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Integrated organic nutrient management enhances growth and yield of summer groundnut (*Arachis hypogaea* L.)

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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.
Pooled analysis of data from both years showed that the integrated application of organic phosphorus sources with biofertilizers significantly enhanced the growth parameters of summer groundnut. Treatment T_5 (50% RDP through FYM + 50% RDP through vermicompost along with seed treatment with Rhizobium and PSB) was recorded the highest number of root nodules per plant at 60 DAS (71.25, 75.62 and 73.44), 90 DAS (62.53, 67.25 and 64.89), and at harvest (38.25, 42.52 and 40.39) during 2022, 2023, and in the pooled analysis, respectively. Similarly, highest dry matter accumulation was recorded with application of T_5 (50% RDP through FYM + 50% RDP through vermicompost + seed treatment with Rhizobium and PSB) at 60 DAS (76.04, 79.96 and 78.00), 90 DAS (154.09, 161.96 and 158.02), and at harvest (181.47, 190.57 and 186.02) in 2022, 2023, and pooled analysis, respectively. With respect to yield parameters, treatment T_5 produced 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}) during 2022, 2023, and in the pooled analysis, respectively. The highest pod yield, haulm yield, and total biomass yield recorded under T_5 can be ascribed to improved source-sink relationship due to enhanced vegetative growth, efficient translocation of photosynthates, and better peg formation and pod development. Overall, the integrated use of FYM and vermicompost in combination with biofertilizers resulted in improved growth, higher biomass production, and superior yield of summer groundnut compared to other treatments.

Keywords: Groundnut (*Arachis hypogaea* L.), FYM, Vermicompost, Biofertilizers (Rhizobium & PSB), Growth and Yield parameters

1. Introduction
Groundnut (*Arachis hypogaea* L.) is a major oilseed crop of India, valued for its high edible oil and protein content and its significant contribution to food security, farm income, and soil fertility. India ranks among the leading producers of groundnut, cultivating the crop over 5.75 million ha with a production of 10.11 million tonnes and an average productivity of 1759 kg ha^{-1}. Gujarat is the foremost groundnut-producing state, contributing nearly 37% of national production. Summer groundnut cultivation in Gujarat is particularly important due to its higher productivity compared to the kharif season, owing to favourable climatic conditions, assured irrigation, higher solar radiation, and lower pest and disease incidence. Despite its importance, groundnut productivity remains constrained by declining soil fertility, nutrient imbalance, and

inefficient fertilizer management practices.

Groundnut is a nutrient-exhaustive crop, removing substantial quantities of nitrogen, phosphorus, and potassium from the soil, necessitating balanced and sustainable nutrient management strategies. Phosphorus plays a critical role in groundnut growth and productivity due to its involvement in energy transfer, root development, biological nitrogen fixation, flowering, pod formation, and seed development. However, phosphorus availability in soils is often limited due to fixation, with only 1-3% present in plant-available forms. This limitation highlights the importance of integrated phosphorus management through organic manures and biofertilizers to enhance phosphorus availability and use efficiency.

Organic nutrient sources such as farmyard manure (FYM) and vermicompost are increasingly recognized for their role in improving soil physical, chemical, and biological properties. FYM supplies essential macro- and micronutrients, enhances soil structure, water-holding capacity, microbial activity, and reduces phosphorus fixation. Vermicompost, enriched with readily available nutrients, organic acids, humic substances, and plant growth regulators, improves nutrient availability, root growth, soil aeration, and microbial populations. The combined application of these organic sources ensures slow and sustained nutrient release, minimizes nutrient losses, and improves soil organic carbon and cation exchange capacity.

Biofertilizers, particularly Rhizobium and phosphate-solubilizing bacteria (PSB), further enhance nutrient availability by fixing atmospheric nitrogen and solubilizing native and applied phosphorus through organic acid production. Integration of organic manures with biofertilizers improves nutrient cycling, root proliferation, and nutrient uptake efficiency while reducing dependency on chemical fertilizers. Such eco-friendly nutrient management practices are essential for sustaining soil health, improving productivity, and ensuring long-term sustainability of summer groundnut-based cropping systems.

The adoption of integrated organic nutrient management practices offers a viable, environmentally safe, and economically feasible approach for enhancing summer groundnut productivity, maintaining soil fertility, and promoting sustainable agriculture under irrigated agro-ecosystems of Gujarat and similar regions.

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 fine 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 color, 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 T_2. 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* 10 ml 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

Based on pooled analysis of field experiments conducted during the summer seasons of 2021-22 and 2022-23, the application of organic phosphorus sources in combination with biofertilizers significantly influenced growth parameters, *viz*., number of root nodules per plant, and dry matter accumulation at various growth stages, as well as yield parameters, *viz*., pod yield, haulm yield, and total biomass yield recorded at harvest of summer groundnut.

