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Effects of different level of NPK and FYM on soil properties of Growth and Yield of Groundnut (*Arachis hypogaea L.*) var TG37A

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Abstract

A field experiment was conducted during the Kharif season of 2025 at the Research Farm of Department of Soil Science and Agricultural Chemistry, SHUATS, Prayagraj, Uttar Pradesh, India, to evaluate the Effects of different level of NPK and FYM on soil properties of Growth and Yield of Groundnut (*Arachis hypogaea L.*) var TG37A. The experiment was laid out in a Randomized Block Design with nine treatment combinations consisting three levels of NPK (0, 50 and 100% RDF) and three levels of FYM (0, 5 and 10 t ha⁻¹), replicated three times. The integrated application of NPK and FYM significantly improved the physical and chemical properties of soil over the control. Treatment T₉ (100% NPK + 100% FYM) recorded the lowest bulk density (1.22 Mg m⁻³), particle density (2.56 Mg m⁻³), soil pH (7.28), and electrical conductivity (0.26 dS m⁻¹), while exhibiting the highest water holding capacity (58.8%), organic carbon (0.75%), available nitrogen (272 kg ha⁻¹), phosphorus (31.2 kg ha⁻¹), and potassium (270 kg ha⁻¹).

Keywords: Groundnut, NPK, farmyard manure, integrated nutrient management, soil physical properties, soil chemical properties, yield

1. Introduction

Soil is a natural resource that sustains life on earth, providing a natural medium for plant growth as well as Soil is a natural resource which supports life on earth. It provides a natural medium for plant growth, raw material for industries, and energy production (Brady & Weil, 2016) [4]. Soil is composed of mineral grains that come from weathering of the rocks which finally constitute soil particles like sand, silt, and clay (Hillel, 2008) [8]. Soil purifies and transforms nutrients and other chemical substances and thus maintains the quality of groundwater, provides plants with nutrients, and affects the climate.

NPK fertilizers provide essential macronutrients required for plant growth. Nitrogen is vital for vegetative growth and chlorophyll synthesis, phosphorus supports root development and energy transfer, and potassium enhances water regulation and disease resistance. Proper application of NPK fertilizers ensures balanced nutrient availability, which is crucial for improving black gram yield and soil productivity. However, excessive or imbalanced fertilizer use may lead to soil acidification, nutrient leaching, and reduced microbial activity, necessitating the exploration of sustainable soil management practices.

Farm Yard Manure (FYM) is the principle source of organic matter in our country which has being used since antiquity of man. The organic carbon in the organic matter act as a source of energy for soil microorganisms and upon mineralization release essential elements during crop growth. In addition to supply of available plant nutrients directly the use of FYM also mobilizes the unavailable nutrients present in the soil system. Use of FYM with other organic amendments has becomes imperative to sustainable crop production. FYM has less nutrient content so it required to applying in bulk and hence, adding more organic matter in the soil.

Groundnut has been recognized around the world with several other names while in India it is well known as 'Mungphali'. It is also called as the 'King of oilseeds' and 'poor man's almond'. It is originated from Brazil in South America. The word *Arachis* is a Latin word meaning 'legume' and *hypogaea* meaning 'below ground' which refers to the geocarpic nature of pod formation.

In the world, groundnut is cultivated in more than 100 countries on 26.54 m hectare area with an annual production of 43.91 m tonnes and productivity of 1655 kg ha⁻¹. China is the largest producer as well as consumer of groundnut in the world followed by India, United States, Nigeria and Sudan (Anonymous, 2020)^[2]. In India, groundnut is grown on 4.77 M hectare area with the production of 7.40 m tonnes. Groundnut is the third major source of edible oil in India with a production of 8.94 M tones in the year 2017-18. The highest state average yield was estimated for Rajasthan which was followed by Gujarat, Maharashtra and Andhra Pradesh and the lowest was recorded for Karnataka. At present, globally India ranks second after China with 4.56 M ha area with 6.771 m tones of production and 1485 kg ha⁻¹ productivity. In Maharashtra state it is cultivated on an area of 0.33 M ha having 0.42 M tones of production with a productivity of 1275 kg ha⁻¹ (Anonymous, 2019). In Konkan region, groundnut is grown on 20,000 ha area with 1.8 t ha⁻¹ productivity.

