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Nutrient content, uptake, quality of chickpea and fertility status of soil as influenced by fertilization of Phosphorus and Zinc

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Abstract

A field experiment was conducted at Agronomy farm, College of Agriculture, Bikaner during *Rabi,* 2009-10. The experiment was laid out in factorial randomized block design with three replications, assigning twelve treatments consisting of four levels of phosphorus (control, 20, 40 and 60 kg ha^{-1}) and three levels of zinc (control, 3.0 and 6.0 kg ha^{-1}). The results indicated that N content and uptake in grain increased significantly with increasing levels of phosphorus upto 60 kg ha^{-1} but N content and uptake in straw increased significantly upto 40 kg P_2O_5 ha^{-1}. P content and uptake by grain and straw was significantly increased by applying increasing level of phosphorus upto 60 and 40 kg P_2O_5 ha^{-1}, respectively. Zn content and uptake in grain and straw decreased significantly with increasing levels of phosphorus. Increasing level of phosphorus application increased significantly the available nitrogen, phosphorus and potassium content in soil after harvest of the crop. Significant decrease in available zinc in soil was observed with increasing level of phosphorus upto 60 kg P_2O_5 ha^{-1}. N and Zn content and uptake by seed and straw increased significantly with increasing levels of zinc upto 6.0 kg ha^{-1}. But P content in grain and straw was decreased significantly with increasing level of zinc.

Keywords: Nutrient content, Uptake, Protein content, Chickpea, Fertility

1. Introduction

Chickpea *(Cicer arietinum* L.) is one of the major Rabi pulse crop which has high digestible dietary iron, niacin, vitamin C and B. Its leaves contain malic acid which is very useful stomach ailments and blood purification. India is the largest producer and importer of the leguminous crops (Shakya, *et al.*, 2008) [33]. Amongst the leguminous crops, Chickpea occupies an important position due to its nutritious value (17-23% protein) in large vegetarian population of the country (Ali and Kumar, 2006) [3]. According to Akhtar and Siddiqui, 2009, during last decade the production of chickpea has declined. In India, it occupies about 9.18 million hectare area with production of 8.22 million tonnes and an average productivity of 900 kg ha-1 (Anonymous, 2013) [5]. Rajasthan is one of the important chickpea growing states and ranks second in respect of area as well as in production after Madhya Pradesh. In Rajasthan, chickpea crop occupied 12.60 lakh hectares and production is 9.80 lakh tonnes with productivity of 778 kg ha-1 (Anonymous 2009) [4]. Fertilizers are the most important inputs in crop production. An adequate supply of chemical fertilizers is closely associated with growth and development of plant (Dinesh *et al*, 2014) [10]. Among the various factors of low productivity lack of application of phosphorus seems to be important. Phosphorus is an important fertilizer for chickpea production (Dotaniya *et al*., 2014) [11]. Being a leguminous crop, it is capable to fix atmospheric N in the soil and 'hence. Requirement of nitrogen is low. Similarly zinc is also an important micro nutrient element which increases resistance to disease in plant. However, Khan *et al.* (2003, 2004) [20, 21] reported that applying Zn increased yield and quality of chickpea. Now days, wide spreads deficiency of zinc is observed in various part of country which limit to the production of crops. Zn application has been noticed in chickpea grown on zinc deficient soil. Phosphorus and Zinc application improved the fertility status of soil and produce higher grain yield of chickpea. A field study was under taken to assess the effect of phosphorus and zinc on nutrient content uptake and quality of chickpea.

2. Material and methods

A field experiment using chickpea as test crop was conducted at Agronomy farm, College of Agriculture, Bikaner during *Rabi*, 2009-10. The experimental site is located in north direction at 28.01° N latitude and 73.22 ° E longitude with an altitude of 234.70 meters above sea level

