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INTERACTIVE EFFECT OF ZINC AND IRON ON PHYSICO-CHEMICAL PROPERTIES OF SOIL OF FIELD PEA

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Abstract– A field experiment was conducted during *Rab*i season (November 2021-February 2022) at Central Research Farm NAI. SHUATS, analysed under RBD having nine treatments and three replications having three level of Zinc 0%, 50%, 100% and three level of Iron 0%, 50%, 100%. The results reported the significant improvement in soil chemical properties (EC (dS m^{-1}) Organic Carbon (%), Available Nitrogen (Kg ha^{-1}). Available Phosphorus (kg ha^{-1}), Available Potassium (Kg ha^{-1}), Available Zinc (mg Kg^{-1}), Available Iron (mg Kg^{-1})). However, Bulk density (Mg m^3), Particle density (Mg m^3), pH showed Non-significant improvement. Chemical properties of the soil increased with application of levels of Zn and Fe, Available NPK, Zn and Fe where found in moderate range. The application of Zn and Fe significantly improved the soil Physico-chemical properties. Increase in level of Zn application decreased in available Fe and P in the soil and increase in level of Fe application increased in available P and decreased in available Zn in soil.

INTRODUCTION

The pea (*Pisum sativum* L.) is one of the world's most important vegetables, ranking among the top ten vegetable crops. Peas are commonly utilised in human diet all over the world, and they are rich in protein (21-25%), carbs, vitamin A and C, calcium, phosphorus, and amino acids, lysine, and tryptophan. Cultivation helps to preserve soil fertility by biological nitrogen fixation in conjunction with symbiotic rhizobium found in its root nodules, and hence plays an important part in promoting sustainable agriculture. Peas are known to leave residual nitrogen in soil of 50-60 kg/ha in addition to meeting their own nitrogen requirements (Prakash *et al.,* 2017). Uttar Pradesh, Madhya Pradesh, Jharkhand, Punjab, Himachal Pradesh, West Bengal, Haryana, Bihar, Uttarakhand, Orissa, and Karnataka are the major pea-growing states. (Navneet Singh *et al.,* 2020).

In terms of development and yield, pea responds strongly to major critical nutrient components including nitrogen, phosphorus, and potassium. Phosphorus is a necessary component of deoxyribonucleic acid (DNA), which is the source of genetic information in plants, and various types of ribonucleic acid (RNA), which are required for protein synthesis. It's also a component of adenosine diphosphate (ADP) and adenosine triphosphate (ATP), two chemicals involved in some of the most important energy transformations in plants, including food absorption, transport, and synthesis. Phosphorus is essential for plant cell division, flowering, and fruiting, as well as seed generation, crop maturation, root development, and crop quality improvement.

Zinc is essential for chlorophyll production, protein synthesis, and water absorption regulation. It also aids in the digestion of carbohydrates and the activation of numerous enzymes. Zinc insufficiency is the most often reported deficit. Zinc shortage has been recorded in many states of India. Zinc is a component of a range of enzymes, including carbonic anhydrates and alcohol dehydrogenases, and is required for the manufacture of plant hormones such as Indole acetic acid (IAA). Zinc is required for nucleic acid and protein synthesis. It also aids in the consumption of phosphate and nitrogen, as well as seed physiology. (Rohith *et al.*, 2020). Some metal cations, such as Cu2+ and Fe2+, restrict zinc uptake by plants, (due to the same carriers forthese elements in the plant roots). (Sayed Roholla Mousavi, 2011).

Fe concentration in soil and plants is higher than P and S levels among the eight minerals. It is important in enzymes such as cytochrome oxidase, catalase, and peroxidase. It is abundant in soils, but its availability to plants is typically poor, making Fe deficiency a prevalent concern. Fe plays the crucial role in enhancing crop yield. Excessive application of Zn, Mn, and Cu causes Fe deficiency in crops, which was first recorded in the early 1960s (Pingoliya *et al.*, 2014).

