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

Abstract

A study on the effects of NPK, zinc, and iron on soil health and yield parameters of greengram was carried out in the crop research farm, department of Soil Science and Agricultural Chemistry at SHUATS, Prayagraj, from May to July of 2023. Nine treatments were used in a randomised block design (RBD) experiment, each of which was replicated three times. During the sowing process, NPK fertiliser, zinc, and iron were added to the soil. The recommended doses of zinc and iron are 15 kg ha^{-1} and 20 kg ha^{-1}, respectively, and of NPK are 25:50:25. 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 T_9 - [[NPK @100% + Zn @100% + Fe @100%]. Bulk density, particle density and soil pH were recorded maximum in T_1- [NPK @ 0 % + Zn @ 0 %+ Fe @ 0%]. Available phosphorous was recorded maximum in T_7- [NPK @100% + Zn @0% + Fe @100%] whereas available zinc was recorded maximum in T_3- [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 greengram situations for Prayagraj region.

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

1. 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. When growth conditions are suitable, greengram, often known as mung beans, go through an epigeal germination process that takes 4-5 days[51,52,53,54].The plant has numerous lateral roots and a well-developed root system with root nodules. 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).** Green gramme is known as the "green pearl" because of its high nutritient content **(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).** By improving the physical, biological, and chemical characteristics of the soil as well as its fertility status through biological nitrogen fixation in a symbiotic relationship with rhizobium from the atmosphere and by mushrooming the number of soil microorganisms, pulses enhance soil health. **(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).**

Among all the macronutrients that are typically applied as commercial fertilisers, nitrogen is the first ingredient. Given that it appears to have the most immediate and noticeable effect, nitrogen is one of the most vital nutrients for plants. Nitrogen gives plants their dark colour and promotes their above-ground vegetative growth. In plants, nitrogen plays a unique role in the synthesis of protein. A lack of nitrogen might cause plants to develop more slowly.

The second fertiliser ingredient is phosphorus, which is necessary for the nourishment of plants as well as for every living cell. It participates in every kind of plant metabolism. It is a structural element of the cell membrane system and a necessary component of most enzymes. Root growth is stimulated by phosphorous. It stimulates rhizobial activity and the production of crop nodules.

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.

2. 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
T_1	[NPK @ 0% + Zn @ 0% + Fe @ 0%]
T_2	[NPK @ 0% + Zn @ 50% + Fe @ 100%]

T_3	[NPK @ 0% + Zn @100% + Fe @ 100%]
T_4	[NPK @ 50% + Zn @ 0% + Fe @ 100%]
T_5	[NPK @ 50% + Zn @ 50% + Fe @100%]
T_6	[NPK @ 50% + Zn @ 100% + Fe @ 100%]
T_7	[NPK @ 100% + Zn @ 0 % + Fe @ 100 %]
T_8	[NPK @100% + Zn @ 50% + Fe @ 100 %]
T_9	[NPK @100 % + Zn @ 100% + Fe @ 100 %]

3. Result and Discussion

3.1. 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 T_9 [NPK @100% + Zn @100% + Fe @100%] followed by 45.25% and 45.64 % in T_5 [NPK @50% + Zn @50% + Fe @100%] and minimum was 43.13 % and 43.21% in T_1- [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 T_9 [NPK @100% + Zn @100% + Fe @100%] followed by 48.60% and 48.48 % in T_5 [NPK @50% + Zn @50% + Fe @100%] and the minimum value recorded was 46.21% and 46.15% in T_1 [NPK @0% + Zn @0% + Fe @0%]. Similar findings were recorded by **Tarun *et al.* (2022).**

		Bulk density (Mg m^{-3})		**Particle density (Mg m^{-3})**		**Water holding capacity (%)**		**Pore space (%)**	
Treatment	**Treatment Combination**	**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-test	**NS**	**NS**	**NS**	**NS**	**S**	**S**	**S**	**S**
	C.D. at 5%	**0.032**	**0.029**	**0.341**	**0.301**	**0.135**	**0.068**	**0.151**	**0.059**
	S.Ed. (+)	**0.015**	**0.013**	**0.161**	**0.142**	**0.064**	**0.032**	**0.071**	**0.028**

