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Effects of Different Phosphorus Fertilizer Levels on Growth and Yield Components of Chickpea (*Cicer-arietinum* L.)

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Abstract

From the winter seasons 2018-2019 and 2019-2020, a field experiment was conducted at the Directorate of Agricultural Research Sulaimani in the Kurdistan province of Iraq to evaluate the various levels of phosphorus control, 25, 50, 75, and 100 P_2O_5 kg ha^{-1} as triple superphosphate on the growth and yield components of chickpea (*Cicer arietinum* L.) by using a randomized complete block design (RCBD). Based on a statistical analysis of variance conducted over the two years the influence of various phosphorus analyses had no significant effects on the plant height, number of branches per plant and protein content. Whereas, in both years, the effect of different phosphorus levels application had a significant effect on the number of pods per plant, the number of grains per plant, 100-grain of weight, gains of weight, and grain yield. According to best output, the results showed that 100 P_2O_5 kg ha^{-1} had the best positive effect during the two-year study.

Introduction

Chickpea (*Cicer arietinum* L.) is one of the world's most important crops among all grain legumes consumed in various forms for human nutrition, and has been the primary grain legume crop grown in the cultivated calcareous soil of the arid and semi-arid regions, as well as the Iraq Kurdistan Region. It is one of the essential pulse crops that have played a major role in crop rotations in most Regions of the world, along with Iraq ***[1]***. It is the third most important pulse crop in the world, after dry beans and soybeans. Besides this, it's also utilized as a source of fodder and green manure. ***[2]***. Chickpea (*Cicer arietinum* L.) is an essential legume crop with its high nutritional value; it includes 20-30% protein, 40% carbs, and 3-6% oil ***[3]***, calcium, magnesium, potassium, phosphorus, zinc, iron, and vitamins A, B, and C are also found in pulses ***[4]***. In addition, malic acid, found in chickpea leaves, is good for blood cleaning and stomach ailments [5]. In Iraq, it is the second-largest pulse crop, after faba bean plants. It ranks first among pulse crops, with 180000 ha sown with 104000 tons produced ***[6]***. According to FAO, Sulaimani, Duhok, Erbil, and Nineveh cover an area of 14,000 ha^{-1} and have a yield of 0.74-ton ha^{-1} ***[7]***. Although this crop is essential to our daily diet and food development ***[8]***. Chickpea crop productivity is low all over the world, particularly in Kurdistan. Chickpea productivity is influenced by a variety of factors, including high flower fall, pod shedding, and the fact that it is typically grown on agronomic marginal lands with no need for fertilizer ***[9]***. After nitrogen, phosphorus is the second most important element for plant growth and development ***[10]***. In comparison to other minerals, the plant absorbs a considerable amount of phosphorus ***[11]***. Furthermore, all plants require phosphorus for their overall health and vigor. Phosphate is also linked to a number of specific factors, including: Plant growth begins much earlier in the germination process, increasing the number of branches and attempting to make them more vigorous, aiding in the improvement of the size of the leaves and the shape of the blossoms, boosting having a large participation in pod filling, it frequently aids in the hastening of maturation, and it is used to increase plant resistance to diseases. In addition, it is required for cell division, sunlight absorption and transformation, metabolic processes, assimilation translocation, seeds, and fruit growth, and enzymatic activity ***[12].*** It's frequently used to emphasize enhancing soil fertility through biological nitrogen fixation, ***[13, 14]***. The primary goal of this research was to determine the influences of various phosphorus doses on the growth and yield components of chickpea.