MATERIALS AND METHODS

Experimental site: The experiment was conducted at CRF NAI, SHUATS' Prayagraj. Field pea variety MD-10 was selected for this experiment as it grows well in this region and gives good yield. Soil: After the crop was harvested, samples were collected from the experimental plot at random depths of 0-15 cm and 15-30 cm with the help of soil auger and khurpi. The soil sample was reduced in size by canning and quartering. Experimental Design and Treatments: A RBD was used for experiment by taking Zn and Fe with different levels (0, 50%, 100%). Sources of NPK were urea, SSP, MOP (20:60:40) and Zn, Fe were Zinc sulphate (25Kg ha^{-1}), ferrous sulphate (10Kg ha^{-1}). Soil physical properties, i.e. Db, Dp, Percent Pore space and Water holding Capacity was determined by Graduated Measuring Cylinder and soil texture by hydrometer. In terms of chemical characteristics, pH was determined by pH meter (Jackson, 1958), EC by EC bridge digital conductivity meter (Wilcox, 1950), The method of wet-oxidation by Walkley and Black's (1934) was employed to determine Organic Carbon. Amount of Available Nitrogen was determined using Alkaline permanganate oxidation method by Subbiah and Asija (1956) method; the amount of Available Phosphorus was estimated using Spectrophotometer Olsenetal, (1954). The amount of available Potassium was determined by Neutral Ammonium Acetate Extraction followed by Flame Photometer Tothand Prince (1949). DTPA extraction was used to determine available Zn and Fe using an Atomic Absorption Spectrophotometer (Lindsay and Norvell).

RESULTS AND DISCUSSION

Effect of Zn and Fe on soil physical properties

Maximum bulk density was recorded in (100%Zn+100%Fe) T_9, i.e. 1.354Mg m^{-3}, 1.356Mg m^{-3} and Lowest bulk density was recorded inabsolute control T_1, i.e.1.348Mg m^{-3}, 1.350Mg m^{-3} at 0-15 cm and 15-30 cm soil depth respectively. Lowest particle density was recorded into T_1, i.e.2.454Mg $m^{-3}$and 2.456Mg $m^{-3}$and maximum particle density was recorded in absolute control into T_9, i.e. 2.512 Mg m^{-3} and 2.516Mg m^{-3} at 0-15 cm and 15-30 cm soil depth respectively. Similar result was recorded by Shilpa and Dongale (2011). The highest pore space (%) of soil was found at T_9 46.13%, 45.99% and wasat par with T_9 (0-15cm), T_8 (15-30cm) and the minimum was found in T_1 43.279, 43.24 at 0-15 cm and 15-30 cm soil depth respectively. Maximum Water holding capacity was recorded into T_9, i.e. 56.02, 53.86% at par with T_9 (0-15 and 15-30 cm) and minimum water holding capacity recorded in absolute control into T_1, i.e. 53.64, 49.30% at 0-15 cm and 15-30 cm soil depth respectively. Similar results were reported by Prakash *et al*. (2017).

Effect of Zn and Fe on Chemical Properties

Maximum soil pH observed in T_9, i.e. 7.696, 7.699 and minimum in T_1, i.e. 7.656, 7.655 in 0-15 cm and 15-30 cm soil depth respective. Maximum electrical conductivity (dSm^{-1}) was observed in T_9, i.e. 20251dSm^{-1}, 0.248 dSm^{-1}, at par with T_8(15-30cm), T_7 (10-15cm) and minimum in absolute control i.e. T_1, i.e. 0.216dSm^{-1}, 0.213 dSm^{-1} at 0-15 cm and 15-30 cm soil depthrespective. Maximum OC was found in T_9, i.e. 0.696 %, 0.690 %, at par with T_2(15-30cm depth), T_3 (15-30cm depth) and minimum OC were recorded in absolute control, i.e. T_1 0.620%, 0.618 % 0-15 cm and 15-30 cm soil depths respectively. Maximum amount of Nitrogen (kg ha^{-1}) was recorded in the treatment T_9, i.e. 263.46kg ha^{-1} and 259.93kg ha^{-1}, at par with T_7 (0-15cm), T_8 (15-30cm). Minimum available nitrogen was recorded in treatment T_1, i.e. 254.40 kg ha^{-1} and 253.52kg ha^{-1} 0-15 cm and 15-30 cm soil depth respectively. Maximum Available potassium (kg ha^{-1}) was recorded in treatment T_9, i.e. 164.08kg ha^{-1} and 163.27kg ha^{-1}, at par with T_8(0-15 and 15-30cm depth). Minimum available potassium was recorded in treatment T_1 i.e. 160.25 kg ha^1, 160.10 kg ha^1 0-15 cm and 15-30 cm soil depth