This region falls under agroclimatic zone I-C [Hyper Arid Partially Irrigated Western Plain Zone] of Rajasthan and agroclimatic zone XIV [Western Dry Region] of India. The soil of experiment site was loamy sand in texture containing 87.72, 20.72 and 164.14 kg ha^{-1} available nitrogen, phosphorus and potassium, respectively in 0-30 cm depth with pH 8.15, EC 0.15 dS m^{-1} and organic carbon 0.08 per cent. The experiment was laid out in factorial randomized block design with three replications, assigning twelve treatments consisting of four levels of phosphorus (control, 20, 40 and 60 kg ha^{-1}) and three levels of zinc (control, 3.0 and 6.0 kg ha^{-1}). The treatments were allotted to various plots with the help of random table as advocated by Fisher (1950). The net plot size 3.0 m x 1.8 m was used for yield and other related studies. Crop variety GNG – 663 developed from a cross between GNG-16x GNG- 146 and identified for North West Plain Zone by varietal evaluation committee during rabi pulses group meet in 1994. The fertilizer applied as nitrogen@ 20 kg ha^{-1} through urea as basal, phosphorus as per treatment through dio ammonium phosphate (DAP) and zinc as per treatment through zinc sulphute. Seed and straw samples collected at harvest were dried (65±2 °C for 48 hr) ground to a fine powder for estimation of N, P and Zn content. Nitrogen content in the seed and straw was estimated as described by Snell and Snell (1949) with slight modification of Nesselar's reagent. Phosphorus was estimated by molybdante vabnadete yellow colour method in diacid digest (Jackson, 1973) [18]. Zn content in triacid digest was estimated by atomic absorption spectrophotometer (Dhyan singh, 2003) [9]. The protein content in chickpea seed was calculated by multiplying per cent nitrogen in the cabbage head by the factor 6.25 (A.O.A.C., 1960) [1]. Initial soil samples were collected from 0-30 cm depth soil collected from chickpea grown field from each plot at harvesting of crop and brought to laboratory. Air dried soil samples were ground to pass through 2.0 mm mesh sieve. Processed soil samples were then subjected to electro-chemical. The results obtained and analyzed standard procedures have been presented in Table 1. Data were analyzed statistically as per Panse and Sukhatme (1985) [29], using the statistical computer programme MSTAT, version 5.

3. Result and discussion

Nutrient content, uptake and quality

Nitrogen content and uptake: Nitrogen content and uptake by seed and straw of chickpea were significantly influenced with increasing levels of phosphorus and zinc (table-2). Nitrogen content and uptake by seed of chickpea increased significantly due to successive levels of phosphorus. Significantly maximum N content (3.96 %) and uptake (56.45 kg ha^{-1}) by seed of chickpea were recorded with 60 kg P_2O_5 ha^{-1}. It was showed superiority over rest of treatment. But the N content (1.01 %) and uptake (23.18 kg ha^{-1}) by straw of chickpea were significantly found in 40 kg P_2O_5 $ha^{-1,}$ which was at par with 60 kg P_2O_5 ha^{-1}. Minimum N content (2.74 & 0.60%) and uptake (23.78 & 13.17 kg ha^{-1}) by seed and straw of chickpea were recorded in control, respectively. This might be due to well-developed root system which helps in increased nitrogen fixation and its availability to plant along with other nutrients. Similar results have also been reported by Kumar (2000) [23] and Dadheech (2001) [8].

Fertilization of zinc significantly increased nitrogen content and uptake by seed and straw of chickpea. Maximum content (3.81 & 1.02 %) and uptake (54.56 & 23.83 kg ha^{-1}) of N by seed and straw of chickpea were recorded with 6.0 kg Zn ha^{-1} and which was showd superiority over rest of treatments. A significant increasing trend of nitrogen content and uptake in grain and straw might due to protein content in chickpea. The protein, carbohydrates and fat synthesis on account of stimulating effect of Zn application on several dehydrogenease, proteinase and peptidase enzyme as it is a constituents of these enzymes. Similar results have also beeen observed by Gupta (2001) [16], Singh *et al.* (2001) [38] and Wasmatkar *et al*. (2002) [42].

It is revealed that the interaction effect of phosphorus and zinc was also found significant on nitrogen content in seed (Table - 3). The significantly higher nitrogen content in seed (4.10%) was recorded under 40.0 kg P_2O_5 ha^{-1} in combination with 6.0 kg Zn ha^{-1}, which was at par with other treatment combination 60.0 kg P_2O_5 ha^{-1} + 3.0 kg Zn ha^{-1} and 60.0 kg P_2O_5 ha^{-1} + 6.0 kg Zn ha^{-1}. Minimum nitrogen content in seed (2.23%) was recorded when neither phosphorus nor zinc was applied.