2. Materials and Methods

The present investigation was carried out at the Research Farm of Department of Soil Science and Agricultural Chemistry, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj, Uttar Pradesh, during the kharif seasons of 2025. The experiment was laid out in Randomized Block Design (RBD) with three levels of NPK, and FYM. The treatments have been replicated three times. The different treatments were employed randomly in each replication. The treatments comprised of T₁(0% NPK + 0% FYM), T₂ (0% NPK + 50% FYM), T₃ 0% NPK + 100% FYM), T₄ (50% NPK + 0% FYM), T₅ (50% NPK + 50% FYM), T₆ (50% NPK + 100% FYM), T₇ (100% NPK + 0% FYM) T₈ (100% NPK + 50% FYM), T₉ (100% NPK + 100% FYM). Soil samples from each experimental plot were collected at 0-15 cm depths following crop harvest. The samples we were air-dried, finely ground, and sieved through a 2 mm mesh, after which samples were stored in polythene bags for subsequent analysis. The processed samples were examined for a range of physico-chemical properties, including bulk density, particle density, Muthuvel *et al.*, (1992)^[13], pH digital pH meter by Jackson (1958)^[9], pore space percentage by measuring cylinder method by Muthuvel *et al.*, (1992)^[13], electrical conductivity, digital EC meter by Wilcox, (1950)^[21], organic carbon, Wet oxidation method by Walkley and Black (1947)^[20], and available macronutrients like Nitrogen (Alkaline (Calorimetric method by Olsen *et al.*, 1956)^[14] Potassium permanganate method by Toth and Prince,(1949)^[19], Phosphorus Flame photometric method by Olsen *et al.*, 1954)^[14]

3. Results and Discussion

3.1 Effect on soil physical properties

The results on soil physical properties recorded after crop harvest are presented in Table 1. Bulk density and particle density decreased, while per cent pore space and water holding capacity increased progressively, with increasing levels of NPK and FYM. The lowest bulk density (1.22 Mg m⁻³) and particle density (2.56 Mg m⁻³), and the highest pore space (51.50%) and water holding capacity (55.59%), were recorded under T₉ (100% NPK + 100% FYM), as against the highest bulk density (1.42 Mg m⁻³) and particle density (2.68 Mg m⁻³), and the lowest pore space (47.00%) and water holding capacity (51.15%), under the control (T₁).

The improvement in soil physical condition under integrated nutrient management may be attributed to the decomposition of FYM, which increases soil organic carbon and promotes the formation of stable soil aggregates. Since organic matter has a much lower density than mineral particles, its incorporation also reduces particle density and creates additional pore channels,

thereby improving aeration, root proliferation and moisture retention. Balanced NPK fertilization further stimulated root growth, which indirectly contributed to soil aggregation through greater root biomass. These findings are in agreement with those of Meena *et al.* (2019)^[12], Jat *et al.* (2020)^[10] and Patel *et al.* (2017)^[16], who reported similar improvement in soil physical properties following integrated application of FYM and inorganic fertilizers.

3.2 Effect on soil chemical properties

The chemical properties of soil recorded after harvest are presented in Table 2. Soil pH declined slightly but remained within the neutral range, from 7.58 under T₁ (control.) to 7.28 under T₉ (100% NPK + 100% FYM), while electrical conductivity decreased from 0.34 to 0.26 dS m⁻¹ over the same treatments, indicating that the soil remained non-saline throughout. Organic carbon increased steadily with increasing levels of NPK and FYM, from 0.42% under T₁ to a maximum of 0.75% under T₉. Similarly, available nitrogen, phosphorus and potassium increased progressively, reaching maximum values of 272, 31.2 and 270 kg ha⁻¹, respectively, under T₉, as against the lowest values of 242, 18.2 and 182 kg ha⁻¹ under T₁.

