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Review

Role of phosphorus in chickpea (*Cicer arietinum* L.) production

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India is a highly populated country under the category of developing nations. The protein requirement of most of the people is fulfilling through pulses. Production of pulse crops and their yield stagnation last so many years. It has been estimated that India's population would reach 1.68 billion by 2030 from the present level of 1.21 billion. Accordingly, vision of Indian Institute of Pulse Research, 2030, the projected pulse requirement by the year 2030 would be 32 million tons with an anticipated required growth rate of 4.2%. Apart from this, Indian pulse remains competitive to protect the indigenous pulse production. Among the pulses, chickpea (*Cicer arietinum* L.) play a vital role in total pulse production. This review paper highlights the role of phosphorus (P) in chickpea production.

Key words: Chickpea, phosphorus, nutrient management.

INTRODUCTION

Pulses are major sources of proteins among the vegetarians in India, and complement the staple cereals in the diets with proteins, essential amino acids, vitamins and minerals (Pingoliya et al., 2013). They contain 22 to 24% protein, which is almost twice the protein in wheat and thrice that of rice (Shukla et al., 2013). It is an easily available source of protein in the rural heart of India, that is, village. Pulses provide significant nutritional and health benefits, and are known to reduce several non-communicable diseases such as colon cancer and cardiovascular diseases (Jukanti et al., 2012). Pulses can be grown on a wide range of soil and climatic conditions, and play important role in crop rotation, mixed and inter-cropping, maintaining soil fertility through nitrogen fixation, release of soil-bound phosphorus (P), and thus contribute significantly to the sustainability of the farming systems.

India is the largest producer and consumer of pulses in the world. Major pulses grown in India include chickpea or bengal gram (*Cicer arietinum*), pigeonpea or red gram (*Cajanus cajan*), lentil (*Lens culinaris*), urdbean or black gram (*Vigna mungo*), mungbean or green gram (*Vigna*

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radiata), pea (*Pisum sativum* var. arvense), lablab bean (*Lablab purpureus*), moth bean (*Vigna aconitifolia*), horse gram (*Dolichos uniflorus*), grass pea or khesari (*Lathyrus sativus*), cowpea (*Vigna unguiculata*), and broad bean or faba bean (*Vicia faba*).

Among the pulses, chickpea is most important grown in every part of India. It is the largest produced food legume in South Asia and the third largest produced food legume global, after the common bean (*Phaseolus vulgaris* L.) and field pea (*P. sativum* L.). India is the largest chickpea producing country, accounting for 64% of the global chickpea production. The other major chickpea producing countries includes Pakistan, Turkey, Iran, Myanmar, Australia, Ethiopia, Canada, Mexico and Iraq. It is grown in an about 30% of the national pulse acreage which contributes to about 38% of national pulse production in India. Phosphorus is an important fertilizer in chickpea production; it is an import fertilizer which enhanced the cost of production (Dotaniya et al., 2013c; Dotaniya and Datta, 2013). In this review paper, we try to describe the role of P in chickpea production.

PHOSPHORUS FATE IN SOIL

Phosphorus has been recognized as one of the important element in plant nutrition (Dotaniya et al., 2014a). Phosphorus is an important nutrient especially for pulses to enhance their productivity. Phosphorus stimulates early root development, leaf size, tillering, flowering, grain yield and hastens maturity. It is a constituent of certain nucleic acids, that is, phospholipids, chromosomes and the coenzymes nicotinamide adenine dineucleotide (NAD), adenosine triphosphate (ATP) and nicotinamide adenine dineucleotide phosphate (NADP). Phosphorus is essential for cell division, seed and fruit development. A range of research experiments were conducted towards defining its chemistry in the soil- plant system. Soils are known to vary widely in their capacity to supply P to crops, as only a small fraction of it in soil solution is in available form to crops (Dotaniya et al., 2014b). In addition to this, phosphorus occurs in very low concentration in soil solution. Its uptake by crops results in a further decrease of its concentration in the soil solution especially near plant root zone (Dotaniya et al., 2013b). As a result, P deficiency has become a limiting factor in crop production in agricultural soils worldwide (Dotaniya et al., 2013c). In India, P fertilizers are totally imported to meet agricultural and allied needs, indigenous rock phosphate having low concentration of P and high cost of P fertilizers production. The phosphatic fertilizers are costly and their efficiency is very low (15 to 20%). A major portion of added phosphatic fertilizer is either chemically fixed by Ca and Mg in high pH; Al and Fe in low pH soils and/or strongly adsorbed on some soil components. Apart from soil factors, rhizospheric process (Dotaniya and Meena, 2013; Dotaniya, 2014), plant process and climatic factors are influencing the P dynamics in soil (Figure 1). Cordell et al. (2009) predicted that P production will peak in 2033, it means not to exploit of all reserve-to-production (RP) reserve, but afterward, supply is expected to decrease each year, due to economic and energy constraints. This peak indicated that high quality RP reserve will be exploited and, world will go for low grade and alternative P supplying sources. A group of researcher gave the different expected time of rock phosphate reserve exploitation (Table 1).

