Vegetable Science (2026) 53(1): 147-154

doi: 10.61180/vegsci.2026.v53.i1.19

ISSN- 0970-6585 (Print), ISSN- 2455-7552 (Online)

www.isvsvegsci.in

RESEARCH ARTICLE

# Influence of application of organic sources on pea (*Pisum sativum* L.) growth and changes in soil nutrient status

**Acharya Balkrishna[1,3], Manohari Rathi[2,4*], Pawan Kumar[2] and K.N. Sharma[4]**

## Abstract

The application of organic sources in agriculture has received considerable attention due to their potential to improve soil health and produce quality. The present study was carried out to investigate the impact of agnihotra ash - a byproduct of the ancient Vedic fire ritual and other organic sources such as compost, vermicompost and jeevamrut on pea (*Pisum sativum* L.) growth and changes in soil nutrient availability. The field experiment was conducted using a randomized complete block design with ten treatments. Each plot received an application of organic source before sowing. The organic sources used in the study were supposed to have sufficient ability to supply the required amount of nutrients to sustain crop growth. Agnihotra ash outperformed the other organic sources and improved the pea growth parameters such as root length (18 cm), shoot length (69 cm), dry root and shoot biomass (0.34, 5.9 g), number of pod/ plants (22), number of seed/pod (6.1) and test weight (27 g). The results revealed that among various organic sources, agnihotra ash contained a higher concentration of macro and micronutrients, which helped in improving the growth and yield of pea. The available nutrient status of the soil also registered an increase with the addition of organic sources. The results suggest that agnihotra ash can be utilized as a promising source for organic and natural farming, particularly for vegetable crops.

**Keywords:** Agnihotra ash, organic source, organic farming, *Pisum sativum* L., soil properties.

[1]Patanjali Research Foundation Trust, Haridwar, Uttarakhand (India)-249405

[2]Agriculture Research Campus, Patanjali Organic Research Institute, Haridwar, Uttarakhand, India

[3]Patanjali University, Haridwar, Uttarakhand, India

[4]Bharuwa Agri Science Pvt. Ltd., Haridwar, Uttarakhand, India

[*]**Corresponding author;** Email: manoharirathi19@gmail.com

**Citation:** Balkrishna, A., Rathi, M., Kumar, P., & Sharma, K.N. (2026). Influence of application of organic sources on pea (*Pisum sativum* L.) growth and changes in soil nutrient status. Vegetable Science, 53(1), 147-154.

**Source of support:** Nil

**Conflict of interest:** None.

**Received:** 10/04/2026; **Revised:** 09/07/2026; **Accepted:** 29/07/2026

## Introduction

The increasing global demand for sustainable agricultural practices has intensified the search for alternatives to synthetic fertilizers and pesticides. While effective in boosting yields, indiscriminate application of chemical inputs is often associated with soil degradation, environmental pollution and health concerns. A crop grown on the same cultivated soil for decades would not be able to obtain the necessary nutrients from that soil because such soils are becoming nutrient-deficient (Kartini et al., 2024). In addition, reduced soil fertility is thought to be one of the main obstacles to increased agricultural productivity. The search for low-input, eco-friendly strategies to rejuvenate soil and support crop growth has led scientists to explore both traditional knowledge and modern organic techniques. This has renewed interest in organic farming systems that enhance soil fertility and crop productivity through natural means. Moreover, the selection of an appropriate organic source is determined by factors, including local and environmental variables as well as the differences in soil types and climate that affect crop cultivation appropriateness. A diverse array of organic amendments such as farmyard manure, vermicompost, compost, and liquid formulations are known to improve the soil structure, water-holding capacity, and microbial diversity. Recently, Sheoran et al. (2024) in their study, identified farm yard manure as a beneficial, long-lasting soil amendment and highlighted its ability to improve the soil health and soil nutrient content over the time. In the same way, other organic manures are another viable method of managing soil. As well, compost and vermicompost are prepared by decomposition of animal manure, farm and kitchen waste, etc. Vermicompost is a fine, granular, odourless material that is rich in microorganisms and nutrients. Likewise, Jeevamrut is an inexpensive homemade microbial liquid formulation that enriches the soil with native microorganisms necessary for the mineralization of soil, helps in improvement of soil fertility (Saharan et al., 2023). Accordingly, waste decomposer is a biological inoculant containing beneficial microorganisms that accelerates the natural process of decomposing organic waste including agricultural waste, kitchen scraps and cow dung into nutrient-rich compost. Conventional wood ash, meanwhile, is well recognized for supplying the soil with essential plant nutrients. The limitation associated with wood ash is presence of source contaminants including heavy metals. An unconventional alternative gaining interest is agnihotra ash. Agnihotra ash is derived from the ritual burning of dried cow dung, ghee, and unpolished rice in a copper pyramid at sunrise and sunset. Agnihotra ash is reported in some studies to possess unique properties that enhance seed germination, plant immunity and soil fertility (Balkrishna et al., 2025; Kumar et al., 2018). Agnihotra is known for its healing capacity from ancient times. The Homa fire or Agnihotra's healing energy is trapped in the ash and the results suggest and support that its effects are not merely nutritional but also energetic, potentially influencing the farm ecosystem. Despite these claims, a significant gap exists in rigorous, scientific literature quantifying the effects of agnihotra ash, especially when used in conjunction with other organic sources. It is hypothesized that a synergistic interaction between Agnihotra ash and other organic sources could create a more favourable rhizosphere environment, leading to enhanced nutrient mineralization, availability and uptake. The present study aims to bridge this knowledge gap by systematically evaluating the influence of agnihotra ash, alone as well as in combination with other organic sources, on peas. Moreover, the beneficial influence of addition of organic sources on changes in soil quality parameters has also been studied.