3.1. Growth parameters of summer groundnut

3.1.1. Number of root nodules per plant

The number of nodules 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 1 and Fig.1.). Across both the years and pooled data, the treatment T_5 (50% RDP through FYM + 50% RDP through vermicompost + seed treatment with Rhizobium + PSB) consistently recorded the highest number of nodules per plant at all growth stages.

At 60 DAS, treatment T_5 recorded the highest number of nodules per plant (71.25, 75.62, and 73.44 during 2022, 2023, and pooled analysis, respectively), which was statistically at par with T_6 (70.22, 74.58, and 72.40). The lowest number of nodules per plant was observed under the control T_1 (52.63, 56.42, and 54.52) during both years and in pooled analysis.

At 90 DAS, treatment T_5 recorded the highest number of nodules per plant (62.53, 67.25, and 64.89 during 2022, 2023, and pooled analysis, respectively), which was at par with T_6 (62.18, 65.81, and 63.99). The lowest number of nodules per plant was recorded under the control T_1 (45.26, 48.56, and 46.91) during both years and in pooled analysis.

At harvest, T_5 recorded the highest number of nodules per plant (38.25, 42.52, and 40.39 during 2022, 2023, and pooled analysis, respectively), which was at par with T_6 (37.53, 41.87, and 39.70). The lowest number of nodules per plant was consistently observed under T_1 (25.60, 32.63, and 29.11) during both years and in pooled analysis.

Overall, the pooled results clearly indicated that combined application of FYM and vermicompost along with Rhizobium and PSB seed treatment significantly enhanced nodulation in summer groundnut compared to control and other treatments.

The combination of FYM, vermicompost, and biofertilizers creates a favorable rhizosphere environment, improving soil fertility, microbial activity, and nutrient availability, which collectively support higher nodulation and nitrogen fixation in groundnut (Mahrous *et al.,* 2015; Gupta *et al*., 2003; Virdia *et al.,* 2011) [23, 12, 42]. Phosphorus is essential for root development, nodule initiation, and nitrogen fixation (Jones & Murray, 2017; Smith *et al*., 2018; Marschner, 2012) [15, 37, 24]. Organic phosphorus sources and PSB inoculation increase P availability in the rhizosphere, which directly correlates with enhanced nodulation.

3.1.2. Dry matter accumulation (g plant-1)

The data on dry matter accumulation (DMA) of summer groundnut as influenced by different organic phosphorus nutrient management treatments are presented in Table 2 and graphically illustrated in Fig. 2. Dry matter accumulation increased progressively from 60 DAS to harvest in all treatments, reflecting active vegetative growth and enhanced photosynthetic activity. Integrated organic phosphorus management significantly enhanced DMA due to improved nutrient uptake, microbial activity, and sustained growth.

At 60 DAS, treatment T_5 recorded the highest dry matter accumulation (76.04, 79.96, and 78.00 g plant^{-1} during 2022, 2023, and pooled analysis, respectively), which was followed by T_6 (73.91, 78.63, and 76.27 g plant^{-1}). Whereas the lowest dry matter accumulation was observed under the control T_1 (50.71, 53.32, and 52.01 g plant^{-1}) during both years and in pooled analysis.

At 90 DAS, the highest dry matter accumulation was recorded under T_5 (154.09, 161.96, and 158.02 g plant^{-1} during 2022, 2023, and pooled analysis, respectively), which remained at par with T_6 (150.64, 159.49, and 155.06 g plant^{-1}), while the lowest was recorded in T_1 (94.58, 99.38, and 96.98 g plant^{-1}).

At harvest, treatment T_5 registered the highest dry matter accumulation (181.47, 190.57, and 186.02 g plant^{-1} during 2022, 2023, and pooled analysis, respectively), which was at par with T_6 (177.77, 186.52, and 182.14 g plant^{-1}). Whereas the lowest dry matter accumulation was consistently recorded under T_1 (109.20, 114.83, and 112.01 g plant^{-1}).

The higher dry matter accumulations in T_5 and T_6 is associated with enhanced nitrogen fixation and phosphorus availability through *Rhizobium* and PSB inoculation, supporting nodule functioning and sustained plant growth. These results align with findings of Gaur (1990) [10] and Subba Rao (2001) [39], who reported that integrated organic amendments and biofertilizers improve biomass accumulation and nodulation in legumes.

