



Impact of Three Cultivation Methods on Quality Characteristics of Camarosa Strawberries Grown under Punjab Conditions

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ABSTRACT

Background: In recent years, there has been growing interest in sustainable and organic farming practices due to concern about environmental impacts and food quality associated with conventional agriculture. Organic farming (OF) has gained popularity for its emphasis on natural inputs and ecological balance. Subhash Palekar natural farming (SPNF), an innovative approach developed in India, promotes low-cost, chemical-free farming using locally available resources.

Methods: This study investigated the effects of three cultivation methods - Organic farming (OF), Subhash Palekar natural farming (SPNF) and conventional farming (CF) on the quality characteristics of strawberry cv. Camarosa grown in Punjab conditions. Field trials were conducted in Lovely Professional University, Punjab from 2022 to 2024 to evaluate physicochemical properties, bioactive compound levels and antioxidant activity.

Result: Results revealed that OF and SPNF practices yielded higher quality fruits compared to CF. Organically grown strawberries exhibited significantly higher total sugars (7.56%), reducing sugars (6.04%), non-reducing sugars (1.51%), total phenolics (266.54 mg/100 g), total flavonoids (167.46 mg/100 g), ascorbic acid (38.78 mg/100 g), total anthocyanins (53.42 mg/100 g) and total antioxidant capacity (86.58%). SPNF produced results comparable to OF in most parameters, consistently outperforming CF. These findings suggest that organic and natural farming methods can intensify the nutritional quality along with bioactive compound content of strawberries while potentially offering more sustainable cultivation practices.

Key words: Conventional farming, Fruit quality, Natural farming, Organic farming, Strawberries.

INTRODUCTION

The significant growth in Indian agriculture began in the 1960s upon the onset of the Green Revolution, marking a transformative period in the country's cultivation history (Cabral *et al.*, 2022). This technology focused on boosting production through the intensive approaches such as the application of pesticides and inorganic fertilizers, the use of high-yielding crop varieties, irrigation, extensive tillage and inadequate management of crop residues (Sarkar *et al.*, 2020). Limited recycling of organic waste materials and accelerated soil erosion necessitate increased reliance on mineral fertilizers and synthetic chemicals (Abebe *et al.*, 2022). This, in turn, negatively impacts soil fertility, arable land productivity and contributes to climate variations, causing widespread harm to soil and water ecosystems (Sahoo *et al.*, 2024).

Several techniques have been developed to grow berries and vegetables organically and naturally in field as well as in greenhouses in response to shifting consumer preference (Singh *et al.*, 2022). Organic farming practices rely heavily on farm-derived organic amendments such as vermicompost, farmyard manure (FYM), neem cake, biochar, biofertilizers, *Amritpani* and *Panchgavya* as nutrient sources, soil conditioners and diseases and pest repellents (Oyege and Balaji Bhaskar, 2023; Soni *et al.*, 2022). Although organic farming may result in lower productivity compared to conventional farming, it enhances fruit quality (Ghanem *et al.*, 2024).

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In India, the low-cost natural farming was introduced by Padmashree awardee Subhash Palekar Dev *et al.* (2022), designating it as 'Subhash Palekar Natural Farming' (SPNF). Following this, many scientists as well as researchers have asserted that natural farming serves as a viable alternative to chemical-based farming, with direct or indirect positive effect on sustainable development (Chauhan *et al.*, 2024; Tripathi *et al.*, 2018). SPNF operates majorly on four key principles: *Jeevamrita*, *Beejamrita*, *Achhadana* and *Whapasa* that utilize the by-products (dung and urine) of native cows along with some naturally available organic materials (Mandla and Sharma, 2022).

SPNF recreates an ecosystem for crops similar to ecosystem of forest that encourages beneficial microbial activity and supports plant development without relying on external chemical inputs (Münster, 2021).

