Interaction effect of phosphorous and zinc on yield attributes, yield and quality characterstics of chickpea under central plain zone of Uttar Pradesh

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Abstract

The present field experiments were conducted on studies effect of phosphorus and zinc on yield and quality parameter of chickpea was taken up at Student's Instructional Farm, at Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, (U.P.) India, during *rabi* season 2021-22.The experiment consists of 16 treatments combinations in factorial randomized block design with three replications consisted of different combination of phosphorus and zinc. Chickpea variety *RVG-203* was grown with the recommended agronomic practices. On the basis of results emanated from investigation it can be concluded that among the yield components and productivity parameters maximum values in relation to number of pods plant^{-1} (61.26), number of grains pod^{-1} (1.73), 100 grain wt. (20.20 gm), grain yield (18.85 q ha^{-1}), straw yield (23.35 q ha^{-1}), biological yield (42.20 q ha^{-1}), harvest index (44.67 %) and protein content in grain (20.93 %)were found in the treatment T_{15} [$P_{90}Zn_{6}$]. Corresponding minimum values in relation to number of pods plant^{-1} (45.00), number of grains pod^{-1} (1.20), 100 grain wt. (16.96 gm), grain yield (12.25 q ha^{-1}), straw yield (17.16 q ha^{-1}), biological yield (29.41 q ha^{-1}), harvest index (41.65 %) and protein content in grain (19.56 %) were associated with the treatment T_1[P_0Zn_0].

Key Words: Chickpea, Phosphorous, Protein, Yield and Zinc.

Introduction

India is the largest producer and consumer of pulses in the world. Among the pulses, chickpea is the most important grown inevery part of India. It is largest produced food legume in South Asia. Chickpea (*Cicer arietinum*L.) is a major legume crop cultivated for its edible seeds legume of the genus *Cicer*, Tribe*Cicereae*, family *Fabaceae*(*leguminaceae*), and subfamily *Papilionaceae*. It provide protein rich diet to the vegetarian of the Indian and complement the stable cereals in the diets with proteins, essential amino acids, vitamins and minerals **(Pingoliya*et al.* 2013).**They contain carbohydrate (61.51%), fat (4.5%) and relatively free from anti nutritional factors. Chickpea is rich in protein content (20.47g/100g), carbohydrate (62.95g/100g), fibre (12.2g/100g), phosphorous (252mg/l00g), high amount of minerals such as calcium (57mg/100g), magnesium (79mg/100g), iron (4.31mg/l00g) and zinc (15mg/100g), low in fat content and most of it is polyunsaturated **(Wallace *et al.* 2016).**

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India is the largest producer (25% of global production), consumer (27% of world consumption) and importer (14%) of pulses in the world. India ranks first in the world in terms of pulse production (25% of total worlds production) (FAOSTAT 2017). In India chickpea occupies 10.17 million ha area, with a production of 11.35 million tonnes registering the productivity of 1116 kg/ha. In Uttar Pradesh, chickpea crop occupied 0.62 million hectares area, 0.85 million tonnes production and 1371 kg/ha productivity **(Anonymous, 2021).**

Phosphorus deficiency can limit nodule number, leaf area, and biomass and grain developmentin legumes. Symbiotic nitrogen fixation has a high P demand because the process consumeslarge amounts of energy **(Schulze *et al.*, 2006)** and energy generating metabolism stronglydepends upon the availability of P **(Plaxton, 2004).Singh and Sale (2000)** reported that Pfertilization stimulates root growth, photosynthesis and increases hydraulic conductibility ofroots. Phosphorus is used in numerous molecular and biochemical plant processes, particularlyin energy acquisition, storage and utilization **(Epstein and Bloom, 2005).** The phosphoruscontent per unit dry weight is usually considerably higher in the nodules than in the roots andshoots, particularly at low external phosphorus supply. Nitrogen fixing plants have an increasedrequirement for P over dose receiving direct nitrogen fertilization, probability due to need fornodule development and signal transduction, and to P-lipids in the large number of bacterioids **(Graham and Vance, 2000).** It acts as a catalyst in several biochemical reactions occurred inplants. It plays an important role in capturing and converting the solar energy into useful plantcompounds. These compounds help in the general health and vigor of plants **(Griffith, B. 2010).** Legumes are heavy feeder of phosphorus and less responsive to nitrogen because oftheir capacity to meet their own nitrogen requirement through symbiotic fixation **(Kumar *et al.* 2016).** Phosphorus is connected with some particular plant growth factors that are rootdevelopment, vigorous stem, enhanced flower formation and seed production, earlier and moreuniform crop maturity, increase nitrogen fixing capacity of legumes, improvement in cropquality and resistance to plant diseases **(Rehan*et al.* 2018).** It is required for higher andsustainable production of grain legumes. Generally, legumes have higher P requisites due tomore consumption of energy in the process of symbiotic nitrogen fixation **(Islam *et al*. 2012).** Phosphorus enhances the activity of rhizobia and increases the formation of root nodules thereby helps in fixing more of atmospheric nitrogen in root nodules. Phosphorus is also an important

