

Effect of Tillage Practices and Integrated Nutrient Management on ~~Soil Health~~ soil physicochemical properties and yield of Cowpea (*Vigna unguiculata* L. Walp) ~~Var. KSP-178-Kashi Nidhi~~ at Uttar Pradesh, India

The concept of soil health is broad and goes beyond the scope of this study; hence, the title should be restructured as suggested above

ABSTRACT

A field investigation was conducted at Central Research Farm of Department of Soil Science and Agricultural Chemistry at Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India during *Zaid* season of 2023. The experimental plot was a 3 – factor factorial (3 x 3 x 1) experiment laid ~~down into~~ out in a Randomized Complete Block Design with to give nine (9) treatments combinations replicated thrice. The factors were tillage practices consist of 3 levels of tillage practices (~~@~~ 0 %, ~~@~~ 50%, ~~@~~100% define what each of these levels of tillage practices represents), 3 levels of and RDF (please write in full before abbreviation) at 3 levels (~~@~~—(0 %, ~~@~~ 50%, ~~@~~100%) and 1level of vermicompost (~~@~~5 t ha⁻¹). ~~In all the treatment combination, RDF at different levels were applied along with the organic manures (vermicompost) to maintain and improve soil health by reducing the application of inorganic fertilizers for a sustainable agriculture management system.~~ How did you sample soils and plants? Indicate what you did with the soil and plant after sampling. The results revealed that maximum bulk density (where is the value? Mg m⁻³) and soil pH (indicate the pH value) were found in T₁ (0% Tillage ~~@~~0% + 0% RDF ~~@~~ 0% + 5t ha⁻¹ VC ~~@~~ 5t ha⁻¹ correct others as indicated here) . The others soil parameters like porosity (%), water holding capacity (%), organic carbon (%), electrical conductivity(dS m⁻¹), (av. Write in full) nitrogen (kg ha⁻¹), av. phosphorus (kg ha⁻¹), av. potassium (kg ha⁻¹) were recorded maximum in T₉ (Tillage ~~@~~ 100% + RDF @ 100% +VC ~~@~~ 5t ha⁻¹) .Whereas in case of yield (150.56 q ha⁻¹) best result was also recorded in T₉ (Tillage ~~@~~ 100% + RDF ~~@~~100% +VC ~~@~~ 5t ha⁻¹) .Economic parameters like gross return (₹271008.00 ha⁻¹) and net return (₹152323.00 ha⁻¹) were found to be maximum in T₉ (Tillage~~@~~ 100% + RDF @ 100% +VC ~~@~~ 5t ha⁻¹) and best cost benefit ratio (C: B) was recorded as (1:2.28) in treatment T₉ (Tillage @ 100% + RDF ~~@~~ 100% +VC ~~@~~ 5t ha⁻¹). How did you arrive at the results you reported here?

(join this paragraph to the existing passage. Abstract is written in single paragraph) Integrated approach of application of RDF (NPK), vermicompost along with 100% tillage practices found to be

the best treatment as the soil parameters and plant **growth yield** parameters **were** significantly ~~affected with the different levels of nutrient and tillage practices.~~ improved by it.

Keywords: ~~INM, tillage, soil health, yield, vermicompost, cowpea, etc.~~ (add one or two more keywords)

INTRODUCTION

~~Soil health refers to the ability of soil to operate effectively within the parameters of its ecosystem and land management practices, supporting the vitality of plants and animals, promoting ecological diversity, enhancing primary productivity, and maintaining environmental integrity. As~~ Soil is a dynamic body, **and** the potentiality of soil to supply nutrients adequately is very important for plant growth & development (ref?). ~~When soil inherent all the physical and chemical properties in between a well -maintained range, is known as healthy soil.~~ (not clear, you can delete it) Integrated nutrient management is one of most important approach to maintain **the soil health quality** and ~~maintains a~~ good soil condition. ~~with the help of application of various alternate nutrient sources as organic amendments which maintains proper supply of nutrients along with keeping soil healthy.~~

