

## Original Research Article

<https://doi.org/10.20546/ijcmas.2018.702.407>

## Chickpea Cultivation Governing by Phosphorus Application in Calcareous Soil

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### ABSTRACT

A field experiment on chickpea (*Cicer arietinum* L.) was carried out under medium black calcareous soil conditions during *rabi* 2015-16 at the Instructional Farm, Department of Agronomy, College of Agriculture, Junagadh Agricultural University, Junagadh. Maximum dry matter accumulation per plant at 45 DAS (2.13 g plant<sup>-1</sup>), 60 DAS (17.10 g plant<sup>-1</sup>), 75 DAS (23.93 g plant<sup>-1</sup>), 90 DAS (32.90 g plant<sup>-1</sup>) and at harvest (34.05 g plant<sup>-1</sup>), plant height (42.30 cm), number of root nodules (8.48) at 45 DAS, dry weight of root nodules per plant (102.90 mg plant<sup>-1</sup>) at 45 DAS, stover yield (2450 kg ha<sup>-1</sup>), biological yield (3944 kg ha<sup>-1</sup>), protein yield (313.61 kg ha<sup>-1</sup>), uptake of N and K by seed, phosphorus and sulphur content and uptake by stover, total uptake of N, P, S by crop, available sulphur status (13.11 ppm), gross return (₹ 62580 ha<sup>-1</sup>) and net return (₹ 36300 ha<sup>-1</sup>) were recorded with the application of 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>, which was significantly higher over control and 20 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>. But maximum branches per plant (6.02), number of pods per plant (64.62), seed index (21.20 g), seed yield (1507 kg ha<sup>-1</sup>), phosphorus and sulphur content and uptake in grain, total phosphorus uptake by crop, available phosphorus status (43.53 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>) were recorded with the application of 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>, which was significantly higher over control and 20 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>. Furthermore application of 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> recorded highest B: C ratio of 2.40 which was higher by 11.62 per cent over control.

### Keywords

Phosphorus,  
Growth, Yield,  
Quality, Uptake and  
Chickpea

### Article Info

Accepted:  
28 January 2018  
Available Online:  
10 February 2018

### Introduction

India is one of the major pulses growing country of the world, accounting roughly for one third of total world area under pulse cultivation and one fourth of total world production. Among the pulses, chickpea is a most important *rabi* crop with high acceptability and wider use (Singh, 2011). Chickpea (*Cicer arietinum* L.) belongs to the genus *Cicer*, tribe *Cicereae*, family *fabaceae*

and sub-family *Papilionaceae*. It has 2n=16 chromosome number. The origin of the crop is considered in Western Asia from where it spread in India and other part of the world (Ali and Kumar, 2001). There are two distinct types of chickpea, "Kabuli" (also known as *macrosperma*) and "Desi" (also known as *microsperma*). "Desi" (*Cicer arietinum* L.) type chickpea's colour ranges from brown to yellow. Seeds are normally small in size. It is widely grown group of chickpea. "Kabuli"

(*Cicer kabulium*) chickpeas are usually white in colour. In many soil types, P is the most limiting nutrient for the production of crops. It plays primary role in many of the physiological processes such as the utilization of sugar and starch, photosynthesis, energy storage and transfer. Legumes generally have higher P requirement because the process of symbiotic nitrogen (N) fixation consumes a lot of energy. Phosphorus is fascinating plant nutrient as it involved a wide range of plant processes from permitting cell division to the development of a good root system ensuring timely and uniform ripening of crop.

### Materials and Methods

A field experiment entitled “Effect of different levels of phosphorus and sulphur on growth, yield and nutrient uptake by chickpea (*Cicer arietinum* L.)” was carried out under medium black silty loam soil and slightly alkaline (calcareous) soil in reaction with pH 8, EC 0.36 dSm<sup>-1</sup>, low in available nitrogen (242.6 kg ha<sup>-1</sup>), medium in available phosphorus (34.50 kg ha<sup>-1</sup>), medium in available potassium (221.0 kg ha<sup>-1</sup>) and low in available sulphur (8.52 ppm), during *rabi* 2015-16 at the Instructional Farm, Department of Agronomy, College of Agriculture, Junagadh Agricultural University, Junagadh. The experiment consisting of 12 treatment combinations, comprising 4 levels of phosphorus (0, 20, 40 and 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>) and 3 levels of sulphur (0, 20, 40 kg S ha<sup>-1</sup>). These treatments were evaluated under factorial randomized block design with 3 replications. The chickpea variety GG 5 (GJG 0809) as selected for this study. This variety was developed and evaluated by Main Pulses Research Station, Junagadh Agricultural University and has been released for general cultivation by central release committee in 2013. The weather condition during *rabi* of 2015-16 (Fig. 01) was favorable for normal growth and development of chickpea. As a result, the growth of

chickpea crop was normal. No severe incidence of insect-pest was observed.

