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Effect of different organic and inorganic sources of nutrients on growth and yield of sunflower (*Helianthus annuus* L.)

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Abstract

An important oilseed crop, sunflower (*Helianthus annuus* L.) is valued both for its high-quality edible oil and its ability to thrive in a range of agroclimatic conditions. To optimize its growth, yield, and oil yield, proper nutrition management is called for. The impact of different organic and inorganic source of nutrients, such as farmyard manure (FYM), vermicompost, poultry manure, dosages of recommended chemical fertilizer (NPK), and their combination treatments on the growth and yield of sunflower. Integrated nutrient management (INM) using a combination of inorganic fertilizers and organic manures worked significantly better than either treatment in isolation. For plant height, leaf area, head diameter, seed yield, and oil content, the NPK and chicken manure combination had the highest values among all treatments. While organic methods on their own improved soil structure and nutrient value, they were less effective in boosting crop yields immediately. Meanwhile, chemical fertilizers on their own exhibited waning return on soil fertility over the years, though stimulating good early growth. Based on the research findings, integrating organic and inorganic sources of fertilizers brings forth a synergistic result that enhances plant performance, raises the efficiency of nutrient use, and contributes to long-term soil well-being. Apart from enhancing sunflower yields and quality of oil, this approach makes sustainable and environmental-friendly agricultural practices a reality. Hence, to ensure both high yields and long-term soil sustainability, adoption of INM must be encouraged in sunflower production systems.

Keywords: Sunflower productivity, nutrient sources, crop yield improvement and sustainable agriculture

Introduction

Sunflower (*Helianthus annuus* L.) is a valuable crop globally due to its high economic and nutritional significance. As the fourth largest oilseed crop after soybean, palm, and rapeseed, sunflower is widely cultivated for its high-quality edible oil, which contains significant levels of polyunsaturated fatty acids, particularly linoleic and oleic acids. These properties make it a popular choice for culinary and industrial applications due to its health benefits, including support for cardiovascular health (Food Agricultural Organization 2021) ^[9]. As it has more flexibility, greater yield potential, a shorter duration, and greater profitability, sunflower holds considerable promise as an oil seed crop. Highly versatile in a variety of soil types and agroclimatic zones. Sunflower can play a vital role in meeting the edible oil deficiency of the country because of the critical position this crop holds in emergency crop planning. Our country is facing acute edible oil deficiency mainly due to the increased demand from industries requiring oil, pressure of population, and high living standards. Imports of edible oil partly meet the requirement. It must become oil self-sufficient under such conditions. Sunflower seeds are incredibly rich in nutrients, consisting of 14-19% protein, 40-45% oil, a very high calorific value, and 30-35% carbs. As it has no cholesterol, the oil is considered to be of high quality characteristics. It is recommended for patients with cardiac diseases, because it contains oleic and linoleic acid. It has a satisfactory amount of iron, calcium, and vitamins A, D, E, B complex. Sunflower oil is mainly used in cooking, though it is an important constituent of many margarine and shortening products. High linoleic acid sunflower seeds are used in confections. Sunflower oil has excellent storage life. 40-44% of the oil cake is high quality protein. It is ideal for livestock and poultry rations. It can be used to make infant food, too. Sunflower kernel can

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be eaten raw or roasted. In addition to being used in cooking, the oil is also used to prepare paintings, soaps, and cosmetics. Sunflower's importance as an oilseed crop in India is of quite recent origin, emerging only in the past three decades. However, its contribution to the nation's "yellow revolution" and edible oil self-sufficiency is quite significant.

The crop's adaptability to semi-arid and marginal lands enhances its role in sustainable agricultural systems, especially in regions prone to drought (Alves & Setiyono, 2015) ^[1]. Furthermore, sunflower is valued for its deep root system, which improves soil aeration, promotes nutrient cycling, and enhances soil structure, making it an excellent choice for crop rotation to control soil erosion and break pest cycles. Sunflower also contributes to agricultural biodiversity by attracting pollinators, particularly bees, which further supports ecosystem health (USDA, 2020) ^[29]. Therefore, sunflower cultivation is essential not only for its yield but also for its ecological benefits, which align with sustainable agricultural practices.