3.2. Yield parameters of summer groundnut

3.2.1. Dry pod yield (kg ha^{-1})

The data presented in Table 3 and illustrated in Fig. 3 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. Followed by treatment T_6 (75% FYM + 25% vermicompost + seed treatment with Rhizobium + PSB) which was recorded 3473, 3500, and 3486 kg ha^{-1}in both years and pooled respectively and the lowest yield was observed in T_1 (control) with 1510, 1559, and 1535 kg ha^{-1}.

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 *et al*., 2017; Mengel and Kirkby, 2001) [5, 30, 25]. 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) [15, 37]. 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) [13, 23].

3.2.2. Haulm yield (kg ha^{-1})

The data on haulm (stover) yield of summer groundnut as influenced by different organic phosphorus nutrient management practices are presented in Table 3 and illustrated in Fig. 3. 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 a pooled mean of 10,505 kg ha^{-1}, and was followed by treatment T_6 (75% RDP through FYM + 25% RDP through vermicompost + seed treatment of Rhizobium + PSB) (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}, indicating severe nutrient limitation across years.

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*. (2011) [36] and Yadav *et al*. (2017) [43] in leguminous crops.

3.2.3. Total Biomass Yield (kg ha^{-1})

The data on total biomass yield of summer groundnut as influenced by different organic phosphorus nutrient management practices are presented in Table 3 and Fig. 3. 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), registered 14,659 and 14,555 kg ha^{-1} during 2022 and 2023, respectively, with a pooled mean of 14,507 kg ha^{-1}, and was followed by treatment T_6 (75% RDP through FYM + 25% RDP through vermicompost + seed treatment of Rhizobium + PSB) (12,758, 12,309 and 12,533 kg ha^{-1} during 2022, 2023 and pooled, respectively) and the lowest biomass yield was observed under T_1 (control) 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) [38] and Lampkin (2002) [20].

Table 1: Number of nodules per plant of summer groundnut at different stages as influenced by different treatments of organic nutrient management

Treatments		Number of nodules plant^{-1}								
		60 DAS			90 DAS			At harvest		
		2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled
T_1	Control	52.63	56.42	54.52	45.26	48.56	46.91	25.60	32.62	29.11
T_2	100% RDF + Seed treatment (*Rhizobium* + PSB)	64.11	67.99	66.05	55.58	60.05	58.01	33.48	38.92	36.20
T_3	100% RDP through FYM + Seed treatment (*Rhizobium* + PSB)	56.91	60.97	58.94	49.26	52.99	51.12	28.54	34.93	31.73
T_4	100% RDP through Vermicompost + Seed treatment (*Rhizobium* + PSB)	61.52	65.13	63.32	53.18	56.92	55.05	31.34	37.20	34.27
T_5	50% RDP through FYM + 50% RDP through Vermicompost + Seed treatment *Rhizobium* + PSB)	71.25	75.62	73.44	62.53	67.25	64.89	38.25	42.52	40.39
T_6	75% RDP through FYM + 25% RDP through Vermicompost + Seed treatment (*Rhizobium* + PSB)	70.22	74.58	72.40	62.18	65.81	63.99	37.53	41.87	39.70
SEm ±		1.64	2.71	3.58	2.24	2.65	2.48	1.64	1.64	1.16
CD (P=0.05)		4.96	8.15	10.80	6.48	7.98	7.49	4.96	4.94	3.35
CV (%)		10.13	8.62	10.73	9.80	9.67	8.48	10.13	8.62	9.32
Interaction (Y × T)										
SEm ±		3.17			2.57			1.64		
CD (P=0.05)		NS			NS			NS		