Phosphorus content and uptake: An appraised that phosphorus content and uptake by seed and straw were significantly increased due to increasing levels of phosphorus in chickpea crop. Significantly P content (0.527 %) and uptake (7.37 kg ha^{-1}) by chickpea seed were reported with application of 40 kg P_2O_5 ha^{-1} and percentage increment of P content (41.84 and 14.47%) and uptake (137.25 and 3.96%) per cent over control and 20 kg P_2O_5 ha^{-1}, respectively. However it remained at par with 60 kg P_2O_5 ha^{-1}. But P content and uptake by straw of chickpea increased significantly with the increasing phosphorus levels. Significantly maximum P content (0.302%) and uptake (7.19 kg ha^{-1}) were found with 60 kg P_2O_5 ha^{-1} and which was increased the P content in straw to the tune of 35.42, 16.60 and 5.96 % and uptake 78.85, 33.64 and 11.12 per cent over control, 20 and 40 kg P_2O_5 ha^{-1}, respectively. The significant increasing trend of phosphorus content and uptake by grain may due to increased concentration of phosphorus in soil solution with increasing phosphorus application and increase in biological activity by P-solubilization. Similar results have also been reported by Singh *et al.* (2003) [36], Jat and Ahalawat (2004) [19], Meena *et al.* (2005) [25] and Singh & Prasad (2008) [37].

Application of zinc adversely affects the content of phosphorus and uptake by seed and straw significantly reduced up to 6 kg Zn ha^{-1}. Maximum phosphorus content in Seed (0.518%) and straw (0.287%) and uptake by seed (5.07) and straw (5.66) kg ha^{-1} were recorded with no zinc application and it significantly reduced the phosphorus content to the tune over 3 kg Zn ha^{-1} and 6 kg Zn ha^{-1}, respectively. Phosphorus content in grain and straw showed decreasing trend in response to different levels of zinc but phosphorus uptake in seed significantly increased up to 3.0 kg ha^{-1} however, phosphorus uptake in straw was found non-significant as compared to control. The reduction in the content of phosphorus due to application of zinc may be due to the antagonistic reaction between zinc and phosphorus. Their interaction in soil may also be partially responsible for this. Phosphorus uptake in seed increased due to increase in yield. Findings were similar to the reports given by Singh *et al.* (2001) [38] and Wasmatkar *et al*. (2002) [42].

The interactive effect of phosphorus and zinc application was found to be significant on phosphorus content in seeds. The maximum phosphorus content in (0.586 per cent) was recorded in 60 kg P_2O_5 ha^{-1} with 0 level of zinc which was significantly higher with other treatment combinations and minimum (0.343 per cent) was observed with the application of 0 kg P_2O_5 ha^{-1} with 6.0 kg ha^{-1} level of zinc (table-4). The significantly higher phosphorus uptake by seed (7.50 kg ha^{-1}) was recorded under 40.0 kg P_2O_5 ha^{-1} in combination with 3.0 kg Zn ha^{-1}, which was at par with other treatment combination 40.0 kg P_2O_5 ha^{-1} + 6.0 kg Zn ha^{-1}, 60.0 kg P_2O_5 ha^{-1} + 0.0 kg Zn ha^{-1}, 60.0 kg P_2O_5 ha^{-1} + 3.0 kg Zn ha^{-1} and 60.0 kg P_2O_5 ha^{-1} + 6.0 kg Zn ha^{-1} (table-5). Minimum phosphorus uptake by grain (1.80%) was recorded when neither phosphorus nor zinc was applied.

Zinc content and uptake: It is clear that application of phosphorus adversely affects the zinc content in grain and significantly reduced up to 60 kg P_2O_5 ha^{-1}. Maximum Zn content in seed of chickpea was recorded with no phosphorus application (0.518 mg/kg) and minimum with 60 kg P_2O_5 ha^{-1} (0.347 mg/kg). The Zn content in straw and significantly reduced up to 60 kg P_2O_5 ha^{-1} and maximum (0.313 mg /kg) Zn content in straw was observed in control and it was significantly reduced by 13.00, 26.21 and 36.68 per cent over 20, 40 and 60 kg P_2O_5 ha^{-1} respectively and minimum (0.229 mg/kg) Zn content in straw was observed in 60 kg P_2O_5 ha^{-1}. Zinc uptakes by straw were influenced non-significantly due to different levels of phosphorus application. Application of phosphorus adversely affected the zinc content in grain and straw but uptake of zinc by grain was increased upto 40 kg P_2O5 ha^{-1}. After increasing doses of phosphorus reduced zinc uptake. It might be due to antagonistic effect of P and Zn. Higher concentration of P in soil from insoluble zinc phosphate which reduces uptake of zinc by grain and straw, eventually reduce the zinc content in grain and straw. The uptake of zinc increased upto some level due to increased biomass of crop and less formation of zinc phosphate. Similar findings were also reported by Enania and Vyas (1994) [13] and Reddy & Ahlawat (1998) [31].