India does not currently produce adequate fertilizer to sustain all the nutrition requirements of this plant. Current use of the high concentration chemical fertilizers will continue to further deteriorate agricultural output sustainability polluting the environment. In the next decades, the management of soil organic matter and the sensible use of organic inputs such as crop wastes, animal manure, and green manure will be critical to the design of sustainable agricultural systems. However, organic manure alone cannot fulfill the entire nutrient requirement of modern agriculture. At present, it seems that nutrients from organic manure and fertilizer sources need to be used together. However, the fundamental premise of the INM system is to stabilize the yield in the majority of the agro-ecoregions through correcting marginal secondary nutrient deficiencies and micronutrients enhance the efficacy of the applied nutrients and bring about good physical conditions to the soil. Interplay between the organic sources of nutrients under the integrated nutrition supply and management resulted in better outcome than that using each one individually. All the above result in maintaining soil fertility, providing nutrients at the optimal level, and producing the highest crop yield with the least inputs through an integrated and balanced utilization of nutrients derived from both organic and inorganic fertilizer sources.

All of the plant nutrients are available in farm yard manure (FYM) which supply all these nutrients consistently to the crop throughout the period of growth. It favors better growth and development of yield qualities which in turn raise growth and yield values. This characteristic further caused a higher production of straw and seeds. Farm yard manure (FYM) and soybean residue have a greater positive impact on soil fertility and yield compared to other fertilizer sources. It also provides nutrients, humus-forming microorganisms, and chemicals that promote plant growth, repairing soil microorganisms, which is essential to preserve both the yield potential and overall health of the soil. To preserve soil health and attain yield potential for reaching self-sufficiency in sunflower production in India, farm yard manure (FYM), containing 0.5% N, 0.2% P, and 0.5% K, plays an immense role.

Using chemical fertilizers alone has degraded soil quality and polluted the environment, but organic sources of nutrients increase soil health, water-retention capacity of the soil, and amounts of nutrients and increase microbial activity in the soil. Chemical fertilization affects sunflower yield and quality since nitrogen is an important plant nutrient that tends to increase both yield and total biomass production. Oil production requires phosphorus. Potash and content aid in disease resistance and

grain filling. An important secondary plant nutrient, sulphur is crucial for raising oilseed crop output and quality.

Effect of organic and inorganic nutrients on growth and yield of sunflower

Nanjundappa *et al.* (2001) ^[18] carried out an experiment in sandy loam soil and reported that application of recommended dose of fertilizers (62.5:75:62.5 kg N:P₂O₅:K₂O ha⁻¹) along with 10t ha⁻¹ FYM recorded higher seed yield (2,250 kg ha⁻¹) and stalk yield (3,053 kg ha⁻¹) in sunflower.

Veerabhadrapa *et al.* (2005) ^[30] reported that basal application of 100 per cent RDF (25 kg N, 75 kg P₂O₅ and 25 kg K₂O ha⁻¹) with foliar spray of N, P, K, Ca and S at 1 per cent each at 60 DAS recorded significantly higher uptake of nitrogen (252 kg ha⁻¹), phosphorus (28.9 kg ha⁻¹), potassium (204 kg ha⁻¹), calcium (74.8 kg ha⁻¹) and sulphur (31.4 kg ha⁻¹) as compared to control.

Byrareddy *et al.* (2008) ^[5] at the Main Agricultural Research Station, University of Agricultural Sciences, Dharwad during kharif 2006-07 to study the integrated nutrient management on sunflower hybrid seed production (KBSH-

1) and reported that application of FYM 8t ha⁻¹ along with RDF (62.5:75:62.5 kg NPK ha⁻¹) recorded higher plant height (32.57, 142.33 and 150.97 cm at 30, 60 and 90 DAS, respectively over control) and yield attributes such as capitulum diameter (20.67 cm), yield per plant (18.52 g), per cent seed filling (76.33%), processed seed yield (965 kg ha⁻¹) and seed recovery percentage (92.47%) respectively, over control.