## Results and Discussion

### Growth parameters

The increasing levels of phosphorus significantly increased the dry matter accumulation at different stages *viz.* 45, 60, 75, 90 DAS and at harvest, number of root nodules per plant at 45 DAS, dry weight of root nodules per plant at 45 DAS, as well as plant height at harvest increased significantly up to 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>, whereas number of branches increased significantly up to 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>. This might be due to as phosphorus is fascinating plant nutrient as it involved a wide range of plant processes from permitting cell division to the development of a good root system ensuring timely and uniform ripening of crop. It is needed by most by young, fast growing tissues and performs a number of functions related to development and growth. It is a constituent of ADP and ATP, two of the most important substances in life processes.

Similar findings were also reported by Shivakumar *et al.*, (2001) in green gram, Basir *et al.*, (2008), Ali *et al.*, (2010), Nawange *et al.*, (2011), Neenu *et al.*, (2014), Hussena *et al.*, (2015) and Hussien *et al.*, (2015) in chickpea, Yadav *et al.*, (2016) in chickpea.

### Yield attributes and yield

The yield attributes and yield *viz.*, number of pod per plant, number of seed per pod, seed index, seed yield, stover yield, biological yield and harvest index, all these parameters are significantly not influenced by various levels of phosphorus, but pod per plant, seed index and seed yield are significantly affected with levels of phosphorus (Table 1). Application of 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> recorded significantly the highest values for these yield attributes and

yield, but stover and biological yield is significantly influenced with application of 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>. Significantly the lowest values for these yield and yield attributes were observed in control.

These results might be possible because, phosphorus plays primary role in many of the physiological processes such as the utilization of sugar and starch, photosynthesis, energy storage and transfer. Legumes generally have higher P requirement because the process of symbiotic nitrogen (N) fixation consumes a lot of energy. Therefore yield attributes and yield of crop highly depends on phosphorus application and its levels of application. Similar results were also reported by Thiyageshwari and Perumal (2000) in blackgram, Singh *et al.*, (2008) in blackgram, Nawange *et al.*, (2011) in chickpea, Parmar *et al.*, (2014) in kharif greengram, Kadam and Khanvilkar, (2015) in summer greengram, Yadav *et al.*, (2016) in chickpea.

### **Nutrient content, uptake and quality**

A significant increase in phosphorus and sulphur content and uptake in grain was recorded with increasing levels of phosphorus up to 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>. Effect of phosphorus levels on potassium and nitrogen content of seed was found non-significant, but uptake of N and K by seed was significantly influenced with increasing levels of phosphorus up to 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>.

An increasing levels of phosphorus up to 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> significant result on phosphorus and sulphur content and uptake by stover, while results on nitrogen and potassium content in stover was found non-significant, but significant influenced on uptake of nitrogen by stover by increasing levels of phosphorus up to 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>. Further total uptake of nitrogen, potassium and sulphur by chickpea crop was significantly influenced by

increasing levels of phosphorus upto 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> and total phosphorus uptake by crop was significantly higher with application of 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>. The quality of chickpea as protein content was found non-significant with increasing levels of phosphorus, but total protein yield kg/ha was significantly increased with increasing levels of phosphorus up to 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>.