Nevertheless, the potential for improving food security through SPNF method in India is not firmly established, primarily because of the lack of technical knowledge in the relevant field (Dorin, 2022). Additionally, this farming method is less explored in horticultural research sectors particularly due to limited data availability Wangchu *et al.* (2024). Although Punjab is rich in readily available and affordable organic materials, including animal manure and crop residues like paddy and wheat straws, research on organic crop cultivation in the region remains limited (Kumar *et al.*, 2023). As a result, the present investigation aimed to assess the impact of three distinct farming methods - Conventional Farming (CF), Organic Farming (OF) and Subhash Palekar Natural Farming (SPNF)- on the quality characteristics of Camarosa strawberries.

MATERIALS AND METHODS

Strawberry runners of the 'Camarosa' cultivar obtained from a local nursery located in Hoshiarpur city of Punjab, were used for field trials conducted from 2022 to 2024 in an open research farm at Lovely Professional University, Punjab (India). This site is situated within the Punjab's Doaba region (30°57' to 32°7'N latitude and 75°4' to 76°30' E longitude) ranging from 270-300 m above MSL. The experimental field is characterized by a loamy soil texture, which is a fertile and well-balanced combination of sand, silt and clay ideal for strawberry cultivation. The plants of strawberry cv. Camarosa were cultivated under three different farming conditions *viz.* organic farming (OF), Subhash Palekar Natural Farming (SPNF) and conventional farming (CF). Three plots were selected for each cultivation system as replicates.

Before the commencement of experiment, the OF and SPNF plots underwent soil solarization by covering the soil using a black polyethylene sheet for two months (August to October) for eradicating all soil borne pathogens and pests. While, CF plots were treated with chemical fumigant metam sodium as VAPAM® @ 50 g m⁻² accompanied with covering the soil with plastic sheet 30 days prior to planting to achieve same objective. In OF treatment, a combination of 100% RDF including vermicompost, neem cake and biochar was incorporated into the soil, serving as nutrient sources.

These amendments were applied at three distinct stages: prior to planting, during crown initiation and at the tillering stage. Complementing the organic amendments, a synergistic formulation comprising biozyme and humic acid @ 2 mL.L⁻¹ of water was applied as a root zone treatment during the vegetative growth stage for enhanced growth. For preventing the plants from diseases and pests attack, *Amritpani* and *Panchgavya* were applied @ 3% particularly at flowering stage 2-3 times at fortnight interval.

For conventional farming, the package of practices of Punjab Agricultural University (PAU) was followed (Thind and Mahal, 2021) whereas for SPNF system, the methods laid down by Palekar (2006) were adopted involving application of *Jeevamrita*, *Beejamrita*, *Achhadana* and *Whapasa* (Table 1). For diseases and pest control under CF system, Thiram, Imidacloprid and Abamectin were used while SPNF system employed natural preparations including fermented buttermilk, cow urine, *Neemastra* and *Brahmastra* (Table 1) for the same purpose.

Fully ripened fruits were collected at the end of the April month and taken to the laboratory for analysis. A homogenate was prepared by blending 100 g of berries in a blender (1.0 L) and samples of this raw homogenate were frozen at subzero temperature (-80°C). This frozen homogenate was utilized for the estimation of sugars (total, reducing and non-reducing) and vitamin-C content upon thawing. Further, for determination of total antioxidant capacity, total phenolic content, total anthocyanin content and total flavonoid content, extracts were prepared using 80% methanol and mixture was subjected to centrifugation at 5000 rpm for 30 min (Remi R-8C plus centrifuge). The resulting supernatant was collected in tightly closed Tarson tubes and stored at 0°C for subsequent use.

The sugar composition of the fruit, encompassing both total sugar and reducing sugar content was determined by titrating a boiling mixture (5 mL each of Fehling A and Fehling B) against hydrolyzed sample solution using methylene blue as an indicator to a brick red endpoint (A.O.A.C., 1980). Additionally, the quantity of non-reducing sugars was obtained by subtracting the values of reducing sugar from the total sugar. For assessing ascorbic acid, procedure listed by (Ranganna, 2003) was followed, using 3% metaphosphoric acid. For determining the total anthocyanin content (TAC) in strawberries, the pH differential method, as described by (Lee *et al.*, 2005) was used. The estimation of total antioxidant content in

Table 1: Preparation of Subhash Palekar Natural Farming (SPNF) components.