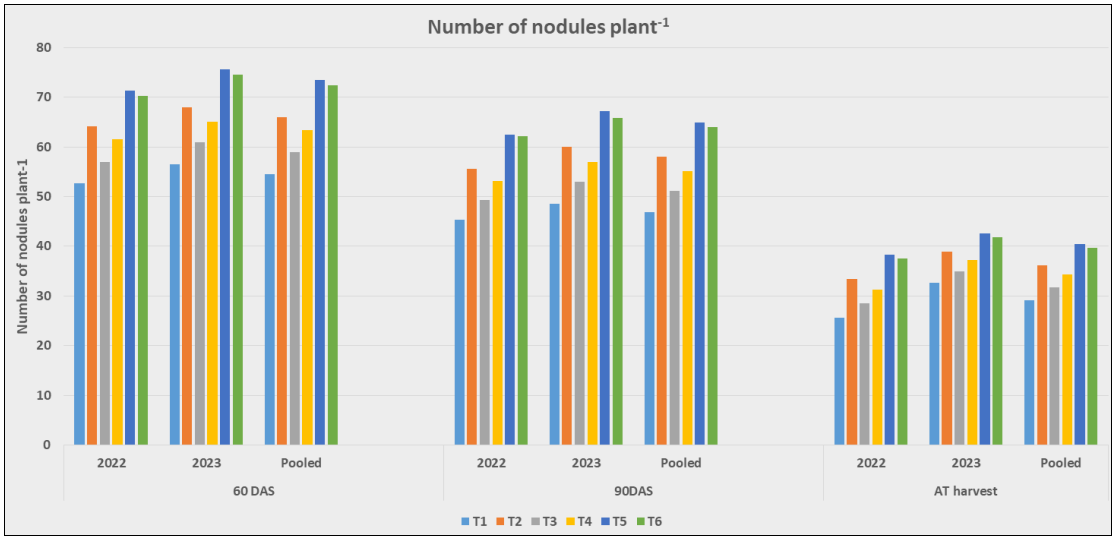

Fig 1: Number of nodules per plant of summer groundnut at different stages as influenced by different treatments of organic nutrient management

Table 2: Dry matter accumulation of summer groundnut at different stages as influenced by different treatments of organic nutrient management

Treatments	Dry matter accumulation (g plant-1)								
	60 DAS			90 DAS			At harvest		
	2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled
T_1: Control	50.71	53.32	52.01	94.58	99.38	96.98	109.20	114.83	112.01
T_2: 100% RDF + Seed treatment (*Rhizobium* + PSB)	68.34	75.54	71.94	134.91	153.11	144.01	159.39	179.35	169.37
T_3:100% RDP through FYM + Seed treatment (*Rhizobium* + PSB)	60.07	62.80	61.43	116.68	122.82	119.75	135.63	142.71	139.17
T_4:100% RDP through Vermicompost + Seed treatment (*Rhizobium* + PSB)	63.70	66.79	65.24	124.34	131.37	127.85	146.46	153.99	150.23
T_5:50% RDP through FYM + 50% RDP through Vermicompost + Seed treatment (*Rhizobium* + PSB)	76.04	79.96	78.00	154.09	161.96	158.02	181.47	190.57	186.02
T_6:75% RDP through FYM + 25% RDP through Vermicompost + Seed treatment (*Rhizobium* + PSB)	73.91	78.63	76.27	150.64	159.49	155.06	177.77	186.52	182.14
SEm ±	1.72	2.27	1.42	6.20	4.36	3.79	6.41	5.60	4.26
CD (P=0.05)	5.20	6.83	4.11	18.68	13.13	10.94	19.32	16.89	12.29
CV (%)	5.27	6.52	5.97	9.59	6.31	8.02	8.45	6.95	7.69
Interaction (Y × T)									
SEm ±	2.01			5.36			6.02		
CD(P=0.05)	NS			NS			NS		

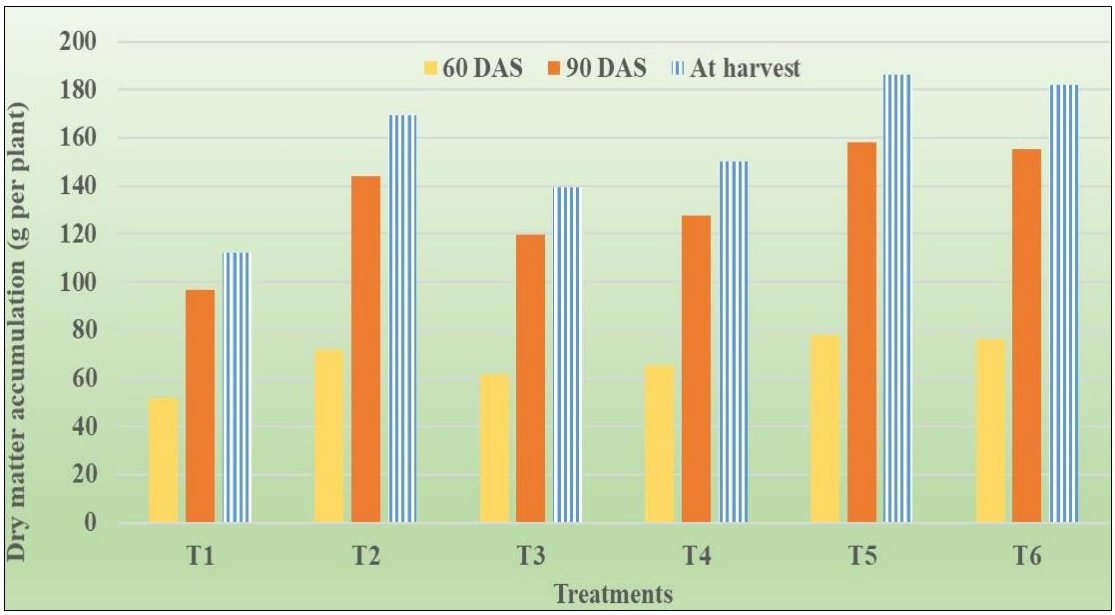

Fig 2: Dry matter accumulation of summer groundnut at different stages as influenced by different treatments of organic nutrient management