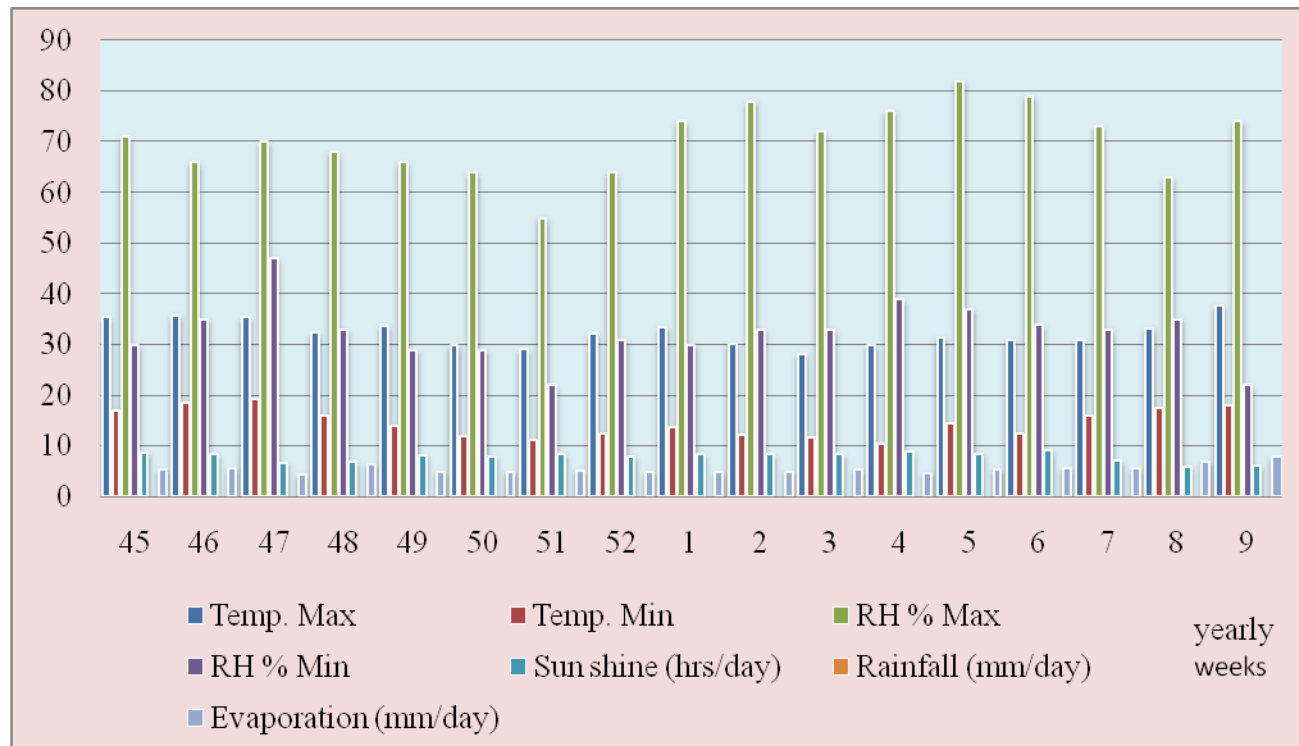
This might be due to increase in the phosphorus concentration in soil solution by phosphorus application in soil, which resulted in increasing intake of the nutrient from soil solution and consequently increased content of phosphorus in grain and stover. Increasing levels of phosphorus in soil improves nutritional environment in rhizosphere and consequently in plant system.

Uptake of nitrogen was generally influenced by phosphorus application up to a certain level, but uptake of potassium by crop is less or rarely effected by phosphorus application. Similar results were found by Yaka *et al.*, (2004) in green gram, Yadav, (2011) in cluster bean, Bhatt *et al.*, (2013) in greengram, Uddin *et al.*, (2014) in chickpea, Dhage *et al.*, (2014) in soybean.

### **Soil nutrient status**

The pH, EC of soil and availability of nitrogen and potassium in soil after harvest did not influence by various levels of phosphorus (Table 3). But varying levels of phosphorus significantly influenced on available phosphorus and sulphur status of soil after harvest of the crop. Application of 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> recorded significantly the highest available phosphorus status (43.53 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>), which remained statistically at par with 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> with the value of 43.14 kg ha<sup>-1</sup>, while the lowest phosphorus status (37.54 kg ha<sup>-1</sup>) was recorded under 0 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> (control).

**Fig.1** Meteorological data recorded during the *rabi* crop season 2015-16



**Table.1** Effect of phosphorus levels on yield and harvest index of chickpea

| Treatments  | Seed yield (kg ha <sup>-1</sup> ) | Stover yield (kg ha <sup>-1</sup> ) | Biological yield (kg ha <sup>-1</sup> ) | Harvest index (%) |
|---|-----------------------------------|-------------------------------------|---|-------------------|
| <b>Phosphorus (kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>)</b> |                                   |                                     |   |                   |
| 0   | 1215.44                           | 2159.56                             | 3375.00                                 | 36.18             |
| 20  | 1402.11                           | 2321.33                             | 3723.44                                 | 37.57             |
| 40  | 1507.44                           | 2383.11                             | 3890.56                                 | 38.74             |
| 60  | 1493.56                           | 2450.78                             | 3944.33                                 | 37.91             |
| SEM±  | 31.93                             | 46.27                               | 55.41                                   | 0.71              |
| CD (P = 0.05)   | 93.64                             | 135.71                              | 162.52                                  | NS                |

