

Effect of NPK Zinc and Iron on Soil Health and Yield Parameters of Green Gram (*Vigna radiata* L.) var SML-668

Abstract

An experiment was conducted during the Zaid season of the year 2023 in the crop research farm, department of Soil Science and Agricultural Chemistry at SHUATS, Prayagraj, trial was conducted on effect of NPK, zinc and iron on soil health and yield parameters of green gram. An experiment was conducted in randomised block design (RBD) with 9 treatments replicated thrice. NPK fertilizer, was applied along with Zinc and Iron as soil application during the time of sowing. Recommended dose of NPK is 25:50:25, and of Zinc and Iron is 15 kg ha⁻¹ and 20 kg ha⁻¹ respectively. The plant height, No. of pods plant⁻¹, No. of seeds pod⁻¹, grain yield, water holding capacity, % pore space, % organic carbon, soil EC, available nitrogen, available potassium, and available iron were found to be significant and was recorded maximum in T₉ - [[NPK @100% + Zn @100% + Fe @100%]. Bulk density, particle density and soil pH were recorded maximum in T₁- [NPK @ 0 % + Zn @ 0 % + Fe @ 0%]. Available phosphorous was recorded maximum in T₇- [NPK @100% + Zn @0% + Fe @100%] whereas available zinc was recorded maximum in T₃- [NPK @ 0% + Zn @ 100% + Fe @100%]. The present study reported that the Zinc and Iron on Soil Health and Yield Parameters of Green gram (*Vigna radiata* L.) var SML-668 fertilizes doses of NPK + Zinc + Iron gave positive test values arching desired yield targets of Green gram situations for Prayagraj region

Keywords: Soil health, yield parameters, zinc, iron, green gram, *etc.*

Introduction

Green gram is grown best in the alluvial tract in the north, as well as black and red soils of southern and peninsular India. It can also be grown on light stony soil to clayey soils. Green gram cultivation is ideal in well drained loam or sandy loam soils. In India during 2023-24, about 15.93 lakh ha (39.38 lakh acres) area was covered under green gram as against 15.57 lakh ha (38.47 lakh acres) during the same period in 2022-23. According to Government 3rd advance estimates, green gram production in 2022-23 was 3.74 million tonnes. The highest production was reported in Rajasthan (39.06%), followed by Madhya Pradesh (11.57%), Maharashtra (8.57%), Bihar (5.54%), Karnataka (5.05%), Tamil Nadu (5.02%), Gujarat (4.63%), and Andhra Pradesh (4.31%) (**Yuvraj *et al.* 2022**). According to directorate of economics and statistics, DAC and FW the total production of green gram in Uttar Pradesh in the year 2020-21 was 61 tonnes ha⁻¹. India is the world's top producer of green gram, it is farmed on roughly 4.5 million hectares, producing 2.5 million tonnes at a productivity of 548 kg per hectare, making up 10% of the world's production of pulses. Green gram is grown in almost all the states in India. Green gram is the most important crop of

the south-east Asia and the most importantly of Indian sub-continent (**Ranpariya et al. 2017**). Being a leguminous crop, green gram has the capacity to fix the atmospheric nitrogen. Due to its less water requirement and deep rooting system green gram is favourable in semi-arid tropics. Green gram or mung beans undergoes epigeal germination that takes place within 4-5 days under favourable growth factors. The plant has well developed root system that contains root nodules and many lateral roots. Green gram is a short duration crop. Being a short duration crop it fits well in many intensive crop rotations. Green gram can be grown thrice a year, in the Kharif season during July to October, in the Rabi season during November to March and Summer season during April to June (**Tiwari and Shivhare, 2017**). Due to its high nutrient content, green gram is regarded as green pearl (**Nair et al. 2013**). Green gram is consumed in different forms such as vegetables, sprouts, dhal, processed grain, fried bean, bean paste or incorporated into noodles, bread, cakes, cold jellies, and desserts (**Asif et al. 2013**). India is the largest producer of green gram and account for 54% of the world production and covers 65% of the world acreage. Besides being the largest pulses producer, India is also one of the largest consumers and importers in the world, because of the rise in population and consumer awareness, India imports pulses to meet the high domestic demand (**Pulses revolution from food to nutritional security, success report, 2017-18**). Green gram is also known as poor man's meat (**Hou et al. 2019**). Pulses improve soil health by enhancing soil physical, biological and chemical properties as well as soil fertility status through biological nitrogen fixation with symbiotic association with rhizobium from the atmosphere and mushrooming the soil microorganism population in soil. (**Peoples et al. 2018**). Mung bean contains about 51.6% carbohydrate, 26 to 27% protein, 4 to 5% minerals and 3 to 4% vitamins (**Dhakal et al. 2015**).