Cowpea, being a leguminous crop, requires minimal nitrogen, especially in small amounts during the early stages of its growth cycle. However, nitrogen remains crucial for its overall growth and development as it constitutes vital components such as amino acids, proteins, nucleic acids, enzymes, and alkaloids (**Anuja et al., 2014**). Phosphorus is one of the vital mineral nutrients for pulse crops like cowpea, plays a crucial role in root growth and development, biological nitrogen fixation, seed germination, flowering, cell division, synthesis of fats and starches. Potassium is the third major macronutrient which is very essential for the plant growth after nitrogen and phosphorus. In case of drought conditions, potassium actively maintains turgidity in plant cells and regulates stomatal activities and helps in water regulation and stress management (ref?). **please, provide some information regarding the economic values of cowpea**

Vermicompost plays an important role in production of cowpea as it supplies various macro and micro nutrients, promotes proper plant growth and yield. It is a rich source of plant nutrients, which are readily available consists of growth-enhancing substances, and beneficial microorganisms. Within vermicompost, one can find a diverse array of organisms, including those, capable of fixing nitrogen, solubilizing phosphorus, and decomposing cellulose with 1.2-1.6%N, 1.8-2.0% P₂ O₅, 0.50 - 0.75% K₂O, and growth enhancing substance such as auxins and cytokines (**Karmegam et al., 2000**).

Cowpea is cultivated in arid and semi-arid regions throughout the world. In India major cowpea growing states are U.P., Punjab, Haryana, Rajasthan, M.P., West Bengal, Andhra Pradesh. It has short duration, high yielding, and quick growing capacity along with rich source of protein, carbohydrates, fibres, potassium *etc.* ~~As per A report~~ ~~elaimed~~ by Indian Council of Medical Research; ~~revealed that~~ the per capita availability of pulses in India is 35.5 g day⁻¹ against the minimum requirement of 70 g day⁻¹ capita⁻¹. It needs very little inputs to grow as cowpea have the capacity to fix nitrogen through root nodule at about 30 kg ha⁻¹, that's why cowpea is suitable for intercropping as it also gives higher income with low input for farmers (**Goud *et al.*, 2020**).

Tillage is the mechanical manipulation of soil or breaking of soil clods for making an even seed bed. Depending upon various factors such as the crop, soil type, climate, and farming objectives, tillage practices in leguminous crops may vary (ref?). Zero tillage practices in leguminous crops are designed to establish an ideal seedbed, control weeds, retain soil moisture, and encourage robust crop development. This approach minimizes soil erosion and preserves the soil structure by avoiding any disruption (ref?). ~~hundred percent (100%)~~ ~~±~~ tillage encompasses enhanced soil structure and tilth, which diminish weed competition, along with better aeration, soil moisture, and nutrient availability (ref?). Together, these improvements likely fostered superior root development, resulting in notable plant growth. Similar results were observed by (**Anjum *et al.*, 2014**) and (**Karki *et al.*, 2013**). **Conclude this paragraph by highlighting the objective of this study**

MATERIALS AND METHODS

Please write this section on the following headings and in this order.

Description of the study area

Sources of treatments and test crop (cowpea)

Treatment combinations

Land preparation and planting of test crop

Soil sampling and collection of plant parameters

Laboratory analyses

Experimental design

Data analysis (Including Cost – benefit analysis)

