International Journal of Research in Agronomy 2025; 8(12): 1040-1047

E-ISSN: 2618-0618
P-ISSN: 2618-060X

NAAS Rating (2025): 5.20
www.agronomyjournals.com
2025; 8(12): 1040-1047
Received: 10-10-2025
Accepted: 15-11-2025

JD Gaikwad
Assistant Professor, Department of Agronomy, College of Agriculture, Golegao, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

HM Virdia
Professor and Head, Department of Agronomy, N. M. College of Agriculture, Navsari Agricultural University, Navsari, Gujrat, India

MD Gaikwad
Ph.D. Student, Department of Agronomy, College of Agriculture, Nagpur, PDKV, Akola, Maharashtra, India

SA Shinde
Assistant Professor, AICRP, on Safflower, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

VG Bavalgave
Assistant Professor, Department of Agronomy, N. M. College of Agriculture, Navsari Agricultural University, Navsari, Gujrat, India

Sonal Tripati
Associate Professor, Department of soil science and Agriculture Chemistry, N. M. College of Agriculture, Navsari Agricultural University, Navsari, Gujrat, India

Corresponding Author:
JD Gaikwad
Assistant Professor, Department of Agronomy, College of Agriculture, Golegao, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Effect of integrated organic nutrient management on growth and yield of summer groundnut (*Arachis hypogaea* L.)

JD Gaikwad, HM Virdia, MD Gaikwad, SA Shinde, VG Bavalgave and Sonal Tripati

DOI: https://www.doi.org/10.33545/2618060X.2025.v8.i12o.4539

Abstract
A field experiment was conducted during the summer seasons of 2022 and 2023 at the College Farm, the soil was clayey, low in organic carbon (0.40%) and available nitrogen (213.42 kg ha^{-1}), medium in available phosphorus (37.55 kg ha^{-1}), and high in available potassium (318.27 kg ha^{-1}), with slightly alkaline reaction (pH 7.96). N. M. College of Agriculture, Navsari Agricultural University, Navsari, Gujarat. The treatments were laid out in a randomized block design with four replications and repeated at the same site in the successive year without altering the randomization to assess residual effects.
The experiment comprised six treatments: T_1 - Control; T_2 - 100% RDF + seed treatment with Rhizobium and PSB; T_3 - 100% RDP through FYM + seed treatment with Rhizobium and PSB; T_4 - 100% RDP through vermicompost + seed treatment with Rhizobium and PSB; T_5 - 50% RDP through FYM + 50% RDP through vermicompost + seed treatment with Rhizobium and PSB and T_6 - 75% RDP through FYM + 25% RDP through vermicompost + seed treatment with Rhizobium and PSB.
During the two years of experimentation (2022 and 2023) and in pooled analysis, the application of T_5 (50% RDP through FYM + 50% RDP through vermicompost along with seed treatment with Rhizobium and PSB) on summer groundnut had a non-significant effect on plant population. However, it recorded the significantly highest values for growth parameters. Plant height was highest at 60 DAS (33.15, 34.86, and 34.00 cm), 90 DAS (52.98, 55.35, and 54.16 cm), and at harvest (66.09, 69.51, and 67.80 cm) during 2022, 2023, and in pooled analysis, respectively. Similarly, the number of leaves per plant was highest at 60 DAS (64.35, 67.01, and 65.68), 90 DAS (86.53, 89.77, and 88.15), and at harvest (141.36, 143.64, and 142.50), while the number of branches per plant was also highest at 60 DAS (12.87, 13.52, and 13.20), 90 DAS (14.24, 14.99, and 14.61), and at harvest (15.81, 16.62, and 16.21) during both years and in pooled analysis.
Regarding yield attributes, treatment T_5 recorded the highest pod yield (4004, 4181, and 4092 kg ha^{-1}), haulm yield (10551, 10458, and 10505 kg ha^{-1}), and total biomass yield (14555, 14639, and 14597 kg ha^{-1}) for 2022, 2023, and in pooled analysis, respectively.
The improved growth and yield under integrated application of organic phosphorus sources along with biofertilizers may be attributed to enhanced nutrient av ailability, better root proliferation, and increased microbial activity in the rhizosphere.

Keywords: Summer groundnut, Integrated organic nutrient management, FYM, Vermicompost, Rhizobium, PSB, Growth and yield

1. Introduction
Groundnut (*Arachis hypogaea* L.) is one of the most important oilseed crops of India and plays a vital role in ensuring food, nutritional, and economic security. It is valued for its high edible oil and protein content and is often referred to as the "Queen of Oilseeds." India is among the leading groundnut-producing countries of the world, with Gujarat contributing the largest share of national production. Among the different growing seasons, summer groundnut consistently records higher productivity than the kharif crop due to favourable climatic conditions such as higher temperatures, longer sunshine hours, assured irrigation, and comparatively lower incidence of pests and diseases. Despite its high yield potential, groundnut productivity remains constrained by declining soil fertility, nutrient imbalance, and inefficient nutrient management

practices, particularly under intensive cropping systems.

Groundnut is a nutrient-exhaustive leguminous crop and requires relatively higher amounts of phosphorus because of its critical role in root development, nodulation, biological nitrogen fixation, and oil biosynthesis. Phosphorus deficiency leads to poor root growth, reduced nodulation, delayed flowering, impaired pod formation, and inferior seed quality, resulting in substantial yield losses. In most agricultural soils, the availability of phosphorus is limited due to fixation into insoluble forms, with only a small fraction of total soil phosphorus being accessible to plants. This low phosphorus use efficiency highlights the need for integrated phosphorus management strategies to improve nutrient availability and crop performance.

Organic nutrient sources such as farmyard manure and vermicompost are key components of sustainable nutrient management systems. Their application improves soil physical properties, including aggregation, porosity, and water-holding capacity, while enhancing chemical properties such as cation exchange capacity and nutrient buffering. Additionally, organic amendments stimulate soil biological activity by increasing microbial biomass, enzyme activity, and nutrient mineralization. The organic acids released during decomposition reduce phosphorus fixation and increase the availability of native and applied phosphorus. Biofertilizers, particularly Rhizobium and phosphate-solubilizing bacteria, further enhance nutrient availability by fixing atmospheric nitrogen, solubilizing insoluble phosphorus, and producing plant growth-promoting substances that improve root development and nutrient uptake.