It is also apparent from data that application of zinc significantly increased Zn content in grain up to 6 kg Zn ha^{-1}. Significantly maximum zinc content in seed (0.463%) and straw (0.285%) and uptake by seed (6.42 kg ha^{-1}) and straw (6.59 kg ha^{-1}) of chickpea were recorded with application of zinc 6 kg Zn ha^{-1} and it showed superiority over control and 3 kg Zn ha^{-1}, respectively (table-2). This can be attributed to increase in the zinc concentration of soil solution, which resulted in increasing intake of the nutrient from soil solution and consequently increased content of zinc in grain and straw. As the content in grain and straw and the grain and straw yield increased, the uptake in seed and straw also increased significantly with the application of zinc. Similar results have been reported by Meena (2001) [26], Singh *et al.* (2001) [35] and Wasmatkar *et al*. (2002) [42].

Combined effect of levels of phosphorus and zinc on zinc content in seed was found to be significant (Table 6). The significantly higher zinc content in seed (0.550) was recorded under 0 kg P_2O_5 ha^{-1} in combination with 6.0 kg Zn ha^{-1}, which was at par with other treatment combination 0 kg P_2O_5 ha^{-1} + 3.0 kg Zn ha^{-1}. Minimum zinc content in seed (0.320) was recorded when neither phosphorus and zinc was applied.

It is revealed from (Table 7) that the interaction effect of phosphorus and zinc was also found significant on zinc uptake by seed. The significantly higher zinc uptake by seed (7.10 kg ha^{-1}) was recorded under 40.0 kg P_2O_5 ha^{-1} in combination with 6.0 kg Zn ha^{-1}, after that zinc uptake significantly reduced in treatment combination of 60.0 kg P_2O_5 ha^{-1} + 3.0 kg Zn ha^{-1} and 60.0 kg P_2O_5 ha^{-1} + 6.0 kg Zn ha^{-1}. Minimum zinc uptake by seed (2.24) was recorded when neither phosphorus nor zinc was applied.

Protein content: The content of protein seed of chickpea significantly increases with the increasing levels phosphorus. Application of 60 kg P_2O_5 ha^{-1} significantly increase the protein content in seed by the extent of 44.43, 21.21 and 7.65 per cent over control, 20 and 40 kg P_2O_5 ha^{-1}, respectively and further show that protein content in seed increases due to application of increasing levels of zinc. The application of 6.0 kg Zn ha^{-1} recorded highest protein content over control and 3.0 kg Zn ha^{-1} by 29.37 and 9.91 per cent, respectively.

It is recorded from that the interaction effect of phosphorus and zinc was also found significant on protein content in seed. The significantly higher protein content in seed (25.63%) was recorded under 40.0 kg P_2O_5 ha^{-1} in combination with 6.0 kg Zn ha^{-1}, which was at par with other treatment combination 60.0 kg P_2O_5 ha^{-1} + 3.0 kg Zn ha^{-1} and 60.0 kg P_2O_5 ha^{-1} + 6.0 kg Zn ha^{-1}. Minimum protein content in seed (13.96%) was recorded when neither phosphorus nor zinc was applied (table-8). Since protein content is essentially the manifestation of nitrogen content in seed. Hence, increase in nitrogen content of seed might have increased the protein content of with increasing levels of phosphorus and zinc application. Similar findings were also reported by Singh *et al.* (2003) [26], Jat and Ahalawat (2004) [19], Meena *et al.* (2005) [25] and Singh & Prasad (2008) [37].