The slight decline in pH under FYM-treated plots may be ascribed to the release of organic acids during decomposition of organic matter; these acids also enhance the solubility of phosphorus and other nutrients without creating an unfavourable soil reaction. The build-up of organic carbon and available macronutrients under integrated nutrient management reflects continuous mineralisation of FYM, improved nutrient retention, reduced nutrient fixation, and the combined contribution of organic and inorganic nutrient sources. These results corroborate the findings of Ashraf *et al.* (2011)^[3], Dashadi *et al.* (2013)^[5], Meena *et al.* (2019)^[12], Jat *et al.* (2020)^[10] and Singh *et al.* (2018)^[17], who reported similar improvement in soil chemical properties under combined use of FYM and NPK fertilizers in groundnut and other crops.

3.3 Effect on growth, yield attributes and yield

Growth and yield attributes of groundnut, as influenced by different levels of NPK and FYM, are presented in Table 3. Plant height at 90 DAS, number of leaves and branches per plant, number of root nodules, number of pods per plant, number of kernels per pod and kernel yield all increased progressively with increasing levels of NPK and FYM, and were maximum under T₉ (100% NPK + 100% FYM) and minimum under the control (T₁). Treatment T₉ recorded the tallest plants (49.8 cm), the highest number of leaves (318.33 plant⁻¹) and number of branches (13.8 plant⁻¹) at 90 DAS, the maximum number of nodules (68.9 plant⁻¹) and pods (32.8 plant⁻¹), and the most kernels per pod (2.48), culminating in the highest kernel yield of 24.84 q ha⁻¹ - an increase of about 85% over the control (13.42 q ha⁻¹).

The superior performance of T₉ may be attributed to the balanced and continuous availability of nitrogen, phosphorus and potassium throughout the crop growth period, which enhanced chlorophyll synthesis, root proliferation and translocation of photosynthates, together with the favourable soil physical and chemical environment created by FYM application. Improved nodulation under integrated nutrient management also points to enhanced biological nitrogen fixation, which, together with better vegetative growth, translated into greater pod set, kernel development and, ultimately, higher kernel yield. These results are in close conformity with those of Jat *et al.* (2020)^[10], Kumar *et al.* (2021)^[11], Singh *et al.* (2018)^[17] and Paramasivan *et al.* (2025)^[15], who also reported significant improvement in growth, yield attributes and kernel yield of groundnut under integrated application of NPK and FYM.

Table 1: Effect of different levels of NPK and FYM on soil physical properties (0-15 cm depth, post-harvest)

Treatment	Treatment combination	Bulk density (Mg m ⁻³)	Particle density (Mg m ⁻³)	Pore space (%)	Water holding capacity (%)
T ₁	0% NPK + 0% FYM	1.22	2.56	47.00	51.15
T ₂	0% NPK + 50% FYM	1.24	2.58	48.01	51.82
T ₃	0% NPK + 100% FYM	1.27	2.59	50.98	52.12
T ₄	50% NPK + 0% FYM	1.29	2.60	48.15	52.47
T ₅	50% NPK + 50% FYM	1.31	2.61	48.30	53.15
T ₆	50% NPK + 100% FYM	1.34	2.63	49.50	53.48
T ₇	100% NPK + 0% FYM	1.37	2.65	51.00	54.50
T ₈	100% NPK + 50% FYM	1.39	2.66	51.10	54.15
T ₉	100% NPK + 100% FYM	1.42	2.68	51.50	55.59
F-test		S	S	S	S
SEm (±)		0.02	0.02	1.352	0.331
CD (P=0.05)		0.06	0.05	0.633	1.155