Component	Raw materials
<i>Beejamrita</i>	1 kg cow dung, 1 L cow urine, 50 g lime (CaCO ₃), a handful forest soil and 5 L water
<i>Liquid Jeevamrita</i>	10 kg cow dung, 10 L cow urine, 2 kg gram flour, 2 kg jaggery and a handful forest soil and 200 L water
<i>Ghan Jeevamrita</i>	100 kg cow dung, 10 L cow urine, 2 kg gram flour, 2 kg jaggery and a handful forest soil (uncontaminated soil)
<i>Achhadana</i>	Paddy straw, wheat husk, or any plant residue
<i>Neemastra</i>	10 kg neem leaves, 10 L cow urine, 2 kg cow dung and 200 L water
<i>Brahmastra</i>	3 kg neem leaves, 10 L cow urine, 2 kg papaya leaves, 2 kg custard apple leaves and 2 kg pomegranate leaves

strawberries was done by DPPH-free radical scavenging assay outlined by Mandave *et al.* (2014). The total antioxidant capacity (%) was determined using the following formula:

$$\% \text{Radical Scavenging Activity} = \frac{\text{OD}_{\text{control}} - \text{OD}_{\text{sample}}}{\text{OD}_{\text{control}}} \times 100$$

Where, control is methanolic solution of DPPH.

The total phenolic content (TPC) was assessed as per the modified colorimetric method listed by Mandave *et al.* (2014) utilizing the Folin-Ciocalteu's reagent and the gallic acid was used as standard to generate linear curve for quantitation of TPC. To determine the total flavonoid content (TFC), methods followed by Roussos *et al.* (2022) were adopted using quercetin as a standard. The outcomes were quantified in mg gallic acid equivalent per 100 g (mg GAE/100g) for TPC and mg quercetin equivalent per 100g (mg QE/100 g) for TFC.

The obtained data were analyzed using SPSS software employing the Duncan multiple range test (DMRT) with descriptive analysis to arrive at homogenous subsets, facilitating the derivation of conclusions ($P < 0.05\%$). Use of the same letters indicates statistically non-significant difference between the examined groups.

RESULTS AND DISCUSSION

Total sugars, reducing sugars and non-reducing sugars

The results from Table 2 demonstrate that all the farming practices significantly influenced sugar content in Camarosa strawberries. Fruits from OF extracted highest levels of sugar content across all categories (total, reducing and non-reducing), which were statistically comparable to SPNF. The results indicate that both OF and SPNF systems produced strawberries with significantly higher total sugar content (7.56% and 7.48% respectively) compared to CF (6.79%). A similar pattern was noted for reducing sugars, with OF and SPNF showing higher values (6.04% and 5.88%) than CF (5.63%). For non-reducing sugars, SPNF and OF again outperformed CF, with values of 1.59% and 1.51%, respectively, compared to 1.16% for CF.

These findings suggest that organic and natural farming practices may enhance the sugar content and potentially the sweetness of strawberries. This trend could be linked to several factors, including improved soil health and nutrient availability in organic systems, stress-induced metabolite production and potentially slower growth rates allowing for extended sugar accumulation periods accounting for greater fruit quality (Conti *et al.*, 2014). *Jeevamrita* being the major component of SPNF might contribute to increased sugars in fruits, attributed to the increased photosynthetic rate, translocation and accumulation of sugars and metabolites in fruits (Maher *et al.*, 2020; Kazimi *et al.*, 2024). Similarly, under OF, combining organic fertilizers with Arbuscular mycorrhizal fungi enhances photosynthetic activity and overall plant development (Amaya-Carpio *et al.*, 2009). Photosynthesis

Table 2: Effect of farming practices on total sugars, reducing sugars and non-reducing sugars in strawberry cv. Camarosa.