Nitrogen is the first fertilizer element of the macronutrients usually applied as commercial fertilizers. Nitrogen is very important nutrients for plants as it seems to have the quickest and the most pronounced effect. Nitrogen encourages above ground vegetative growth of the plants and it imparts dark colour to the plants. Nitrogen is of special importance in the formation of protein in plants. Nitrogen deficiency may result in the stunted growth of the plants.

Phosphorous is the second fertilizer element and it is an essential constituent of every living cell and for the nutrition of plants. It takes part in all types of metabolism of plant. It is an essential constituent of majority of enzyme and also structural component of membrane system of cell. Phosphorous stimulates root development. It induces nodule formation of the crop and rhizobial activity.

Potassium is the third fertilizer element. Potassium acts as a root booster, stalk strengthner, food former, sugar and starch supporter. It is also essential for the photosynthesis. It increases the boldness of the grain. Potassium is also refered to as a value element because of its contributions to the quality, taste, colour etc (**Mishra et al. 2011**).

Zinc is a trace element, it is very significant as it performs numerous functions such as proper growth of the

plant, synthesis of chlorophyll, biosynthesis of plant growth hormone and RNA synthesis. Green gram when grown under zinc deficient soils suffers from yield loss (**Partha et al. 2017**). Zinc insufficiency is the most often reported deficit. Zinc shortage has been reported in many states of India (**Likihittakutum et al. 2023**).

Whereas iron plays a very important role in nitrogen fixation. It regulates respiration, photosynthesis, Sulphur absorption and nitrogen-fixing. It is also involved in the synthesis of protein. Therefore, present investigation was undertaken to study the effect of NPK, Zinc and Iron on soil health parameters and yield.

Materials and Methods

The soil samples were collected randomly from the experimental site prior to tillage operation as well as after the harvest from a depth of 0-15 and 15-30 cm. The topography of experimental field was uniform and levelled. The experimental soil was sandy loam in texture. Seed was sown by dibbling method with the spacing of 30 cm between rows and 10 cm within plants. The experimental field was well prepared by ploughing with tractor. The field was leveled and stubbles and weed were picked up from the field manually. As per experimental recommendations, the fertilizers Nitrogen, Potassium, Phosphorous, Zinc and Iron were weighed and applied in the field by mixing thoroughly with soil. Thinning was done to maintain proper spacing of 10 cm between plants. In order to keep field free from weeds, and to ensure soil moisture two hand weeding was done at 15 and 35 DAS to maintain the optimum population of the plant.

Physical parameters like bulk density, particle density, pore space and water holding capacity was analysed through 100 ml graduated measuring cylinder method and the process given by (**Muthuval et al. 1992**).

Soil chemical parameters

- a. Soil pH - (**Jackson, 1958**)
- b. Soil EC (dS m^{-1}) - (**Wilcox, 1950**)
- c. Organic carbon (%) - (**Walkley and Black, 1947**).
- d. Available Nitrogen (kg ha^{-1}) - (**Subbiah and Asija, 1956**).
- e. Available Phosphorus (kg ha^{-1}) - (**Olsen et al., 1954**).
- f. Available Potassium (kg ha^{-1}) - (**Toth and Prince, 1949**).
- g. Available Zinc and Iron (Mg kg^{-1}) - (**Lindsay and Norvell, 1978**).