Treatments	Depth (cm)	BD (Mg m^{-3})	PD (Mg m^{-3})	Pore Space (%)	WHC (%)	pH	EC dSm^{-1}	OC (%)	N (Kg/ha)	P (Kg/ha)	K (Kg/ha)	Zn (mg/Kg)	Fe (mg/kg)
T1	0-15	1.348	2.454	44.82	48.49	7.654	0.216	0.620	254.40	15.57	160.25	0.52	4.4
	15-30	1.350	2.456	44.78	48.29	7.655	0.213	0.618	253.52	14.92	160.10	0.47	4.0
T2	0-15	1.352	2.455	44.92	48.66	7.656	0.220	0.626	255.96	17.78	161.07	0.50	5.2
	15-30	1.354	2.459	44.90	48.40	7.658	2.217	0.622	253.82	17.17	160.70	0.47	4.8
T3	0-15	1.351	2.454	44.94	48.89	7.657	0.229	0.628	256..06	18.37	161.36	0.48	5.7
	15-30	1.352	2.458	44.93	48.72	7.659	0.226	0.624	254.36	17.69	161.15	0.47	5.3
T4	0-15	1.352	2.455	44.92	49.15	7.660	0.231	0.632	256.56	15.57	161.52	0.56	4.2
	15-30	1.353	2.456	44.91	49.02	7.662	0.228	0.628	254.77	15.01	161.27	0.53	4.0
T5	0-15	1.351	2.457	45.05	49.46	7.662	0.242	0.636	258.40	16.06	162.24	0.57	4.7
	15-30	1.354	2.459	45.01	49.24	7.663	0.239	0.632	255.31	15.86	162.02	0.54	5.1
T6	0-15	1.352	2.461	45.10	50.02	7.660	0.237	0.640	259.56	16.12	162.88	0.52	5.5
	15-30	1.355	2.463	45.06	49.56	7.662	0.234	0.636	255.96	15.80	162.30	0.50	5.1
T7	0-15	1.351	2.463	45.14	50.37	7.662	0.244	0.643	261.70	14.57	163.15	0.66	4.0
	15-30	1.353	2.466	45.13	50.12	7.663	0.241	0.640	256.63	14.25	162.82	0.64	3.6
T8	0-15	1.350	2.465	45.23	51.79	7.661	0.248	0.648	261.92	15.77	163.56	0.63	4.8
	15-30	1.351	2.467	45.23	50.57	7.662	0.245	0.646	258.98	15.43	163.19	0.58	4.4
T9	0-15	1.354	2.467	45.32	52.04	7.663	0.251	0.654	262.46	15.76	164.08	0.60	5.0
	15-30	1.356	2.469	45.35	51.26	7.665	0.248	0.650	259.63	15.48	163.27	0.56	4.6
S.Em. (±)	0-15	-	-	0.005	0.057	-	0.175	0.029	0.416	0.062	0.080	0.016	0.147
	15-30	-	-	0.010	0.022	-	0.173	0.014	0.181	0.171	0.051	0.013	0.080
C.D. at 5%	0-15	-	-	0.017	0.017	-	0.005	0.031	1.248	0.187	0.242	0.049	0.442
	15-30	-	-	0.032	0.068	-	0.004	0.030	0.543	0.514	0.153	0.041	0.242
F-test	0-15	NS	NS	S	S	NS	S	S	S	S	S	S	S
	15-30	NS	NS	S	S	NS	S	S	S	S	S	S	S

