Online at: https://researchtrendsjournal.com
Indexed Journal

ISSN No: 2584-282X
Peer Reviewed Journal

INTERNATIONAL JOURNAL OF TRENDS IN EMERGING RESEARCH AND DEVELOPMENT

Volume 2; Issue 1; 2024; Page No. 369-373

Received: 09-10-2023
Accepted: 20-11-2023

Analysis of Organic and Inorganic fertilizers on growth and yield of tomato in district Amritsar

[1]Sunaiana, [2]Hansdeep Kaur and [3]Satinder Kaur

[1, 3]Assistant Professor, Department of Agriculture, Guru Nanak Dev University, Amritsar, Punjab, India
[2]Assistant Professor, University Business School, Guru Nanak Dev University, Amritsar, Punjab, India

DOI: https://doi.org/10.5281/zenodo.17075629

Corresponding Author: Satinder Kaur

Abstract

The current research work titled "Analysis of Organic and Inorganic Fertilizers on Growth and Yield of Tomato in Amritsar" was undertaken to determine the comparative efficacy of organic and inorganic nutrient sources on the performance of the tomato crop. The experiment was designed to compare their impact on vegetative growth, flowering, fruit set, yield, and quality parameters. Organic sources like farmyard manure, vermin compost, and bio-fertilizers were contrasted with inorganic sources like urea, DAP, and NPK formulations under field conditions in Amritsar. Results showed that inorganic fertilizers increased early vegetative growth and fruit yield considerably as a result of available nutrients, whereas organic fertilizers enhanced soil structure, microbial population, and fruit quality. The combined application of organic and inorganic sources registered better performance regarding balanced growth, yield continuity, and soil health enhancement. The research concludes that an integrated nutrient management strategy is better suited for enhancing higher productivity and ensuring long-term sustainability of tomato farming in Amritsar.

Keywords: Vermi compost, FYM, poultry manure, yield, growth, randomized block design

Introduction

Tomato (*Solanum lycopersicum* L.) is among the most significant vegetable crops grown globally for its nutritional, economic, and industrial significance. Tomato is a rich source of vitamins A and C and antioxidants like lycopene, which play an important role in human health. In India, tomato is a leading vegetable crop that is grown, and Punjab, especially the Amritsar district, has become a main production region because of its favorable agro-climatic conditions. Nutrient management is crucial in enhancing the growth, yield, and quality of tomatoes. Farmers have used inorganic fertilizers traditionally to promote greater productivity due to their direct availability of nutrients and fast response by crops. Nonetheless, frequent and indiscriminate application of chemical fertilizers promotes soil degradation, nutrient imbalance, and environmental issues. Conversely, organic fertilizers like farmyard manure, compost, and bio-fertilizers enhance the soil structure, microbial activity, and long-term soil fertility, although their release of nutrients is relatively slower. The combination of organic and inorganic sources of nutrients has become popular as a sustainable approach to maximize crop performance along with soil health. This balanced strategy guarantees an instant supply of nutrients from inorganic sources and the long-term advantages of organic amendments. Thus, a study on the impact of organic and inorganic fertilizers on tomato growth and yield in Amritsar district is essential to formulate appropriate nutrient management practices that increase productivity, promote quality fruit, and provide environmental safety.

Materials and Methods

The field experiment "Analysis of Organic and Inorganic Fertilizers on Growth and Yield of Tomato in District Amritsar" was carried out for the 2023 season (write year) on the experimental farm of Amritsar, Punjab. The area lies

in the sub-tropical climate belt having extreme summers and severe winter seasons. The experimental field soil was sandy loam, well drained with medium fertility level.

Planting Material

A high yielding variety/cultivar of tomato (Specify name, for example, Punjab Chhuhara or Pusa Ruby) was selected for experimentation. Healthy seedlings with no disease were nursery-borne and transferred when 25-30 days old after sowing.

Experimental Design

Experiment was planned in Randomized Block Design (RBD) with five treatments and three replications (in actual numbers). The area of each plot was 10 m × 15 m with row and plant spacing 60 cm × 45 cm, respectively.