The integrated use of organic manures and biofertilizers enhances nutrient use efficiency, improves yield stability, and sustains soil fertility while reducing dependence on chemical fertilizers. Such eco-friendly and biologically sound nutrient management practices minimize environmental degradation and support long-term productivity. Overall, adoption of integrated nutrient management approaches is essential for achieving sustainable groundnut production under both irrigated and rainfed conditions, while maintaining soil health and ensuring the resilience of groundnut-based cropping systems**.**

2. Materials and Methods

The present investigation was carried out by laying out a field experiment on groundnut with the application of inorganic fertilizer, organic manure (vermicompost and FYM) and biofertilizer to groundnut in summer season and levels of recommended dose of fertilizer apply in form of organic during two consecutive years, 2022 and 2023

2.1. Experimental Site

The field experiment was conducted at Block - F and Plot no - 21, College Farm, Navsari Agricultural University, Navsari during summer and kharif seasons of 2022 and 2023. Geographically, university campus is situated at 20º 57' North latitude, 72º 54' East longitudes and has an altitude of 10 meters above the mean sea level. It is located 12 km away in the east from the great historical place ‘Dandi’ on the Arabian seashore.

2.2. Soil

The soil of south Gujarat is locally known as “Deep Black Soil”. The soil of Navsari campus is classified under the order Inceptisols comprising of Afine montmorillonitic, isohyperthermic, family of Vertic ustrochrepts and soil series Jalalpur by the soil survey officer, Navsari, Department of Agriculture, Gujarat state, having poor drainage capacity and good water holding capacity. The soil cracks heavily on drying and expands on wetting. The experimental field has flat topography. A representative soil sample was drawn from 0-15 cm depth covering entire area before sowing of the groundnut crop. The samples were mixed thoroughly and then, the composite sample was analysed for desired physico-chemical properties of the soil.

2.3. Treatment details

The experiment was laid out in randomised block design with four replications. The main plot treatments $T_{1:}$ Control T_2: 100% RDF + Seed treatment (Rhizobium + + PSB) T_3: 100 % RDP through FYM + Seed treatment (Rhizobium + PSB) T_4: 100% RDP through Vermicompost + Seed treatment (Rhizobium + PSB) T_5: 50% RDP through FYM + 50% RDP through Vermicompost+ Seed treatment (Rhizobium + PSB) $T_{6:}$ 75% RDP through FYM + 25% RDP through Vermicompost+ Seed treatment (Rhizobium + PSB)

2.4. Salient Features of summer Groundnut

cv. GG 34 Groundnut Variety GG 34 (Gujarat Groundnut 34) released from Anand Agricultural University, Anand and Year of Release 2018.It has spanish bunch plant habit and it is recommended for summer cultivation. The kernels are rose red colour, bold in size, high oil content (52.82%), protein content (26. 38%). It has maturity days 111-125, with average yield potential of pod yield and kernel yield is 3715 kg ha^{-1} and 2525 kg ha^{-1}, respectively

2.5. Field preparations

The experimental plot was ploughed and fine seedbed was prepared by subsequent harrowing with tractor drawn harrow in both directions, followed by planking. Irrigation channels were prepared by V-ditcher. Layout and allotment of treatments as

2.6. Application of Fertilizer and Organic Manure

The application of manures and fertilizers were done as per treatments. The nitrogen was applied through urea (46 % N) whereas phosphorus was applied through single super phosphate (16 % P2O5) in treatment T2. Farm Yard Manure and vermicompost were applied in the required quantities and proportions as specified in the treatments and uniformly spread and mixed in particular plots before sowing to treatment T_3 to T_6. All the manures were applied 09 days prior to sowing of crop while in treatments. The desired quantity of FYM and vermicompost was worked out as per treatments. By considering P content in Farm Yard Manure (FYM) and vermicompost. Nutrient content in manure analyzed as per standard laboratory method

2.7. Seed Treatment and Sowing

Summer Groundnut variety, GG 34 was used for this experiment. The required quantity of seeds was worked out for the experimental area. Inoculation of biofertilizer (Rhizobium 10ml kg^{-1}) to the seeds was done in both the years before sowing. In the treatments T_2 to T_6, Rhizobium and phosphate solubilizing bacteria (PSB) were applied. For this purpose, 100 ml of Rhizobium was used for seed treatment at the time of sowing and 100 ml of PSB was used. The inoculated seeds were dried under shade and were sown at recommended seed rate of 100 kg ha^{-1}. The seeds were sown manually in the furrows spaced at 30 cm and were covered with soil uniformly.

3. Results and Discussion
3.1. Growth parameter
3.1.1 Plant population
The plant population of summer groundnut recorded at 15 DAS and at harvest did not differ significantly due to different organic phosphorus management practices during 2022 and 2023 as well as in the pooled analysis (Table 1). Although numerical variations were observed, both initial and final plant population remained statistically non-significant across treatments. The integrated organic nutrient management treatment recorded numerically higher initial plant population (32.66 and 32.90 plants m^{-2} during 2022 and 2023, respectively; pooled mean 32.78 plants m^{-2}) and final plant stand (31.84 and 32.03 plants m^{-2} during 2022 and 2023, respectively; pooled mean 31.94 plants m^{-2}). Comparable values were observed under other nutrient management treatments at both stages.

The control treatment recorded relatively lower initial and final plant population during both years and in pooled analysis; however, the differences were marginal and non-significant. The non-significant response of plant population to organic phosphorus management may be attributed to uniform seed rate and spacing, along with favourable soil moisture conditions at sowing, which ensured uniform germination and crop establishment. Similar results have been reported earlier, indicating that organic manures mainly improve soil physical properties without causing marked variation in plant population (Gaur, 1991; Sahrawat, 2006) [9, 27]. Although biofertilizers such as *Rhizobium* and phosphate-solubilizing bacteria enhance early root growth and nutrient availability (Chetti *et al*., 1995; Khan *et al*., 2019) [5, 14], their effect on plant population was non-significant under the present experimental conditions.