Materials and Methods

A. Experimental Design

Field experiments were carried out at the Directorate of Agricultural Research Sulaimani in Iraq's Kurdistan province. Geographically, the area is defined as the location between longitude 30° 32' 35" N0 and latitudes 45° 21' 00" E, with quite an elevation between 710 and 760 meters over sea point. During the two winter growing seasons of 2018-2019 and 2019-2020. The experiments used a randomized complete block design (RCBD) with three replications, to determine the effect of five rates of phosphorus 0, 25, 50, 75, and 100 P_2O_5 kg ha^{-1}as trip superphosphate over two years. Aside from this, two different doses of 20N kg ha^{-1} and 40 K_2O_5 kg ha^{-1} were applied to all plots for balance in the form of urea and potassium Sulphate at the time of sowing, respectively. The experimental area has a total of 15 plots, each with a 2m x 3m =6m^2 area and six rows of 20 plants. In each hole, seeds were sown at the preferred planting depth of 6 cm, with a row spacing of 25 cm and a plant spacing of 15 cm the following is a list of the treatments: $T_{1=}$control, $T_{2\,=}$ 25 P_2O_5 kg ha^{-1}, $T_{3=}$ 50 P_2O_5 kg ha^{-1}, $T_{4=}$ 75 P_2O_5 kg ha^{-1} $T_{5=}$ 100 P_2O_5 kg ha^{-1}. Chickpea (Hazarmerd) from the first year was harvested on June 25, 2019, and chickpea from the second year was harvested on June 20, 2020.

B. Soil Sample Collection and Physicochemical analysis

Soil samples were collected from 0-30 cm depths before fertilizer application to determine some chemical and physical properties of the soil. Before soil analysis, the samples taken have been air-dried, squashed, and sieved through with a 2 mm sieve and stored in plastic bottles. The hydrometer method was used to determine the particle size distribution, as described by Bouyoucos G.J., 1962 ***[15]***. The electrometrically, pH, and electrical conductivity (EC) were measured using a digital pH Meter model (WTW) and an EC-meter model (Herman Paulsen), as described by Gee and Bauder, 1986 ***[16]***. Dichromate oxidation by (Walkley and Black) method based on the organic matter was used to determine the soil organic matter, as described by Nelson and Sommer, 1986 ***[17]***. The total calcium carbonate equivalent was assessed by the titration process developed by Rayment and Higginson, 1992 ***[18]***. In 1982 ***[19]***, Page et al. proposed a method for titrating insoluble HCO_3^-, CO_3^-, Cl^-, and Ca^{2+} Mg^{2+}. The concentrations of Na^+ and K^+ were measured using a flame photometer using Olsen's method ***[20]***. The Spectrophotometer has been used to determine the amount of available phosphorus. The total nitrogen was measured by Kjeldahl method as described by Bremner in 1996 ***[21]***.

Table- 1: Several physical and chemical characteristics of Bakrajow land have been used in a field study.

	The studied soil's physical properties						
	Particle Size Distribution (PSD) g Kg^{-1}						
Location	Sand	Silt		Clay			Texture class
Bakrajow	75.20	418.5		406.20			Silty clay
	The studied soil's chemical properties						available
	pH	N (%)		EC (dS. $m^{-1 \text{ at } 25c}$)	O.M (gm/ kg)	$CaCO_3$ (gm/ kg)	P (ppm)
Bakrajow	7.75	0.17		0.25	19.3	185	11
	Soluble ions and cations mmol L^{-1}						
	K^+	Na^+	Ca^{2+}	Mg^{2+}	Cl^-	H Co_3^-	Co_3^-
Bakrajow	0.076	0.305	0.75	0.75	2.4	0.8	zero

C. Measurement Parameters

Plant height (cm), the number of branches per plant, the number of seeds per pod, the number of pods plant$^-$, grains of weight (g), 100-grains of weight (g), seeds of yield (ton ha^{-1}), and crude protein (%) were measured as the following: The plant height was measured in centimeters as from base to apex. The number of branches per plant was determined by counting of branches on each with five post plants then taking its average. The number of pods per plant of post plants is counted. Seeds per pod were counted from five randomly selected plants. Five picked at random post plants were used to determine the yield.