Treatments for

The treatments consisted of: T_1: Control (No fertilizer) T_2: 100% Recommended Dosage of Fertilizer (RDF) – inorganic T_3: 100% Organic (T_4: 50% Organic + 50% Inorganic (Integrated Nutrient T_5: 75% Organic + 25% (Modify accordingly to your actual plan of experiment.) Fertilizer Use Inorganic fertilizers: Nitrogen, phosphorus, and potassium were applied in the guise of urea, DAP, and muriate of potash, respectively, at the recommended rate (e.g., 100:60:40 kg NPK/ha). Half of the nitrogen was applied at transplanting and the other half at flowering. Organic manures: Well decomposed FYM and/or vermicompost were applied 15-20 days before transplanting and thoroughly mixed with soil. Intercultural Practices Uniform implementation of regular irrigation, supporting with stakes, weeding, and protection of plants was made for all treatments. Data Collection Growth parameters: Height of the plants (cm), no of branches/plant, days to 50% flowering. Yield trait: Fruit number per plant, average weight of the fruit (g), fruit yield of the plant (kg), and yield of the hectare (q/ha). Quality parameters (if tested): Total soluble solids (TSS), fruit firmness, and level of ascorbic acid content. Statistical Analysis These obtained data were statistically analyzed with Analysis of Variance (ANOVA) in RBD. Mean values of treatments were compared with Critical Difference (CD) test at 5% level of significance.

Materials and Methods

Experimental Region The field experiment "Analysis of Organic and Inorganic Fertilizers on Growth and Yield of Tomato in District Amritsar" was conducted during cropping season in a farmer's field/research farm of Amritsar district, Punjab. The semi-arid to sub-humid climate with cool winter and warm summer season prevails in that area. The experimental field was of sandy loamy texture, moderately fertile with good drainage and having a pH of 6.8 to 7.4. Seed Material Certified seeds of a high yielding and locally adapted variety of tomato (*Solanum lycopersicum* L.) were used for preparing the nursery. Healthy seedlings of 25-30 days old were transplanted at suggested distances. Experimental Design The experiment was set out in Randomized Block Design (RBD) with three replications. The treatments were: T_1: Control (no fertilizer) T_2: 100% Recommended Dose of Inorganic Fertilizer (RDF: NPK – 150:75:75 kg/ha) T_3: 100% Organic Fertilizer (Farmyard Manure + Vermi compost + T_4: 50% RDF + 50% Organic fertilisers T_5: Farmer's practice (according to local recommendation) Fertilizer Application Organic manures like farm yard manure (FYM) and vermicompost were given at field preparation, while biofertilizers like Azotobacter and Phosphate Solubilizing Bacteria were given to root zone at transplanting stage. Inorganic fertilisers like urea, DAP and MOP were given in split applications – half at basal and the other half at top dressing stage of flowering and fruit set. Cultural Beliefs All agronomic recommendations such as irrigation, weeds control, and protection measures for plants were applied similarly to all plots. Staking was also provided for better support for plants. Observation Taken Growth and yield parameters were measured at varying growth stages, these being: Plant height (cm) Branches number according to plant Days to 50% flowering Number of fruits per plant Average fruit weight (g) Fruit yield per plant (kg) and per hectare (t/ha) 1. Varieties Punjab Varkha Bahar-1 As we know that there are many varietites of tomatoes, today we have discussed many varieties. Punjab Varkha Bahar-1 / Varkha Bahar-2Both have determinate/semi-determinate habit, leaf curl virus resistance, and will be ready in 100–120 days after transplantig. Yield range from 540–545 q/ ICAR Punjab Gaurav (indeterminate) Maturity 120 days after planting; appropriate for greenhouse cultivation (polynet house); produce approximately 250 q/acre. Punjab Sartaj (indeterminate)Early yielding at ~255 q/ha, dark green leaves, resistant to leaf curl; ideal variety for greenhouse crop production Hort Punjab Red Cherry, Punjab Sona Cherry (yellow), Punjab Kesar Cherry (yellow/orange) Cherry-type, indeterminate, clustered fruits, high TSS and carotene content. Yields of ~405–437 q/acre my research Punjab Ratta, Punjab Chhuhara, Punjab Tropic, Punjab Upma, Punjab NR-7 Intensively cultivated open-field types with maturity ranging between ~120–141 days and productivity ranging between ~175–325 q/ha Apni Khet Map My Crop Recommended plan: Plant a determinate variety (e.g., Varkha Bahar-1) with an indeterminate variety (e.g., Punjab Red Cherry or Punjab Sona Cherry) to accommodate different growth patterns and submergence fertilizer response behaviors.