3.1.2. Plant height
Plant height of summer groundnut at 60 DAS, 90 DAS and at harvest was significantly influenced by different organic nutrient management treatments during 2022, 2023 and on pooled basis (Table 2. and fig 1) Across both the years and pooled data, T_5 (50% RDP through FYM + 50% RDP through vermicompost + seed treatment with Rhizobium + PSB) consistently recorded the highest plant height at all growth stages. At 60 DAS, T_5 recorded highest plant height of 33.15, 34.86 cm and 34.00 cm, during 2022, 2023, and pooled respectively which was at par with T_6 (32.65 and 34.29 and 33.47 cm) and T2 (30.74 32.08 31.41) during 2022, 2023 and pooled respectively. The lowest plant height at this stage was observed under T_1 (control) with values of 25.35 cm (2022), 26.65 cm (2023) and 26.00 cm (pooled).

At 90 DAS, T_5 produced significantly higher plant height of 52.98 cm in 2022 and 55.35 cm in 2023, with a pooled mean of 54.16 cm, and remained at par with T_6 (52.65 and 54.72 and pooled 53.68 cm) and T_2 (48.13, 52.71 and 50.42) during 2022,2023 and pooled respectively;). In contrast, T_1 recorded the minimum plant height of 38.02 cm (2022), 39.99 cm (2023) and 39.00 cm (pooled).

At harvest, the maximum plant height was again recorded under T_5 with values of 66.09 cm during 2022 and 69.51 cm during 2023, and pooled of 67.80 cm, which was closely at par with T_6 (65.35. 69.25 and 67.30 cm). and (60.18, 66.50 and 63.34 cm) 2022,2023 and pooled respectively. The lowest plant height at harvest was consistently observed under T_1, recording 48.14 cm (2022), 50.60 cm (2023) and 49.37 cm (pooled).

The increased plant height under integrated organic phosphorus management may be attributed to improved phosphorus availability, enhanced microbial activity, and sustained nutrient release from FYM and vermicompost, which supported continuous vegetative growth. Phosphorus plays a key role in cell division, energy transfer, and root development, thereby enhancing nutrient uptake and plant growth (Smith *et al.*, 2018; Jones and Murray, 2017) [29, 12]. Similar improvements in plant height of groundnut under integrated organic nutrient management have been reported earlier by Mahrous *et al*. (2015) [18] and Patel *et al*. (2019) [22].

3.1.3. Number of leaves per plant
The number of leaves plant^{-1} of summer groundnut at 60 DAS, 90 DAS and at harvest was significantly influenced by different organic nutrient management treatments during 2022, 2023 and on pooled basis (Table 3 with Fig.2). Across both the years and pooled analysis, the treatment T_5 (50% RDP through FYM + 50% RDP through vermicompost + seed treatment with Rhizobium + PSB) consistently recorded the highest number of leaves per plant at all growth stages

At 60 DAS, T_5 recorded the highest number of leaves per plant (64.35 and 67.01 during 2022 and 2023, respectively, with a pooled 65.68), which was at par with T_6 (64.06, 66.01 and 65.03) and T_2 (. 60.43, 63.10 and 61.76) during 2022 and 2023, pooled respectively. The lowest number of leaves per plant was recorded under T_1 (control) with values of 52.84 (2022), 54.37 (2023) and 53.61 (pooled).

At 90 DAS, the highest number of leaves per plant was observed under T_5 with values of 86.53 in 2022 and 89.77 in 2023, and a pooled 88.15, which was at par with T_6 (85.75, 89.53 and 87.64) T_2 (81.69, 84.94 and 83.31) in 2022, 2023 and pooled respectively. In contrast, T_1 recorded the lowest number of leaves per plant, registering 72.55 (2022), 75.04 (2023) and 73.80 (pooled).

At harvest, T_5 continued to show superiority, recording the highest number of leaves per plant of 141.36 in 2022 and 143.64 in 2023, with a pooled 142.50, which was at par with T_6 (140.59, 142.89 and 141.74) and T_2 (133.73, 135.50 and134.61) in 2022, 2023 and pooled basis respectively. The lowest number of leaves per plant at harvest was consistently recorded under T_1, with values of 118.83 (2022), 121.11 (2023) and 119.97 (pooled).

Overall, the pooled results clearly indicated that integrated application of FYM and vermicompost along with biofertilizer seed treatment significantly enhanced leaf production compared to control and other treatments

The enhanced leaf production and retention under integrated organic phosphorus management may be attributed to sustained nutrient release, improved phosphorus availability, and enhanced microbial activity, which collectively supported prolonged vegetative growth and delayed senescence. Similar findings have been reported by Bhardwaj and Omanwar (1994) [4], Stevenson (1994) [30], and Kejiya *et al*. (2019) [13].

3.1.4. Number of branches per plant
The number of branches per plant of summer groundnut at 60 DAS, 90 DAS and at harvest was significantly influenced by different organic nutrient management treatments during 2022, 2023 and on pooled basis (Table 4 with Fig.3). Across both the years and pooled analysis, the treatment T_5 (50% RDP through FYM + 50% RDP through vermicompost + seed treatment with Rhizobium + PSB) consistently recorded the highest number of branches per plant at all growth stages.

At 60 DAS, T_5 recorded the highest number of branches per plant of 12.87 during 2022 and 13.52 during 2023, with pooled 13.20, which was at par with T_6 (12.77 and 13.28 during 2022 and 2023, respectively; pooled 13.03). The lowest number of branches per plant was recorded under T_1 (control) with values of 7.21 (2022), 7.58 (2023) and 7.40 (pooled).