Table 2: Effect of different levels of NPK and FYM on soil chemical properties (0-15 cm depth, post-harvest)

Treatment	Treatment combination	Soil pH	EC at 25°C (dS m ⁻¹)	Organic carbon (%)	Available N (kg ha ⁻¹)	Available P (kg ha ⁻¹)	Available K (kg ha ⁻¹)
T ₁	0% NPK + 0% FYM	7.58	0.34	0.42	242	18.2	182
T ₂	0% NPK + 50% FYM	7.54	0.33	0.46	252	19.7	191
T ₃	0% NPK + 100% FYM	7.50	0.32	0.50	256	21.3	201
T ₄	50% NPK + 0% FYM	7.47	0.31	0.55	251	22.8	212
T ₅	50% NPK + 50% FYM	7.43	0.30	0.59	257	24.5	223
T ₆	50% NPK + 100% FYM	7.39	0.29	0.63	259	26.1	235
T ₇	100% NPK + 0% FYM	7.35	0.28	0.67	260	27.8	246
T ₈	100% NPK + 50% FYM	7.31	0.27	0.71	269	29.4	258
T ₉	100% NPK + 100% FYM	7.28	0.26	0.75	272	31.2	270
F-test		S	S	S	S	S	S
SEm (±)		0.04	0.01	0.02	5.60	0.72	4.50
CD (P=0.05)		0.12	0.03	0.06	16.80	2.16	13.50

Table 3: Effect of different levels of NPK and FYM on growth, yield attributes and kernel yield of groundnut (90 DAS / at harvest)

Treatment	Treatment combination	Plant height (cm)	Leaves plant ⁻¹	Branches plant ⁻¹	Nodules plant ⁻¹	Pods plant ⁻¹	Kernels pod ⁻¹	Kernel yield (q ha ⁻¹)
T ₁	0% NPK + 0% FYM	34.2	248.33	7.4	34.7	18.6	1.72	13.42
T ₂	0% NPK + 50% FYM	35.6	257.67	8.1	39.5	20.4	1.81	14.86
T ₃	0% NPK + 100% FYM	37.4	266.33	9.0	44.8	22.3	1.92	16.28
T ₄	50% NPK + 0% FYM	39.2	274.67	10.0	49.6	24.7	2.01	18.12
T ₅	50% NPK + 50% FYM	41.5	283.33	10.9	54.2	26.1	2.11	19.48
T ₆	50% NPK + 100% FYM	43.7	292.67	11.6	58.3	28.2	2.23	20.94
T ₇	100% NPK + 0% FYM	45.3	301.33	12.4	61.8	29.9	2.31	22.31
T ₈	100% NPK + 50% FYM	47.2	309.67	13.1	65.4	31.4	2.39	23.52
T ₉	100% NPK + 100% FYM	49.8	318.33	13.8	68.9	32.8	2.48	24.84
F-test		S	S	S	S	S	S	S
SEm (±)		0.93	4.58	0.36	1.14	0.72	0.04	0.48
CD (P=0.05)		2.80	13.74	1.08	3.42	2.16	0.12	1.44

4. Conclusion

The results of the present investigation indicate that integrated application of inorganic fertilizers and farmyard manure improves soil physical and chemical properties as well as the growth and yield of groundnut var. TG-37A more effectively than either nutrient source applied alone. Treatment T₉ (100% recommended NPK + 100% FYM, i.e. 10 t ha⁻¹) consistently recorded the most favourable bulk density, particle density, pore space and water holding capacity; the most favourable soil pH, electrical conductivity, organic carbon and available N, P and K status; and the best growth and yield performance, including the highest kernel yield (24.84 q ha⁻¹). Combined application of the recommended dose of NPK with 10 t FYM ha⁻¹ may therefore be

recommended as an effective integrated nutrient management practice for sustaining soil health and enhancing the productivity of groundnut under the agro-climatic conditions of Prayagraj.

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