## Materials and Methods

### *Study site and organic sources*

The study was carried out at the Agriculture Research Campus (29.9029ºN, 77.9945ºE) located at Roorkee-Haridwar national highway. Compost, vermicompost, agnihotra ash and jeevamrut were used in the present study. Compost, vermicompost, and jeevamrut were prepared according to the methodology of the Indian Council of Agriculture Research (ICAR). Agnihotra ash was procured from a yagya or homa performed in Yog Bhavan, Patanjali Yogpeeth, Haridwar. Waste decomposer was obtained from National Council of Organic Farming (NCOF), Ghaziabad (India). A 10 mL of the waste decomposer was mixed with 200 litres of water in a tank. Clockwise stirring of the mixture 2-3 times daily was carried out for 5 to 6 days.

### *Experimental setup*

The experiment was laid out in a randomized complete block design (RCBD) with ten treatments- T1 (control), T2 (Jeevamrut), T3 (Compost), T4 (Vermicompost), T5 (Agnihotra ash), T6 (Compost + Jeevamrut), T7 (Vermicompost + Jeevamrut), T8 (Agnihotra ash + Jeevamrut), T9 (Agnihotra ash + Vermicompost) and T10 (Compost + Vermicompost) in three replicates. Compost, vermicompost, agnihotra ash and jeevamrut were applied @ 5, 5 ton/ha, 1500 kg/ha and 5% 500 L/ha dose, respectively. Waste decomposer was applied @ 200 (litre/hectare) after every 15 days with the irrigation. The waste decomposer was light to dark brown in colour with pH of 3.4 and contain *Lactobacillus* (7.8 x 108), yeast (55 x 106) and aerophilic (6.6 x 108). The organic sources were analysed with standard procedures. The pea seeds were sown at a spacing of 40 cm between rows and 20 cm between plants. Nine plants were randomly selected from each treatment to obtain information on the ancillary parameters.

### *Plant sampling and analysis*

The plants were uprooted with intact root system at 60 DAS and were used for measurement and recording of plant growth attributes. The plants were cleaned with tap water. Root and shoot systems were separated, and their lengths were measured with a measuring tape. Plant material was kept in an oven for drying at 60ºC for 48 hours to a constant weight. The dried material was ground and stored for subsequent analysis.

### *Soil sampling*

The soil samples from each treatment plot were taken after harvesting the crop. The collected soil samples were prepared and analysed for pH, organic carbon, available macro nutrients (nitrogen, phosphorus and potassium), sulphur and micro nutrients (copper, zinc, iron and manganese) according to the methods given by Walkley & Black (1934), Subbiah & Asija (1956), Olsen (1954), Merwin & Peech (1950), Chesnin & Yen (1950) and Lindsay & Norvell (1978), respectively.

### *Statistical analysis*

Two-way analyses of variance (ANOVA) were used to assess the significance of the variations among treatments.

## Results and Discussion

### *Characterization of organic sources*

The physical and chemical characteristics of the organic sources used in the present study are summarized in Table 1. A considerable variation among the organic sources was observed. Jeevamrut exhibited acidic (4.9) nature probably due to presence of organic acids, produced during anaerobic fermentation. In contrast, vermicompost was neutral (pH 7.2), whereas compost showed a slightly alkaline nature (pH 7.6). Agnihotra ash, as expected from its combustion origin, was strongly alkaline (pH 10.4), suggesting its potential to decrease the influence soil pH in rhizosphere when applied in substantial quantities. The electrical conductivity (EC) values also varied widely among the sources. The EC of compost, vermicompost, agnihotra ash and jeevamrut was 0.1, 0.02, 0.5 and 3.4 dS/m, respectively, indicating a vide variability in soluble salt concentration among sources. Compost and vermicompost exhibited low EC, indicating minimal soluble salts. Agnihotra ash showed a moderate EC value of 0.5 dS/m, while jeevamrut exhibited the highest EC (3.4 dS/m) value, probably due to the presence of dissolved nutrients released during microbial decomposition. It is a powerful concentrate and needs to be diluted sufficiently before its use. Total carbon content ranged from extremely low in jeevamrut (0.1%) to very high in vermicompost (29.1%). The higher carbon level in vermicompost indicates its advanced humification and potential to improve soil structure and microbial activity. Conversely, the low carbon content in jeevamrut is mainly because of its liquid nature and rapid decomposition characteristics. Available nitrogen, phosphorus and potassium in different organic sources ranged between 0.20 to 2.0%, 0.20 to 0.90% and 0.30 to 7.9%, respectively. Sulphur content ranged between 0.20 to 0.60%. The highest content of copper, zinc, and manganese was observed in agnihotra ash. The available iron content (mg/kg) was found to be maximum in vermicompost (1943) followed by compost (1871) and agnihotra ash (1822), respectively. The higher concentration of iron in vermicompost may be ascribed to intense microbial decomposition resulting in the stabilization of iron-bearing organic complexes.

The chemical analysis of organic materials indicates differential nutrient content among these. Agnihotra ash serves as a potent supplier of macro and micronutrients, mostly P, K, Cu, Zn and Mn. Jeevamrut provides relatively higher nitrogen and sulphur, making it valuable in meeting the nutrient requirements of crops, though partially. Vermicompost exhibited exceptionally higher carbon and iron content, suggesting its beneficial influence on soil organic matter build up and micronutrient supply. Differential nutrient supply behaviour among the organic sources suggests the complementary roles of these organic inputs besides highlighting the potential benefits of integrated nutrient management for improving soil fertility and crop nutrition.