Table 1. Treatment combinations of Greengram

Treatment	Treatment Combination
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T₁	[NPK @ 0% + Zn @ 0% + Fe @ 0%]
T₂	[NPK @ 0% + Zn @ 50% + Fe @ 100%]
T₃	[NPK @ 0% + Zn @ 100% + Fe @ 100%]
T₄	[NPK @ 50% + Zn @ 0% + Fe @ 100%]
T₅	[NPK @ 50% + Zn @ 50% + Fe @ 100%]
T₆	[NPK @ 50% + Zn @ 100% + Fe @ 100%]
T₇	[NPK @ 100% + Zn @ 0% + Fe @ 100%]
T₈	[NPK @ 100% + Zn @ 50% + Fe @ 100%]
T₉	[NPK @ 100% + Zn @ 100% + Fe @ 100%]

Result and Discussion

Physical properties of soil

As depicted in table 2. the soil bulk density, particle density, water holding capacity and pore space was found non-significant. Bulk density and particle density increases with the increase in depth. Similar findings were recorded by **Chintha *et al.* (2021)** and **Hussain *et al.* (2022)**. Whereas water holding capacity and pore space was found significant. Water holding capacity increases with the increase in depth, the maximum data recorded was 45.31% and 45.71 % in T₉ [NPK @100% + Zn @100% + Fe @100%] followed by 45.25% and 45.64 % in T₅ [NPK @50% + Zn @50% + Fe @100%] and minimum was 43.13 % and 43.21% in T₁. [NPK @ 0% + Zn 0% + Fe @ 0 %]. Similar findings were recorded by **Prakash *et al.* (2017)**, **Banjara *et al.* (2019)**. Soil pore space decreases with the decrease in depth. The maximum value recorded for pore space was 48.76% and 48.53 % at 0-15 cm and 15-30 cm respectively in T₉ [NPK @100% + Zn @100% + Fe @100%] followed by 48.60% and 48.48 % in T₅ [NPK @50% + Zn @50% + Fe @100%] and the minimum value recorded was 46.21% and 46.15% in T₁ [NPK @0% + Zn @0% + Fe @0%]. Similar findings were recorded by **Tarun *et al.* (2022)**.

Treatment	Treatment Combination	Bulk density (Mg m ⁻³)		Particle density (Mg m ⁻³)		Water holding capacity (%)		Pore space (%)	
		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	NPK @0% + Zn @0% + Fe @0%	1.304	1.305	2.55	2.58	43.13	43.21	46.21	46.15
T ₂	NPK @0% + Zn @50% + Fe @100%	1.261	1.265	2.45	2.49	43.37	43.39	47.41	47.36
T ₃	NPK @0% + Zn @100% + Fe @100%	1.291	1.292	2.38	2.45	43.33	43.44	47.46	47.40
T ₄	NPK @50% + Zn @0% + Fe @100%	1.283	1.284	2.33	2.37	44.40	44.50	47.57	47.50
T ₅	NPK @50% + Zn @50% + Fe @100%	1.274	1.276	2.15	2.19	45.25	45.64	48.60	48.48
T ₆	NPK @50% + Zn @100% + Fe @100%	1.291	1.293	2.17	2.21	45.18	45.22	48.43	48.29
T ₇	NPK @100% + Zn @0% + Fe @100%	1.283	1.285	2.23	2.26	45.14	45.16	48.47	48.35
T ₈	NPK @100% + Zn @50% + Fe @100%	1.287	1.290	2.28	2.32	45.07	45.09	48.51	48.42
T ₉	NPK @100% + Zn @100% + Fe @100%	1.268	1.274	2.09	2.12	45.31	45.71	48.76	48.53
	F-		NS	NS	NS	S	S	S	S
	test	NS							
	C.D. at 5%	0.032	0.029	0.341	0.301	0.135	0.068	0.151	0.059
	S.Ed.		0.013	0.161	0.142	0.064	0.032	0.071	0.028
	(+)	0.015							