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fertilizer in chickpea production; it is a very important chemical fertilizerthat can raise the water holding capacity of soil **(Dotaniya*et al.*, 2014)**.

Zinc is required for the proper functioning of various metabolic processes. It's necessary for chlorophyll and carbohydrate production. Several enzyme systems, auxin and protein synthesis, seed formation and maturity rate all require zinc, either directly or indirectly. Zinc is known to help with RNA synthesis, which is required for protein production. In the plant, zinc is not translocated. As a result, symptoms occur first on the plant's younger leaves and other sections. Stunted growth, the formation of light green yellowish patches and chlorotic bands on either side of the midrib in the plants are all common symptoms of zinc deficiency. The sustainable production needs balanced supply from soil along with suitable physical and biological properties to attain a better growth of roots and efficient utilization of nutrient from the rhizosphere.

The soils of Kanpur are alkaline in nature, low in organic content ingenerally low in fertility status. All these factors lead to the deficiency of zinc in soils. As such, it is possible that the application of zinc may be helpful in increasing the yields of chickpea under agro climatic condition of Kanpur.

Resources and Methods

Experimental Site

The experiment was conducted during *rabi*season of 2021-22 at student's Instructional farm, C.S.A. University of Agriculture and Technology, Kanpur Nagar (U.P.). The field was well leveled and irrigated by tube well. The farm is situated at main campus of the university, in the west northern part of Kanpur city under sub-tropical zone in V^{th}agroclimatic zone (central plain zone).

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EdaphicCondition

The soil was moist, well drained with uniform plane topography. The soil of the experimental field was alluvial in origin, sandy loam in texture and slightly alkaline in reaction having pH 7.9 (1:2.5 soil: water suspension method given by **Jackson, 1973**), electrical conductivity 0.30 dSm^{-1} (1:2.5 soil: water suspension method given by **Jackson, 1973**), Organic carbon percentage in soil is 0.45 per cent (Walkley and Black's rapid titration method given by **Walkley and Black, 1934**), with available nitrogen 210 kg ha^{-1} (Alkaline permanganate method given by

Subbiahand Asija, 1956), available phosphorus as sodium bicarbonate-extractable P was 12.8 kg ha^{-1} (Olsen's calorimetrically method**, Olsen *et al*., 1954**) available potassium was 198 kg ha^{-1} (Flame photometer method given by **Hanwey and Heidel, 1952**), available **and** available zinc was0.55kg ha^{-1}**(**DTPA extraction method given by (**Lindsay and Norvell, 1978).**

Detail of treatments and design

The 16 treatments combination of nutrient management practices of inorganic fertilizer (DAP and zincsulphate). Experiment was laid out in factorial randomized block design with three replications.

Table -1: detail of the treatment combinations:

S. No.	**Symbol**	**Treatment combination**
1.	T_1	$P_0\ Zn_0$
2.	T_2	$P_0\ Zn_3$
3.	T_3	$P_0\ Zn_6$
4.	T_4	$P_0\ Zn_9$
5	T_5	$P_{30}\ Zn_0$
6.	T_6	$P_{30}\ Zn_3$
7.	T_7	$P_{30}\ Zn_6$
8.	T_8	$P_{30}\ Zn_9$
9.	T_9	$P_{60}\ Zn_0$
10.	T_{10}	$P_{60}Zn_3$
11.	T_{11}	$P_{60}\ Zn_6$
12.	T_{12}	$P_{60}\ Zn_9$
13.	T_{13}	$P_{90}\ Zn_0$
14.	T_{14}	$P_{90}\ Zn_3$
15.	T_{15}	$P_{90}\ Zn_6$
16.	T_{16}	$P_{90}\ Zn_9$