### *Impact of organic sources on plant growth*

The root and shoot lengths of pea plants under various treatments were measured at 60 days after sowing (DAS) and the results are presented in Table 2. The root length among various treatment plots ranged from 12 to 18 cm and the shoot length ranged from 54 to 67 cm. The data indicated significantly higher root length (18 cm) in T5 treatment (Agnihotra ash) as compared to plots which did not receive any fertilizer. Likewise, maximum shoot length was noticed

**Table 1:** Physical and chemical characteristics of organic sources

| *Parameter* | *Compost* | *Vermicompost* | *Agnihotra ash* | *Jeevamrut* |
|---|---|---|---|---|
| Color | Dark brown | Dark brown | Gray | Light brown |
| Moisture content (%) | 17.7 ± 0.3 | 59.2 ± 0.8 | 8.8 ± 0.2 | 99.5 ± 0.01 |
| pH | 7.6 ± 0.04 | 7.2 ± 0.1 | 10.4 ± 0.04 | 4.9 ± 0.01 |
| Electrical conductivity (dS/m) | 0.1 ± 0.01 | 0.02 ± 0.0 | 0.5 ± 0.01 | 3.4 ± 0.03 |
| Total carbon (%) | 17.8 ± 0.4 | 29.1 ± 0.8 | 5.2 ± 0.2 | 0.1 ± 0.01 |
| Total nitrogen (%) | 1.1 ± 0.00 | 1.6 ± 0.02 | 0.2 ± 0.0 | 2.0 ± 0.01 |
| Total phosphorus (%) | 0.3 ± 0.01 | 0.4 ± 0.03 | 0.9 ± 0.1 | 0.2 ± 0.02 |
| Total potassium (%) | 0.5 ± 0.02 | 0.5 ± 0.01 | 7.9 ± 0.5 | 0.3 ± 0.01 |
| Sulphur (%) | 0.2 ± 0.00 | 0.3 ± 0.01 | 0.5 ± 0.1 | 0.6 ± 0.02 |
| Copper (ppm) | 27.3 ± 1.04 | 27.6 ± 1.0 | 145.2 ± 4.4 | 54.8 ± 1.7 |
| Zinc (ppm) | 137.9 ± 3.8 | 176.0 ± 1.9 | 257.8 ± 0.9 | 6.4 ± 0.1 |
| Iron (ppm) | 1871 ± 6.9 | 1943 ± 3.4 | 1822 ± 3.6 | 286 ± 0.9 |
| Manganese (ppm) | 215 ± 2.9 | 243 ± 6.1 | 603 ± 2.1 | 47.6 ± 1.4 |

Values are mean of triplicates. ± represents the standard deviation among the replicates

**Table 2:** Impact of organic sources on pea plant length and biomass (per plant)

| *Treatments* | *Root length (cm)* | *Shoot length (cm)* | *Root dry biomass (g)* | *Shoot dry biomass (g)* |
|---|---|---|---|---|
| T1 | 14 ± 0.3 | 60 ± 0.5 | 0.21 ± 0.08 | 3.7 ± 0.50 |
| T2 | 12 ± 0.6* | 54 ± 0.8* | 0.20 ± 0.05 | 3.6 ± 0.31 |
| T3 | 13 ± 0.6* | 62 ± 0.1 | 0.23 ± 0.02 | 4.9 ± 0.41* |
| T4 | 14 ± 0.1 | 60 ± 0.8 | 0.24 ± 0.02 | 4.2 ± 0.25 |
| T5 | 18 ± 0.6* | 69 ± 0.4* | 0.34 ± 0.10* | 5.9 ± 0.66* |
| T6 | 13 ± 0.5* | 54 ± 0.3* | 0.23 ± 0.01 | 3.5 ± 0.47 |
| T7 | 13 ± 0.7* | 60 ± 0.7 | 0.20 ± 0.02 | 3.9 ± 0.26 |
| T8 | 14 ± 0.3 | 64 ± 0.9* | 0.28 ± 0.11 | 5.2 ± 0.31* |
| T9 | 14 ± 0.5 | 60 ± 0.2 | 0.21 ± 0.02 | 3.8 ± 0.56 |
| T10 | 13 ± 0.3* | 57 ± 0.2* | 0.21 ± 0.11 | 3.4 ± 0.29 |
| CD (0.05) | 1.0 | 0.89 | 0.09 | 0.70 |

Values are mean of triplicates, (±) represents standard deviation and (*) represent values are significant at $p < 0.05$

in plots receiving agnihotra ash alone. However, a significant reduction in plant height occurred in plots receiving jeevamrut alone (T2) and in combination with compost (T6). The lower shoot lengths in jeevamrut treated plots may be ascribed to nutrient loss due to application of liquid N source (Jeevamrut). The higher plant growth in treatment T5 may be attributed to the high availability of nutrients in agnihotra ash. These findings are in agreement with Bhutia et al. (2019), who reported that wood ash, in combination with organic manures and biofertilizers, enhanced plant length, number of leaves, biomass and yield in pea.

The effect of variable root and shoot length was reflected in dry biomass of plant. The root and shoot biomass was sufficiently and significantly higher in plots receiving agnihotra ash alone or in combination with jeevamrut (T8). The similar trend was noticed in shoot biomass among various treatment plots. The results clearly indicated the superiority of agnihotra ash over other organic sources. These findings are consistent with earlier research findings indicating that organic and ash-based amendments can enhance plant biomass accumulation (Bhutia et al., 2019; Arshad et al., 2020).