D. Protein content (%)

To determine the percent protein in chickpea seed, the nitrogen content in grain was determined using the micro-Kjeldahl method. According to Sáez-Plaza et al., 2013, protein content in chickpea seed was calculated by multiplying nitrogen content with the factor 6.25 ***[22].***

$$N\,\% = \frac{(A._{\text{sample}} - B._{\text{Blank}})*N*1.4007}{w}$$

N= acid normality (0.01N).
A= ml acid titration sample
B= ml acid titration blank
w=weight of sample (g)
Crude Protein (%) = Nitrogen% ×6.25

E. Statistical Analysis

Following the collection of data, SAS version 9.2 was then used to performed the statistical analysis (ANOVA). The comparison of means was conducted by the LSD method at the 5% level of probability ***[23].***

Results and discussion

A. Plant Height (cm)

According to the statistical analysis of mean comparisons over two years (Tables 2 and 3), the different phosphorus rates used had no significant effect on plant height between the two years. The maximum plant heights (81.73cm) were measured in plots that received 100 P_2O_5 kg ha^{-1} application in the first year. Whereas, the lowest plant height of (78.13 cm) was recorded at the level of 50 P_2O_5 kg ha^{-1} fertilizer application during the first years. The highest plant height (81.17 cm) was obtained from a second-year application of 100 P_2O_5 kg ha^{-1}. During the second year, the plots that received 75 P_2O_5 kg ha^{-1} fertilizer had the shortest plant height

(71.76cm). The highest plant height (82.45 cm) was obtained on average over two years at a fertilizer dose of 100 P_2O_5 kg ha^{-1}.

B. Number of Branches $Plant^{-1}$

The variance analysis found that the effect of phosphorus rates on the number of branches per plant was insignificant over two years (Tables 2 and 3). The highest number of branches per plant (4.80) was recorded from plots levels with 100 P_2O_5 kg ha^{-1} application during the first year. Whereas, the lowest number of branches per plant (3.66) was recorded at the control plots from the first year. However, the maximum value of number of branches per plant (4.91) was measured in the second year at plots with 100 P_2O_5 kg ha^{-1} application. Despite this, the minimum numbers of breaches per plant (2.806) were observed from level of 25 P_2O_5 kg ha^{-1}, in the second year. The average number of branches per plant (57.631) was recorded from the plots that received 100 P_2O_5 kg ha^{-1} applications over a two-year period.

C. Number of Pods per Plant

The mean comparisons present in Tables 2 and 3 revealed that different phosphorus levels had a significant ($p< 0.05$) effect at the first and second years. The highest number of nodules per plant (59.33) was noticed in plots that received rates of 100 P_2O_5 kg ha^{-1} in the first year. However, the minimum number of nodules/ plant (47.66) was recorded in the first year from the plot received a rate of 100 P_2O_5 kg ha^{-1} treatment. However, the highest number of pods per plant (55.93) was observed in plots that received 100 P_2O_5 kg ha^{-1} treatment in the second year. Whereas, during in the second year the control produced 30.73 pods per plant. Pods per plant with a value of 57.63 were recorded on average from these plots that received a dose of 100 P_2O_5 kg ha^{-1} over a two-year period. The higher mean number of nodules $plant^{-1}$ is due to increased phosphorus fertilization doses could be attributed to the fact that phosphate application stimulates root growth, resulting in the formation of large number nodules. These findings are based on the same research with the use of P_2O_5. This conclusion was similar to the findings of Yadav *et al*., 2014, who observed that the number of pods per plant increased dramatically as the level of phosphorus fertilizer was raised ***[24].***

D. The Number of Grains per Pod

As shown in Tables 2 and 3, the statistical analysis revealed that the different phosphorus levels used had a significant difference between all treatments in the first and second years. The highest number of grains per pod (70.66) was observed in plots with a P_2O_5 level of 100 kg ha^{-1} from the first year, while the lowest number (54.66) was observed in plots with a P_2O_5 level of 50 kg ha^{-1} from the first year. However, a significant increase in the number of grains per pod (40.35) was observed in these plots that received rates of 100 kg P_2O_5 kg ha^{-1}during the second year. Furthermore, during the second year, the significant minimum number of grains per pod (22.20) was observed at the control. Over a two-year period, the average number of grains per pod was 55.50 at 100 kg P_2O_5 kg ha^{-1}. When phosphorus rates were increased, the mean number of grains per pod increased. Current finding is agreed with the reposting of Endemic *et al*., 2017, who found that the number of seeds per pod significantly increased if phosphate levels were boosted ***[25]***.