Table 2. Effect of NPK Zinc and Iron on bulk density (Mg m^{-3}) particle density (Mg m^{-3}) water holding capacity (%) and pore space (%) of post-harvest soil

Chemical properties of soil

As depicted in table 3. the value of soil pH, soil EC and organic carbon, Soil pH and soil EC was found non-significant whereas organic carbon was found to be significant. The maximum pH of soil 7.25 and 7.37 was found in treatment T₁ [NPK @ 0 % + Zn @ 0 % + Fe @0%] and the minimum pH of soil 6.85 and 6.92 was found in treatment T₉ [NPK @100% + Zn @100% + Fe @100%]. Similar findings were recorded by **Lokendra et al. (2023)**. The maximum EC value 0.36 dSm^{-1} and 0.40 dSm^{-1} was recorded in T₉ [NPK @100% + Zn @100% + Fe @100%]. The minimum EC value 0.21 dSm^{-1} and 0.23 dSm^{-1} was recorded in T₁[NPK @0% + Zn @0% + Fe @0%]. The maximum

value of EC in T₉ might be due to the application of 100% inorganic fertilizers which results in an increase in salt content in soil, as soil EC is directly proportional to the nutrient concentration level, and inversely proportional to the depth. Similar findings were recorded by **Likhithakuttum et al. (2022)** and **Lokendra et.al (2023)**. The maximum organic carbon of soil 0.55% and 0.57 % was found in treatment T₉ [NPK @100% + Zn @100% + Fe @100%] and minimum organic carbon of soil 0.30% and 0.28 % was found in treatment T₁ [NPK @0% + Zn @0% + Fe @0%] respectively. The increased organic carbon (%) might be due to the fertilization which indirectly increases the soil organic carbon. Inorganic fertilizers improve the soil organic matter content in the soil by increasing the plant biomass which remains in the field and undergoes decomposition thus increasing the soil organic matter. Similar findings were recorded by **Sahu et al. (2020)**, **Deshlahare et al. (2019)**. As depicted in the table 4 and Fig 1. the value of NPK was found to be significant. The maximum available nitrogen 304.19 Kg ha⁻¹ and 306.20 kg ha⁻¹ was recorded maximum in T₉ [NPK @100% + Zn @100% + Fe @100%] followed by 303.20 Kg ha⁻¹ and 304.99 kg ha⁻¹ was found in T₇ [NPK @100% + Zn @0% + Fe @100%] and the minimum value recorded was 275.85 Kg ha⁻¹ and 276.98 kg ha⁻¹ was found in T₁ [NPK @0% + Zn @0% + Fe @0%]. The application of NPK together with Zinc and Iron resulted in significantly increase of nitrogen in soil, it might be due to increased microbial activity leading to the mineralization of nutrients. The increase in the nitrogen content may be due to the synergistic effect of Zinc on Nitrogen in soil. Similar findings were recorded by **Hemraj et al. (2022)**, **Mohammad et al. (2019)**. The maximum available phosphorous 31.50 kg ha⁻¹ and 32.51 kg ha⁻¹ was recorded in T₇ [NPK @100% + Zn @0% + Fe @100%] followed by 30.87 and 31.64 kg ha⁻¹ in T₄ [NPK @50% + Zn @0% + Fe @100%] and the minimum value recorded was 26.48 Kg ha⁻¹ and 28.05 kg ha⁻¹ in T₁ [NPK @0% + Zn @0% + Fe @0%]. Phosphorous content increases with the increase in level of NPK whereas it decreased with an increase in level of Zinc due to its antagonist effect with zinc. Similar findings were recorded by **Koushik et al. (2022)**. The maximum value of available potassium recorded was 210.07 kg ha⁻¹ and 213.27 kg ha⁻¹ in T₉ [NPK @100% + Zn @100% + Fe @100%] followed by 207.99 kg ha⁻¹ and 211.4 kg ha⁻¹ in T₇ [NPK @100% + Zn @0% + Fe @100%] and the minimum available potassium recorded was 180.85 and 182.84 kg ha⁻¹ in T₁ [NPK @0% + Zn @0% + Fe @0%]. Similar findings were recorded by **Mohammad et al. (2019)**, **Chethan KV et al. (2018)**, **Rohit et al. (2018)**. As depicted in table 5 and Fig 2. the value of zinc and iron was found significant. The value of available zinc increases with the increase in depth. The maximum value of zinc recorded was 0.94 kg ha⁻¹ and 0.97 kg ha⁻¹ in T₃ [NPK @0% + Zn @100% + Fe @100%] followed by 0.91 kg ha⁻¹ and 0.89 kg ha⁻¹ in T₉ [NPK @100% + Zn @100% + Fe @100%] and the minimum value recorded was 0.71 kg ha⁻¹ and 0.75 kg ha⁻¹ in T₁ [NPK @0% + Zn @0% + Fe @0%]. The minimum value of Zinc might be due to the reaction of zinc with phosphorous which results in the formation of insoluble compounds of Zn. Similar findings were recorded by **Choudhary et al. (2021)**, **Rajendra et al. (2016)**. The value of available iron increase with the increase in depth. The maximum value of iron recorded was 6.59 kg ha⁻¹ and 6.84 kg ha⁻¹ in T₉ [NPK @100% + Zn @100% + Fe @100%] followed by 6.47 kg ha⁻¹ and 6.78 kg ha⁻¹ in T₅ [NPK @50% + Zn @50% + Fe @100%] and the minimum value recorded was 5.10 kg ha⁻¹ and 5.07 kg ha⁻¹ in T₁ [NPK @0% + Zn @0% + Fe @0%] Similar findings were recorded by **Fulpagare et al. (2018)**, **Sunil et al. (2017)**.

