EFFECT OF DIFFERENT LEVELS OF NPK AND FARMYARD MANURE ON SOIL PHYSICO - CHEMICAL PROPERTIES, GROWTH AND YIELD ATTRIBUTES OF COWPEA (*Vigna unguiculata*) Var. ANKUR HARI

Neha Kumari[1], Narendra Swaroop[1], Tarence Thomas[1], Satya Ranjan Mohanta[1] and Ashima Thomas[2]

[1]Department of Soil Science and Agricultural Chemistry, Sam Higginbottom University of Agriculture, Technology and Sciences. Prayagraj, Uttar Pradesh, India

[2]Department of Agro-Food Sciences, Bologna University, Italy

Corresponding author:nehakumari13464@gmail.com

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ABSTRACT

This study examines the effect of various treatment combining Farm Yard Manure (FYM) with different NPK level fertilization on yield, growth and soil properties of cowpea plants. Our objective was to identify the treatment that optimizes physical plant growth and offers the best economic returns. We performed a controlled trial with nine treatments (T1 to T9) that varied in the percentage of prescribed NPK levels and the application of FYM. The experiment assessed several growth factors such as plant height, pod length, number of pods, and seed weight at 40 and 60 days after sowing (DAS). Samples of soil were examined before planting and after harvesting for evaluation changes in physical and chemical characteristics including bulk density, particle density, pore space, water holding capacity, soil pH, electrical conductivity, organic carbon, nitrogen, phosphorus, and available potassium. T9, which included 100% required NPK levels and FYM, showed superior performance compared to other treatments in plant height, pod length, number of pods, seed weight, and total seed production. This treatment yielded superior physical development metrics and generated the greatest gross return, net profit, and a cost-benefit ratio of 1:2.81. Post-harvest soil research revealed that T9 improved soil health by increasing water retention, nutrient availability, and structural qualities. This research highlights the efficacy of combining full recommended dosages of NPK with FYM to provide improved agronomic performance and economic advantages in cowpea production. The results support using this treatment plan to enhance efficiency and financial gain in sustainable farming methods.

Keywords: Treatment, Application, Evaluation, FYM, Retention

INTRODUCTION

Studying nutrient management by using both inorganic fertilisers (NPK) and organic additions like farm yard manure (FYM) is crucial for sustainable agriculture. This integration has substantial effects on the physical and the chemical properties of the soil, which in turn affects the yield characteristics of crops like cowpea (Vigna unguiculata L.), an important legume for subsistence farming in semi-arid areas.

The combined effect of NPK fertilisation and FYM has been well-documented in enhancing soil structure and fertility. For instance, *Ojeniyi et al. (2003)* Stated that combining NPK with FYM improves soil porosity and water retention capacity, essential for cowpea root growth. Similarly, *Adeniyan and Ojeniyi (2005)* Stated that using both treatments together raised the organic matter in the soil, enhancing its ability to store nutrients.

Further, studies by *Singh et al. (2010)* Studies have shown that incorporating farmyard manure (FYM) into plots treated with nitrogen, phosphorus, and potassium (NPK) leads to a notable rise in soil pH. This increase may help alleviate soil acidity, a prevalent problem in tropical soils that hinders the development of legumes. This amendment procedure also affects the cation exchange capacity (CEC) of soils. as highlighted by *Gupta and Singh (2004),* which is essential for nutrient availability to plants.

From the perspective of nutrient dynamics, *Rajput and Patel (2006)* demonstrated that integrating FYM with NPK optimizes the nitrogen and the phosphorus availability in the soil. This is particularly beneficial for cowpea, which requires substantial amounts of phosphorus for its pod development phase. Additionally, potassium, critical for water regulation and disease resistance in cowpea, is more efficiently utilized when FYM is used to amend the soil, as shown in the findings by *Kumar and Sharma (2011).*

The yield attributes of cowpea, including length of pod, no. of pods/ plant, and weight of seed, are positively influenced by this integrated nutrient management approach. *Chandra et al. (2012)* Noted a significant rise in yield metrics when combining FYM with NPK, ascribing this improvement to the enhanced soil fertility and nutrient absorption in the enriched soil environment.