Table 3: 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
T_1: Control	1510	1559	1535	3991	4117	4054	5501	5676	5588
T_2: 100% RDF + Seed treatment (*Rhizobium*+ PSB)	3150	3240	3195	8320	8707	8514	11471	11947	11709
T_3:100% RDP through FYM + Seed treatment (*Rhizobium*+ PSB)	3066	3300	3183	7973	9123	8548	11039	12423	11731
T_4:100% RDP through Vermicompost + Seed treatment (*Rhizobium*+ PSB)	3255	3385	3320	8600	8425	8513	11855	11810	11833
T_5:50% RDP through FYM + 50% RDP through Vermicompost + Seed treatment (*Rhizobium*+ PSB)	4004	4181	4092	10551	10458	10505	14555	14639	14597
T_6:75% 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		

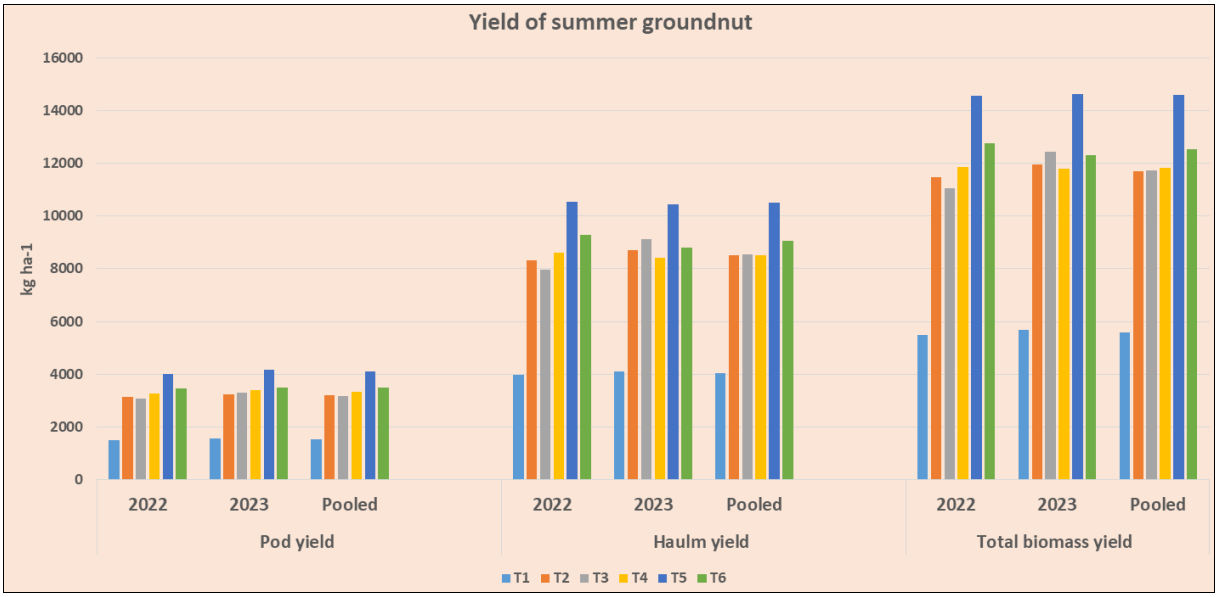

Fig 3: Pod, Haulm and Total biomass yield of summer groundnut as influenced by different treatments of organic nutrient management

4. Conclusion

Application of T_5 (50% RDP through FYM + 50% RDP through vermicompost along with seed treatment with Rhizobium and PSB) recorded the highest values for growth parameters, including the number of root nodules per plant and dry matter accumulation at 60 DAS, 90 DAS, and at harvest in summer groundnut during 2022, 2023, as well as in pooled analysis. With respect to yield parameters, T_5 also registered the highest dry pod yield, haulm yield, and total biomass yield of summer groundnut during both years of experimentation and in pooled analysis.

These results indicate that the combined application of FYM, vermicompost, and biofertilizers (Rhizobium + PSB) is highly effective in improving both growth and productivity of summer groundnut.

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