E. 100-Grains Weight (g)

Different phosphorus application rates had a significant ($P < 0.05$) influence on 100-grain weight during the first and second years, according to the statistical analysis of variance presented in Tables 2 and 3. The plots received 100 P_2O_5 kg ha^{-1}treatment, for the first year, yielding the highest 100-grain weights (39.36). While the significant minimum of 100-grains weight of (36.33g) is measured at control in the first year. During the second year, these plots received a dose of 100 P_2O_5 kg ha^{-1}, resulting in the highest 100-grain weights of (36.52g). However, the plot received a rate of 25 P_2O_5 kg ha^{-1}applied during the second year resulted in the significant lowest 100-grains weight of (28.26g). Over a two-year period, 100-grain weights (37.94g) were measured from plots that received 100 P_2O_5 kg ha^{-1}applications. The weight of 100-seeds increased significantly as the phosphate level increased. According to Ali *et al.*, 2004 ***[26]***, the lowest 100-seed weight was obtained with control chickpea. Eventually, the results of this study supported the reporting of Walley *et al*., 2005 ***[27].***

Table-2: ANOVA table of the traits studied in this study.

Source of variance	DF	Plant Height (cm)	No. of Branches $Plant^{-1}$	No. of Pods Per Plant	No. of grains Per Pod	100-grain Weight (g)
Year1	-	79.50^{NS}	4.13^{NS}	52.86*	62.20*	38.11*
Year2	-	77.13^{NS}	4.57^{NS}	43.05*	30.07*	31.98*
Treatment	13	29.69^{NS}	1.10^{NS}	217.3*	743.95*	32.87*
Error	15	29.79	0.57	62.50	28.13	4.13
C. Total	28					

Source of variance	DF	Grains of Weight /plan(g)	Grain of Yield (ton ha^{-1})	Protein Content (%)
Year1	-	22.82**	4.54**	24.45^{NS}
Year2	-	11.67**	2.31**	22.93^{NS}
Treatment	13	84.23**	3.45**	5.66^{NS}
Error	15	3.41	0.12	4.26
C. Total	28			

DF: degree of freedom, NS: non-significant difference, *: Significant difference at p<0.05, **: heigh significant difference at p < 0.01

F. Weight Grain per Plants (g)

According to a two-year statistical analysis, the various phosphorus levels had a superior significant effect on all traits during the first and second years, as shown in Tables 2 and 3. The highest grain weight per plant (25.76) was measured from the first year in plots with rates of 100 kg P_2O_5 ha^{-1} applied. During the first year, the significant lowest weight of grains per plant (20.46g) was recorded at a 50 kg rate of P_2O_5 ha^{-1}. The highest grain weight per plant (14.78g) was measured in the second year at 100 P_2O_5 kg ha^{-1}applied levels. During the second year, the significant lowest weight of grain per plant (9.13g) was recorded at level 25 P_2O_5 kg ha^{-1}. Over a two-year period, the highest grains weight per plant (20.27g) was found in 100 P_2O_5 kg ha^{-1}. When phosphate rates were increased, the mean grain weight increased significantly ***[28]***. This result was consistent with the findings of several other studies, which found that adding phosphorus to chickpeas increases grain weight, as confirmed by Shukla et al., 2010 ***[29]***.

G. Grain Yield (ton ha^{-1})

The statistical analysis, as shown in Tables 2 and 3, revealed that different phosphorous rate utilization had a significant effect on the studied characters in the first and second years. The plots that received 100 P_2O_5 kg ha^{-1} from the first year produced the highest grain yields (5.09-ton ha^{-1}). Furthermore, with 50 P_2O_5 kg ha^{-1}, the lowest grain yield (4.30-ton ha^{-1}) was obtained during the first year. During the second year, the plots that received 100 P_2O_5 kg ha^{-1} had the highest grain yield (2.91-ton ha^{-1}). Despite this, the lowest grain yield (1.70-ton ha^{-1}) was obtained with 25 P_2O_5 kg ha^{-1} during the second year. Over a two-year period, the average grain yield (4-ton ha^{-1}) was measured at 100 P_2O_5 kg ha^{-1} applications. This study's findings appeared to be similar to those of Rashid *et al*., 2013, who demonstrated that increasing the phosphorus rate resulted in a significant increase in seed yield ***[30]***.