### *Effect of organic sources on nutrient concentration in pea*

The data presented in Table 3 showed that the organic amendments significantly improved the concentration of nitrogen in the pea plant. Phosphorus and potassium content increased significantly in plots receiving agnihotra ash alone or in combination with jeevamrut (T5 and T8). This behaviour of agnihotra ash may be ascribed to higher nutrient content and its decomposition at a vigorous rate as compared to other organic sources. The addition of agnihotra ash along with jeevamrut (a liquid source) might also have caused higher decomposition of organic sources which helped in release of nutrients and thereby higher content in pea plant was noticed. The addition of organic sources on sulphur content of pea plant was found to be significant among all the sources as compared to control plot. The positive influence of organic sources on sulphur nutrition can be ascribed to synergistic influence of N and S. The leguminous nature of pea crop resulted in higher N accumulation due to organic manure which helped in subsequent rise in S content in pea plant (Scherer et al., 2006).

The concentration of micronutrients (Cu, Zn, Mn and Fe) content in pea plant was not affected significantly in any of the plot receiving different sources alone or in combination (Table 4). No doubt the decomposition of organic sources

**Table 3:** Impact of organic sources on N, P, K and S concentration in pea plant

| *Treatments* | *Nitrogen (%)* | *Phosphorus (%)* | *Potassium (%)* | *Sulphur (%)* |
|---|---|---|---|---|
| T1 | 3.4 ± 0.32 | 0.32 ± 0.04 | 1.4 ± 0.00 | 0.12 ± 0.02* |
| T2 | 3.2 ± 0.20 | 0.30 ± 0.04 | 1.4 ± 0.12 | 0.17 ± 0.00* |
| T3 | 3.3 ± 0.24 | 0.31 ± 0.05 | 1.3 ± 0.03* | 0.17 ± 0.02* |
| T4 | 3.4 ± 0.16 | 0.31 ± 0.04 | 1.2 ± 0.04* | 0.16 ± 0.00* |
| T5 | 4.1 ± 0.15* | 0.44 ± 0.02* | 2.2 ± 0.01* | 0.22 ± 0.03* |
| T6 | 3.1 ± 0.05* | 0.32 ± 0.04 | 1.4 ± 0.08 | 0.16 ± 0.01* |
| T7 | 3.2 ± 0.01* | 0.33 ± 0.02 | 1.5 ± 0.06 | 0.17 ± 0.01* |
| T8 | 3.8 ± 0.26* | 0.42 ± 0.01* | 2.1 ± 0.14* | 0.25 ± 0.03* |
| T9 | 3.7 ± 0.12* | 0.36 ± 0.03 | 2.1 ± 0.12* | 0.24 ± 0.02* |
| T10 | 3.1 ± 0.05* | 0.33 ± 0.01 | 1.5 ± 0.09 | 0.18 ± 0.01* |
| CD (0.05) | 0.39 | 0.10 | 0.15 | 0.03 |

Values are mean of triplicates, (±) represents standard deviation and (*) represents values are significant at $p < 0.05$

**Table 4:** Impact of organic sources on micronutrient concentration in pea plant

| *Treatments* | *Copper (ppm)* | *Zinc (ppm)* | *Manganese (ppm)* | *Iron (ppm)* |
|---|---|---|---|---|
| T1 | 5.9 | 38 | 43 | 410 |
| T2 | 6.2 | 39 | 45 | 376 |
| T3 | 5.1 | 36 | 39 | 454 |
| T4 | 5.2 | 46 | 46 | 354 |
| T5 | 6.6 | 56 | 47 | 458 |
| T6 | 5.3 | 40 | 46 | 367 |
| T7 | 5.6 | 40 | 47 | 321 |
| T8 | 8.0 | 64 | 40 | 384 |
| T9 | 7.9 | 58 | 45 | 399 |
| T10 | 5.4 | 50 | 52 | 322 |
| CD (0.05) | NS | NS | NS | NS |

Values are mean of triplicates

resulted in the release of micronutrients also but the effect did not seem to be more pronounced to reach the level of significance. Such influence seemed to be higher with respect to macronutrient and sulphur concentration in pea plant.

### *Impact of organic sources on pea yield attributes*

The major determinants of pea yield attributes are number of pods per plant, number of seeds per pod and test weight. The impact of different organic treatments on these yield attributes is presented in Table 5. The results indicated a significant variation among most of the treatment plots as compared to plots that did not receive any organic source (T1). The application of agnihotra ash (T5) showed a significant positive influence in terms of a higher number of pods per plant, seeds per pod, and seed weight. This treatment was closely followed by treatment plots which received agnihotra ash along with jeevamrut (T8) and vermicompost (T9), respectively. The number of pods per plant was more or less similar in plots that received different organic sources alone, except agnihotra ash where, the increase was marginally significant. Moreover, combined application of jeevamrut with compost (T6) or vermicompost also exhibited similar influence. Another yield-attributing parameter (seeds/pod) was not affected significantly with the addition of jeevamrut alone (T2), whereas all the remaining treatment plots that received organic sources alone or in combination had a positive significant effect on this parameter. Likewise, the test weight was not affected significantly with the addition of jeevamrut alone (T2). On the other hand, a positive significant influence on the weight of a hundred seeds per plant was noticed with the addition of organic sources alone or in combination. The results clearly indicate a positive influence on all the yield-attributing parameters. The seeds were bold and big enough in size to register a significant increase in the test weight. Priyadharshini & Seran (2009) reported higher seed weight of cowpea with addition of paddy husk ash.