Farming system	Total sugars (%)			Reducing sugars (%)			Non-reducing sugars (%)		
	2023	2024	Pooled	2023	2024	Pooled	2023	2024	Pooled
OF	7.15±0.186 ^b	7.97±0.119 ^b	7.56±0.044 ^b	5.88±0.066 ^a	6.210.123 ^b	6.04±0.089 ^b	1.26±0.231 ^a	1.75±0.005 ^b	1.51±0.044 ^b
SPNF	7.01±0.382 ^b	7.94±0.143 ^b	7.48±0.254 ^b	5.76±0.026 ^a	6.01±0.237 ^{ab}	5.88±0.126 ^{ab}	1.25±0.353 ^a	1.93±0.134 ^b	1.59±0.257 ^b
CF	6.46±0.216 ^a	7.12±0.267 ^a	6.79±0.121 ^a	5.44±0.468 ^a	5.82±0.087 ^a	5.63±0.278 ^a	1.02±0.523 ^a	1.30±0.180 ^a	1.16±0.123 ^a
S. Em (±)	0.148	0.130	0.130	0.103	0.073	0.080	0.119	0.101	0.081

Where, OF = Organic farming, SPNF = Subhash Palekar natural farming and CF = Conventional farming. *Differences marked by distinct letters in the same column are statistically significant ($P < 0.05$).

Table 3: Effect of farming practices on ascorbic acid, total phenolic content and total flavonoid content in strawberry cv. Camarosa.

Farming system	Ascorbic acid (mg/100 g)			TPC (mg /100 g)			TFC (mg/100 g)		
	2023	2024	Pooled	2023	2024	Pooled	2023	2024	Pooled
OF	37.97±1.227 ^c	39.58±0.870 ^b	38.78±0.187 ^c	264.04±3.666 ^b	269.04±2.746 ^b	266.54±3.200 ^b	164.96±1.700 ^c	169.96±2.343 ^c	167.46±1.985 ^c
SPNF	34.67±2.323 ^b	37.13±0.345 ^b	35.90±1.297 ^b	258.34±6.073 ^b	263.00±4.975 ^b	260.67±5.522 ^b	160.53±5.824 ^{ab}	165.20±6.941 ^{ab}	162.86±6.381 ^{ab}
CF	28.37±0.372 ^a	31.88±0.152 ^a	30.13±0.112 ^a	227.56±4.534 ^a	236.25±5.519 ^a	231.90±4.993 ^a	153.80±5.144 ^a	159.80±2.858 ^a	156.80±3.751 ^a
S. Em (±)	1.474	1.146	1.290	5.834	5.209	5.518	2.095	1.968	1.334

Where OF = Organic farming, SPNF = Subhash Palekar natural farming, CF = Conventional farming; TPC = Total phenolic content and TFC = Total flavonoid content. * Differences marked by distinct letters in the same column are statistically significant (P<0.05).

in leaves produces carbohydrates, which are then transported to fruits as sucrose or sorbitol and upon reaching the fruit, these sugars undergo metabolic transformations (Li *et al.*, 2018). A higher rate of photosynthesis per plant could potentially result in increased carbohydrate levels in both leaves and fruits (Garrido *et al.*, 2023). Similar to present study, higher sugar levels in strawberry fruits have been observed by (Al-Karawi and Al-Rawi, 2016) with organic fertilizers.

Ascorbic acid (mg/100 g), total phenolic content (mg GAE/100 g) and total flavonoid content (mg QE/100 g)

The data presented in Table 3 reveal a markable variation for bioactive compound content in strawberries as influenced by different farming practices. Fruits from OF exhibited markedly higher concentrations of all analyzed compounds resulting in significantly higher ascorbic acid content (38.78 mg/100 g), followed by SPNF (35.90 mg/100 g) while lowest levels were reported from CF (30.13 mg/100 g). Similarly, OF resulted in the highest level of total phenolic content (266.54 mg GAE/100 g), which is at par with SPNF (260.67 mg GAE/100g), with both significantly exceeding CF (231.90 mg GAE/100 g). Regarding total flavonoid content, OF again led (167.46 mg QE/100 g), while SPNF (162.86 mg QE/100 g) and CF (156.80 mg QE/100 g) showed no significant difference, though SPNF maintained a slight edge over CF.

The increased levels of bioactive compounds in the strawberry fruits under OF can be correlated with the combined application of biostimulants (humic acid and biozyme) in addition to organic resources, which may create a more favorable physiological state in plants, optimizing metabolism and mildly stressing the plants in ways that encourages the production of these beneficial compounds (Rathor *et al.*, 2023). These findings are in line with the findings of Amodio and Colelli (2020) who reported that grapes grown organically had higher nutritional value (including phenol content, antioxidant activity, sugars, organic acids and ascorbic acid) than the conventional methods which resulted in better visual quality, storability and yield.