respectively. Similar result reported by Chethan KV *et al*. (2018); Rohit *et al.* (2020); Prakash *et al*. (2017). Maximum Available phosphorous was recorded in T_3, i.e. 18.37 kg ha^{-1} and 17.36kg ha^{-1}, at par with T_3 (0-15cm), T_2 (15-30cm). Minimum was recorded in T_7, i.e. 14.57kg ha^1 and 14.25kg ha^1 0-15 cm and 15-30 cm soil depth respectively. Maximum Available Zinc was recorded in T_7, i.e. 0.66mg/Kg and 0.63 mg/Kg, at par with T_8(0-15 and 15-30cm depth) and minimum was recorded in T_3, i.e 0.50 63 mg/Kg and 0.4563 mg/Kg 0-15 cm and 15-30 cm soil depth respectively. Available Fe was recorded maximum in T_3, i.e. 5.7 mg/Kg and 5.3 mg/Kg, at par with T_2 (0-15cm), T_9 (0-15cm) and minimum was recorded in T_7, i.e. 4.0 mg/Kg and 3.6 mg/Kg 0-15 cm and 15-30 cm soil depth respectively. Increase in dose of Fe lead to Increase in available P and decrease in available Zn in soil, this is due to precipitation of zinc as Zn phosphate and Fe depress the solubility of Zn through formation of $ZnFe_2O_4$. Simlar were found in Rajendra Prasad *et al*., 2016 and Lambert *et al.*, 2007

CONCLUSION

The research conducted on yield, physical, and chemical parameters of soil following field pea harvest has concluded that the application of macro and micro nutrients played a crucial influence on yield, physical, and chemical characteristics of soil. The results showed that adding NPK, Zn, and Fe to the soil after harvesting field pea plants improved yield, physical, and chemical properties. The highest yield components, as well as physical and chemical parameters of soil, were obtained in treatment T_9. Based on the

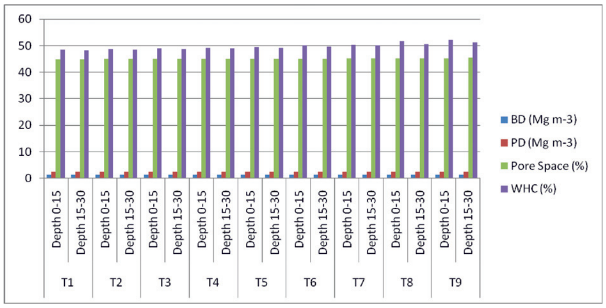

Fig. 1. Effect of zinc and iron fertilizers on Physical Properties of soil.

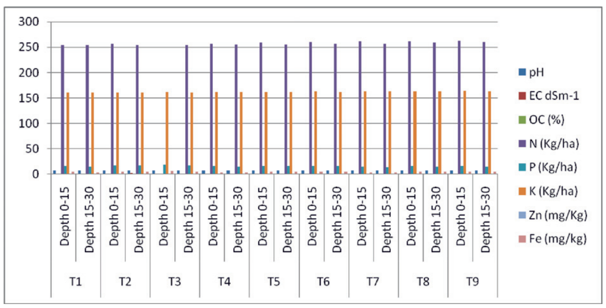

Fig. 2. Effect of zinc and iron fertilizers on Chemical properties of soil

above findings, it was concluded that nutrient management with recommended dose of Nitrogen, Phosphorus, Potassium, 100% Fe and 100% Zinc improved the Physico-Chemical properties of soil and maximum growth, yield of field pea. As shown in the above table, Increase in doses of Zn lead to the decrease in available Fe and P in soil as Zn is antagonistic to these two elements. Increase in dose of Fe lead to Increase in available P and decrease in available Zn in soil, this is due to precipitation of zinc as Zn phosphate and Fe depress the solubility of Zn through formation of $ZnFe_2O_4$.

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