**Table 5:** Efficacy of organic sources on pea yield attributes

| *Treatments* | *Pod/plant* | *Seed/pod* | *Weight of 100 seeds (g)* |
|---|---|---|---|
| T1 | 15 ± 0.10 | 5.1 ± 0.20 | 18 ± 0.00 |
| T2 | 16 ± 0.01* | 5.3 ± 0.20* | 18 ± 0.10* |
| T3 | 16 ± 0.50* | 5.8 ± 0.10* | 22 ± 0.00* |
| T4 | 16 ± 0.40* | 5.5 ± 0.10* | 23 ± 0.10* |
| T5 | 22 ± 0.50* | 6.1 ± 0.05* | 27 ± 0.20* |
| T6 | 16 ± 0.10* | 5.5 ± 0.02* | 20 ± 0.20* |
| T7 | 16 ± 0.60* | 5.6 ± 0.01* | 20 ± 0.10* |
| T8 | 21 ± 1.00* | 6.0 ± 01* | 26 ± 0.20* |
| T9 | 20 ± 0.60* | 5.8 ± 0.02* | 26 ± 0.10* |
| T10 | 16 ± 0.01* | 5.9 ± 0.03* | 22 ± 0.00 |
| CD (0.05) | 0.90 | 0.36 | 1.8 |

Values are mean of triplicates, ( ± ) represents standard deviation and (*) represents values are significant at $p < 0.0$

### *Impact of organic sources on soil properties*

The results presented in Table 6 exhibited a notable influence of organic amendments on soil properties. The soil pH, EC and OC ranged between 8.7 to 8.8, 0.14 to 0.23 (dS/m), 0.13 to 0.23 %, respectively among various treatment plots. The soil maintained its alkaline character among all the treatments in spite of distinct variation in pH values obtained with addition of organic sources. The minimum value of pH was observed in T3 (Compost) whereas the maximum value was noticed in T9 (Agnihotra ash + Vermicompost). The treatments T2, T3, T4, T5, and T10 exhibited a nominal reduction in pH compared to the control plot. However, the observed changes in soil pH was not significant. The variation in changes in soil pH due to addition of organic sources may be ascribed to release of various organic acids during decomposition of these materials. Since the organic acids are weak, the observed changes are not significant (Ondrasek et al., 2019 and Xu et al., 2025).

The electrical conductivity remained within the normal range among all the treatments. The lowest EC value was noticed in T6 (Compost + Jeevamrut) and the highest in T5 (Agnihotra ash). The EC significantly decreased in T6 (Compost + Jeevamrut) relative to the control, but significantly increased in Agnihotra treated plot alone (T5) or in combination with jeevamrut (T8). The increase or decrease in salt concentration with organic sources may be attributed to release of nutrients during decomposition of these sources as well as release of root exudates during growth of crop (Bandan et al., 2021; Ma et al., 2022). The highly alkaline nature of agnihotra ash might have resulted in decreased soil pH in the rhizosphere which probably helped in increased nutrient availability (dissolved salt concentration). The organic carbon content indicated a substantial positive influence of addition of organic sources with the observance of minimum influence in treatment T6 and T10, respectively and the maximum effect was observed in T9 (Agnihotra ash + Vermicompost) plot. The significant differences were observed in Treatments T2, T3, T4, T8 and T9 as compared to the control plot. The higher organic carbon content may also be ascribed to pea crop (leguminous) resulting in more N fixation and root growth. It is seen from the data that the observed changes in pH, EC and OC content are more in treatment combinations involving combined addition of two organic sources. This may be ascribed to synergistic influence of combined organic sources on the growth of pea crop. These findings corroborated the earlier observations of Hammad et al. (2020), who also reported an increase in soil organic carbon following the application of organic amendments. The soil available macronutrients increased in all the treatment plots as compared to the control one

**Table 6:** Impact of organic sources on change in soil fertility parameters

| *Treatment* | *pH* | *EC* | *OC %* | *N (Kg/ha)* | *P (Kg/ha)* | *K (Kg/ha)* | *S (Kg/ha)* |
|---|---|---|---|---|---|---|---|
| T1 | 8.8 ± 0.02 | 0.17 ± 0.02 | 0.13 ± 0.02 | 72 ± 0.3 | 12 ± 0.4 | 27 ± 0.2 | 0.11 ± 0.1 |
| T2 | 8.7 ± 0.03 | 0.16 ± 0.01 | 0.17 ± 0.05* | 130 ± 0.8* | 17 ± 0.2* | 30 ± 0.6 | 1.4 ± 0.2* |
| T3 | 8.7 ± 0.02 | 0.17 ± 0.01 | 0.18 ± 0.04* | 121 ± 1.0* | 17 ± 0.7* | 29 ± 0.5 | 1.6 ± 0.5* |
| T4 | 8.7 ± 0.04 | 0.16 ± 0.01 | 0.17 ± 0.01* | 122 ± 0.8* | 12 ± 0.5 | 28 ± 0.8 | 1.9 ± 0.6* |
| T5 | 8.7 ± 0.03 | 0.23 ± 0.01* | 0.16 ± 0.02 | 172 ± 0.2* | 38 ± 0.5* | 43 ± 0.9* | 3.8 ± 0.02* |
| T6 | 8.8 ± 0.03 | 0.14 ± 0.01* | 0.15 ± 0.01 | 78 ± 0.6 | 14 ± 0.5 | 31 ± 0.2 | 1.2 ± 0.4* |
| T7 | 8.8 ± 0.06 | 0.18 ± 0.02 | 0.16 ± 0.01 | 114 ± 0.5* | 13 ± 0.4 | 29 ± 0.4 | 1.4 ± 0.3* |
| T8 | 8.8 ± 0.03 | 0.19 ± 0.01* | 0.18 ± 0.03* | 79 ± 0.4 | 23 ± 0.6* | 36 ± 0.6* | 2.0 ± 0.7* |
| T9 | 8.8 ± 0.05 | 0.18 ± 0.02 | 0.23 ± 0.01* | 135 ± 0.5* | 39 ± 0.7* | 47 ± 0.2* | 4.8 ± 0.3* |
| T10 | 8.7 ± 0.05 | 0.17 ± 0.01 | 0.15 ± 0.04 | 96 ± 0.3* | 18 ± 0.5* | 31 ± 0.5 | 1.5 ± 0.4* |
| CD (0.05) | 0.64 | 0.04 | 0.04 | 16 | 3.6 | 5.4 | 1.1 |