Total anthocyanin content (mg/100mg) and total antioxidant capacity (%)

The results from Table 4 indicate that the total antioxidant capacity and total anthocyanin content in strawberries cv. Camarosa increased consistently, adhering to the same trend OF (86.58% and 53.42 mg/100 g), > SPNF (83.93% and 51.28 mg/100 g) > CF (77.80 % and 46.56 mg/100 g), respectively. Specifically, the total antioxidant capacity (DPPH % radical scavenging activity) varied significantly among all the farming systems, suggesting that the organic farming may enhance the nutritional quality of strawberries.

These results are supported by the latest studies that have reported the beneficial effects of organic practices on the phytochemical composition of fruits (Roussos *et al.*, 2022). The higher amounts of antioxidants and anthocyanins

Table 4: Effect of farming practices on total antioxidant capacity and total anthocyanin content in strawberry cv. Camarosa.

Farming system	Total antioxidant capacity (%)			Total anthocyanin content (mg/100 g)		
	2023	2024	Pooled	2023	2024	Pooled
OF	84.67±1.474 ^c	88.49±1.166 ^b	86.58±0.820 ^c	51.15±1.519 ^b	55.68±1.660 ^b	53.42±0.402 ^b
SPNF	81.56±0.294 ^b	86.29±3.578 ^b	83.93±1.789 ^b	49.71±1.565 ^b	52.85±2.003 ^b	51.28±0.905 ^b
CF	75.91±1.642 ^a	79.68±1.900 ^a	77.80±1.117 ^a	44.75±1.349 ^a	48.38±0.558 ^a	46.56±1.036 ^a
S. Em (±)	1.334	1.497	1.354	1.058	1.151	0.687

Where OF = Organic farming, SPNF = Subhash Palekar natural farming and CF = Conventional farming. * Differences marked by distinct letters in the same column are statistically significant ($P < 0.05$).

under OF and SPNF might be related with the greater determined phenolic, flavonoid and anthocyanin contents (Salazar-Orbea *et al.*, 2023). Studies have proven that conventional farming does not increase the antioxidant and anthocyanin contents in fruits as much as organic farming does (Zahid *et al.*, 2022).

CONCLUSION

The present study concludes that organic farming (OF) and Subhash Palekar natural farming (SPNF) practices significantly enhanced the quality characteristics of Camarosa strawberries compared to Conventional Farming (CF) under Punjab conditions. OF and SPNF consistently produced fruits with higher sugar content, ascorbic acid, total anthocyanins, total phenolics, total flavonoids and total antioxidant capacity. These improvements are likely due to enhanced soil health, improved nutrient cycling, stimulation of plant defense mechanisms and enhanced plant metabolism associated with organic and natural farming methods. Further research is required to explore long-term impacts, underlying mechanisms and broader applicability across different cultivars and regions. Overall, this study highlights the potential of OF and SPNF as sustainable alternatives for strawberry production that can deliver both environmental and health benefits.

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Disclaimers

The views and conclusions expressed in this article are solely those of the authors and do not necessarily represent the views of their affiliated institutions. The authors are responsible for the accuracy and completeness of the information provided, but do not accept any liability for any direct or indirect losses resulting from the use of this content.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this article. No funding or sponsorship influenced the design of the study, data collection, analysis, decision to publish, or preparation of the manuscript.