Crop Husbandry

A pre-sowing irrigation (Paleva) was done in the experimental field with an object to get optimum moisture conditions for attaining good germination. At proper tilth, one ploughing with tractor drawn mould bold plough was done followed by two ploughings by cultivator.fulldoseofPhosphorus, and Zincwereapplied as basal at the time of sowing in the form ofDAP and Zinc sulphate respectively. The sowing of seeds of Chickpea variety RGV-203was done by linesowing by hand at 4-5 cm depth of soil and with line to line spacing of 45 cm to maintainuniform plant population.

Harvesting and threshing: The crop was harvested at maturity and was allowed to dry in sun. Separate bundles were made for each plot and weighted. The after drying harvest was threshed manually.

Data Collection

Grain yield

After threshing the grain yield from each plot was separately weighed and recorded after converting into quintals per hectare.

Straw yield

After subtracting the grain yield per plot from the total biological yield. After converting the yields into quintals per hectare, yields were recorded.

Biological yield (q ha^{-1})

Seed yield and Stover yield together were regarded as biological yield. The biological yield was calculated with the following formula:

Biological yield = Seed yield + Stover yield

Harvest index(%):

The recovery of grains in total dry matter was considered as harvest index, expressed in percentage.

It has been calculated by following formula:

Harvest Index (%) = [Seed Yield (q ha^{-1}) / Biological Yield (q ha^{-1})] x 100

Protein content (%):

Nitrogen content (%) in grains was determined by Kjeldahl's method. Protein content of chickpea seed was determined by multiplying the N content of chickpea seed with factor 6.25 (N % × 6.25). (A.O.A.C., 1970).

Statistical analysis: The growth parameters and yields were recorded and analysed as per Gomez and Gomez (1984) the tested at 5% level of significance to interpret the significant differences.

Result and Discussion

Yield Components

At a glance over the data given in the Table-2and depicted in Fig.-1 clearly shows that among the yield attributing characters of chickpea such asnumber of pods plant^{-1}, number of grain pod^{-1}and 100 grain weight (gm) significantly increase due to the application of Phosphorus and Zinc. Significantly response on yield components was recorded with T_{15} [P_{90} Zn_6] over other treatments. The number of pods plant^{-1}, number of grain pod^{-1} and 100 grain weight (gm) increased to the magnitude of 45.00 to 61.26, 1.20 to 1.73 and 16.96 to20.20, respectively. Maximum number of pods plant^{-1}(61.26), number of grain pod^{-1} (1.73) and 100 grain weight (20.20 gm) was associated with the treatment T_{15} [P_{90} Zn_6]. Minimum number of pods plant^{-1}(45.00), number of grain pod^{-1} (1.20) and 100 grain weight (16.96 gm) was associated with the treatment T_1 [Control]. The results of the present investigation are also in agreement with the findings of **Yadav *et al.* (2022), Singh *et al.* (2022), Kumar *et al.* (2022), Yadav *et al.* (2022) and Sachan*et al.* (2022)**

Table-2: Effect of different treatment combinations on yield components of chickpea

Treatment	No of pods plant^{-1}	No of grains pod^{-1}	100 Grains weight (g)
T_1	45.00	1.20	16.96
T_2	47.21	1.27	17.42
T_3	52.21	1.36	17.65
T_4	48.43	1.31	17.53
T_5	50.12	1.32	17.61
T_6	54.31	1.48	17.71
T_7	55.18	1.49	17.87
T_8	53.42	1.43	17.68
T_9	56.21	1.52	17.94
T_{10}	59.87	1.62	18.12
T_{11}	60.89	1.71	19.82
T_{12}	58.13	1.57	18.10
T_{13}	57.32	1.55	18.03
T_{14}	60.38	1.69	19.11
T_{15}	61.26	1.73	20.20
T_{16}	60.12	1.65	18.42

S.E (m) ±	**P**	0.055	0.34	0.010
	Zn	0.055	0.49	0.010
	P × Zn	0.110	0.59	0.019
CD at 5%	**P**	0.159	1.03	0.028
	Zn	0.159	1.48	0.028
	P × Zn	NS	NS	NS