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

3.2. 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 T_1 [NPK @ 0 % + Zn @ 0 %+ Fe @0%] and the minimum pH of soil 6.85 and 6.92 was found in treatment T_9 [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 T_9 [NPK @100% + Zn @100% + Fe @100%]. The minimum EC value 0.21 dSm^{-1} and 0.23 dSm^{-1} was recorded in T_1[NPK @0% + Zn @0% + Fe @0%]. The maximum value of EC in T_9 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 T_9 [NPK @100% + Zn @100% + Fe @100%] and minimum organic carbon of soil 0.30% and 0.28 % was found in treatment T_1 [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 T_9 [NPK @100% + Zn @100% + Fe @100%] followed by 303.20 Kg ha^{-1} and 304.99 kg ha^{-1} was found in T_7 [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 T_1 [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 T_7 [NPK @100% + Zn @0% + Fe @100%] followed by 30.87 and 31.64 kg ha^{-1} in T_4 [NPK @50% + Zn @0% + Fe @100%] and the minimum value recorded was 26.48 Kg ha^{-1} and 28.05 kg ha^{-1} in T_1 [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 T_9 [NPK @100% + Zn @100% + Fe @100%] followed by 207.99 kg ha^{-1} and 211.4 kg ha^{-1} in T_7 [NPK @100% + Zn @0% + Fe @100%] and the minimum available potassium recorded was 180.85 and 182.84 kg ha-^{1} in T_1 [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 T_3 [NPK @0% + Zn @100% + Fe @100%] followed by 0.91 kg ha^{-1} and 0.89 kg ha^{-1} in T_9 [NPK @100% + Zn @100% + Fe @100%] and the minimum value recorded was 0.71 kg ha^{-1} and 0.75 kg ha^{-1} in T_1 [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 T_9 [NPK @100% + Zn @100% + Fe @100%] followed by 6.47 kg ha^{-1} and 6.78 kg ha^{-1} in T_5 [NPK @50% + Zn @50% + Fe @100%] and the minimum value recorded was 5.10 kg ha^{-1} and 5.07 kg ha-^{1} in T_1 [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

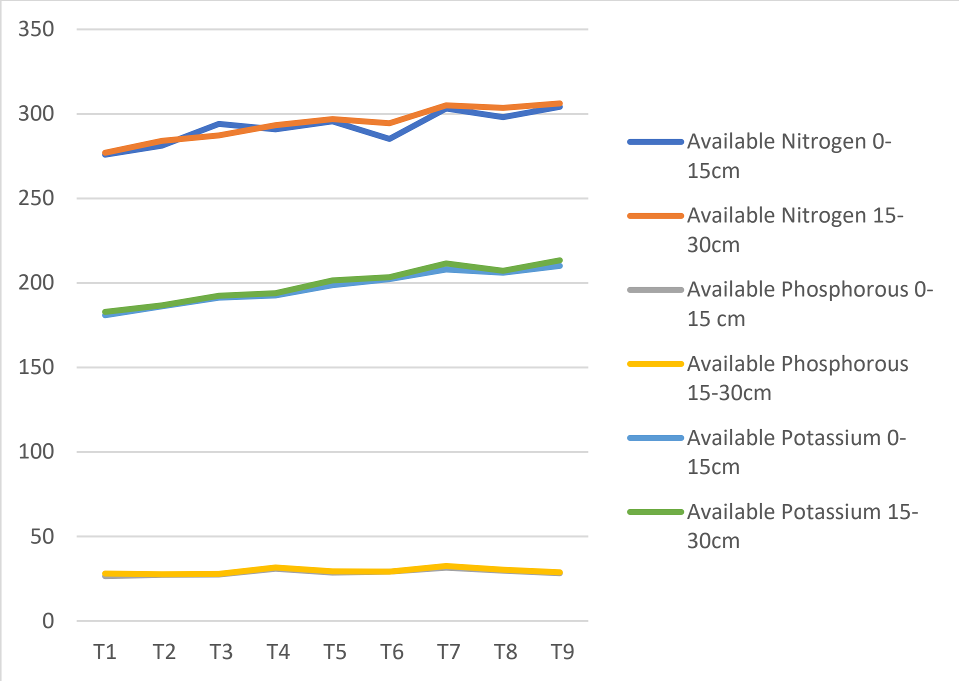

Fig 2. Effect of NPK, Zinc and Iron on available Zinc and Iron of Post-harvest soil