Furthermore, the environmental impact of combining FYM with NPK must not be ignored. As *Reddy et al. (2015)* point out, this practice not only reduces the dependency on chemical fertilizers but also contributes to carbon sequestration in the soil, promoting environmental sustainability. This is corroborated by *Jones et al. (2017),* who suggest that organic amendments like FYM can mitigate greenhouse gas emissions from soil, particularly in nitrogen-rich fertilized conditions.

Combining farmyard manure (FYM) with nitrogen-phosphorus-potassium (NPK) fertilisers has been shown to be economically and operationally feasible for small-scale farmers. *Sharma and Mittra (2018)* This approach is believed to decrease the total cost of fertiliser inputs and increase crop output, thereby boosting the profit margins for cowpea growers.

Utilising both NPK and FYM is a strong approach to improve soil quality and increase cowpea output. It tackles agronomic and environmental difficulties, making it a viable option for next agricultural systems. Additional study and field experiments are necessary to optimise application rates and procedures for different soil types and climates in order to fully use the advantages of this integrated nutrient management strategy.

Material and Methods

The experiment was place at the experimental farm during the 2023 growing season. The research site is located at 25°19'N latitude and 82°34'E longitude in a tropical region, at an elevation of 85 metres above sea level. The regional climate ranges from 18°C to 24°C in low temperatures and from 35°C to 40°C in hot temperatures. The region has a humid subtropical climate characterised by relative humidity levels ranging from 60 to 85 percent. It gets monsoonal rains from June to September, with an average annual precipitation of around 1200 mm.

The research used a randomised block design (RBD) consisting of nine treatments and three replications. The treatments were comprised of T1 (0% NPK and 0% FYM), T2 (0% NPK and 50% FYM), T3 (0% NPK and 100% FYM), T4 (50% NPK and 0% FYM), T5 (50% NPK and 50% FYM), T6 (50% NPK and 100% FYM), T7 (100% NPK and 0% FYM), T8 (100% NPK and 50% FYM), and T9 (100% NPK and 100% FYM). The treatments investigated various combinations of NPK and Farm Yard Manure (FYM) levels. Guidelines for applying NPK were sourced from the "Textbook of Vegetables, Tuber crops and Spices, ICAR, (2018)" and the agritech.tnau.ac.in recommendations were used to calculate the FYM doses.

The experimental field had a total width of 8.8 metres and was subdivided into 27 plots, with each plot measuring 2 metres by 2 metres. The cowpea cultivar 'Ankur Hari' was planted on August 8, 2023. The experiment made use of the site's sandy loam soil, which is common in highland agricultural areas in tropical regions and has excellent drainage.

Soil samples were taken from the top 15 cm layer of soil before the treatments and after the harvest. Conventional methods were used to analyse the soil samples for physical and chemical characteristics, such as soil texture and nutrient levels.

Plant growth parameters, including plant height, leaf number, pod quantity, and seed yield, were consistently documented. Ten plants were randomly chosen from each plot for a thorough evaluation to determine the impact of various treatment combinations on cowpea growth and production.

This methodology was created to investigate the interactions between chemical (NPK) and biological (FYM) fertilisers and their combined impact on soil health and plant production in order to promote sustainable agricultural practices in cowpea cultivation.

Table 1: Treatment Combinations

Treatment	Treatment Combination
T_1	@ 0% NPK and @ 0% FYM
T_2	@ 0% NPK and @ 50% FYM
T_3	@ 0% NPK and @ 100% FYM
T_4	@ 50% NPK and @ 0% FYM
T_5	@ 50% NPK and @ 50% FYM
T_6	@ 50% NPK and @ 100% FYM
T_7	@ 100% NPK and @ 0% FYM
T_8	@ 100% NPK and @ 50% FYM
T_9	@ 100% NPK and @ 100% FYM

RESULTS

Table 2: Examining the soil sample's physical and chemical qualities prior to planting the crop