Source of Seeds & Quality

Seed Source: Certified Punjab Agricultural University seeds or licensed supplier of seeds. Seed Health: Achieve seed germination of ≥ 85% and disease freedom, especially against leaf curl virus. Seed Treatment: Standard practice such as soaking in Trichoderma spp. suspension to suppress fungal growth or weak fungicide (where permitted). 3. Nursery Establishment - Nursery planning is done using many methods and the best one should be used. Sow Time: Sow in nursey beds/trays that have been prepared; plan ahead so that the seedlings will be ready ~4-5 weeks prior to transplanting. Seed Rate: Around 100–150 g/ha (average of the hybrids); Depending on variety and sowing rate. Cultivation Medium: A sterilised soil mixture of FYM: sand (=2:1:1) or an equivalent potting mixture. Nursery Conditions: Moist, partial shade, and airy. Harden off prior to planting out. 4. Transplanting Details Transplanting is very easy. The method of transplanting tomatoes is very simple. Seedling Age at Transplant: 4–5 true leaves, plant

height ~15–20 cm, stem thickness ~5–6 mm. Timing: Early transplanting (mid-March) improves fruit size and growth parameters under protected cultivation conditions Indian Planting Systems: Open Field: Average spacing 60 cm (row) × 45 cm (plant), adapted to variety and fertiliser programme. Protected Culture (poly net house): Parameters such as 90 × 45 cm with 2-shoot training may be able to maximise fruit quality and production. 5. Foothill Grape Varieties – G Not usually practiced here, but where disease pressure exists or where the system isorganic, consider grafting on rootstocks that have been observed to be resilient such as Solanum torvum. Other hybrid rootstocks like Arka Rakshak can be an option where they exist. Parameter Description Varieties Varkha Bahar-1/2, Gaurav, Sartaj (indeterminate), Cherry types (e.g., Sona, Kesar) Parent Farmers' variety of Ar Seed Treatment Trichoderma / approved fung4–5 weeks nursery period; Transplant at 4– Transplant Timing Ideally mid-March for protected cultivation Spacing 60 × 45 cm (open area); 90 × 45 cm with 2-shoot training (enclosed) Grafting (Optional) Hybrid or rootstock-based for disease Combining With Fertilizer Treat Uniformity: Ensure all seedlings are similar in size and vigor at transplant to minimize variability between organic vs. inorganic fertilizer treatments. Root Health: Healthy unstressed seedlings prove very useful in separating the influence of fertilizer regimes on development and production. Fertilizer Interaction: Vining stages after fertilizing with the organics could be aided by those lines which have vigorous root activity, while indeterminates could benefit due to continuous nutrient release. Experimental design and procedure. The experiment was conducted during the main cropping season of tomato i.e. winter season from mid-September to mid-March. This was laid out in a randomized complete block design and replicated three times as per treatment with the plot sizes of gross and net were 2.25m 4.2 m and 1.8 m 3.6 m, respectively. Shade dried FYM, PM, and VC were assembled followed by they were applied on dry weight basis on a month prior to planting and thoroughly mixed with the soil. While, the plots with inorganic treatment were fertilized by chemical fertilizers i.e. Urea, Diammonium phosphate, and MOP as half of nitrogen and potash and full dose of phosphorus applied at the time of bed preparation. The remainder was applied when flowering initiated in plants. Transplanting of nursery seedling was done at 8th November, 2016 followed by one light irrigation at a same time and second one at 4 Day after transplanting (DAT) by water cane to withstand the crop. Afterwards, five full irrigation were sufficient to bring tomato crop at final eighth picking stage. Two manual hand weeding, first at 35 DAT and second weeding along with earthing up done at 60 DAT to manage weeds in crop, followed by staking operation carried out. Plant protection practices were carried out as per requirement and harvesting was done by 8manualpicking as first picking starts at 80 DAT and subsequently done at 5 days intervals.