**Table.2** Effect of phosphorus levels on economics of chickpea

| Treatments  | Gross return (₹ ha <sup>-1</sup> ) | Cost of cultivation (₹ ha <sup>-1</sup> ) | Net return (₹ ha <sup>-1</sup> ) | B:C ratio |
|---|------------------------------------|---|----------------------------------|-----------|
| <b>Phosphorus (kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>)</b> |                                    |   |                                  |           |
| 0   | 41379                              | 19126                                     | 22253                            | 2.15      |
| 20  | 49652                              | 21710                                     | 27942                            | 2.28      |
| 40  | 59716                              | 24914                                     | 34802                            | 2.40      |
| 60  | 62580                              | 26280                                     | 36300                            | 2.38      |

**Table.3** Effect of varying levels of phosphorus on macro-nutrient status in Soil after harvest of chickpea

| Treatments  | Available macro-nutrients (kg ha <sup>-1</sup> ) |   |                            |                   |
|---|--|---|----------------------------|-------------------|
|   | Available N                                      | Available P <sub>2</sub> O <sub>5</sub> | Available K <sub>2</sub> O | Available S (ppm) |
| <b>Phosphorus (kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>)</b> |  |   |                            |                   |
| <b>0</b>  | 242.22   | 37.54                                   | 230.69                     | 11.18             |
| <b>20</b>   | 242.91   | 39.79                                   | 231.08                     | 12.30             |
| <b>40</b>   | 242.13   | 43.53                                   | 232.14                     | 12.96             |
| <b>60</b>   | 243.05   | 43.14                                   | 233.01                     | 13.11             |
| <b>SEm±</b>   | 0.74   | 0.35                                    | 2.06                       | 0.06              |
| <b>CD (P = 0.05)</b>  | NS   | 1.01                                    | NS                         | 0.17              |

Application of 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> recorded significantly the highest available sulphur status (13.11 ppm S ha<sup>-1</sup>), which remained statistically at par with 40 kg P<sub>2</sub>O<sub>5</sub>ha<sup>-1</sup> with the value of 12.96 ppm ha<sup>-1</sup>, while the lowest phosphorus status (11.18 ppm ha<sup>-1</sup>) was recorded under 0 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> (control).It may be possible because of increasing levels of phosphorus increases available phosphorus in soil solution and also having synergistic interaction with sulphur in terms of sulphur availability in soil. Furthermore phosphorus application does not influence on available potassium and nitrogen status after harvest of crop. Similar findings also reported by Akabari *et al.*, (1983) in greengram, Raju and Verma (1984) in bengalgram, Narwal and Malik (1987) in chickpea, Aulakh *et al.*, (1990) in soybean, Yadav, (2011) in clusterbean, Dhage *et al.*, (2014) in soybean.

### Economics

The gross returns increased due to successive increase in varying levels of phosphorus in chickpea. Application of 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> recorded gross returns of ₹ 62580 ha<sup>-1</sup>. Application of 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> recorded higher net returns of ₹ 36300 ha<sup>-1</sup>. It is clear from the data presented in Table 2. revealed that B: C ratio increased due to successive increase in varying levels of phosphorus up to

40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> in chickpea. Application of 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> recorded the B: C ratio of 2.40 which was higher by 11.62 per cent over control. This might be due to maximum recovery from application of phosphorus with less expenditure.

Based on the experimental results, it can be concluded that for obtaining higher seed yields, improving soil available nutrients status after harvest and economic profitability of improved variety of chickpea crop (*Rabi*, variety GG-5 /GJG 0809) was found effective with fertilization of phosphorus 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> under irrigated conditions in medium black calcareous soils of South *Saurashtra* region of Gujarat.

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**How to cite this article:**

Vikram Singh, Ajeev Kumar, Manohar Lal and Mahesh Kumar. 2018. Chickpea Cultivation Governing by Phosphorus Application in Calcareous Soil. *Int.J.Curr.Microbiol.App.Sci.* 7(02): 3419-3425. doi: <https://doi.org/10.20546/ijcmas.2018.702.407>