Values are mean of triplicates, (±) represents standard deviation and (*) represents values are significant at $p < 0.05$

**Table 7:** Impact of organic sources on changes in soil available micronutrients

| *Treatments* | *Cu (ppm)* | *Zn (ppm)* | *Mn (ppm)* | *Fe (ppm)* | *B (ppm)* |
|---|---|---|---|---|---|
| T1 | 0.81 ± 0.01 | 1.0 ± 0.2 | 7.3 ± 0.1 | 8.4 ± 0.4 | 0.14 ± 0.1 |
| T2 | 0.70 ± 0.5 | 0.83 ± 0.3 | 8.8 ± 0.6 | 8.3 ± 0.4 | 0.19 ± 0.1 |
| T3 | 0.70 ± 0.6 | 1.0 ± 0.4 | 9.2 ± 0.2 | 8.1 ± 0.1 | 0.25 ± 0.1 |
| T4 | 1.0 ± 0.2 | 0.97 ± 0.2 | 7.4 ± 0.6 | 7.4 ± 0.6 | 0.21 ± 0.1 |
| T5 | 1.2 ± 0.4* | 1.1 ± 0.2 | 8.9 ± 0.3 | 8.8 ± 0.4 | 0.21 ± 0.2 |
| T6 | 0.88 ± 0.2 | 0.85 ± 0.2 | 7.7 ± 0.2 | 8.7 ± 0.5 | 0.17 ± 0.1 |
| T7 | 0.86 ± 0.4 | 0.85 ± 0.3 | 7.9 ± 0.8 | 8.9 ± 0.6 | 0.18 ± 0.04 |
| T8 | 0.89 ± 0.5 | 0.95 ± 0.1 | 7.3 ± 0.2 | 8.1 ± 0.7 | 0.10 ± 0.02 |
| T9 | 0.95 ± 0.6 | 0.96 ± 0.2 | 7.3 ± 0.3 | 8.6 ± 0.2 | 0.12 ± 0.06 |
| T10 | 0.76 ± 0.5 | 1.0 ± 0.3 | 7.6 ± 0.6 | 8.0 ± 0.6 | 0.15 ± 0.07 |
| CD (0.05) | 0.25 | NS | 0.9 | NS | 0.06 |

Values are mean of triplicates, (±) represents standard deviation

and ranged from 72 to 172 kg/ha N, 12 to 39 kg/ha P and 27 to 47 kg/ha K, respectively. The highest increase in available nitrogen was recorded in treatment T5 (Agnihotra ash), followed by T9. This might be possible because of increase in microbial activity resulting in the stimulation of mineralization of existing organic nitrogen in the soil. The effect seemed to be more profound in this treatment as compared to other organic sources. Significant differences in soil available nitrogen were observed in all treatments except T6 and T8. These changes can be ascribed to the same reasons as mentioned earlier in respect of organic carbon. Moreover, the leguminous nature of pea crop also contributed to increased N content in different treatments. The available P content improved with the addition of organic sources except T4, T6, and T7 significantly. The highest phosphorus content was noticed in T9 (39 kg/ha), followed by T5 (38 kg/ha). A substantially significant rise in available P with agnihotra ash alone or in combination with vermicompost can be ascribed to the release of organic acids resulting in solubilization of bound P to an available form. Such effect was more pronounced with agnihotra ash. This can also be attributed to decreased soil pH in the rhizosphere due to the addition of highly alkaline agnihotra ash. The combined effect of these observations resulted in increased availability of P as well as other nutrients. The available potassium increased significantly in Treatment T5, T8 and T9, with the highest increase in T9 (Agnihotra ash + Vermicompost), followed by T5 (Agnihotra ash) and T8. The increase may be attributed to the same reason as already explained in case of increased availability of P.

The available sulphur (S) content under various treatments is presented in Table 6 and the values ranged from 0.11 to 4.8 kg/ha. The highest sulphur content was observed in treatment T9 (Agnihotra ash + Vermicompost), followed by T5 (Agnihotra ash). All the organic sources enhanced soil available sulphur levels significantly compared to control plots. The leguminous nature of pea crop might have resulted in increase in S content in soil. There is mostly a positive synergistic interaction between N and S. The higher fixation of atmospheric N by pea crop also caused an increase in the availability of S (Zhoa et al., 1999; Scherer et al., 2006; Salvagiotti et al., 2009).