The present study entitled “Effect of Tillage Practices and Integrated Nutrient Management on Soil Health and Yield of Cowpea (*Vigna unguiculata* L. Walp) Var. KSP-178-Kashi Nidhi” field experiment was done at Central Research Farm of Department of Soil Science and Agricultural Chemistry, Sam Higginbottom University of Agriculture Technology And Sciences, Prayagraj (Allahabad), Uttar Pradesh, India during *Zaid* season of 2023. Cowpea seed variety KSP-178-Kashi Nidhi was used for cultivation. The place falls under subtropical belt in the south east of Uttar Pradesh and agro-ecological sub region [North Alluvium plain zone (0-1 % slope)] and Agro-climatically zone under upper Gangetic plain region. The experimental field is located at 25° 24' 30" N latitude and 81° 51' 10" E longitude and 98 m above MSL (Mean-sea level). The field is situated at about 6 km away from Prayagraj city on the right bank of river Yamuna and south east of Uttar Pradesh, thus the location faces extremely hot summer and cold winter seasons. In the time of summer temperature rises maximum up to 46-48° C and seldom falls as low as 4 °C- 5° C. The relative humidity of the research location ranges between 20 to 94 percent. Annual average rainfall of this area recorded about 1100 mm whereas monsoon happens mostly on July-September.

The trial was laid down into a randomized block design with 9 treatments replicated thrice, consist of 3 levels of tillage practices (0 %, 50% ,100%), 3 levels of RDF (0 %, 50% ,100%) ,1 level of vermicompost (5 t ha⁻¹) respectively.

Before any tillage operations soil samples were collected randomly from five distinct locations within the experimental plot and after harvesting of the crop soil samples also collected as per different treatment combinations plot wise; extracted from a depth of 0-15cm. To prepare the soil samples ;they were undergoes reduction through coning and quartering and subsequently, the soil samples were air-dried and shifted through a 2 mm sieve and preserved in polythene bags and then brought to laboratory for analysis of various physical parameters such as soil texture, soil colour, bulk density (Mg m⁻³), particle density (Mg m⁻³), porosity percentage(%), water holding capacity (%) and chemical properties such as soil pH, electrical conductivity (dS m⁻¹), organic carbon(%), av. nitrogen (kg ha⁻¹), av. phosphorus (kg ha⁻¹), av. potassium (kg ha⁻¹) by standard methodology(pH :Jackson,1958 ; E.C. :Wilcox,1950);Organic carbon :Walkley and Black,1947 ; av. Nitrogen: Subbiah and Asija,1956 ;av. Phosphorus: Olsen *et al.*,1954 ; potassium :Toth and Prince,1949.

Table 1. Treatment Combinations of Cowpea

Treatments	Treatment Combination	Symbols
T ₁	Tillage @ 0% + RDF @ 0% +VC @ 5t ha ⁻¹	T ₁ I ₁ V

T₂	Tillage @ 0% + RDF @ 50% +VC @ 5t ha ⁻¹	T ₁ I ₂ V
T₃	Tillage @ 0% + RDF @ 100% +VC @ 5t ha ⁻¹	T ₁ I ₃ V
T₄	Tillage @ 50% + RDF @ 0% +VC @ 5t ha ⁻¹	T ₂ I ₁ V
T₅	Tillage @ 50% + RDF @ 50%+VC @ 5t ha ⁻¹	T ₂ I ₂ V
T₆	Tillage @ 50% + RDF @ 100% +VC @ 5t ha ⁻¹	T ₂ I ₃ V
T₇	Tillage @ 100% + RDF @ 0% +VC @ 5t ha ⁻¹	T ₃ I ₁ V
T₈	Tillage @ 100% + RDF @ 50% +VC @ 5t ha ⁻¹	T ₃ I ₂ V
T₉	Tillage @ 100% + RDF @ 100% +VC @ 5t ha ⁻¹	T ₃ I ₃ V

[Note: VC- Vermicompost *i.e.*, used enriched with PSB @ 1 kg tonne⁻¹ of Vermicompost] (please refer to my comments above)

RESULTS AND DISCUSSION

Please present your results and discussions in sub-headings based on your results' Tables, for instance

Effect of Tillage practices at different levels of NPK and Vermicompost on soil physical health
Parameters properties