Fertility of status of soil

Available nitrogen: The increasing levels of phosphorus upto 40 kg P_2O_5 ha^{-1} significantly increase nitrogen content in soil after harvest. The application of 40 kg P_2O_5 ha^{-1} significantly increased available nitrogen in soil over control and 20 kg P_2O_5 ha^{-1} was in order of 25.62 and 9.14 per cent respectively. However it remained at par with 6 kg P_2O_5 ha^{-1}. Also zinc application was significantly increased available nitrogen in soil. The application of 6 kg Zn ha^{-1} significantly increased available nitrogen in soil over control and 3 Kg Zn ha^{-1} in order of 16.55 and 6.44 per cent, respectively. This could be due to the fact that ample supply of phosphorus in soil provides a congenial environment in rhizosphere for microbial population and mineralization through its "energy currency' functions. Besides, on addition of fertilizer to the soil, there might be a sort of triggering action on native soil P, resulting in increased availability. In alkaline soils phosphatase activities are enhanced which also led to increase phosphorus availability, moreover, increased P availability showed synergistic effect on N and P and antagonistic on Fe and Zn availability in plants. Similar findings were reported by Panwar (1997) [30] and Khoja *et al.* (2002) [22].

Available phosphorus: Increasing levels of phosphorus significantly increase phosphorus content in soil after harvest. The application of 60 kg P_2O_5 ha^{-1} significantly increased available nitrogen in soil over control, 20 and 40 kg P_2O_5 ha^{-1} in order of 14.59, 8.46 and 3.70 per cent respectively. This is due to fact that phosphorus application increased root nodulation which might have promoted microbial activity and thereby higher mineralization. These results corroborate with findings of Sasode and Singh, 2008 [37] and Wagadre, *et al.*, 2010 [44]. The application of zinc adversely affect on available phosphorus in soil upto 6 kg Zn ha^{-1}. Maximum available phosphorus content after harvest was observed under application of 0 level of zinc (18.02 kg ha^{-1}) and minimum (16.70 kg ha^{-1}) with 6 kg Zn ha^{-1} respectively. Application of zinc decreased the availability of phosphorus in soil after harvest of the chickpea crop. It might be due to antagonistic effect of Zn and P. Higher concentration of zinc from insoluble zinc phosphate which reduced the availability of phosphorus. These findings are in similarity to the report given by Gupta and Gupta (1984) [17], Nair *et al.* (1992) [27] and Gour (1994) [15].

Available potassium: Application of different levels of phosphorus upto 40 kg P_2O_5 ha^{-1} significantly increased potassium content in soil after harvest. The application of 40 kg P_2O_5 ha^{-1} significantly increased available potassium in soil over control and 20 kg P_2O_5 ha^{-1} in order of 7.24 and 3.25 per cent, respectively and it remained at par with 60 kg P_2O_5 ha^{-1}. Different levels zinc significantly increase potassium content in soil. Application of 6 kg Zn ha^{-1} significantly increases potassium content in soil over control and 3 kg Zn ha^{-1} in order of 6.07 and 2.75 per cent, respectively.

Available zinc: The application of different levels of phosphorus adversely affected available zinc in soil. Application of 60 kg P_2O_5 ha^{-1} significantly reduced zinc content in soil after harvest. Maximum zinc content in soil was recorded with no phosphorus application (1.64 mg/kg) and minimum (1.46 mg/kg) with 60 kg P_2O_5 ha^{-1}. It was also apparent from the increasing levels of zinc application significantly increase zinc content in soil after harvest.

It is obvious from the data that there was remarkable decrease in zinc content in soil with increase in the rate of P application. Zinc content decreased by P application due to antagonistic relationship between P and Zn. This relation from insoluble zinc phosphate which reduce the availability of phosphorus. Similar findings were reported by Panwar (1997) [30] and Khoja *et al.* (2002) [22]. Application of 6 kg Zn ha^{-1} significantly increases zinc content in soil over control and 3 kg Zn ha^{-1} by 8.16 and 3.24 per cent respectively. Increasing levels of zinc application upto 6.0 kg ha^{-1} significantly increased available nitrogen, potassium and zinc status in soil after harvest of chickpea. This is due to increase in Zn concentration to the soil by application of zinc and experimental soil was low to medium in soil status. The results were confirmed by Singhal and Rattan (1999) [39] and Dube *et al.* (2001) [12].