Oyinlola *et al.* (2010) ^[19] has taken field experiment in Northern Guinea on alfisol to determine the effect of N fertilizer on growth and yield parameters of sunflower. Nitrogen was applied at 0, 30, 60, 90, 120 and 150 kg N ha⁻¹. Significantly higher capitulum diameter (13 cm), plant height (120 cm) seed yield (1,222 kg ha⁻¹), oil yield (703.3 kg ha⁻¹) and oil content (57.5%) were recorded by application of 120 kg N ha⁻¹. Application of N significantly increased seed and oil yields while excess N (150 kg N ha⁻¹) reduced the contents of the above two parameters. Suryavanshi *et al.* (2013) ^[26] carried out an experiment on vertisols and opined that in sunflower application of 150% RDF produced significantly higher seed yield (1,432 kg ha⁻¹) over 100% RDF (1,281 kg ha⁻¹), 50% RDF (1,120 kg ha⁻¹) and control (952 kg ha⁻¹).

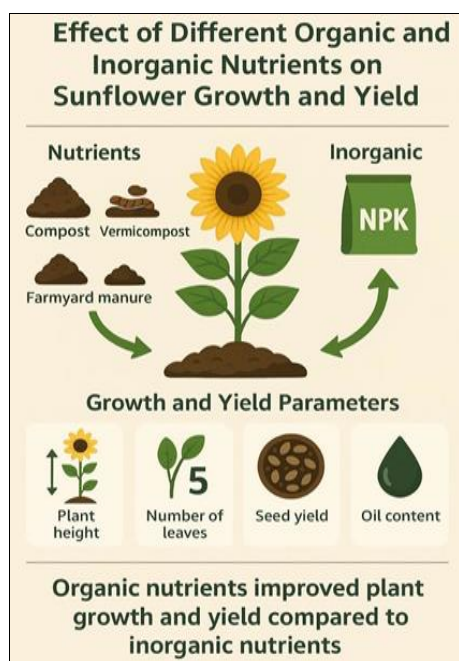
Khakwani *et al.* (2014) ^[11] conducted an experiment during the spring season to study the response of sunflower hybrid (Hysun-33) to NPK levels (50:50:0, 100:100:50 and 150:120:100 kg ha⁻¹) on growth and yield traits of sunflower. Days to flowering, plant height, head diameter, 1000-seed weight, seed yield, biomass yield and harvest index were significantly ($P \leq 0.05$) affected by NPK levels. The highest plant height (162.88 cm), seed yield (4,645.8 kg ha⁻¹) and biomass production (19,736 kg ha⁻¹) was recorded in the highest fertilizer dose of 150:120:100 NPK kg ha⁻¹. Byomkesh *et al.* (2014) ^[4] carried out an experiment at Hyderabad revealed that the application of 125% RDF had recorded significantly higher number of filled seeds head⁻¹ over 75% RDF but 125% RDN was comparable with 100% RDF which in turn was comparable with 75% RDF in sunflower.

Muzzammil *et al.* (2009) ^[17] found that the best seed yield (2,261 kg ha⁻¹) and higher uptake of both micro and macro-nutrients were recorded under combined application of 90:45:45 kg NPK ha⁻¹ with 20:2.0 kg Zn:B ha⁻¹ compared to control (0:0:0 kg NPK ha⁻¹) and 0:0 kg Zn:B kg ha⁻¹ respectively in sunflower. Patil *et al.* (2009) ^[20] observed that in hybrid sunflower KBSH-1 recorded significant differences in growth parameters viz.,

number of functional leaves, stem girth, dry matter, leaf area, head diameter, number of filled grains, test weight, grain yield per plant and seed yield ($1,296 \text{ kg ha}^{-1}$), stalk yield ($4,374 \text{ kg ha}^{-1}$), dry weight of capitulum ($1,522 \text{ kg ha}^{-1}$), harvesting index (55.8%), oil content (39.9%) and oil yield (517.7 kg ha^{-1}) over SCH-35. Application of fertilizer dose 80: 40:40 NPK kg ha^{-1} recorded higher in all growth and yield attributing characters and seed yield ($1,447 \text{ kg ha}^{-1}$) as compared with other fertilizer doses and control.