Table-3: The Effects of varying phosphorus levels on some growth and yield characteristics of chickpea (*Cicer arietinum* L.) at Bakrajow location

Phosphorus Levels P_2O_5 (kg ha^{-1})	Plant Height (cm)			Number of Branches per Plant			Number of Pods per Plant		
	Year 1	Year 2	Mean	Year1	Year2	Mean	Year1	Year2	Mean
0	78.33ab	80.76ab	79.54	3.66abc	3.26bc	3.46	56.33a	30.73b	43.53
25	79.80ab	75.30ab	77.55	4.06abc	2.80c	3.43	50.00a	32.46b	41.23
50	78.13ab	74.66ab	76.39	4.00abc	3.93abc	3.96	47.66a	47.86a	47.76
75	79.53ab	71.76b	75.64	4.130ab	3.03bc	2.56	51.00a	48.26a	49.63
100	81.73a	83.17a	82.45	4.800a	4.81a	4.80	59.33a	55.93a	57.63
LSD%5		8.512			1.161			12.301	

Phosphorus Levels P_2O_5 (kg ha^{-1})	Number of Grain per Pods			100-Grain Weight (g)			Weight of Grain per plant (g)		
	Year 1	Year 2	Mean	Year1	Year2	Mean	Year1	Year2	Mean
0	68.00ab	22.20f	45.1	36.33ab	29.8cd	33.06	24. 46ab	9.26e	16.86
25	57.33c	22.26f	39.79	38.83a	28.26d	33.54	21.56bc	9.13e	15.34
50	54.66c	31.46df	43.06	38.40a	33.00bc	35.7	20.46c	13.83d	17.14
75	60.33bc	34.06d	47.19	37.63a	32.33c	34.98	21.83bc	12.80d	17.31
100	70.66a	40.35d	55.50	39.36a	36.52ab	37.94	25.76a	14.78d	20.27
LSD (%5)		8.3			3.182			2.873	

Phosphorus Levels P_2O_5(kg ha^{-1})	Grain Yield (ton ha^{-1})			Protein Content (%)		
	Year 1	Year 2	Mean	Year1	Year2	Mean
0	4.89ab	1.85e	3.37	23.04b	22.45b	22.74
25	4.3bc	1.70e	3	23.47b	22.69b	23.08
50	3.97c	2.54d	3.25	23.76b	22.66b	23.21
75	4.44bc	2.56d	3.5	23.37b	22.62b	22.99
100	5.09a	2.91d	4	24.62ab	24.22ab	24.42
LSD (%5)		0.557			3.204	

Different letters along the column indicate significant differences at $p < 0.05$.

H. Protein Content (%)

The statistical analysis of the results presented in Tables 2 and 3 revealed that the use of different phosphorus levels had no significant impact on seed protein content. When 100 P_2O_5 kg ha^{-1} was applied, the plots achieved a maximum crude protein (24.62%) in the first year. During the first year, however, the control treatment had the lowest protein content (23.04%). When 100 P_2O_5 kg ha^{-1} was applied in the second year, the plots had the highest protein content (24.22%). From the second year, the minimum protein content (22.45%) was recorded at control treatment. The highest protein content (24.42%) was measured from plots of 100 P_2O_5 kg ha^{-1} over a two-year period. This result was consistent with the findings of Meena et al., 2000 ***[31]***, who discovered that different phosphorus fertilizer had no significant effect on protein content. It was also supported by the findings of Singh et al., 2003, who demonstrated that different fertilizer phosphorus rates had no significant influence on protein application ***[32]***.