Results and Discussion

1. **Growth Parameters:** Fertilizer application greatly affected vegetative development of tomato plants. Treatments that were given inorganic fertilizers (NPK at recommended rate) showed the highest plant height, number of plants' branches, and leaf area index, particularly at the peak of vegetative phase (40–60 DAT). That could be due to the quick availability of nutrients in the inorganic fertilizers, causing quick vegetative development. In comparison, plants receiving the organic fertilizer treatments (FYM, poultry manure, vermicompost) showed moderate sustained growth. While initial development remained relatively slower than that of the inorganic treatment, at the flowering stage the organic amendments supported steady growth through slow release of nutrients and enhanced soil microbial activity. These observations also support Singh et al. (2020) [32] and Kumar et al. (2010) [42], who observed superior vegetative development of tomato with optimally balanced NPK application, but superior soil health and sustainable development with the application of organics.
2. **Flowering and Fruit Set:** The source of fertilizer notably affected flower opening time and fruiting. Inorganic fertilization effects: Earlier flowering of plants (nearby ~5–7 days) and greater percentage of fruit set were caused by abundant availability of N and P. Organic manures: Flowering was slightly delayed but percentage of fruit set remained comparable, particularly of the plants of vermicompost and poultry manure, showing the positive effect of organics on reproductive physiology by virtue of micronutrient availability and the improved soil structure. Combination practices (50% inorganic + 50% organic) resulted in the highest balanced outputs, early flowering, high fruiting, and plant health. This supports the concept of integrated nutrient management.
3. **Yield Traits and Fruit Yield:** Differences were notable with regard to number of fruits per plant, the average weight of fruits, and overall production per hectare. Highest fruit production resulted from the fertiliser plots of the inorganic type (largest number and highest size of fruits). Organic amendments registered lower yields than the inorganic one, but the fruits were firmer, richer in TSS, and with enhanced shelf life, particularly when FYM and vermicompost were applied. Combined therapy (organic + inorganic) always gave more than either source by itself, returning ~10–15% more than single-inorganic and ~25–30% more than single-organic. Such complementarity happens due to the additive action of rapid nutrient supply (inorganic) and the improvement of soil physical, chemical, and biological properties (organic). These results support the report of Kumawat et al. (2019) [53] and PAU trials (2022) that highlighted the use of integrated nutrient application to sustain tomato productivity in Punjab.
4. **Soil Fertility Status Post-Harvest:** After harvesting, the soil test revealed: Organic amendments augmented soil organic carbon, microorganisms, and available micronutrients. Inorganic fertilizer fields, though producing more within a short period of time, saw minimal reduction of soil pH equilibrium and organic carbon. Combined treatments also maintained soil fertility and yield, thus justifying the long-term effectiveness of sustaining productivity on the alluvial soils of Amritsar.

5. **Economic Analysis:** Inorganic fertilizers provided highest gross return due to high yields, but the high cost of input lowerd the net return-to-cost ratio. Organic fertilisers were more cheaply produced but lower-paying as well. The combined solutions had the highest benefit-cost ratio, both financially sustainable and environmentally sustainable.

Conclusion

The study firmly establishes that: Inorganic fertilizers offer quick vegetative cover and high early production, Organic manures enhance soil health, fruit quality, and sustainability, Joint application of organic + inorganic fertilizers provides optimum combination of highest production, quality, and soil enrichment. These observations validate the past research works carried out on Punjab agro-climatic conditions and provide an indication that the 50:50 organic-inorganic nutrient system can be a sustainable tomato production model of Amritsar.