EFFECT OF PHOSPHORUS ON GROWTH ATTRIBUTES

The number of nodules, number of pods, weight of pods, green pod yield and protein content (per cent) were markedly increased with increasing P levels up to 90 $kgha^{-1}$ over control in cowpea (Baboo and Mishra, 2001). Ram and Dixit (2001) also found that the application of P at 60 kg P_2O_5 ha^{-1} significantly increased the plant height, branches per plant, leaves per plant and dry matter accumulation as compared to control and 20 kg P_2O_5 ha^{-1} in green gram. Later on, it was reported that growth attributes like plant height and dry matter accumulation per plant were significantly higher with 60 kg P_2O_5 ha^{-1} than 30 and 0 kg P_2O_5 ha^{-1} in chickpea (Arya et al., 2002). The positive effect of nitrogen with P fertilizers (20 kg N + 20 kg P_2O_5 ha^{-1}) conducted a field experiment at Jobner with chickpea crop and reported that the fertility levels significantly increased the plant height over control and 10 kg N + 20 kg P_2O_5 ha^{-1} (Khoja et al., 2002). Whereas, number of branches per plant and dry matter accumulation per plant was significantly increased due to 10 kg N + 20 kg P_2O_5 ha^{-1} over control.

In cowpea, crop plant height, pods per plant, length of pods etc were greatly increased by the application of P at 40 kg P_2O_5 ha^{-1} over control (Sharma and Jat, 2003). The application of P at 40 kg P_2O_5 ha^{-1} significantly increased all growths attributes, that is, plant height, number of branches per plant, dry matter accumulation, dry weight and number of nodules per plant in lentil over 0 and 20 kg P_2O_5 ha^{-1} (Singh et al., 2003). Similarly, Sunder et al. (2003) also observed that the application of P at 40 kg P_2O_5 ha^{-1} significantly increased the dry matter accumulation per meter row length by 20.57 and 7.81% over control and 20 kg P_2O_5 ha^{-1}, respectively in cluster bean. The dry matter accumulation per plant and leaf area index (LAI) was significantly increased with the application of 26.4 kg P_2O_5 ha^{-1} over 0 and 13.4 kg P_2O_5 ha^{-1} in gram (Jat and Ahalawat, 2004). The growth characters of chickpea as plant height, number of nodules per plant and dry matter accumulation were significantly increased up to 30 kg P_2O_5 ha^{-1} (Meena et al., 2004). However, the plant growth from 0 to 30 kg P_2O_5 ha^{-1} application was considerably more as compared to 30 to 60 kg P_2O_5 ha^{-1} application.