REFERENCES

- A.O.A.C.(1980).Official Methods of Analysis.(13th edn), Association of Official Analytical Chemists, Washington, DC.
- Abebe, T.G., Tamtam, M.R., Abebe, A.A., Abtemariam, K.A., Shigut, T.G., Dejen, Y.A. and Haile, E.G.(2022).Growing use and impacts of chemical fertilizers and assessing alternative organic fertilizer sources in Ethiopia. Applied and Environmental Soil Science. (1): 4738416.
- Al-Karawi, H.N.R. and Al-Rawi, W.A. (2016).Effect of foliar application of organic extract and humic acid application on strawberry production. Iraqi Journal of Agricultural Sciences. 47(3): 749-756.
- Amaya-Carpio, L., Davies, F.T., Fox, T. and He, C. (2009). Arbuscular mycorrhizal fungi and organic fertilizer influence photosynthesis, root phosphatase activity, nutrition and growth of Ipomoea carnea ssp fistulosa. Photosynthetica. 47: 1-10.
- Amodio, M.L. and Colelli, G. (2020). Physio-chemical quality attributes of 'Italia' grapes from organic and conventional farming at harvest and during storage. Advances in Horticultural Science. 34(1S): 109-115.
- Cabral, L., Pandey, P. and Xu, X. (2022). Epic narratives of the green revolution in Brazil, China and India. Agriculture and Human Values. 39(1): 249-267.
- Chauhan, N., Bakshi, M., Singh, S.K. and Sharma, J.B. (2024). Comparative evaluation of strawberry cultivars under Subhash Palekar natural farming and conventional farming regimes in Doaba region of Punjab conditions. Journal of Applied and Natural Science. 16(1): 282-288.
- Conti, S., Villari, G., Faugno, S., Melchionna, G., Somma, S. and Caruso, G. (2014). Effects of organic vs. conventional farming system on yield and quality of strawberry grown as an annual or biennial crop in southern Italy. Scientia Horticulturae. 180: 63-71.
- Dev, P., Paliyal, S. S. and Rana, N. (2022). Subhash Palekar natural farming-scope, efficacy and critics. Environment Conservation Journal. 23(1 and 2): 99-106.
- Dorin, B. (2022). Theory, practice and challenges of agroecology in India. International Journal of Agricultural Sustainability. 20(2): 153-167.
- Frison, E. and Clément, C. (2020). The potential of diversified agroecological systems to deliver healthy outcomes: Making the link between agriculture, food systems and health. Food Policy. 96: 101851.
- Garrido, A., Conde, A., Seródio, J., De Vos, R.C. and Cunha, A. (2023). Fruit photosynthesis: More to know about where, how and why. Plants. 12(13): 2393.