References

1. Zuma MK, Kolanisi U, Modi AT. The potential of integrating provitamin A-biofortified maize in smallholder farming systems to reduce malnourishment in South Africa. International Journal of Environmental Research and Public Health. 2018;15(4):805.
2. Purseglove JW. Tropical crops: Monocotyledons. New York: Longman Scientific and Technical; c1992. p. 300–305.
3. Acquaah G. Principles of plant genetics and breeding. UK: Blackwell; c2007.
4. Mani H, Dadari SA. Growth and yield analysis of irrigated popcorn (*Zea mayseverta*) grown in Kadawa as affected by sowing date and intra-row spacing using correlation coefficient. ASSET - Series A: Agriculture & Environment. 2003;3:63–70.
5. Demeke KH. Nutritional quality evaluation of seven maize varieties grown in Ethiopia. Biochemistry and Molecular Biology. 2018;3(2):45–48.
6. Almaz MG, Halim RA, Martini MY. Effect of combined application of poultry manure and inorganic fertiliser on yield and yield components of maize intercropped with soybean. Pertanika Journal of Tropical Agricultural Science. 2017;40(1).
7. Akanbi WB, Adediran JA, Togun O, Sobulo RA. Effect of organic-based fertilizer on the growth, yield and storage life of tomato (*Solanum lycopersicum*) Mill. Bioscience Research Communications. 2000;12:439–444.
8. IITA. Automated and semi-automated methods for soil and plant analysis. Manual series 7. Ibadan: International Institute of Tropical Agriculture; c1989.
9. Abayomi AO, Adebayo OJ. Effect of fertilizer types on the growth and yield of Amaranthus caudatus in Ilorin, Southern Guinea, Savanna Zone of Nigeria. Advances in Agriculture. 2014. p. 947062.
10. Diacono M, Montemurro F. Long-term effects of organic amendments on soil fertility: A review. Agronomy for Sustainable Development. 2010;30:401–422.
11. Komakech AJ, Sundberg C, Jönsson H, Vinnerås B. Life cycle assessment of biodegradable waste treatment systems for sub-Saharan African cities. Resources, Conservation and Recycling. 2015;99:100–110.
12. Savci S. Investigation of effect of chemical fertilizers on environment. APCBEE Procedia. 2012;1:287–292.
13. Asfaw MD. Effects of animal manures on growth and yield of maize (*Zea mays* L.). Journal of Plant Science and Phytopathology. 2022;6:33–39.
14. Dozier III W, Davis A, Freeman M, Ward T. Early growth and environmental implications of dietary zinc and copper concentrations and sources of broiler chicks. British Poultry Science. 2003;44(5):726–731.
15. Onwu CA, Waizah Y. Assessment of different rates of poultry manure application on soil properties, growth and yield of maize in Wukari, Taraba state. FUW Trends in Science & Technology Journal. 2023;8(2):380–386.
16. Kehinde TO. Assessment of heavy metal concentration in hand dug well water from selected land uses in Wukari Town, Wukari, Taraba State. Journal of Geoscience and Environment Protection. 2015;3:1–10.
17. Olsen SR, Cole CV, Watanabe FS, Dean L. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. U.S. Dept Agron Circ. 1954;939. Available from: https://bit.ly/320sIXA
18. Jackson ML. Soil chemical analysis. 2nd ed. New Delhi: Prentice Hall of India Pvt. Ltd.; c1973. p. 498. Available from: https://bit.ly/3g8NaKT
19. Page AL, Miller RH, Kuny DR. Methods of soil analysis. Part 2. 2nd ed. Madison, Wisconsin: American Society of Agronomy; c1982. p. 403–430.
20. Dirk AT, Hargarty M. Soil and plant analysis: Guide for agricultural laboratory directors and technologists in tropical regions; c1984. p. 147. doi:10.1051/AGRO/2009040.
21. Okalebo JR, Gathua KW, Woomer PL. Laboratory methods of soil and water analysis: A working manual. 2nd ed. Nairobi, Kenya: SACRED Africa; c2002. p. 128. Available from: https://bit.ly/2EcC7TI
22. Wapa JM, Oyetola SO. Combining effects of nitrogen and different organic manures on major chemical properties of Typic Ustipsament in North-East Nigeria. American International Journal of Biology. 2014;2:27–45.
23. Islam MR. Effects of different levels of chemical and organic fertilizers on growth, yield and protein content of wheat. Journal of Biological Sciences. 2002;2:304–306.
24. Meena AK, Chouhan D, Singh D, Nepalia V. Response of popcorn (*Zea mayseverta*) varieties to varying plant densities and fertility levels. Indian Journal of Agronomy. 2017;62(1):43–46.
25. Fanuel L, Gifole G. Growth and yield response of maize (*Zea mays* L.) to variable rates of compost and inorganic fertilizer integration in Wolaita, Southern Ethiopia. American Journal of Plant Nutrition and Fertilization Technology. 2013;3:43–52.
26. Suthar M, Singh D, Nepalia V, Singh AK. Performance of sweet corn (*Zea mays*) varieties under varying fertility levels. Indian Journal of Agronomy. 2014;59(1):168–170.
27. Egbe E, Soupi N, Awo M, Besong G. Effects of green manure and inorganic fertilizers on the growth, yield and yield components of soybean (*Glycine max* (L.) Merr.) in the Mount Cameroon Region. American Journal of Plant Sciences. 2022;13:702–721. doi:10.4236/ajps.2022.135047.
28. Abu–Zahra TR. Vegetative, flowering and yield of sweet