Fig 1. Effect of NPK, Zinc and Iron on available NPK of post- harvest soil

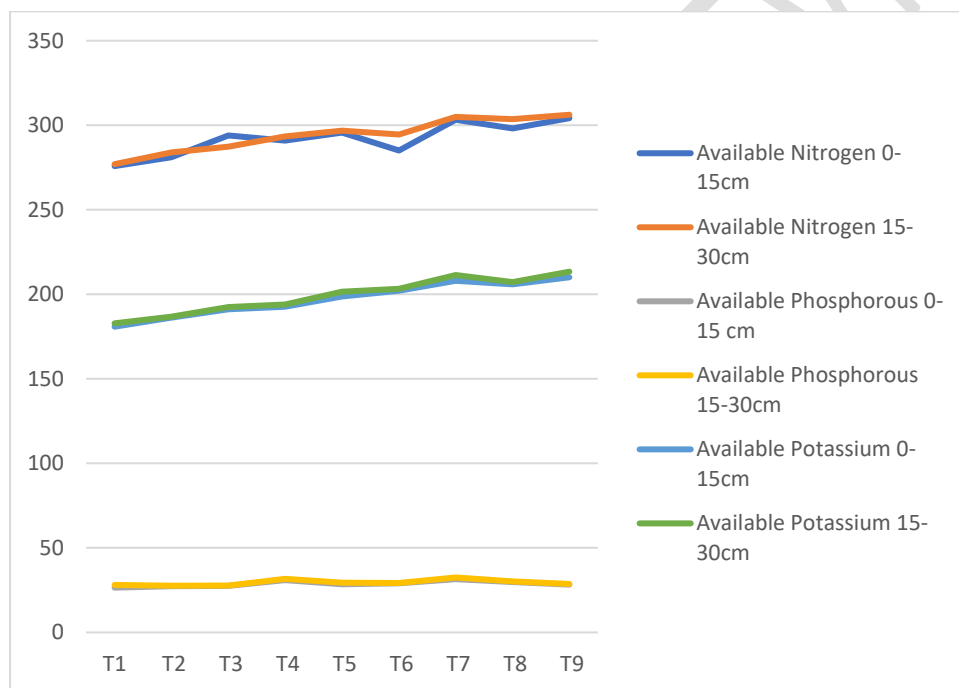


Fig 2. Effect of NPK, Zinc and Iron on available Zinc and Iron of Post-harvest soil