At 90 DAS, T_5 again recorded the highest number of branches per plant (14.24 in 2022 and 14.99 in 2023, with a pooled mean of 14.61) and remained at par with T_6 (13.97 in 2022, 14.97 in 2023 and 14.47 on pooled basis). In contrast, T_1 recorded the lowest number of branches per plant, registering 8.19 (2022), 8.61 (2023) and 8.40 (pooled).

At harvest, the highest number of branches per plant was observed under T_5 with values of 15.81 during 2022 and 16.62 during 2023, and a pooled 16.21, which was at par with T_6 (15.57 in 2022, 16.43 in 2023 and 16.00 on pooled basis). The lowest number of branches per plant at harvest was consistently recorded under T_1, with values of 8.67 (2022), 9.13 (2023) and 8.90 (pooled).

Overall, the pooled results indicated that integrated application of FYM and vermicompost along with biofertilizer seed treatment significantly enhanced branching in summer groundnut compared to control and other treatments.

The superior branching observed under integrated organic phosphorus management may be attributed to improved phosphorus availability, sustained nutrient release from FYM and vermicompost, and enhanced microbial activity, which collectively supported better root development and vegetative growth. Similar findings on increased branching in groundnut under integrated organic nutrient management have been reported earlier by Akbari *et al.* (2002) [1] and Patel *et al.* (2019) [22].

3.2. Yield parameter

3.2.1. Dry pod yield

The data presented in Table 5 and illustrated in Fig. 4 revealed that different organic phosphorus nutrient management treatments significantly influenced dry pod yield (kg ha^{-1}) of summer groundnut during 2022, 2023, and pooled analysis. The highest dry pod yield was recorded under treatment T_5 (50% RDP through FYM + 50% RDP through vermicompost + seed treatment with Rhizobium + PSB), producing 4181, 4092, and 4052 kg ha^{-1} in 2022, 2023, and pooled data, respectively. Treatment T_6 (75% FYM + 25% vermicompost + seed treatment with Rhizobium + PSB) was followed with T_5, producing 3473, 3500, and 3486 kg ha^{-1} in in 2022, 2023, and pooled respectively. The lowest yield was observed in T_1 (control) with 1510, 1559, and 1535 kg ha^{-1} in 2022, 2023, and pooled respectively

The higher yield under T_5 can be attributed to the synergistic effect of FYM and vermicompost, which ensured a balanced and sustained release of nutrients, improved soil structure, and enhanced microbial activity. The inclusion of Rhizobium and phosphate-solubilizing bacteria (PSB) facilitated biological nitrogen fixation and increased phosphorus availability, promoting better vegetative growth, root development, and pod formation (Brady and Weil, 2008; Patil, 2017; Mengel and Kirkby, 2001). Adequate phosphorus availability supported energy transfer, ATP synthesis, and reproductive development, enhancing peg penetration, pod setting, and seed filling (Jones and Murray, 2017; Smith *et al.*, 2018) [12, 29].

Overall, the results confirm that integrated organic phosphorus management (FYM + vermicompost + microbial inoculation) enhances nutrient use efficiency, improves source-sink relationships, and promotes physiological processes, resulting in higher dry pod yield in summer groundnut (Hegde and Sudhakara Babu, 2004; Mahrous *et al.*, 2015) [18].

3.2.2. Haulm yield

The data on haulm (stover) yield of summer groundnut as influenced by different organic phosphorus nutrient management practices are presented in Table.5 and illustrated in Fig. 4. The results revealed that haulm yield was significantly influenced by organic nutrient management practices during both the years (2022 and 2023) as well as in the pooled analysis. Among the treatments, application of 50% RDP through FYM + 50% RDP through vermicompost along with seed treatment of Rhizobium + PSB (T_5) recorded the highest haulm yield of 10,458 and 10,551 kg ha^{-1} during 2022 and 2023, respectively, with pooled 10,505 kg ha^{-1}, and followed treatment T_6 (75% RDP through FYM + 25% RDP through vermicompost + seed treatment of Rhizobium + PSB) also produced higher haulm yield (8,909, 9,047 and 8,978 kg ha^{-1} during 2022, 2023 and pooled, respectively. The lowest haulm yield was observed under T_1 (control) with 3,931, 4,117 and 4,024 kg ha^{-1} during 2022, 2023 and pooled, respectively.

The superior haulm yield under integrated organic phosphorus management, particularly in T_5, may be attributed to sustained nutrient release, improved soil physical and biological properties, enhanced nitrogen availability, and increased chlorophyll synthesis, resulting in vigorous vegetative growth and higher biomass accumulation. Similar findings have been reported by Singh *et al.* (2010) [35] and Yadav *et al.* (2017) [36] in leguminous crops.

3.2.3. Total Biomass Yield

The data on total biomass yield of summer groundnut as influenced by different organic phosphorus nutrient management practices are presented in Table.5 and Fig. 4. The results indicated that total biomass yield (kg ha^{-1}) was influenced by organic nutrient management during both the years (2022 and 2023) as well as in pooled analysis. The highest total biomass yield was recorded with application of 50% RDP through FYM + 50% RDP through vermicompost along with seed treatment of Rhizobium + PSB (T_5), registering 14,659 and 14,555 kg ha^{-1} during 2022 and 2023, respectively, with pooled 14,507 kg ha^{-1}, and followed by treatment T_6 (75% RDP through FYM + 25% RDP through vermicompost + seed treatment of Rhizobium + PSB) also produced comparable biomass yield (12,758, 12,309 and 12,533 kg ha^{-1} during 2022, 2023 and pooled, respectively). The lowest biomass yield was observed under T_1 (control) with 5501,5676 and 5588 kg ha^{-1} during 2022, 2023 and pooled, respectively.

The superiority of T_5 (50% RDP through FYM + 50% RDP through vermicompost along with seed treatment of Rhizobium + PSB) may be attributed to the balanced and sustained nutrient supply through integrated organic sources, improved soil physical and biological properties, and enhanced microbial activity, resulting in better crop growth and higher biomass accumulation. Similar improvements in total biomass under integrated organic nutrient management have been reported by Stevenson (1994) [30] and Lampkin (2002).