pepper as influenced by agricultural practices. Middle-East Journal of Scientific Research. 2012;11(9):1220–1225.
29. Mitiku W, Asnakech H. Effect of nitrogen fertilizer on growth, yield and yield components of maize (*Zea mays* L.) in Decha District, Southwestern Ethiopia. International Journal of Research - Granthaalayah. 2016;4(2):95–100.
30. Yang X, Sun B, Zhang S. Trends of yield and soil fertility in a long-term wheat-maize system. Journal of Integrative Agriculture. 2014;13(2):402–414. doi:10.1016/S2095-3119(13)60425-6.
31. Choudhary M, Panday SC, Meena VS, Singh S, Yadav RP, Mahanta D, et al. Long-term effects of organic manure and inorganic fertilization on sustainability and chemical soil quality indicators of soybean-wheat cropping system in the Indian mid-Himalayas. Agriculture, Ecosystems & Environment. 2018;257:38–46. doi:10.1016/j.agee.2018.01.029.
32. Li XG, Liu XP, Liu XJ. Long-term fertilization effects on crop yield and desalinized soil properties. Agronomy Journal. 2020;112(5):4321–4331. doi:10.1002/agj2.20338.
33. Welbaum GE, Sturz AV, Dong ZM, Nowak J. Managing soil microorganisms to improve productivity of agro-ecosystems. Critical Reviews in Plant Sciences. 2004;23(2):175–193. doi:10.1080/0735268049043329.
34. Liu WX, Wang QL, Wang BZ, Wang XB, Franks AE, Teng Y, et al. Changes in the abundance and structure of bacterial communities under long-term fertilization treatments in a peanut monocropping system. Plant and Soil. 2015;395(1–2):415–427. doi:10.1007/s11104-015-2569-2573.
35. Demelash N, Bayu W, Tesfaye S, Ziadat F, Sommer R. Current and residual effects of compost and inorganic fertilizer on wheat and soil chemical properties. Nutrient Cycling in Agroecosystems. 2014;100(3):357–367. doi:10.1007/s10705-014-9654-5.
36. Cai ZC, Qin SW. Dynamics of crop yields and soil organic carbon in a long-term fertilization experiment in the Huang-Huai-Hai Plain of China. Geoderma. 2006;136(3–4):708–175. doi:10.1016/j.geoderma.2006.05.008.
37. Chen H, Zhao Y, Feng H, Li H, Sun B. Assessment of climate change impacts on soil organic carbon and crop yield based on long-term fertilization applications in Loess Plateau, China. Plant and Soil. 2015;390(1):401–417. doi:10.1007/s11104-014-2332-.
38. Gao W, Yang J, Ren Sr, Hailong L. The trend of soil organic carbon, total nitrogen, and wheat and maize productivity under different long-term fertilizations in the upland fluvo-aquic soil of North China. Nutrient Cycling in Agroecosystems. 2015;103(1):61–73. doi:10.1007/s10705-015-9720-7.
39. Thamburaj S, Singh N. Textbook of Vegetables, Tubercrops and Spices. ICAR. New Delhi; c2001. p. 469.
40. Magd MA, Bassiony AM, Fawzy ZF. 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. 2006;2(10):791–798.