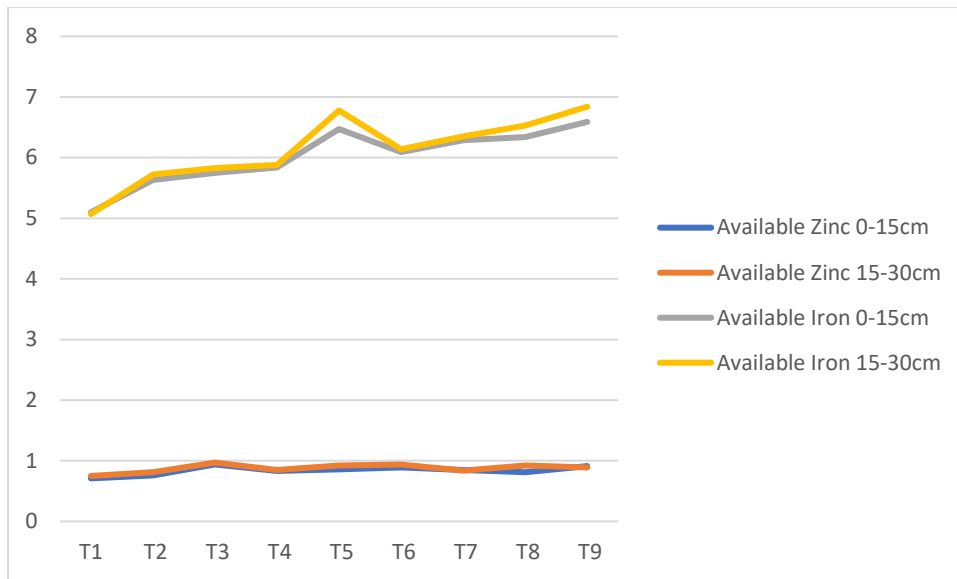


Table 3. Effect of NPK, Zinc and Iron on soil pH, soil EC (dS m⁻¹) and organic carbon (%) of post-harvest soil

Treatment	Treatment Combination	Soil pH		Soil EC (dS m ⁻¹)		organic carbon (%)	
		0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
T ₁	NPK @0% + Zn @0% + Fe @0%	7.25	7.37	0.21	0.23	0.30	0.28
T ₂	NPK @0% + Zn @50% + Fe @100%	7.23	7.32	0.27	0.29	0.32	0.31
T ₃	NPK @0% + Zn @100% + Fe @100%	7.18	7.25	0.33	0.36	0.37	0.34
T ₄	NPK @50% + Zn @0% + Fe @100%	7.16	7.21	0.32	0.35	0.40	0.39
T ₅	NPK @50% + Zn @50% + Fe @100%	6.94	6.93	0.34	0.36	0.54	0.55
T ₆	NPK @50% + Zn @100% + Fe @100%	7.09	7.14	0.30	0.33	0.51	0.52
T ₇	NPK @100% + Zn @0% + Fe @100%	7.11	7.19	0.28	0.31	0.46	0.47
T ₈	NPK @100% + Zn @50% + Fe @100%	7.07	7.14	0.24	0.25	0.42	0.44
T ₉	NPK @100% + Zn @100% + Fe @100%	6.85	6.92	0.36	0.40	0.55	0.57

F-test	NS	NS	NS	NS	S	S
C.D. at 5%	0.294		0.112	0.131	0.02	0.018
		0.380				
S. Ed. (+)	0.138		0.052	0.061	0.01	0.008
		0.179				

Table 4. Effect of NPK, Zinc and Iron on available nitrogen (kg ha⁻¹), phosphorous