Table 1: Initial and final plant population of groundnut as influenced by different treatments of organic nutrient management

Treatments		Plant population (m2)					
		Initial			Final		
		2022	2023	Pooled	2022	2023	Pooled
T_1	Control	31.77	32.03	31.90	31.15	31.27	31.21
T_2	100% RDF + Seed treatment (*Rhizobium* + PSB)	32.33	32.58	32.45	31.58	31.72	31.65
T_3	100 % RDP through FYM + Seed treatment (*Rhizobium* + PSB)	31.97	32.23	32.10	31.32	31.45	31.38
T_4	100% RDP through Vermicompost + Seed treatment (*Rhizobium* + PSB)	32.18	32.44	32.31	31.46	31.63	31.55
T_5	50% RDP through FYM + 50% RDP through Vermicompost + Seed treatment *Rhizobium* + PSB)	32.66	32.90	32.78	31.84	32.03	31.94
T_6	75% RDP through FYM + 25% RDP through Vermicompost + Seed treatment (*Rhizobium* + PSB)	32.62	32.85	32.74	31.81	31.98	31.90
SEm ±		1.01	0.71	0.62	0.58	0.84	0.51
CD (P=0.05)		NS	NS	NS	NS	NS	NS
CV (%)		5.90	4.11	5.07	3.68	5.30	4.57
Interaction (Y × T)							
SEm ±		0.87			0.77		
CD (P=0.05)		NS			NS		

Table 2: Plant height at different stages of summer groundnut as influenced by different treatments of organic nutrient management

Treatments		Plant height (cm)								
		60 DAS			90 DAS			At harvest		
		2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled
T_1	Control	25.35	26.65	26.00	38.02	39.99	39.00	48.14	50.60	49.37
T_2	100% RDF + Seed treatment (*Rhizobium* + PSB)	30.74	32.08	31.41	48.13	52.71	50.42	60.18	66.50	63.34
T_3	100 % RDP through FYM + Seed treatment (*Rhizobium* + PSB)	28.22	29.62	28.92	43.25	45.67	44.46	54.69	57.55	56.12
T_4	100% RDP through Vermicompost + Seed treatment (*Rhizobium* + PSB)	29.29	30.79	30.04	45.75	47.82	46.78	57.45	60.25	58.85
T_5	50% RDP through FYM + 50% RDP through Vermicompost + Seed treatment *Rhizobium* + PSB)	33.15	34.86	34.00	52.98	55.35	54.16	66.09	69.51	67.80
T_6	75% RDP through FYM + 25% RDP through Vermicompost + Seed treatment (*Rhizobium* + PSB)	32.65	34.29	33.47	52.65	54.72	53.68	65.35	69.25	67.30
SEm ±		0.97	1.17	0.76	2.06	1.87	1.39	1.97	3.91	2.19
CD (P=0.05)		2.92	3.53	2.20	6.20	5.62	4.01	5.94	11.78	6.32
CV (%)		6.49	7.47	7.02	8.79	7.56	8.17	6.72	12.55	10.24
Interaction (Y × T)										
SEm ±		1.08			1.96			3.20		
CD (P=0.05)		NS			NS			NS		

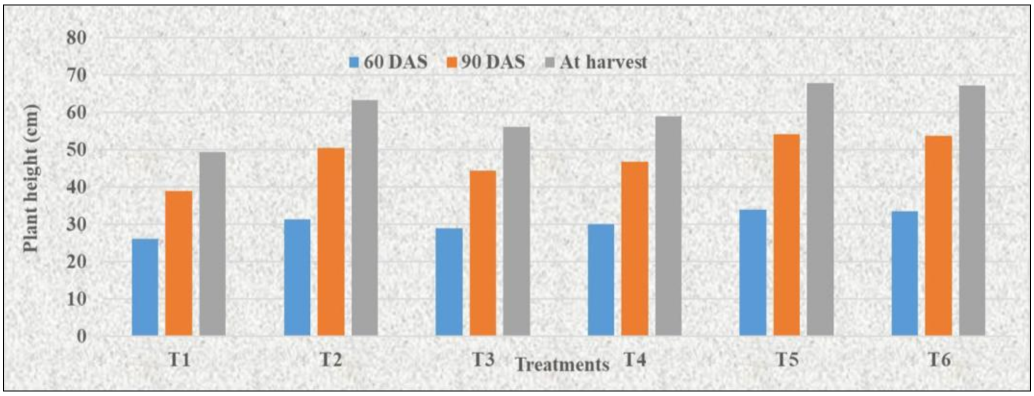

Fig 1: Plant height at different stages of summer groundnut as influenced by different treatments of organic nutrient management

Table 3: Number of leave per plant at different stages of summer groundnut as influenced by different treatments of organic nutrient management

Treatments		Number of leave plant -1								
		60 DAS			90 DAS			At harvest		
		2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled
T_1	Control	52.84	54.37	53.61	72.55	75.04	73.80	118.83	121.11	119.97
T_2	100% RDF + Seed treatment (*Rhizobium* + PSB)	60.43	63.10	61.76	81.69	84.94	83.31	133.73	135.50	134.61
T_3	100 % RDP through FYM + Seed treatment (*Rhizobium* + PSB)	57.03	59.05	58.04	77.78	80.40	79.09	126.81	129.62	128.21
T_4	100% RDP through Vermicompost + Seed treatment (*Rhizobium* + PSB)	58.86	60.93	59.90	79.97	83.02	81.49	130.36	132.56	131.46
T_5	50% RDP through FYM + 50% RDP through Vermicompost + Seed treatment *Rhizobium* + PSB)	64.35	67.01	65.68	86.53	89.77	88.15	141.36	143.64	142.50
T_6	75% RDP through FYM + 25% RDP through Vermicompost + Seed treatment (*Rhizobium* + PSB)	64.06	66.01	65.03	85.75	89.53	87.64	140.59	142.89	141.74
SEm ±		2.56	2.74	1.88	3.05	3.29	2.24	5.02	4.97	3.53
CD (P=0.05)		8.61	8.87	8.75	9.20	9.92	6.48	15.12	14.97	10.19
CV (%)		9.93	10.36	10.16	7.56	7.85	7.72	7.60	7.40	7.50
Interaction (Y × T)										
SEm ±		2.65			3.17			4.99		
CD (P=0.05)		NS			NS			NS		