The experiment data presented that the effect of tillage practices, inorganic fertilizers and vermicompost significantly affected various soil properties. Tillage encompasses enhanced soil structure and tilth, which diminish weed competition, along with better aeration, soil moisture, and nutrient availability. Together, these improvements likely fostered superior root development, resulting in notable plant growth and increase of yield. Result of this field experiment in **table.2,3,4** revealed that soil bulk density and pH is decreasing with the increasing level of vermicompost and found maximum in T₁ (0% Tillage @ 0% + 0% RDF @ 0% + 5 t ha⁻¹ VC @ 5t ha⁻¹ please correct others accordingly) *i.e.* 1.29 Mg m⁻³ and 7.10 respectively, where, minimum pH found to be 6.80 and bulk density around 1.07 Mg m⁻³ in T₉ (Tillage @ 100% + RDF @ 100% +VC @ 5t ha⁻¹). Electrical conductivity (0.25 dS m⁻¹), porosity (55.60%), water holding capacity (46.63 %), organic carbon (0.49 %), available nitrogen (331.54 kg ha⁻¹), available phosphorus (28 kg ha⁻¹), available potassium (193.73 kg ha⁻¹) found significantly maximum with the increased nutrient doses and best found in T₉ (Tillage @ 100% + RDF @ 100% +VC @ 5t ha⁻¹). Whereas, T₁ treatment combination showed lowest values in electrical conductivity (0.19 dS m⁻¹), particle density (2.59 Mg m⁻³), pore space (43.42%), water holding capacity (40.77 %), organic carbon (0.28 %), available nitrogen (297.17 kg ha⁻¹), available phosphorus (17.70 kg ha⁻¹), available

potassium (144.71 kg ha⁻¹). T₉ has showed the greatest potential to enhance soil health by improving various soil parameters.

Results also revealed that maximum pod yield *i.e.*, 150.56 q ha⁻¹ found in T₉ (Tillage @ 100% + RDF @ 100% +VC @ 5t ha⁻¹) and minimum pod yield was recorded in T₁(Tillage @ 0% + RDF @ 0% +VC @ 5t ha⁻¹) *i.e.*, about 87 q ha⁻¹.

Economic parameters like gross return (₹271008.00 ha⁻¹) and net return (₹152323.00 ha⁻¹) were found to be maximum in T₉ (Tillage @ 100% + RDF @ 100% +VC @ 5t ha⁻¹) and best cost benefit ratio (C: B) was recorded as (1:2.28) in treatment T₉ (Tillage @ 100% + RDF @ 100% +VC @ 5t ha⁻¹).

Table.2. Effect of Tillage practices at different levels of NPK and Vermicompost on soil physical health parameters

Treatment	Bulk density (Mg m ⁻³) 0-15 cm	Particle density (Mg m ⁻³) 0-15 cm	% Porosity 0-15 cm	Water holding capacity (%) 0-15 cm
T ₁	1.29	2.59	43.42	40.77
T ₂	1.28	2.60	44.34	41.05
T ₃	1.27	2.59	45.49	41.67
T ₄	1.25	2.59	46.58	42.34
T ₅	1.23	2.60	47.65	42.53
T ₆	1.25	2.60	47.03	43.52
T ₇	1.12	2.59	52.74	43.93
T ₈	1.14	2.60	52.10	44.85
T ₉	1.07	2.61	55.60	46.63
F-Test	S	NS	S	S
S.Em. (±)	0.34	0.04	0.45	0.27
C.D.@5%	0.72	0.08	0.96	0.57

Table 3. Effect of Tillage practices at different levels of NPK and Vermicompost on soil chemical health parameters