(kg ha⁻¹) and potassium (kg ha⁻¹) of post-harvest soil

Treatment No.	Treatment Combination	Available Nitrogen (kg ha ⁻¹)		Available phosphorous (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
T ₁	NPK @0% + Zn @0% + Fe @0%	275.85	276.98	26.48	28.05	180.85	182.84
T ₂	NPK @0% + Zn @50% + Fe @100%	281.14	283.98	27.34	27.64	186.20	186.79
T ₃	NPK @0% + Zn @100% + Fe @100%	294.00	287.31	27.55	27.77	191.17	192.40
T ₄	NPK @50% + Zn @0% + Fe @100%	290.87	293.40	30.87	31.64	192.57	194.00
T ₅	NPK @50% + Zn @50% + Fe @100%	295.64	296.86	28.54	29.43	198.70	201.55
T ₆	NPK @50% + Zn @100% + Fe @100%	285.12	294.49	29.07	29.24	202.18	203.29
T ₇	NPK @100% + Zn @0% + Fe @100%	303.20	304.99	31.50	32.51	207.99	211.49
T ₈	NPK @100% + Zn @50% + Fe @100%	298.07	303.58	29.75	30.27	205.99	207.18
T ₉	NPK @100% + Zn @100% + Fe @100%	304.19	306.20	28.23	28.73	210.07	213.37
	F-test	S	S	S	S	S	S
	C.D. at 5%	1.511	1.976	0.364	0.823	1.945	1.243
	S. Ed. (+)	0.713	0.932	0.171	0.388	0.917	0.586

Table 5. Effect of NPK, Zinc and Iron on available Zinc (Mg kg⁻¹) and iron (Mg kg⁻¹) of post-harvest soil

Treatment No.	Treatment Combination	Available Zinc (Mg kg ⁻¹)		Available Iron (Mg kg ⁻¹)	
		0-15 cm	15-30 cm	0-15 cm	15-30 cm
T1	NPK @0% + Zn @0% + Fe @0%	0.71	0.75	5.10	5.07
T2	NPK @0% + Zn @50% + Fe @ 100%	0.76	0.81	5.63	5.72
T3	NPK @0% + Zn @100% + Fe @100%	0.94	0.97	5.75	5.83
T4	NPK @50% + Zn @0% + Fe @100%	0.83	0.85	5.84	5.88
T5	NPK @50% + Zn @50% + Fe @100%	0.86	0.92	6.47	6.78
T6	NPK @50% + Zn @100% + Fe @100%	0.89	0.94	6.09	6.14
T7	NPK @100% + Zn @0% + Fe @100%	0.85	0.84	6.29	6.35
T8	NPK @100% + Zn @50% + Fe@100%	0.81	0.92	6.34	6.53
T9	NPK @100% + Zn @100% + Fe @100%	0.91	0.89	6.59	6.84
F-test		S	S	S	S
C.D. at 5%		0.265	0.022	0.073	0.081
S.Ed. (+)		0.012	0.010	0.034	0.038

Growth parameters

As depicted in table 6. the value of plant height, No. of pod plant⁻¹, No. of seeds pod⁻¹ and grain yield are found to be significant. At 15,30,45 and 60 DAS the plant height was recorded maximum in T₉ [NPK @100% + Zn@100% + Fe@100%] Followed by T₅ [NPK@ 50% + Zn@ 50% + Fe@100%] and the minimum plant height was recorded in T₁ [NPK @ 0% + Zn@0% + Fe @0%]. The increase in plant height might be due to the role of zinc and iron in various physiological activities such as, enzyme activation, chlorophyll synthesis, photosynthesis, cell elongation and differentiation which resulted in the vigorous growth of plant. Similar findings were also reported by **Tribhuwana et al. (2024)**. No of pods plant⁻¹ was recorded maximum in T₉ [NPK @100% + Zn @100% + Fe @100%] followed by T₅ [NPK @50% + Zn @50% + Fe @100%] and the minimum No. of pods plant⁻¹ was recorded in T₁ [NPK @0% + Zn @0% + Fe @0%]. An increase in the No. of pods plant⁻¹ might be due to an increase availability of Iron which helps in sufficient absorption of nutrients. Zinc also plays a very significant role in affecting the growth parameters as it has a direct influence on the synthesis of tryptophan which is a precursor for the production of growth hormones known as auxin. Similar findings were recorded by **Maddila et al. (2022)** and **Vinodkumar et al. (2020)**. The No of seeds pod⁻¹ was recorded maximum in T₉ [NPK @100% + Zn @100% + Fe @100%] followed by T₅ [NPK @50% + Zn @50% + Fe @100%] and the minimum No. of seeds pod⁻¹ was recorded in T₁ [NPK @0% + Zn @0% + Fe @0%]. The increase in No of seed pod⁻¹ might be due to the important role of iron and zinc in affecting the growth characters and also the yield attributes. Other reasons may be due to the involvement of Zinc in IAA synthesis, IAA is a hormone which plays a major role in preventing the pod abscission which determines the seed yield. Zinc also plays