Particulars	Results	
	(0-15) cm	(15-30) cm
Sand (%)	61.1	59.5
Silt (%)	24.4	25.3
Clay (%)	14.5	15.2
Textural class	Sandy-loam	Sandy-loam
Bulk density	1.322	1.329
Particle density	2,184	2.201
Pore space (%)	45.69	44.77
Water holding capacity (%)	41.75	39.95
Soil pH (1:2.5)	7,601	7.609
EC (dS m-1)	0.175	0.196
Organic Carbon (%)	0.253	0.247
Nitrogen (kg ha-1)	167.10	148.64
Phosphorus (kg ha-1)	24.01	21.10
Potassium (kg ha-1)	194.51	186.79

Table 3: Impact of varying amounts of NPK and FYM on growth and yield attributes

Treatment	Height of Plant		Length of Pod		No. of pods		Weight of Seeds per Pod (g)	Seed Yield (q ha-1)
	40 DAS (cm)	60 DAS (cm)	50 DAS (cm)	75 DAS (cm)	50 DAS	75 DAS		
T_1	17.03	25.56	10.7	12.9	10.7	5.7	7.6	40.2
T_2	18.07	27.09	10.9	12.9	11.4	6.4	8.1	43.5
T_3	19.01	28.52	12.4	13.2	12.5	7.2	8.8	47.3
T_4	21.04	31.58	12.8	13.7	13.7	7.9	9.5	49.6
T_5	23.02	34.51	13.2	13.9	15.5	8.7	10.3	55.8
T_6	25.08	37.53	13.9	14.1	16.8	9.5	11.1	56.2
T_7	27.06	40.59	14.2	14.5	18.0	10.3	11.9	54.2
T_8	29.08	43.52	14.9	15.2	19.7	12.3	12.7	66.3
T_9	31.04	45.57	15.1	16.6	21.7	14.8	13.6	80.1

Table 4: Impact of varying NPK and FYM levels on soil physical characteristics after cowpea harvest

Treatment Combination	Bulk Density		Particle Density		Pore Space		Water Holding Capacity	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
T_1	1.32	1.35	2.47	2.50	42.41	41.01	41.30	40.78
T_2	1.26	1.29	2.40	2.44	45.08	42.10	44.54	41.81
T_3	1.25	1.28	2.39	2.40	45.19	43.20	46.73	42.67
T_4	1.24	1.30	2.41	2.44	48.31	45.40	47.48	44.02
T_5	1.27	1.30	2.42	2.45	49.95	43.50	48.95	42.28
T_6	1.24	1.29	2.38	2.41	48.10	44.60	47.72	43.42
T_7	1.13	1.17	2.43	2.37	49.58	46.80	48.73	45.56
T_8	1.15	1.16	2.41	2.42	47.15	48.20	46.36	44.23
T_9	1.15	1.14	2.30	2.30	49.55	49.25	48.55	47.06

Table 5: Impact of varying amounts of NPK and FYM on soil chemical characteristics after cowpea plant harvest at depths of 0-15 cm and 15-30 cm

Treatment Combination	Soil pH		EC (dS m-1)		Organic Carbon (%)		Available Nitrogen (Kg ha-1)		Available Phosphorus (Kg ha-1)		Available Potassium (Kg ha-1)	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
T_1	7.55	7.55	0.39	0.42	0.40	0.34	247.32	183.93	21.11	18.80	169.62	159.13
T_2	7.57	7.46	0.40	0.41	0.41	0.35	248.41	188.31	22.08	20.81	174.61	158.15
T_3	7.48	7.48	0.42	0.42	0.42	0.35	252.32	192.38	22.96	20.00	175.78	164.13
T_4	7.50	7.50	0.41	0.43	0.41	0.35	264.58	202.24	22.35	21.95	187.89	168.67
T_5	7.47	7.43	0.45	0.44	0.41	0.35	273.32	207.23	21.54	21.78	190.31	179.13
T_6	7.39	7.39	0.43	0.44	0.41	0.35	278.48	210.21	22.28	20.82	192.73	183.45
T_7	7.38	7.38	0.44	0.43	0.41	0.35	282.21	212.18	23.95	21.91	201.20	182.25
T_8	7.30	7.32	0.40	0.43	0.41	0.36	293.51	224.78	22.33	19.55	202.32	187.29
T_9	7.20	7.24	0.44	0.45	0.42	0.37	299.27	239.50	23.30	21.57	205.25	185.38

Table 6: Impact of varying NPK and FYM levels on the cost-benefit ratio (C: B) of cowpea.