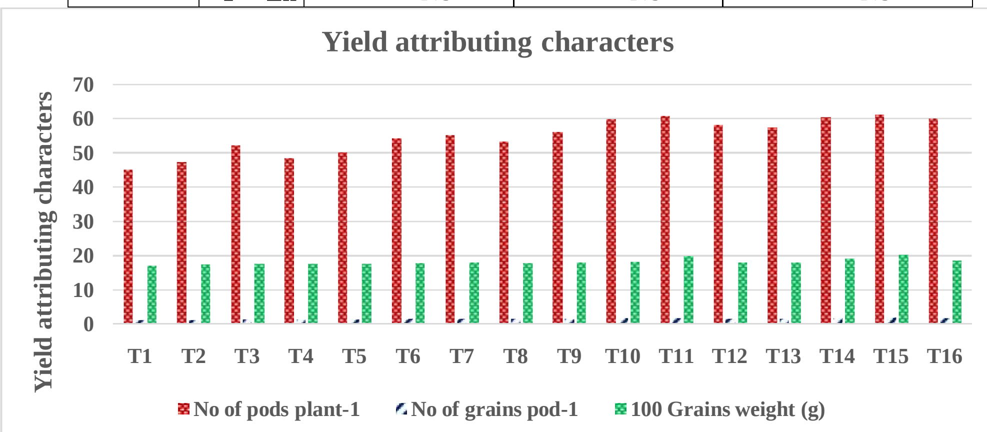

Fig.-1: Effect of different treatment combinations on yield components of chickpea

Productivity Parameters

It is visualized from the data given in Table-3and depicted in Fig.-2 clearly indicate that among the productivity parameters viz. grain yield (q ha^{-1}), straw yield (q ha^{-1}), biological yield (q ha^{-1}) and harvest index (%) significantly increase due to the application of Phosphorus and Zinc. Grain yield varied from 12.25 to 18.85 q ha^{-1}, straw yield varied from 17.16 to 23.35 q ha^{-1}, biological yield varied from 29.41 to 42.20 q ha^{-1} and harvest index varied from 41.65 to 44.67 %. The maximum grain yield (18.85 q ha^{-1}), straw yield (23.35q ha^{-1}), biological yield (42.20 q ha^{-1}) and harvest index (44.67 %)was associated with the treatment T_{15} [$P_{90}Zn_6$] during the experimentation. The minimum grain yield (12.25 q ha^{-1}), straw yield (17.16 q ha^{-1}), biological yield (29.41q ha^{-1})and harvest index (41.65 %)was under the treatment T_1 [control] during the experimentation. The surge in seed and straw yields under adequate nutrients supply might be attributed to mainly to the collective effect of a greater number of number of podplant^{-1}, number of grains pod^{-1} and higher test weight, which was the result of improved translocation of photosynthates from source to sink ultimately yield is increased. The increase in grain yield under adequate nutrients supply mainly due to more yield attributes ultimately resulted more grain yield. Grain, straw yield, biological yield and harvest indexof chickpea significantly increased due to application of P 90 (kg ha^{-1}) andZinc 6(kg ha^{-1}) over their controls. These results also confirms the findings of **Singh*et al*. (2021)**, **Pal *et al*. (2021), Yadav *et al.* (2022), Kumar *et al.* (2022) and Sachan*et al. (*2022)**

Table-3:Effect of different treatment combinations on productivity parameters of chickpea

Treatment		**Grain yield (qha^{-1})**	**Straw yield (qha^{-1})**	**Biological yield (qha^{-1})**	**Harvest index (%)**
T_1		12.25	17.16	29.41	41.65
T_2		12.52	17.35	29.87	41.91
T_3		13.76	18.72	32.48	42.36
T_4		12.87	17.81	30.68	41.95
T_5		13.24	18.25	31.49	42.05
T_6		14.86	19.65	34.51	43.05
T_7		15.34	20.12	35.46	43.26
T_8		14.25	19.10	33.35	42.73
T_9		15.77	20.46	36.23	43.53
T_{10}		16.96	21.78	38.74	43.78
T_{11}		18.24	22.96	41.20	44.27
T_{12}		16.71	21.34	38.05	43.91
T_{13}		16.10	20.95	37.05	43.45
T_{14}		17.65	22.54	40.19	43.92
T_{15}		18.85	23.35	42.20	44.67
T_{16}		17.31	22.24	39.55	43.76
S.E (m) ±	**P**	0.022	0.021	0.043	0.010
	Zn	0.022	0.021	0.043	0.010
	P×Zn	0.044	0.043	0.087	0.019
CD at 5%	**P**	0.064	0.062	0.126	0.028
	Zn	0.064	0.062	0.126	0.028
	P×Zn	NS	NS	NS	NS