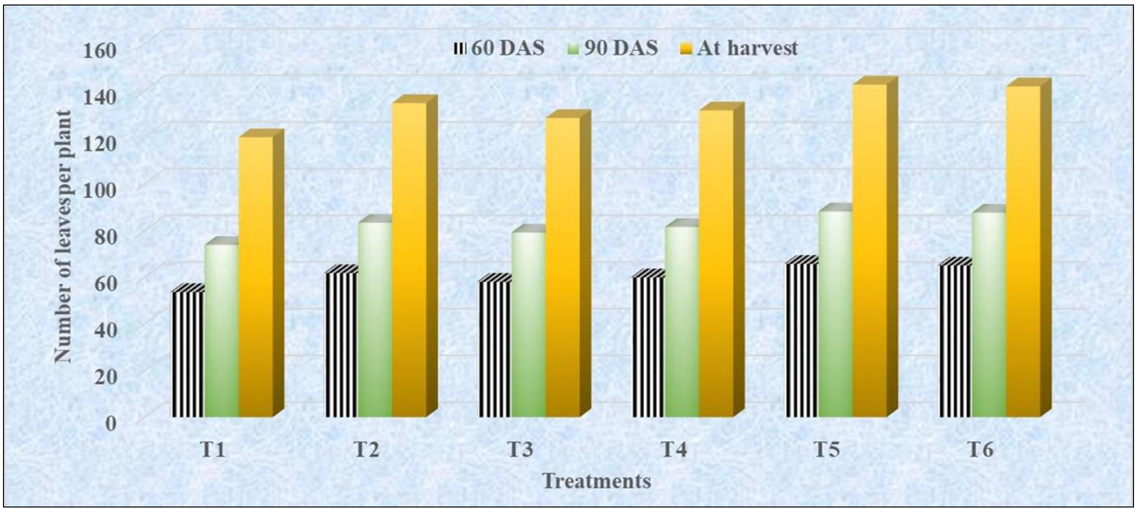

Fig 2: Number of leave per plant at different stages of summer groundnut as influenced by different treatments of organic nutrient management

Table 4: Number of branches per plant of summer groundnut at different stages as influenced by different treatments of organic nutrient management

Treatments		Number of branches plant-1								
		60 DAS			90 DAS			At harvest		
		2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled
T_1	Control	7.21	7.58	7.40	8.19	8.61	8.40	8.67	9.13	8.90
T_2	100% RDF + Seed treatment (*Rhizobium* + PSB)	11.12	13.12	12.12	12.46	14.55	13.51	13.35	15.47	14.41
T_3	100 % RDP through FYM + Seed treatment (*Rhizobium* + PSB)	9.31	9.77	9.54	10.34	10.98	10.66	11.32	11.83	11.57
T_4	100% RDP through Vermicompost + Seed treatment (*Rhizobium* + PSB)	10.18	10.66	10.42	11.30	11.86	11.58	12.25	12.93	12.59
T_5	50% RDP through FYM + 50% RDP through Vermicompost + Seed treatment *Rhizobium* + PSB)	12.87	13.52	13.20	14.24	14.99	14.61	15.81	16.62	16.21
T_6	75% RDP through FYM + 25% RDP through Vermicompost + Seed treatment (*Rhizobium* + PSB)	12.77	13.28	13.03	13.97	14.97	14.47	15.57	16.43	16.00
SEm ±		0.41	0.33	0.26	0.38	0.67	0.38	0.57	0.69	0.45
CD (P=0.05)		1.24	0.99	0.76	1.14	2.02	1.11	1.72	2.08	1.29
CV (%)		7.79	5.80	6.80	6.43	10.58	8.91	8.88	10.05	9.53
Interaction (Y × T)										
SEm ±		0.37			0.54			0.63		
CD (P=0.05)		NS			NS			NS		

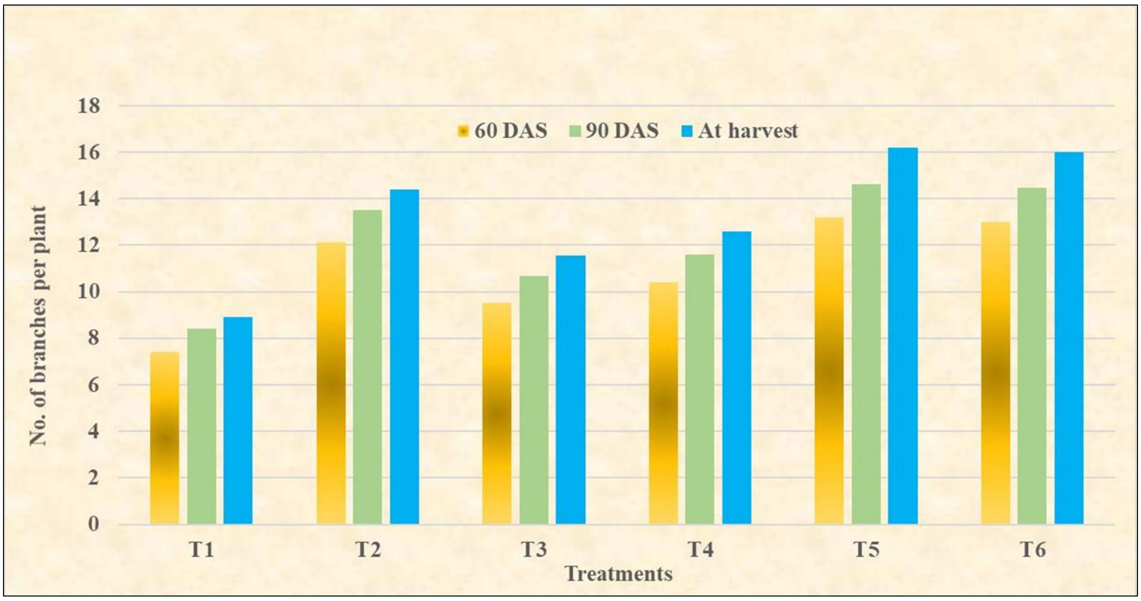

Fig 3: Number of branches per plant of summer groundnut at different stages as influenced by different treatments of organic nutrient management