Ramulu *et al.* (2011) [21] conducted a field experiment at Gandhi Krishi Vignana Kendra (GKVK), Bangalore during kharif season of 2008 to study the influence of different levels of nutrients on growth and yield of sunflower and revealed that the application of 100% RDF+B (12.5 kg ha^{-1})+ Zn (10 kg ha^{-1}) + FYM (7.5 t ha^{-1}) recorded significantly higher head diameter at harvest (23.5), 100 seed weight (9.03 g), number of seeds per head (2,072.8), seed Adityakumar and Krishnamurthi *et al.* (2015) [2] observed that increasing levels of N, P, K increased yield, yield components and oil content. Maximum seed yield ($1,170 \text{ kg ha}^{-1}$) and oil content (41.4%) was recorded with NPK @ 120:90:90 kg ha^{-1} .

Ravichandran and Srinivasan *et al.* (2017) [22] in a two years experiment at Coimbatore revealed that yield parameters like head diameter (33.1cm and 32.4cm), number of seeds per head (1,391 and 1,356), head weight (24.3 and 24.9 and seed volume weight (38.5 and 38.4 g) were higher under the sowing density of 60 x 30 cm with single seedling and 100% RDF during both the years respectively. The seed yield was significantly higher by adoption of 30 x 30 cm with single seedling and application of 200% RDF.



Effect of Biofertilizers on growth and yield of sunflower

Bio-fertilizers have become a more promising part of the integrated plant nutrition system in agriculture in recent years. By enhancing the biological and chemical characteristics of the soil, increasing the efficiency of nutrient usage, and lowering the need for expensive inorganic fertilizers, the integration of bio-fertilizers with inorganics maintains production (Singh *et al.*, 1990) [25]. Biofertilizers, also referred to as "microbial inoculants," aid in increasing the fertility of the soil. They consist of microorganisms that fix nitrogen, solubilize phosphate, mobilize phosphate, and promote growth.

Sharma *et al.* (2002) [24] reported that application of phosphatic fertilizer in combination with PSB and vesicular arbuscular mycorrhizal fungi showed higher availability and P uptake, activity of phosphatase and dehydrogenase in the rhizosphere soil. The best results however, were obtained by application of single super phosphate with vesicular arbuscular mycorrhiza and triple super phosphate in combination with PSB and VAM performed on par with SSP alone as far as the dry matter yield, P uptake and availability was concerned.

Kishore *et al.* (2005) [12] found that maximum increase in plant biomass was observed following treatment with a rhizosphere isolate identified as *Bacillus firmis* GRS 123 and two phylloplane isolates *Bacillus megatherium* GPS 55 and *Pseudomonas aeruginosa* GPS 21 in case of groundnut.

Rubapunithavathy *et al.* (2006) [23] observed that in sunflower crop, the highest seed yield was recorded with 50% N + Azospirillum + Azotobacter seed treatment in both the seasons ($3,668 \text{ kg ha}^{-1}$ and $3,660 \text{ kg ha}^{-1}$) which is comparable with that of 100% N in both the seasons ($3,734 \text{ kg ha}^{-1}$ and $3,731 \text{ kg ha}^{-1}$).

Kramany *et al.* (2007) [13] conducted a field experiment on sandy soil of Egypt and revealed that in groundnut crop, application of 25% recommended NPK dose + 75% organic fertilizer (FYM) + biofertilizer (microbein) produced the greatest number of pods plant⁻¹, seeds pod⁻¹, pod weight, seed yield and biological yield and shelling percent. Mirzakhani *et al.* (2009) [14] inoculated seeds of spring safflower (*Carthamus tinctorius* L.) with Azotobacter and mycorrhiza in combination with nitrogen and phosphorus fertilizers and found an improvement in the yield and oil content. Azotobacter inoculation has significantly increased the grain yield whereas mycorrhiza could affect significantly on characters such as harvest index, root dry weight, root mycorrhizal colonization.