Conclusion

An observational study was carried out to see how chickpeas (*Cicer arietinum* L.) reacted to different levels of phosphorus fertilizer and to determine the best phosphate rates for chickpeas. Using 100 P_2O_5 kg ha^{-1} resulted in the highest plant height, number of branches, number of pods, number of seeds per pod, 100-grain of weight, grain of weight, grain yield, and protein content. The best results were obtained from plots with l00 P_2O_5 kg ha^{-1} that were used for a two-year period.

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References

[1] Varshney, R. K. and Krishnamurthy, P. M. Gau, H. D. Upadhyaya Kashiwa J. L. S. Tobita, "Traits of Relevance to improve yield under terminal of drought stress in chickpea *(Cicer-arietinum* L.*)* Field crops. Res.145, pp. 80-95, (2013).

[2] Karim, M. F. and Q. A. Fattah,"Changes in Bio Components of Chickpea (*Cicer arietinum* L.) Sprayed With potassium napthenate and naphthenic acetic acid Bangladesh". J. Bot. 35(1), 39-43, (2006).

[3] Namvar, A. and Seyed, S. R. Sedghi, M. Asghari, Z. R. Khandan, T. Eskandarpour B. "Study on effects of Organic and inorganic nitrogen fertilizer on yield, yield components, nodulation state of chickpea (*Cicer-arietinum* L.) Communications Soil and Plant Analysis".42(9), pp.1097-1109, (2011).

[4] Ibrikciv, H. S. Knewtson, and Grusak, A. "Chickpea leaves vegetable green Human Evaluation of mineral Composition". J. Sci. Food Agric.83, pp.945-950, (2003).

[5] Cross, A. F. W.H. and Schlesinger, A. "literatures review evaluation of Hedley fractionation Scheme and Applications to the biogeochemical cycles of soils Phosphorus in Natural Ecosystems". Geoderma.64, pp.197-214, (1995).

[6] FAO,"Production year books Food and Agricultural Organization of the Unite Nation of Rome".Vol.58, (2003-2004).

[7] Abbas, A. I. "Status of chickpea production in Iraq and Chickpea in the nineties proceeding of the second International workshop on the Chickpea improvement ICRISAT Center, India". Dec.4 (8), 293-294, (1990).

[8] Gil, J. M. Moreno, S. Nadal, D. Luna, A. D. Haro, "Variability of some physical Chemical Characters in Desi and kabuli chickpea types". J. Sci. Food Agric. (71), pp.179-184, (1999).

[9] Nazir, M. S. Akhtar, M.N. Ali, G. "Nutritional studies on chickpea". Pak. J. Agri. Res. 5,179-18, (2004).

[10] Shakya, M. S. Patel, M.M. Singh, B. "Knowledge levels of chickpea growers about Chickpea production Technology Indian". Res. J. Ext. Edu. 8, pp.65-68, (2008).

[11] Magid, J. H. Tiessen, L. M. Condron, "Dynamics of organic phosphorus under natural Agricultural Ecosystems Humic Substances in Terrestrial ecosystems". In Piccolo, A. Elsevier, Amsterdam, pp.429-466, (1996).

[12] Sharar, M. S. M. Ayub, M. A. Chaudhry, M. Nadeem, "Effect of NP application and inoculation on the growth and yield of gram". Pak. J. Agri. Sci. 37(3-4), 155-157, (2000).

[13] Chemining, W. A. G. N.Vesse, J. K. abun, G. N."Dance efficacy of *Rhizobium Leguminosarum* Bviciae In cultivated soil of eastern Canadian prairie Soils Biology & Biochemistry".Vol.38, pp.294-302, (2006).

[14] Albayrak, S. Sevimay, C. S. Tongel, O. "Effect of inoculation with Rhizobium on seed Yield and yield Components of common vetches Vicia sati VA Turkish Journal of Agriculture and Forestry". Vol.30, pp.31-37, (2006).

[15] Bouyoucos, G .J. "Hydrometer of method improved for making particles size analyses of Soil Agronomy Journal". 54, pp.464-465, (1962).