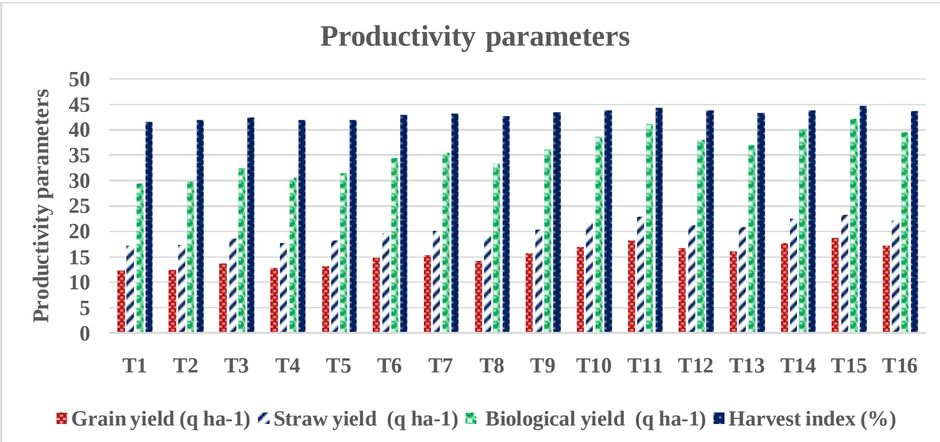

Fig.-2:Effect of different treatment combinations on productivity parameters of chickpea

Quality parameter

Protein

It is visualized from the data given in Table-4 clearly indicate that among the quality parameters viz. proteincontent increase due to the application of Phosphorus and Zinc. Protein content varied 19.56 to 20.93 (%) The maximum protein content 20.93 % was associated with the treatment T_{15} [$P_{90}Zn_6$]. The minimum protein content 19.53% was under the treatment T_1 [control]. Similar findings were reported by **Ahmed *et al.* (2003), Vikrant *et al.*(2005) and Tripathy*et al.* (2019)**

Table-4:Effect of different treatment combinations on quality parameters of chickpea

Treatment	Treatment combination	Protein content in grain (%)
T_1	P_0Zn_0	19.56
T_2	P_0Zn_3	19.68
T_3	P_0Zn_6	19.94
T_4	P_0Zn_9	19.81
T_5	$P_{30}Zn_0$	19.87
T_6	$P_{30}Zn_3$	20.18
T_7	$P_{30}Zn_6$	20.25

T_8	**$P_{30}Zn_9$**	20.06
T_9	**$P_{60}Zn_0$**	20.37
T_{10}	**$P_{60}Zn_3$**	20.62
T_{11}	**$P_{60}Zn_6$**	20.87
T_{12}	**$P_{60}Zn_9$**	20.56
T_{13}	**$P_{90}Zn_0$**	20.44
T_{14}	**$P_{90}Zn_3$**	20.75
T_{15}	**$P_{90}Zn_6$**	20.93
T_{16}	**$P_{90}Zn_9$**	20.68
S.E (m) ±	**P**	0.34
	Zn	0.29
	P×Zn	0.49
CD at 5%	**P**	1.03
	Zn	1.03
	P×Zn	NS

Conclusion

The current study demonstrates the benefit of application of phosphorus 90 kg ha^{-1} and zinc 6 kg ha^{-1} significantly increased yield attributes, productivity and quality parameter like number of pod $plant^{-1}$, number of grains pod^{-1}, test weight of 100 seeds, grain yield, straw yield, biological yield, harvest index and protein quality. Finally it can be concluded that the treatment T_{15} [$P_{90}Zn_6$] is a best option for improving productivity, yields and quality parameter of chickpea crop.

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