Treatment	pH W/V (1:2.5)	EC (dS m ⁻¹) to physical	Organic carbon (%)	Av. Nitrogen (kg ha ⁻¹)	Av. Phosphorus (kg ha ⁻¹)	Av. Potassium (kg ha ⁻¹)
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	properties					
	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm	0-15 cm
T₁	7.10	0.19	0.28	297.17	17.70	144.71
T₂	6.97	0.21	0.30	303.45	18.22	148.30
T₃	6.77	0.22	0.32	307.22	19.21	152.32
T₄	7.13	0.17	0.37	309.19	20.53	153.97
T₅	7.01	0.23	0.39	313.13	21.47	159.95
T₆	6.91	0.24	0.41	318.08	23.21	171.06
T₇	7.11	0.18	0.43	321.94	25.02	176.92
T₈	7.04	0.20	0.46	326.23	26.81	182.08
T₉	6.80	0.25	0.49	331.54	28.00	193.73
F-Test	S	S	S	S	S	S
S.Em. (±)	0.09	0.02	0.02	1.63	4.87	2.96
C.D.@5%	0.20	0.03	0.03	3.45	10.33	6.28

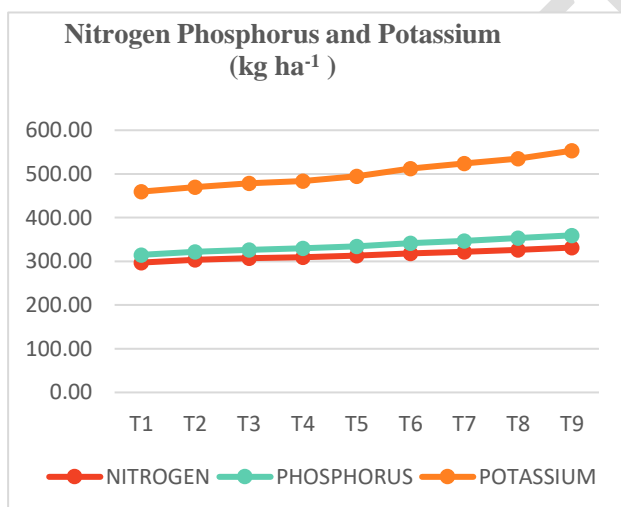


Fig 1. Graphical representation of Treatment combination vs Nitrogen, Phosphorus and Potassium

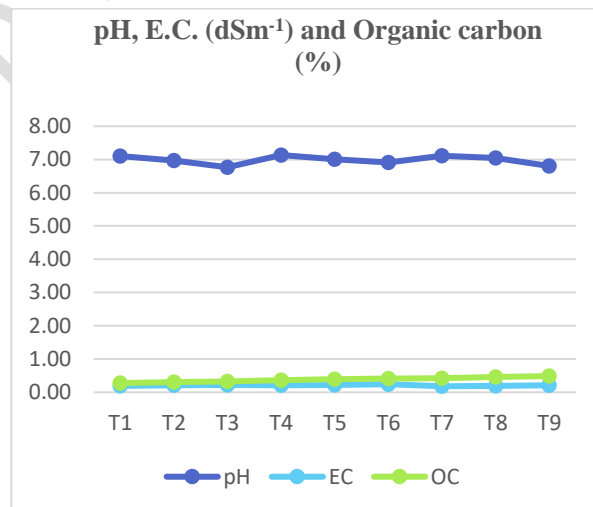


Fig 2. Graphical representation of Treatment combination vs pH, E.C. and Organic carbon

Please, these graphs are not necessary if the data they contain have been reported in the Tables, hence, delete accordingly