Table 5: Pod, Haulm and Total biomass yield of summer groundnut as influenced by different treatments of organic nutrient management

Treatments	Pod yield kg ha-1			Haulm yield kg ha-1			Total biomass yield kg ha-1		
	2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled
T1: Control	1510	1559	1535	3991	4117	4054	5501	5676	5588
T2: 100% RDF + Seed treatment (*Rhizobium*+ PSB)	3150	3240	3195	8320	8707	8514	11471	11947	11709
T3:100 % RDP through FYM + Seed treatment (*Rhizobium*+ PSB)	3066	3300	3183	7973	9123	8548	11039	12423	11731
T4:100% RDP through Vermicompost + Seed treatment (*Rhizobium*+ PSB)	3255	3385	3320	8600	8425	8513	11855	11810	11833
T5:50% RDP through FYM + 50% RDP through Vermicompost + Seed treatment (*Rhizobium*+ PSB)	4004	4181	4092	10551	10458	10505	14555	14639	14597
T6:75% RDP through FYM + 25% RDP through Vermicompost + Seed treatment (*Rhizobium*+ PSB)	3473	3500	3486	9285	8809	9047	12758	12309	12533
SEm ±	127.0	134.5	92.5	321.2	394.1	254.2	357.1	460.8	291.5
CD (P=0.05)	382.9	405.5	267.2	968.2	1187.8	734.2	1076.6	1389.1	841.9
CV (%)	8.3	8.4	8.4	7.9	9.5	8.8	6.4	8.0	7.3
Interaction (Y × T)									
SEm ±	130.8			359.5			412.3		
CD (P=0.05)	NS			NS			NS		

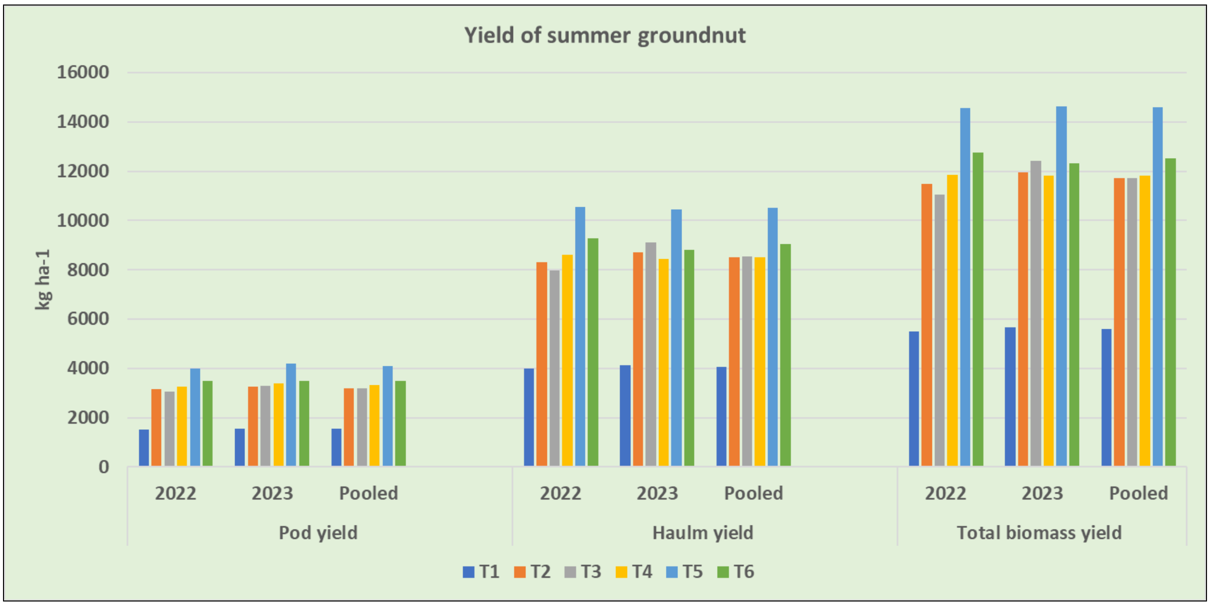

Fig 4: Pod, Haulm and Total biomass yield of summer groundnut as influenced by different treatments of organic nutrient management

4. Conclusion

Application of T_5 (50% RDP through FYM + 50% RDP through vermicompost along with seed treatment of Rhizobium and PSB) showed non-significant differences in initial and final plant population, while it significantly enhanced growth parameters such as plant height, number of leaves and number of branches per plant at different growth stages during both years and on pooled basis. Consequently, treatment T_5 (50% RDP through FYM + 50% RDP through vermicompost along with seed treatment of Rhizobium and PSB) recorded the highest pod yield, haulm yield and total biomass yield of summer groundnut, proving its superiority over the remaining treatments during 2021-22, 2022-23 and in pooled analysis

The results clearly demonstrate that partial substitution of organic phosphorus through FYM and vermicompost, coupled with biofertilizer inoculation, is an effective and sustainable nutrient management strategy for enhancing crop growth, yield and for sustainable groundnut production

References

1. Akbari KN, Polara KB, Bhoraniya MF. Effect of farmyard manure and fertilizers on yield and nutrient uptake by groundnut. Indian Journal of Agronomy. 2002;47(3):482-485.
2. Anonymous. Agricultural Statistics at a Glance 2022a. New Delhi: Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare, Government of India; 2022.
3. Anonymous. State-wise area, production and yield of groundnut 2022b. New Delhi: Directorate of Economics and Statistics, Ministry of Agriculture, Government of India; 2022.
4. Bhardwaj S, Omanwar P. Organic acids and their role in phosphorus availability. Soil Science and Plant Nutrition. 1994;40(2):89-96.
5. Chetti MB, Rachappa V, Kulkarni GN. Effect of phosphate solubilizing bacteria and *Rhizobium* on growth and yield of groundnut. Karnataka Journal of Agricultural Sciences. 1995;8(4):522-526.
6. Das P. Oilseeds in India: production, processing and utilization. New Delhi: Indian Council of Agricultural Research; 1997. p. 45-47.
7. DES. Agricultural Statistics at a Glance 2023. New Delhi: Directorate of Economics and Statistics, Department of Agriculture & Farmers Welfare, Ministry of Agriculture, Government of India; 2023. p. 1-200.
8. FAO. Food and Agriculture Organization Production Yearbook. Rome: FAO; 2003.
9. Gaur AC. Farmyard manure (FYM) and its role in sustainable agriculture. Agricultural Science Digest.