a major role in seed setting. Similar findings were recorded by **Boradkar *et al.* (2023)**. The grain yield was recorded maximum in T₉ [NPK@100% + Zn @100% + Fe @100%] followed by T₅[NPK @50% + Zn @50% + Fe @100%] and the minimum grain yield was recorded in T₁ [NPK @0% + Zn @0% + Fe @0%]. Increase in green gram grain yield might be due to enhancement of pod formation and increase in number of seeds pod⁻¹. Highest grain yield obtained maybe due to the availability of 100% Zinc and Iron at all the growth stages, which resulted in enhanced metabolic process of plant which resulted in better yield attributes and application of Zinc and Iron directly in the soil has a synergistic effect on yield component. Similar finding was recorded by **Jyoti *et al.* (2020)**, **Partha *et al.* (2013)**, **Gaffar *et al.* (2011)**.

Table 6. Effect of NPK, Zinc and Iron on Plant height (cm), No. of pods plant⁻¹, No of seeds pod⁻¹ and grain yield (t ha⁻¹) of post-harvest soil

Treatment	Treatment Combination	Plant height (cm)				No of pods plant ⁻¹	No of seeds pod ⁻¹	Grain yield (t ha ⁻¹)
		15 DAS	30 DAS	45 DAS	60 DAS			
T ₁	NPK @0% + Zn @0% + Fe @0%	11.08	22.48	30.41	36.71	17.56	5.17	1.15
T ₂	NPK @0% + Zn @50% + Fe @ 100%	12.36	25.18	33.57	40.78	23.20	7.87	1.78
T ₃	NPK @0% + Zn @100% + Fe @100%	12.55	25.24	33.69	41.14	24.49	8.03	1.81
T ₄	NPK @50% + Zn @0% + Fe @100%	12.80	25.38	33.79	41.27	24.84	7.92	1.87
T ₅	NPK @50% + Zn @50% + Fe @100%	13.83	26.27	37.51	45.25	28.40	8.43	2.06
T ₆	NPK @50% + Zn @100% + Fe @100%	13.55	26.23	37.31	45.14	28.27	8.35	1.91
T ₇	NPK @100% + Zn @0% + Fe @100%	13.42	26.16	35.37	43.34	27.36	8.23	1.96
T ₈	NPK @100% + Zn @50% + Fe@100%	13.10	25.70	35.92	42.21	26.24	8.16	2.03
T ₉	NPK @100% + Zn @100% + Fe@100%	13.92	26.44	38.43	45.53	29.70	8.68	2.09
	F-test	S	S	S	S	S	S	S
	C.D. at 5%	0.156	0.108	0.323	0.849	0.865	0.215	0.808
	S.Ed. (+)	0.073	0.051	0.152	0.400	0.408	0.101	0.381

Conclusion

It revealed from the trial the T₉[NPK @100% + Zn @100% + Fe@100%] is considered the best treatment for the physicochemical properties followed by T₅[NPK @50% + Zn @50% + Fe @100%] and then T₁[NPK @0% + Zn @0% + Fe @0%]. The highest cost benefit ratio was recorded in T₈ [NPK @100% + Zn @50% + Fe@100%] *i.e.* 1:2.49 followed by T₅[NPK @50% + Zn @50% + Fe @100%] *i.e.* 1:2.41.

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