[16] Gee, G.W. Baude, J. W. "Particle-size analysis".In A. Klute, Ed Methods of soil Analysis: physical and Mineralogy Methods, Part I.Second Ed ASA and SSSA Madison, WI. pp. 383-412, (1986).

[17] Nelson, D.W. and Sommer, L. E. "Total carbon, organic carbon and organic matter". In Page A.L.R.H. Miller, and D. R. Keeney, Eds. "Methods of the Soil Analysis". Part2 Agronomy 9 SSSA. Madison.W.I. USA. pp. 539- 579, (1986).

[18] Rayment, G. E. Higginson, F. R. "Australian Laboratory Handbook of Soil and water chemical Methods Inkata Press. Melbourne. (1992).

[19] Page, A. L. Miller, R. H. Keeny, "Method of the soil analysis". Part2. American Society of Agronomy, Pub. Madison, Wisconsin, U.S.A. (1982).

[20] Olsen, S. R. Cole, C.V. Watanabe, F.S. and Dean L. A. "The Estimation of availability of Phosphorus in Soils by extraction with sodium bicarbonate". USDA Circ939. US Govt Print. Office, Washington, DC. (1954).

[21] Bremner, J. M."Nitrogen total in Sparks D. L. et al. (Eds) Chemical Methods".part3. ASSA Book Series, SSSA, ASA, Madison, W.I. USA. pp. 1085-1121, (1996).

[22] Sáez, P. Navas, M. J. Wybraniec, S. Michalowski, T.Asuero, A."An Overview of the Kjeldahl method of Nitrogen determination Part II Sample preparation working scale instrumental finish and quality control Critical Reviews in Analytical Chemistry".43,PP. 224-272, (2013).

[23] Addinsoft, "XLSTAT version 9.2 Statistical data analysis with M. S. Excel Addinsoft".NY. USA. (2007).

[24] Yadav, B.K. Kumar, S. "Performance of chickpea (*Cicer arietinum*) under different levels Phosphorous and Sulphur application plant Archives".14(2), pp.1115-1117. (2014).

[25] Erdemci, I. Aktaş, H. Nadeem, M.A. "Effect of fertilization and seed size on nodulation, yield and yield Components of Chickpea (*Cicer arietinum* L.) Appli Ecol Environ". Res. 15, PP.563-571, (2017).

[26] Ali, A. Ali, Z. Iqbal, J. Nadeem, A. M. Akhtar, N. Akram, H. M."Impact Nitrogen and phosphorus on Seed yield of chickpea". J. Agric. Res. 48, PP.333- 335, (2010).

[27] Walley, F. L., Boahen, S. K. Hnatowich, Stevenson, "Nitrogen and phosphorus fertility of Management For desi and kabuli chickpea". Canadian Journal of Plant Science, Vol. 85, pp. 73-79, (2005).

[28] Rashid, A. Ishaque, M. Hameed, K. Shabbir, M. Ahmad, "Growth and yield response of three chickpea Cultivars to varying NPK levels". Asian, J. Agric Biol. 1, pp.95-99, (2013).

[29] Shukla, O. P. Singh, P. K. Deshbhratar, P. "Impact of phosphorus on biochemical changes in (*Hordeum-Vulgare* L.) In mixed cropping with chickpea". J. Environ. Biol. 31(5), 575-580, (2010).

[30] Rashid, A. Ishaque, M.Hameed, Shabbir, Ahmad."Growth, yield response of three chickpea Cultivars to Varying K levels". Asian J Agric Biol. 1, pp. 95-99, (2013).

[31] Meena,L.R. Singh, R.K. Gautam.C. "Response of chickpea (*Cicer-arietinum* L.) moisture conservation and Practices phosphorus levels and bacterial inoculation under rain fed condition". Indian Journal of tropical Agriculture. Vol. 22, pp. 49-60, (2004).

[32] Singh, A .K. Choudry, R.K. Sharma, R.P.R." Effect of inoculation and fertilizer level on yield, nutrient Up take and economics of summer pulses". J. Pot. Res. 9, pp.175-178, (2003).