- Ghanem, A.M.K., Alwis, K.N. and Al-Nashwan, O.S. (2024). Study the implications of the potential expansion of organic agriculture on self-sufficiency and production inputs (Chemical Fertilizers and Pesticides). *Indian Journal of Agricultural Research*. 58(5): 895-903. doi: 10.18805/IJARE.AF-859.
- Kazimi, R., Tajzadah, A.W. and Merzai, M.S. (2024). Impacts of alternative growing medium in combination with Jeevamrit on strawberry growth and fruit quality parameters under open field condition. *Multidisciplinary Science Journal*. 6(10): 2024212. <https://doi.org/10.31893/multiscience.2024212>.
- Kumar, J., Rana, S., Rani, V. and Ahuja, A. (2023). What affects organic farming adoption in emerging economies? A missing link in the Indian agriculture sector. *International Journal of Emerging Markets*. pp 1746-8809.
- Lee, J., Durst, R.W., Wroldstad, R.E. and Collaborators: Eisele T Giusti MM Hach J Hofsommer H Koswig S Krueger DA Kupina; S Martin SK Martinsen BK Miller TC Paquette F Ryabkova A Skrede G Trenn U Wightman JD. (2005). Determination of total monomeric anthocyanin pigment content of fruit juices, beverages, natural colorants and wines by the pH differential method: collaborative study. *Journal of AOAC International*. 88(5): 1269-1278.
- Li, M., Li, P., Ma, F., Dandekar, A.M. and Cheng, L. (2018). Sugar metabolism and accumulation in the fruit of transgenic apple trees with decreased sorbitol synthesis. *Horticulture Research*. 5(60). <https://doi.org/10.1038/s41438-018-0064-8>.
- Maher, M.M., Shylla, B., Sharma, D., Sharma, U. and Kuchay, M. (2020). Yield and quality of polyhouse grown strawberries as affected by soilless media and jeevamrit. *Int. J. Chem. Stud*. 8: 585-589.
- Mandave, P.C., Pawar, P.K., Ranjekar, P.K., Mantri, N. and Kuvalekar, A.A. (2014). Comprehensive evaluation of *in vitro* antioxidant activity, total phenols and chemical profiles of two commercially important strawberry varieties. *Scientia Horticulturae*. 172: 124-134.
- Mandla, I. and Sharma, S. (2022). Subhash Palekar natural farming: introduction and its four pillars. *Just Agric*. 3: 39.
- Münster, D. (2021). The nectar of life: fermentation, soil health and bionativism in Indian natural farming. *Current Anthropology*. 62(S24): S311-S322.
- Oyege, I. and Balaji Bhaskar, M.S. (2023). Effects of Vermicompost on Soil and Plant Health and Promoting Sustainable Agriculture. *Soil Systems*. 7(4): 101.
- Palekar, S. (2006). Text book on shoonya bandovalada naisargika krushi, published by swamy anand. Agri Prakashana, Bangalore. 67.
- Ranganna, S. (2003). Hand Book of Analysis and Quality Control for Fruits and Vegetable Products. 7th Edition, Tata McGraw Hill Book Co., New Delhi. 594-625
- Rathor, P., Gorim, L.Y. and Thilakarathna, M.S. (2023). Plant physiological and molecular responses triggered by humic based biostimulants- A way forward to sustainable agriculture. *Plant and Soil*. 492(1): 31-60.
- Roussos, P.A., Triantafyllidis, A., Kepolas, E., Peppas, P., Piou, A., Zoti, M. and Gasparatos, D. (2022). Effects of integrated and organic management on strawberry (cv. Camarosa) plant growth, nutrition, fruit yield, quality, nutraceutical characteristics and soil fertility status. *Horticulturae*. 8(2): 184.
- Sahoo, S., Baral, N., Nayak, A., Naik, A., Behera, D., Mahapatra, M. and Sahoo, J.P. Effect of Pesticides on Human Health and Biodiversity: A Comprehensive Insight. *Bhartiya Krishi Anusandhan Patrika*. 39(2): 115-124.
- Salazar-Orbea, G.L., García-Villalba, R., Bernal, M.J., Hernández, A., Tomás-Barberán, F.A. and Sánchez-Siles, L.M. (2023). Stability of phenolic compounds in apple and strawberry: Effect of different processing techniques in industrial set up. *Food Chemistry*. 401: 134099.
- Sarkar, S., Skalicky, M., Hossain, A., Brestic, M., Saha, S., Garai, S. and Brahmachari, K. (2020). Management of crop residues for improving input use efficiency and agricultural sustainability. *Sustainability*. 12(23): 9808.
- Singh, M., Rana, R. K., Monga, S. and Singh, R. (2022). Organic and natural farming-a critical review of challenges and prospects. *Bhartiya Krishi Anusandhan Patrika*. 37(4): 295-305. doi: 10.18805/BKAP569.
- Soni, R., Gupta, R., Agarwal, P. and Mishra, R. (2022). Organic farming: A sustainable agricultural practice. *Vantage: Journal of Thematic Analysis*. 3(1): 21-44.
- Thind, S. K. and Mahal, J.S. (2021). Package of practices for cultivation of fruits. Additional Director of Communication for Punjab Agricultural University: Ludhiana. India. 1-188.
- Tripathi, S., Shahidi, T., Nagbhushan, S. and Gupta, N. (2018). Zero budget natural farming for the sustainable development goals. Council on Energy, Environment and Water, New Delhi, India.
- Wangchu, L., Angami, T., Jini, D., Bam, J., Singh, R., Tasung, A. and Suryawanshi, A. (2024). Natural Farming: Scope and Prospective in Arunachal Pradesh. ICAR (Research Complex) for NEH Region, Umiam, Meghalaya.
- Zahid, N., Maqbool, M., Tahir, M.M., Horvitz, S., Hamid, A., Khalid, M.S. and Ali, A. (2022). Influence of organic and inorganic fertilizer regimes on growth patterns and antioxidants capacity of strawberry (*Fragaria × ananassa* Duch.) cv. Chandler. *Journal of Food Quality*. 1: 8618854.