Dhage and Kachhave *et al.* (2010) [7] found that, in soyabean dual inoculation of Rhizobium + PSB @ 250 g per 10 kg seeds was found beneficial for soyabean with and without chemical fertilizers. The treatment (100% RDF + Rhizobium + PSB) under rainfed condition gave highest seed yield (15.5 q ha^{-1}) as well as highest N and P content in seed compared to control (no RDF and no biofertilizers) i.e 7.5 q ha^{-1} .

Ekin *et al.* (2010) [8] at Turkey reported that the inoculation with *Bacillus M-13* without P fertilizer increased stem diameter by 11.2%, head diameter by 13.5%, number of filled grains per head by 10.1%, 1000 seed weight by 14.1% and seed yield by 30.1%, compared to the control + without phosphorus in sunflower crop.

Gehan and Abo-Baker *et al.* (2010) [10] observed that in sunflower application of Azospirillum lipoferum + Bacillus polymyxa + 100% chemical fertilizer (100:100:50 N: P: K kg ha^{-1}) recorded significantly higher values of no. of leaves, leaf area, plant fresh weight, plant dry weight, roots dry weight, higher number of ray florets, inflorescence diameter and seed weight compared to control (full dose of chemical fertilization alone).

Morteza *et al.* (2013) [16] reported that applying the highest levels of ammonium phosphate (300 kg ha^{-1}) had resulted into maximum grain yield and the minimum was obtained from control. Mycorrhiza and Azotobacter treatment recorded higher oil percentage compared to control (39.50%) i.e without any fertilizer. The application of mycorrhiza as bio-fertilizer on grain yield of sunflower was more effective than Azotobacter and increased it to more than 500 kg ha^{-1} .

Amit *et al.* (2014) [3] conducted an experiment on sandy loam soil of Dharwad and revealed that application of 30 kg sulphur ha^{-1} with sulphur oxidizing biofertilizer recorded significantly

higher plant height (195 cm) which was on par with 30 kg sulphur ha⁻¹ alone (192 cm) and 20 kg sulphur ha⁻¹ with sulphur oxidizing biofertilizer (188.33 cm) followed by 20 kg sulphur ha⁻¹ alone (186.22). However, significantly lower plant height (178.22 cm) was recorded in control.

Tomar *et al.*, (2011)^[28] observed that, maximum soyabean yield of 1798 kg ha⁻¹ was obtained with the application of 75% NPK + 5t FYM + inoculation of Rhizobium + PSB@ 20g kg⁻¹ seeds which was 112.52% and 39.48% higher than farmers practice (9:23:0) and 100% NPK alone respectively.

Mohamed *et al.* (2015)^[15] conducted an experiment in sandy loam soils of new valley and showed that application of biofertilizer in sunflower crop had significant effect on plant height, head diameter, 1000-seed weight, seed yield and oil percent in seeds and oil yield respectively in the second growing season. Biofertilizer increased seed yield (kg fed-1) and oil yield (kg fed-1) by 11.0%, 12.0% and 16.6%, 14.0% over the control in the first and second growth seasons respectively.

Thete *et al.* (2011)^[27] reported that application of 80 kg P₂O₅ ha⁻¹ with PSB, recorded significantly maximum growth attributes viz., plant height (141.84 cm), leaf area per plant (29.00 cm²), total dry matter per plant (59.31g) and head diameter per plant (15.28 cm) over rest of the treatments.

Conclusion

The study on the effect of different organic and inorganic nutrient sources on sunflower (*Helianthus annuus* L.) growth and yield revealed that integrated nutrient management enhances crop performance. The treatment involving 100% RDF (Recommended Dose of Fertilizer) + FYM (Farmyard Manure) @ 5 t/ha showed a significant increase in plant height, leaf area, and dry matter accumulation. The combination of 75% RDF + Vermicompost @ 2.5 t/ha + Azospirillum (Dambale *et al.*, 2018)^[6] improved soil health and microbial activity while maintaining comparable yield levels. In contrast, sole application of organic fertilizers resulted in lower initial growth due to slow nutrient mineralization. However, combining organic and inorganic sources optimized nutrient availability, leading to higher seed yield, better oil content, and sustainable soil fertility. Therefore, integrating organic amendments with chemical fertilizers is a viable strategy for enhancing sunflower productivity while ensuring long-term soil health.

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