane, N., Farhaoui, A., El Hamss, H., Tahiri, A., Barka, E.A., & Lahlali, R. (2023). Bacillus cereus B8W8 an effective bacterial antagonist against major postharvest fungal pathogens of fruit. Postharvest Biology and Technology, 200, 112315. https://doi.org/10.1016/j.postharvbio.2023.112315
7. Kumar, A., Kumar, M., Singh, B., Singh, M.K., Singh, S.P., Singh, R., & Kumar, R. (2020). Growth, yield and quality of cauliflower as influenced by different sources of nutrients and mulching in Indo-Gangatic Plains of Western Uttar Pradesh. International Research Journal of Pure and Applied Chemistry, 21, 300–307. https://doi.org/10.1111/gfs.12561
8. Kumar, G., & Sengar, V.S. (2023). Effect of different doses of N and farm yard manure on growth, yield and yield contributing characters of baby corn (Zea mays L.) under Uttarakhand condition.
9. Manzeke-Kangara, M.G., Joy, E.J., Lark, R.M., Redfern, S., Eilander, A., & Broadley, M.R. (2023). Do agronomic approaches aligned to regenerative agriculture improve the micronutrient concentrations of edible portions of crops? A scoping review of evidence. Frontiers in Nutrition, 10, 1078667. DOI:10.3389/fnut.2023.1078667
10. Mondal, D.R., Malek, M.A., Bose, S.K., & Rahman, M.M. (2023). Innovative Research. International Journal of Innovative Research, 8, 20–25.
11. Moni, S.S. (2023). Functional Vegetables and Medicinal Uses: Cure and Curse, in: Applications of Functional Foods and Nutraceuticals for Chronic Diseases. CRC Press, pp. 117–136.
12. Noopur, K., Chauhan, J.K., Kumar, L., Chandegara, A.K., & Panwar, S.S. (2023). Vegetables for Food and Nutritional Security: A Review. Indian Research Journal of Extension Education, 23, 21–27. DOI:10.54986/irjee/2023/oct_dec/21-27

13. Qi, Q., Chu, M., Yu, X., Xie, Y., Li, Y., Du, Y., Liu, X., Zhang, Z., Shi, J., & Yan, N. (2023). Anthocyanins and Proanthocyanidins: Chemical Structures, Food Sources, Bioactivities, and Product Development. Food Reviews International, 39, 4581–4609. https://doi.org/10.1080/87559129.2022.2029479
14. Yadav, D., KV, R.R., Ayu, A.T., Rajwade, Y., & Verma, N. (2023). Reflective mulch films a boon for enhancing crop production: A review. Environment Conservation Journal, 24, 281–287.
15. Zargar, J., Kumar, M., Kumar, Satesh, Chopra, S., Kumar, Sanjeev, Bhushan, A., Samnotra, R.K., & Gupta, R.K. (2022). Integrated nutrient management studies in cabbage (Brassica oleracea) under subtropical plains of Jammu. The Indian Journal of Agricultural Sciences, 92, 59–62.