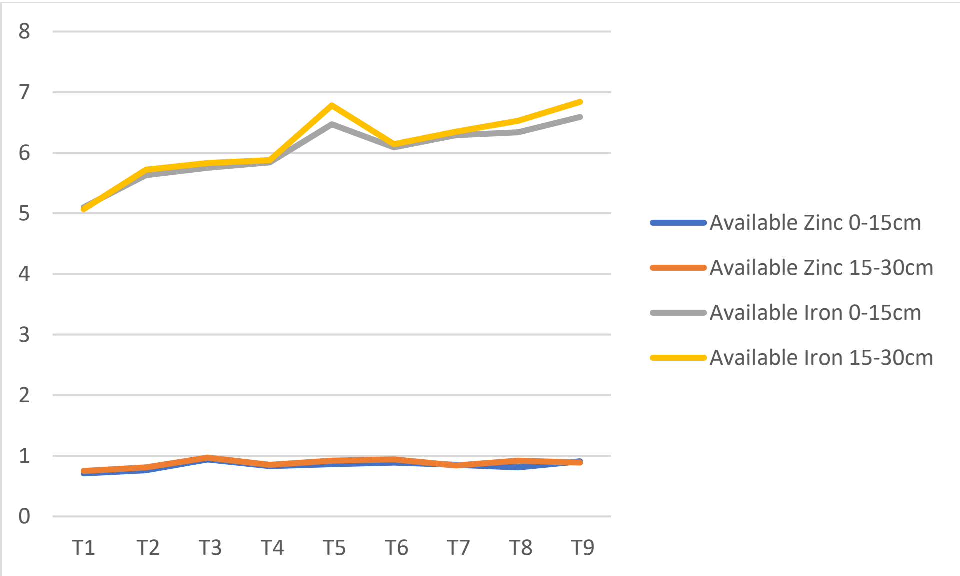

Table 3. Effect of NPK, Zinc and Iron on soil pH, soil EC (dS m^{-1}) and organic carbon

(%) of post-harvest soil

		Soil pH		Soil EC (dS m^{-1})		organic carbon (%)	
Treatment	**Treatment Combination**	**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**	**0.380**	**0.112**	**0.131**	**0.02**	**0.018**
	S. Ed. (+)	**0.138**	**0.179**	**0.052**	**0.061**	**0.01**	**0.008**

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

		Available Nitrogen (kg ha^{-1})		Available phosphorous (kg ha^{-1})		Available potassium (kg ha^{-1})	
Treatment No.	**Treatment Combination**	**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
T3	NPK @0% + Zn @100% + Fe @100%	294.00	287.31	27.55	27.77	191.17	192.40
T4	NPK @50% + Zn @0% + Fe @100%	290.87	293.40	30.87	31.64	192.57	194.00
T5	NPK @50% + Zn @50% + Fe @100%	295.64	296.86	28.54	29.43	198.70	201.55
T6	NPK @50% + Zn @100% + Fe @100%	285.12	294.49	29.07	29.24	202.18	203.29
T7	NPK @100% + Zn @0% + Fe @100%	303.20	304.99	31.50	32.51	207.99	211.49
T8	NPK @100% + Zn @50% + Fe@100%	298.07	303.58	29.75	30.27	205.99	207.18
T9	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

		Available Zinc (Mg kg^{-1})		Available Iron (Mg kg^{-1})	
Treatment No.	**Treatment Combination**	**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**

3.3. 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 T_9 [NPK @100% + Zn@ 100% + Fe@100%] Followed by T_5 [NPK@ 50% + Zn@ 50% + Fe@100%] and the minimum plant height was recorded in T_1 [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 T_9 [NPK @100% + Zn @100% + Fe @100%] followed by T_5[NPK @50% + Zn @50% + Fe @100%] and the minimum No. of pods plant^{-1} was recorded in T_1[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 T_9 [NPK @100% + Zn @100% + Fe @100%] followed by T_5 [NPK @50% + Zn @50% + Fe @100%] and the minimum No. of seeds pod $^{-1}$ was recorded in T_1 [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 T_9 [NPK@100% + Zn @100% + Fe @100%] followed by T_5[NPK @50% + Zn @50% + Fe @100%] and the minimum grain yield was recorded in T_1 [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**

4. Conclusion

The results of experiment on Effect of NPK, zinc and iron on soil health and yield parameters of greengram was found positively significant on Percentage pore space, Water holding capacity, Percentage organic carbon, Av. Nitrogen, Phosphorus, Potassium, zinc and iron while Bulk density, Particle density and pH and EC was found non-significant. Treatment T_9 [NPK @100% + Zn @100% + Fe @100%] was found most effective in improving Physico-chemical properties of soil. Similarly, the maximum plant height, number of pods plant^{-1}, no of seeds pod^{-1}, Grain yield treatment T_9 [NPK @100% + Zn @100% + Fe @100%]. It is also recorded that treatment T_8 [NPK @100% + Zn @50% + Fe@100%] gave maximum Net Return of ₹ 140975.40 ha^{-1} with Cost benefit ratio of 1:2.49.

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