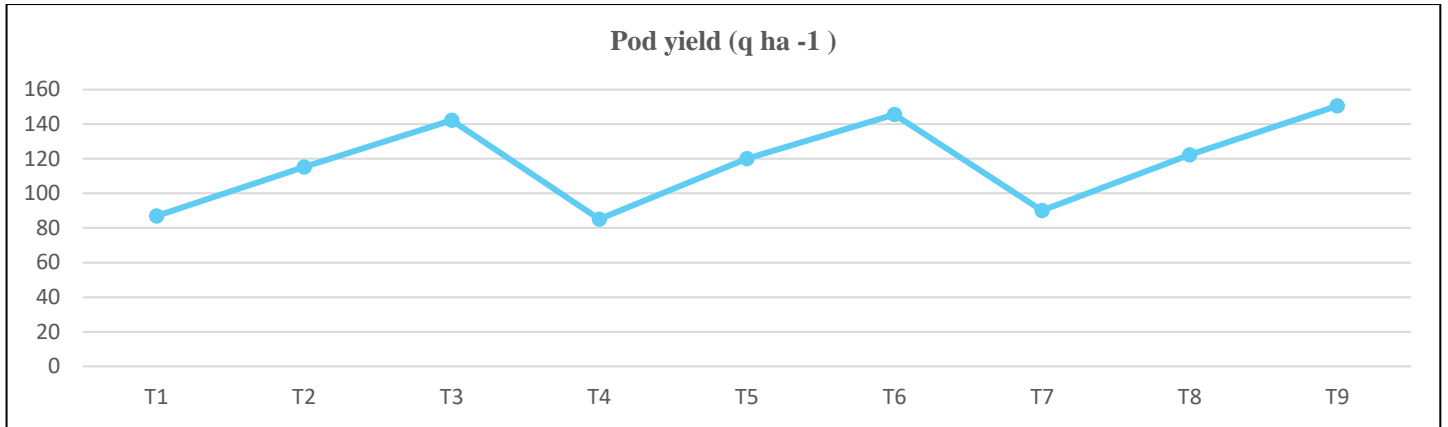


Fig 3. Graphical representation of Treatment combination vs Pod yield (q ha⁻¹)

Table 4. Effect of different treatment combinations on cost benefit ratio (C: B) of Cowpea

Treatments	Yield (q ha ⁻¹)	Selling price (₹ q ⁻¹)	Gross return (₹ ha ⁻¹)	Total cost of Cultivation (₹ ha ⁻¹)	Net profit (₹ ha ⁻¹)	C:B ratio
T ₁	87	1800	156600	111750	44850.00	1:1.40
T ₂	115.26	1800	207468	114517.5	92950.50	1:1.81
T ₃	142.23	1800	256014	117285	138729.00	1:2.18
T ₄	85.11	1800	153198	112450	40748.00	1:1.36
T ₅	120	1800	216000	115217.5	100782.50	1:1.87
T ₆	145.57	1800	262026	117985	144041.00	1:2.22
T ₇	90.12	1800	162216	113150	49066.00	1:1.43
T ₈	122.23	1800	220014	115917.5	104096.50	1:1.90
T ₉	150.56	1800	271008	118685	152323.00	1:2.28

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CONCLUSION

The experimental results indicated that the application of Tillage, Vermicompost and Inorganic fertilizers in treatment T₉ (Tillage @ 100% + RDF @ 100% +VC @ 5t ha⁻¹) significantly affected the physico-chemical properties of the soil. These results included a reduction in bulk density and pH, **as well as but there are** no significant changes were recorded in particle density. Whereas porosity, water holding capacity and electrical conductivity **have** showed significant

variations including organic carbon, available Nitrogen, Phosphorus, and Potassium. Moreover, treatment T₉ exhibited the tallest plants and longest pods. Additionally, it has recorded the highest number of pods per plant and the greatest pod yield weight per hectare compared to other treatments.

Based on this trial results, we can conclude that among the various treatment combinations of Tillage Practices, N, P, K, Vermicompost levels tested, T₉ (Tillage @ 100% + RDF @ 100% +VC @ 5t ha⁻¹) has emerged as was the most effective for cultivating Cowpea (*Vigna unguiculata* L. Walp), particularly for the KSP-178-Kashi Nidhi variety. The 100 % Tillage encompasses enhanced soil structure and tilth, which diminish weed competition, along with better aeration, soil moisture, and nutrient availability. Together, these improvements likely fostered superior root development, resulting in notable plant growth and also ensures quality yield. This treatment demonstrated superior outcomes for both crop yield and soil physical and chemical properties. Therefore, it is recommended for achieving profitable Cowpea production within the study area. but it is important to note that it may differ depending on the different soil type of different areas. Employing integrated nutrient management practices like this can significantly contribute to maintaining soil health and optimizing Cowpea yields.

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