Table 1: Initial physico-chemical characteristics of the experimental soil

Soil properties	Value	Methods of analysis with reference
A. Mechanical Composition		
Sand (%)	84.25	Hydrometer method (Bouyoucos, 1962) [6]
Silt (%)	7.70	
Clay (%)	7.84	
Texture	loamy Sand	Triangular method (Brady, 1983) [7]
B. Physical properties		
Bulk density (Mg m^{-3})	1.58	Method No. 38, USDA HandBook No. 60 (Richards, 1954) [32]
Particle density (Mg m^{-3})	2.65	Method No. 39, USDA HandBook No. 60 (Richards, 1954) [32]
Field Capacity (%)	7.92	Method No. 30, USDA HandBook No. 60 (Richards, 1954) [32]
Porosity (%)	37.30	Method No. 40, USDA Handbook No. 60 (Richards, 1954) [32]
C. Chemical properties		
Soil pH (1:2 soil water suspension)	8.15	Method No. 21 b, USDA Handbook No. 60 (Richards, 1954) [32]
EC (dS m^{-1}) (1:2 soil water suspension at 25^0C)	0.15	Method No.4 USDA Handbook No.60 (Richards, 1954) [32]
Organic carbon (%)	0.08	Walkley and Black's rapid titration method (Jackson, 1973) [18]
Available N (kg ha^{-1})	87.72	Alkaline $KMnO_4$ method (Subbiah and Asija, 1956) [41]
Available P_2O_5 (kg ha^{-1})	20.72	Olsen's method (Olsen *et al*., 1954) [28]
Available K_2O (kg ha^{-1})	164.14	Flame photometric Method (Jackson, 1973) [18]

Table 2: Effect of levels of Phosphorus and Zinc on nutrient content, uptake by chickpea and fertility status of soil.

Treatments	Nitrogen content (%)		Nitrogen uptake (kg ha^{-1})		Phosphorus content (%)		Phosphorus uptake (kg ha^{-1})		Zinc content (%)		Zinc uptake (kg ha^{-1})		Protein content in seed	Available nitrogen (kg ha^{-1})	Available phosphorus (kg ha^{-1})	Available potassium (kg ha^{-1})	Available zinc (mg ha^{-1})
	Seed	Straw	Seed	Straw	Seed	Straw	Seed	Straw	Seed	Straw	Seed	Straw					
Phosphorus level																	
(i) Control	2.74	0.60	23.78	13.17	0.368	0.223	2.98	4.02	0.518	0.313	4.35	5.72	17.12	118.99	16.10	161.65	1.64
(ii) 20 kg P_2O_5 ha^{-1}	3.27	0.88	38.44	18.47	0.456	0.259	5.20	5.38	0.442	0.277	5.18	5.83	20.41	136.95	17.01	167.90	1.55
(iii) 40 kg P_2O_5 ha^{-1}	3.68	1.01	51.07	23.18	0.522	0.285	7.07	6.47	0.387	0.248	5.41	5.69	22.98	149.48	17.79	173.36	1.49
(iv) 60 kg P_2O_5 ha^{-1}	3.96	1.05	56.45	25.18	0.527	0.302	7.37	7.19	0.347	0.229	4.93	5.49	24.74	158.03	18.45	175.30	1.46
S.Em±	0.04	0.02	1.13	0.77	0.006	0.005	0.13	0.19	0.007	0.005	0.15	0.22	0.27	3.29	0.22	1.76	0.02
CD (5%)	0.13	0.07	3.31	2.25	0.017	0.015	0.38	0.54	0.022	0.015	0.43	NS	0.79	9.66	0.63	5.17	0.05
Zinc level																	
(i) Control	2.95	0.75	29.18	18.42	0.518	0.287	5.07	5.66	0.381	0.246	3.37	4.71	18.42	129.61	18.02	164.45	1.47
(ii) 3 kg Zn ha^{-1}	3.47	0.88	43.57	21.68	0.470	0.265	5.93	5.76	0.426	0.269	5.12	5.74	21.68	141.92	17.29	169.77	1.54
(iii) 6 kg Zn ha^{-1}	3.81	1.02	54.56	23.83	0.417	0.249	5.96	5.88	0.463	0.285	6.42	6.59	23.83	151.07	16.70	174.44	1.59
S.Em±	0.04	0.02	0.98	0.23	0.005	0.005	0.11	0.16	0.006	0.004	0.13	0.19	0.23	2.85	0.19	1.53	0.02
CD (p=5%)	0.11	0.06	2.87	0.68	0.015	0.013	0.33	NS	0.019	0.013	0.38	0.55	0.68	8.37	0.55	4.48	0.05