The influence of organic sources on DTPA extractable micronutrients is presented in Table 7. The micronutrient concentration among various treatments ranged between 0.70 to 1.2 ppm for Cu, 0.83 to 1.1 ppm for Zn, 7.3 to 9.2 ppm for Mn, 7.4 to 8.9 ppm for Fe and 0.14 to 0.25 ppm for B. A decline in available Cu content was noticed in treatment plots which received jeevamrut or compost alone and combined application of compost and vermicompost. On the other hand, the DTPA extractable Cu registered an increase in the remaining plots, but the significant influence was noticed only in the agnihotra ash-treated plot (T5). The changes in available Zn content under various treatments were not significant. The available Mn content was significantly influenced in plots where jeevamrut (T2), compost and agnihotra ash was added to pea crop. As observed in case of available Zn, the influence of addition of various organic sources on available Fe status was non-significant. The changes in hot soluble boron among various treatments was significant only in compost (T3), vermicompost (T4) and agnihotra ash (T5) treated plots. An increase in available micronutrients status with organic sources may be ascribed to the release of organic acids during their decomposition, along with root exudates during the growth of pea plants. The effect seemed to be more pronounced in plots where the increase was significant. These results indicate that organic amendments effectively increased the availability of both macro and micronutrients in the soil. Similar findings have been reported by Adekiya et al. (2020) and Singh et al. (2021). Tian et al. (2022) found enhanced organic carbon, nitrogen and phosphorus under long-term organic amendments.

## Conclusion

The application of organic sources such as compost, vermicompost, agnihotra ash and jeevamrut to pea resulted in improved soil nutrient availability, plant growth, nutrient concentration in pea plants and test weight. The findings of this study indicate that the agnihotra ash applied at the rate of 1500 kg/ha was the most effective treatment for improving growth performance and yield attributes of pea, a legume crop. Furthermore, synergistic effects were observed when agnihotra ash was combined with either jeevamrut and vermicompost, suggesting that integrated use of these organic inputs can further optimize nutrient availability and crop productivity.

## References


Adekiya, A, O., Ejue, W.S., Olayanju, A., Dunsin, O., Aboyeji, C.M., Aremu, C., Adegbite, K., & Akinpelu, O. (2020). Different organic manure sources and NPK fertilizer on soil chemical properties, growth, yield and quality of okra. Scientific Reports, 10, 16083.

Arshad, S., Iqbal, M.Z., Shafiq, M., Kabir, M., & Farooqui, Z.R. (2020). The effects of wood ash on seed germination and seedling growth of pulse crop *Vigna radiata* (L.) R. Wilczek. Bioscience Research, 17, 221-227.

Balkrishna, A., Yagyadev, S., Vipradev, S., Rathi, M., Saini, T., Kumar, G., & Kumar, P. (2025). Release of plant essential nutrients from yagya ash and impact on pea (*Pisum sativum*) growth. International Journal of Environmental & Agriculture Research, 11(8).

Bandan, B.K., Thakur, C.L., Sharma, H., & Kumar, D. (2021). Influence of organic manures on soil physico-chemical properties under Morus based Agri silviculture system. Agricultural Science Digest, 41(4), 584-589.

Bhutia, P., Anal, P.S.M., Sarma, P., Singh, A.K., Singh, S.R., & Mailappa, A.S. (2019). Influence of organic manures, biofertilizers and wood ash on growth and yield of edible podded pea (*Pisum sativum* var. macrocarpon) var. Arka Apoorva. International Journal of Current Microbiology and Applied Sciences, 8, 210-219.

Chesnin, L., & Yen, C.H. (1950). Turbidimetric determination of available sulphates. Soil Science Society of America, 15, 149-151. http://dx.doi.org/10.2136/sssaj1951.036159950015000C0032x.

Hammad, H.M., Khaliq, A., Abbas, F., Farhad, W., Fahad, S., Aslam, M., & Bakhat, H. F. (2020). Comparative effects of organic and inorganic fertilizers on soil organic carbon and wheat productivity under arid region. Communications in Soil Science and Plant Analysis, 51(10), 140-1422.

Kartini, N.L., Saifulloh, M., Trigunasih, N.M., Sukmawati, N.M.S., Mega, I.M. (2024). Impact of long term continuous cropping on soil nutrient depletion. Ecological Engineering & Environmental Technology, 25(11), 18-29.

Kumar, R., Singh, P., Rai, R.K., Kumari, M., Kumar, A., Pathak, A.D., & Olekar, N.S. (2018). Homa organic farming reduces pest and disease infestations in okra and improves its quality and yield. Journal of Entomology and Zoology Studies, 6(6), 211-218.

Lindsay, W.L., & Norvell, W.A. (1978). Development of a DTPA soil test for zinc, iron, manganese and copper. Soil Science Society of America Journal, 42, 421-428.

Ma, W., Tang, S., Dengzeng, Z., Zhang, D., Zhang, T., & Ma, X. (2022). Root exudates contribute to belowground ecosystem hotspots: A review. Frontiers in Microbiology, 5(13), 937940.

Merwin, H.D., & Peech, M. (1950). Exchangeability of soil potassium in the sand, silt and clay fractions as influenced by the nature of the complimentary exchangeable cations. Soil Science Society of America Proceedings, 15, 125-28.

Olsen, S.R., Cole, C.V., Watanabe, F.S., & Dean, L.A. (1954). Estimation of available phosphorus in soils by extraction with sodium bicarbonate. USDA Cir.939. U.S. Washington.

Ondrasek, G., Bakić Begić, H., Zovko, M, Filipović L, Meriño-Gergichevich C, Savić R, & Rengel Z (2019) Biogeochemistry of soil organic matter in agroecosystems and environmental implications. Science of the Total Environment, 658, 1559-1573.