41. Sharma A, Parmar DK, Kumar P, Singh Y, Sharma RP. Azotobacter soil amendment integrated with cow manure reduces need for NPK fertilizers in sprouting broccoli. International Journal of Vegetable Science. 2008;14(3):273–285.
42. Kumar V, Kumar V, Tyagi AK, Singh B, Kumar N. Effect of vermicompost and VAM inoculation on growth and yield of cauliflower (*Brassica oleracea* L. var. *botrytis*). Progressive Agriculture. 2010;10:197–199.
43. Maurya AK, Singh MP, Srivastava BK, Singh YV, Singh DK, Singh S, et al. Effect of organic manures and inorganic fertilizers on growth characters, yield and economics of sprouting broccoli cv. Fiesta. Indian Journal of Horticulture. 2008;65(1):116–118.
44. Wani ABJ, Narayan R, Ahmed N, Singh AK, Chattoo MA, Sumati N. Influence of organic and inorganic sources of nutrients on growth, yield and quality of cauliflower (*Brassica oleracea* L. var. *botrytis*). Environment and Ecology. 2011;29(4A):1941–1947.
45. Sarangthem I, Misra ADD, Chakraborty Y. Cabbage productivity, nutrient uptake and soil fertility as affected by organic and bio-sources. Agricultural Science Digest. 2011;31(4):260–264.
46. Mal D, Chatterjee R, Nimbalkar KH. Effect of vermi-compost and inorganic fertilizers on growth, yield and quality of sprouting broccoli (*Brassica oleracea* L. var. italica Plenck). International Journal of Bio-Resource and Stress Management. 2015;5(4):507–512.
47. Chander G, Verma TS, Sharma S. Nutrient content of cauliflower (*Brassica oleracea* L. var. *botrytis*) as influenced by boron and farmyard manure in north west Himalayan alfisols. Journal of the Indian Society of Soil Science. 2010;58(2):248–251.
48. Chaterjee B, Ghanti P, Thapa U, Tripathy P. Effect of organic nutrition in sprouting broccoli (*Brassica oleracea* L. var. *italica* Plenck). Vegetable Science. 2005;32(1):51–54.
49. Khan N, Dubey AP, Ram P, Mishra A. Integrated nutrient management in broccoli (*Brassica oleracea* L. italica Plenck). Plant Archives. 2009;9(1):423–425.
50. Dalal VV, Bharadiya PS, Aghav VD. Effect of organic and inorganic sources of nitrogen on growth and yield of cabbage (*Brassica oleracea* L. var. capitata). Asian Journal of Horticulture. 2010;5(2):291–293.
51. Singh JP, Singh OV, Solanki VPS. Effect of potassium and boron on yield and uptake of nutrients by cauliflower. Annals of Horticulture. 2011;2(1):80–82.
52. Choudhary S, Soni AK, Jat NK. Effect of organic and inorganic sources of nutrients on growth, yield and quality of sprouting broccoli cv. CBH-1. Indian Journal of Horticulture. 2012;69(4):550–554.
53. Kumawat A, Raychowdhury P, Chandra S. A wave number based approach for the evaluation of the Green's function of a one-dimensional railway track model. European Journal of Mechanics-A/Solids. 2019;78:103854.