Table 3: Interaction effect between phosphorus and zinc on nitrogen content in seed of chickpea

Treatments	**Control**	**20 kg P_2O_5 ha^{-1}**	**40 kg P_2O_5 ha^{-1}**	**60 kg P_2O_5 ha^{-1}**
Control	2.23	2.64	3.28	3.64
3 kg Zn ha^{-1}	2.85	3.36	3.65	4.01
6 kg Zn ha^{-1}	3.13	3.79	4.10	4.23
Mean	2.74	3.27	3.68	3.96
S.Em.±	0.07			
CD (5%)	0.22			

Table 4: Interaction effect between phosphorus and zinc on phosphorus content in seed of chickpea

Treatments	Control	20 kg P_2O_5 ha^{-1}	40 kg P_2O_5 ha^{-1}	60 kg P_2O_5 ha^{-1}
Control	0.400	0.510	0.577	0.583
3 kg Zn ha^{-1}	0.360	0.450	0.533	0.537
6 kg Zn ha^{-1}	0.343	0.407	0.457	0.460
Mean	0.368	0.456	0.522	0.527
S.Em.±	0.010			
CD (5%)	0.030			

Table 5: Interaction effect between phosphorus and zinc on phosphorus uptake by seed of chickpea

Treatments	Control	20 kg P_2O_5 ha^{-1}	40 kg P_2O_5 ha^{-1}	60 kg P_2O_5 ha^{-1}
Control	1.80	4.92	6.47	7.10
3 kg Zn ha^{-1}	3.25	5.29	7.50	7.69
6 kg Zn ha^{-1}	3.90	5.38	7.24	7.33
Mean	2.98	5.20	7.07	7.37
S.Em.±	0.22			
CD (5%)	0.66			

Table 6: Interaction effect between phosphorus and zinc on zinc content in seed of chickpea

Treatments	**Control**	**20 kg P_2O_5 ha^{-1}**	**40 kg P_2O_5 ha^{-1}**	**60 kg P_2O_5 ha^{-1}**
Control	0.497	0.383	0.323	0.320
3 kg Zn ha^{-1}	0.507	0.450	0.390	0.357
6 kg Zn ha^{-1}	0.550	0.493	0.447	0.363
Mean	0.518	0.442	0.387	0.347
S.Em.±	0.013			
CD (5%)	0.037			

Table 7: Interaction effect between phosphorus and zinc on zinc uptake by seed chickpea

Treatments	**Control**	**20 kg P_2O_5 ha^{-1}**	**40 kg P_2O_5 ha^{-1}**	**60 kg P_2O_5 ha^{-1}**
Control	2.24	3.71	3.63	3.89
3 kg Zn ha^{-1}	4.58	5.30	5.49	5.11
6 kg Zn ha^{-1}	6.24	6.53	7.10	5.80
Mean	4.35	5.18	5.41	4.93
S.Em.±	0.26			
CD (5%)	0.75			

Table 8: Interaction effect between phosphorus and zinc on protein content of chickpea

Treatments	**Control**	**20 kg P_2O_5 ha^{-1}**	**40 kg P_2O_5 ha^{-1}**	**60 kg P_2O_5 ha^{-1}**
Control	13.958	16.500	20.479	22.750
3 kg Zn ha^{-1}	17.813	21.021	22.833	25.063
6 kg Zn ha^{-1}	19.583	23.708	25.625	26.417
Mean	17.118	20.410	22.979	24.743
S.Em.±	0.47			
CD (5%)	1.37			

4. Conclusion

Application of phosphorus and zinc was significantly influenced the content, uptake and fertility of soil. Increasing doses of phosphorus reduced zinc uptake and similarly increasing dose of Zinc was also reduced the content and uptake of phosphorus. It might be due to antagonistic effect of P and Zn. Higher concentration of P in soil from insoluble zinc phosphate which reduces uptake of zinc by grain and straw, eventually reduce the zinc content in grain and straw. The combined effect of phosphorus x zinc were found significant for N content in grain, N uptake in grain and straw, protein content in grain, phosphorus and zinc content and uptake in grain.

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