Priyadharshini, J., & Seran, T. H. (2009). Paddy husk ash as a source of potassium for growth and yield of cowpea (*Vigna unguiculata*

L.). Journal of Agricultural Sciences, 4, 67-76.

Saharan, B.S., Tyagi, S., Kumar, R., Vijay, O.H., Mandal, B.S., & Duhan, J.S. (2023). Application of Jeevamrit improves soil properties in zero budget natural farming fields. Agriculture, 13(1), 196. https://doi.org/10.3390/agriculture13010196.

Salvagiotti, F., Castelları´n, J.M., Miralles, D.J., & Pedrol, H.M. (2009). Sulfur fertilization improves nitrogen use efficiency in wheat by increasing nitrogen uptake. Field Crops Research, 113, 170-177.https://doi.org/ 10.1016/j.fcr.2009.05.003.

Scherer, H.W., Pacyna, S., Manthey, N., & Schulz, M. (2006). Sulphur supply to peas (*Pisum sativum* L.) influences symbiotic $N_2$ fixation. Plant, Soil and Environment, 52(2), 72-77. https://doi.org/ 10.17221/3348-PSE.

Sheoran, S., Prakash, D., Yadav, P.K., Gupta, R.K., Al-Ansari, N., Hendawy, S., & Mattar, M.A. (2024). Long-term application of FYM and fertilizer N improve soil fertility and enzyme activity in 51st wheat cycle under pearl millet-wheat. Scientific Reports, 14, 21695. https://doi.org/10.1038/s41598-024-72076-w.

Singh, R., Babu, S., Avasthe, R.K., Meena, R.S., Yadav, G.S., Das, A., Mohapatra, K.P., Rathore, S.S., Kumar, A., & Singh, C. (2021). Conservation tillage and organic nutrients management improve soil properties, productivity, and economics of a maize-vegetable pea system in the Eastern Himalayas. Land Degradation & Development Land, 32, 4637-465. https://doi.org/10.1002/ldr.4066.

Subbiah, B.V., & Asija, G.L. (1956). A rapid procedure for the determination of available nitrogen in soil. Current Science, 25, 259-260.

Tian, S., Zhu, B., Yin, R., Wang, M., Jiang, Y., Zhang, C., Li, D., Chen, X.Y., Kardol, P., & Liu, M. (2022). Organic fertilization promotes crop productivity through changes in soil aggregation. Soil Biology & Biochemistry, 165, 108533. https://res.slu.se/id/publ/116855.

Walkley, A., & Black, I.A. (1934). An examination of the Degtjareff method for determining soil organic matter, and a proposed modification of the chromic acid titration method. Soil Science, 37, 29-38.

Xu, J., Li, Y., & Li, L. (2025). A comprehensive review of the effects of organic amendments on soil health and fertility: mechanisms, greenhouse gas emissions, and implications for sustainable agriculture. Agronomy, 15, 2705.

Zhao, F. J., Wood, A. P., & Mcgrath, S. P. (1999). Effects of sulphur nutrition on growth and nitrogen fixation of pea (*Pisum sativum* L.). Plant & Soil, 212(2), 207-217. https://doi.org/10.1023/A:1004618303445.

## सारांश

खेती में ऑर्गेनिक स्रोतों के इस्तेमाल पर काफी ध्यान दिया गया है क्योंकि इनमें मिट्टी की सेहत और उपज की क्वालिटी को बेहतर बनाने की क्षमता होती है। यह स्टडी मटर के पौधे की उपज और मिट्टी में पोषक तत्वों की उपलब्धता में बदलाव पर अग्निहोत्र राख (जो प्राचीन वैदिक अग्नि अनुष्ठान से मिलने वाला एक बाय-प्रोडक्ट है) और अन्य ऑर्गेनिक स्रोतों जैसे कम्पोस्ट वर्मीकम्पोस्ट और जीवामृत के असर की जांच करने के लिए की गई थी। खेत में यह एक्सपेरिमेंट दस ट्रीटमेंट्स के साथ रैंडमाइज्ड कम्प्लीट ब्लॉक डिजाइन का इस्तेमाल करके किया गया था। बुवाई से पहले हर प्लॉट में ऑर्गेनिक खाद डाली गई। स्टडी में इस्तेमाल की गई ऑर्गेनिक खादों में फसल की बढ़त के लिए जरूरी पोषक तत्व देने की काफी क्षमता थी। बाकी ऑर्गेनिक खादों के मुकाबले अग्निहोत्र की राख ने मटर की उपज के पैरामीटर्स को बेहतर बनाया, जैसे कि जड़ की लंबाई (18 cm), तने की लंबाई (69 cm), सूखी जड़ और तने का बायोमास (0.34 g, 5.9 g), प्रति पौधा फलियों की संख्या (22), प्रति फली बीजों की संख्या (6.1) और टेस्ट वेट (27 g)। नतीजों से पता चला कि अलग-अलग ऑर्गेनिक स्रोतों में से, अग्निहोत्र की राख में मैक्रो और माइक्रोन्यूट्रिएंट्स की मात्रा ज्यादा थी, जिससे मटर की बढ़त और पैदावार बेहतर हुई। ऑर्गेनिक स्रोतों के इस्तेमाल से मिट्टी में मौजूद पोषक तत्वों की मात्रा में भी बढ़ोतरी हुई। नतीजों से संकेत मिलता है कि अग्निहोत्र की राख का इस्तेमाल ऑर्गेनिक और प्राकृतिक खेती के लिए, खासकर सब्जियों की फसलों के लिए, एक अच्छे स्रोत के तौर पर किया जा सकता है।