1991;11(2):108-112.
10. Gupta RD, Saxena RK, Tilak KVBR. Biofertilizers: an eco-friendly alternative to chemical fertilizers. Indian Journal of Fertilizers. 2003;48:117-130.
11. Jamwal S. Soil fertility and nutrient turnover in sustainable agriculture. Indian Journal of Agronomy. 2006;51(2):124-128.
12. Jones DL, Murray PJ. Phosphorus in plant science: roles and management. Plant Nutrition Reviews. 2017;35(2):123-145.
13. Kejiya P, Vajantha B, Naidu MVS, Nagavani AV. Effect of phosphatic fertilizer and biofertilizers on yield and quality of finger millet (*Eleusine coracana* L.). International Journal of Current Microbiology and Applied Sciences. 2019;8(7):846-852.
14. Khan MS, Zaidi A, Wani PA. Phosphate-solubilizing microbes: sustainable approach for managing phosphorus deficiency in agricultural soils. Springer; 2019. p. 215-219.
15. Kumari B, Ushakumari K. Effect of vermicompost on nutrient uptake and yield of rice. Agricultural Science Digest. 2002;22(4):258-260.
16. Lourduraj CA, Rajagopal. Effect of irrigation and manuring on N, P, K uptake and soil nutrient status in groundnut. Indian Journal of Agricultural Sciences. 1999;86:61-65.
17. Mahdi SS. Biofertilizers—an approach to sustainable agriculture. Agricultural Reviews. 1992;13(4):234-240.
18. Mahrous NM, Fathi ESM, Hassan MA. Integrated use of bio and organic fertilizers for improving soil properties, nutrient availability, and productivity of groundnut. Middle East Journal of Agriculture Research. 2015;4(3):522-529.
19. Nagar RK. Role of farmyard manure in phosphorus availability and soil fertility management. Journal of Plant Nutrition. 2019;42(12):1349-1359.
20. Nambiar KKM, Ghosh AB. Highlights of long-term fertilizer experiments in India (1971-82). New Delhi: Indian Council of Agricultural Research; 1984. p. 1-56.
21. Nziguheba G, Merckx R, Palm CA, Mutuo P. Combining *Tithonia diversifolia* and fertilizers for maize production in a phosphorus-deficient soil in Kenya. Agroforestry Systems. 1998;44(3):305-318.
22. Patel AM, Virdia HM, Kejiya JP. Effect of integrated nutrient management on growth and yield of summer groundnut. Journal of Pharmacognosy and Phytochemistry. 2019;8(3):1586-1590.
23. Patel JR, Patel DJ, Patel KJ. Biofertilizers: a potential input for sustainable crop production and soil health. International Journal of Agriculture Sciences. 2022;14(1):56-60.
24. Rajagopal K, Srinivasan A, Natarajan S. Nutritional composition and quality characteristics of groundnut. Journal of Oilseeds Research. 2000;17(2):242-245.
25. Ramanathan K. Groundnut: the queen of oilseeds. Hyderabad: Directorate of Oilseeds Research; 2001.
26. Sabale RN, Khuspe VS. Comparative performance of summer and kharif groundnut under different environments. Journal of Maharashtra Agricultural Universities. 1986;11(3):334-336.
27. Sahrawat KL. Soil organic carbon: key to soil fertility and sustainable agriculture. Journal of Soil Science. 2006;57(5):462-469.
28. Sharma S, Jat NL, Puniya MM, Shivran AC, Choudhury S. Fertility levels and biofertilizers on nutrient concentrations, uptake and quality of groundnut (*Arachis hypogaea* L.). Annals of Agricultural Research. 2014;35(1):71-74.
29. Smith AP, Johnson KE, Zhang M. Role of phosphorus in crop development and productivity: a comprehensive review. Plant Physiology and Biochemistry. 2018;130:301-312.
30. Stevenson FJ. Humus chemistry: genesis, composition, reactions. 2nd ed. New York: Wiley-Interscience; 1994.
31. Sulochna, Alam MP. Nutrient uptake and quality parameters of finger millet as influenced by tillage and organic nutrient management in finger millet-French bean cropping system. International Journal of Plant & Soil Science. 2023;35(10):118-128.
32. Talashilkar SK, Gohil MN, Soni SS. Nutrient contents of vermicompost and its role in sustainable agriculture. Indian Journal of Agricultural Chemistry. 1999;32(1):55-60.
33. Tandon HLS. Methods of analysis of soils, plants, waters and fertilizers. New Delhi: Fertilizer Development and Consultation Organisation; 2005. p. 62-66.
34. Virdia HM, Mehta HD, Patel AP, Patel MC, Parmar VN. Productivity and profitability of summer groundnut (*Arachis hypogaea* L.) on heavy black kyari land of South Gujarat. Asian Journal of Soil Science. 2011;6(1):101-104.
35. Singh D, Kumar R, Singh RK. Effect of integrated nutrient management on growth, yield and nutrient uptake of leguminous crops. Indian Journal of Agronomy. 2010;55(3):213-218.
36. Yadav SS, Meena RN, Meena MC. Influence of organic and inorganic phosphorus sources on growth, yield and soil fertility in legumes. Journal of Plant Nutrition. 2017;40(12):1685-1694.