Treatment	Seed Yield (q ha-1)	Seed Yield (₹ q-1)	Gross Return (₹ ha-1)	Total Cost of Cultivation (₹ ha-1)	Net Profit (₹ ha-1)	Cost-Benefit Ratio (C: B)
T_1	40.2	2200	88,440	28,120	60,320	1:1.65
T_2	43.5	2200	95,700	33,370	62,330	1:1.77
T_3	47.3	2200	104,060	34,620	69,440	1:1.83
T_4	49.6	2200	109,120	34,763.62	74,356.38	1:2.09
T_5	55.8	2200	122,760	36,013.62	86,746.38	1:2.27
T_6	56.2	2200	123,640	37,263.62	86,376.38	1:2.22
T_7	54.2	2200	119,240	37,413.58	81,826.42	1:2.08
T_8	66.3	2200	145,860	38,663.58	107,196.42	1:2.66
T_9	80.1	2200	176,220	39,913.58	136,306.42	1:2.81

DISCUSSION

Initial Soil Conditions

Table 2 displays the original characteristics (physical and chemical) of the soil. The dominant sand content (over 59%) categorizes the soil as sandy loam for both depths analyzed (0-15 cm and 15-30 cm). Sandy loam is generally well-aerated, has quick water drainage, and is easier to till, making it suitable for various crops but may require more frequent watering and fertilization. The bulk density values are typical for sandy loam and indicate moderate compaction. Soil pH values close to neutral suggest that nutrient availability is likely optimal for a wide range of agricultural crops. Low organic carbon and nutrient levels (Nitrogen, Phosphorus, Potassium) signify that while the soil has moderate fertility, it would benefit from nutrient augmentation to support healthy crop growth.

Effects of Treatment on Plant Development and Yield

Table 3 examines how varying quantities of NPK and FYM impact the growth and productivity of plants. Treatment T1 through T9 show a clear trend: increasing NPK levels generally result in higher plant height, pod length, number of pods, seed weight per pod, and overall seed yield. This indicates that nutrient supplementation, possibly enhanced by FYM nitrogen-fixing capabilities, substantially boosts plant growth and productivity. Specifically, treatment T9, which combines 100% recommended NPK levels with FYM, shows the highest growth metrics and yield, underscoring the effectiveness of integrated nutrient management practices.

Post-Harvest Soil Characteristics

Table 4 and Table 5 detail the soil's physico-chemical properties. Notably, treatment with higher NPK levels maintained or slightly reduced bulk densities and increased pore space, which could be attributed to better root growth and soil structure. The enhancement in water holding capacity and slight increases in soil pH in higher NPK treatments may indicate improved soil health. The organic carbon content remains relatively stable across treatments, suggesting that short-term cropping cycles might not significantly alter this parameter. Importantly, available nitrogen, phosphorus, and potassium levels are markedly higher in treatments that received full NPK applications, validating the importance of replenishing soil nutrients to sustain soil fertility over successive planting cycles.

Economic Analysis

Table 6 presents an essential economic viewpoint by outlining the cost-benefit ratio for each therapy. Increased yields are associated with better gross profits. Despite the rise in cultivation costs due to increased inputs, treatments with higher NPK and FYM application show significantly enhanced net profits and cost-benefit ratios. Investing in thorough soil and plant management tactics results in significant economic gains, which in turn, helps sustain the feasibility of these agricultural methods.

CONCLUSION

The most effective treatment for attaining optimum physical development in plants and maximising economic returns is T9, which consists of 100% NPK and 100% FYM. This treatment promotes a sustainable and economically feasible agricultural method by effectively using resources to achieve optimal results in terms of plant quality and financial profits. Investing in an integrated strategy of nutrient management together with biological improvements like FYM is a strategic decision for farmers and agricultural stakeholders seeking optimal production and profitability.

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