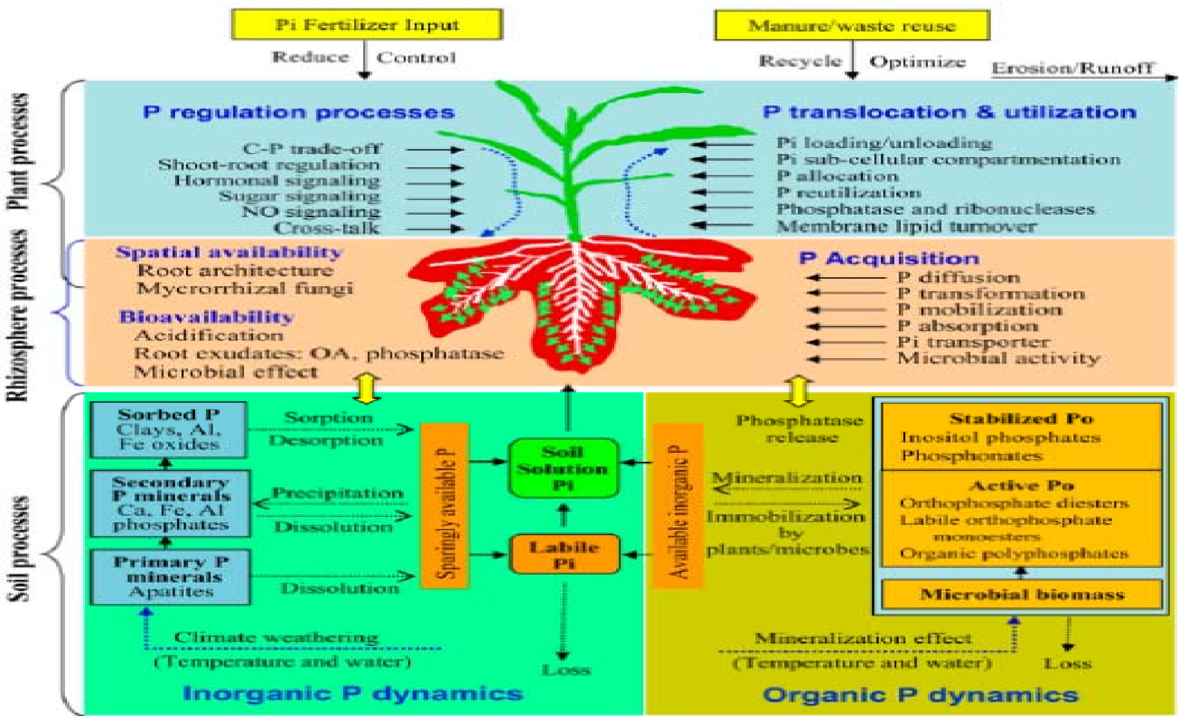

Figure 1. Phosphorus dynamics in soil/rhizosphere-plant continuum (Shen et al., 2011; Dotaniya et al., 2013c).

Table 1. Estimates of availability of remaining phosphate rock reserve.

Author	Estimated reserves (years)	Lifetime assumptions
Steen (1998)	60 - 130	2-3% increase demands rates, most likely 2% increase until 2020 and 0% growth thereafter if efficacy and reuse measures are implemented.
Smil (2000)	80	At current rate of extraction
Smit et al. (2009)	69 - 100	Assuming 0.7-2% increase until 2050, and 0% increase after 2050
Vaccari (2009)	90	At current rate
Fixen (2009)	93	At 2007-2008 production rates

A field experiment was conducted at IARI, New Delhi by Shivkumar et al. (2004) and they reported that the growth attributes viz., plant height, branches per plant and dry matter accumulation were increased with increasing level of P_2O_5 up to 80 kg ha^{-1} over control in chickpea. In the same year, Tripathy et al. (2004) reported that the application of nitrogen at 20 kg ha^{-1} and P at 25 kg P_2O_5 ha^{-1} significantly increased primary, secondary and tertiary branches of chickpea at successive growth stage of 40 and 85 days after sowing and harvest over control. But the application of 60 kg P_20_5 ha^{-1} significantly increased the growth attributes in chickpea like plant height, dry matter accumulation, and pods per plant over the control (Choudhary and Goswami, 2005). Das et al. (2005) also reported that the application of P at 75 kg P_2O_5 ha^{-1} significantly increased growth attributes like plant height and dry root weight over control in vegetable pea (*P. sativum*). The increasing levels of P up to 60 kg P_2O_5 ha^{-1} resulted in a significant increase in dry matter accumulation in chickpea over 0 and 30 kg P_2O_5 ha^{-1} (Meena et al., 2005).

Jarande et al. (2006) reported that the application of P at 37.5 kg P_2O_5 ha^{-1} + vermicompost + phosphate solubilizing bacteria (PSB) + *Rhizobium* recorded higher value of growth as well as yield contributing parameters in chickpea. The acid formation by a micro organism and crop plant roots enhanced the P mobilization in soil (Dotaniya et al., 2013a; Ammal et al., 2001). Sune et al. (2006) conducted a field experiment at College of Agriculture, Nagpur, and reported that the three levels of P in incremental dose increased the plant height, number of branches per plant and dry matter accumulation in linseed and 45 kg P_2O_5 ha^{-1} was the best and superior over 30 and 20 kg P_2O_5 ha^{-1}. Kushwaha (2007) conducted a field experiment on sandy loam soil at Chitrakoot and observed that application of nitrogen at 15 kg ha^{-1} + P at 30 kg P_2O_5 ha^{-1} significantly increased the growth parameters viz., plant height, dry matter accumulation, branches per plant and seeds per pod over control in chickpea. Singh and Prasad (2008) reported that dry matter accumulation and dry weight of nodules increased with levels of P up to 55 kg P_2O_5 ha^{-1}, thereafter increase was not significant. Singh and Yadav (2008) concluded that the application of 60 kg P_2O_5 ha^{-1} being at par with 45 kg P_2O_5 ha^{-1} recorded that the maximum plant height, number of primary branches, dry matter per plant, grain yield, stalk yield and uptake of P in pigeon pea over control. From the results of a field experiment, Ahmed and Badr (2009) concluded that the application of mineral P fertilizer at 46.5 kg P_2O_5 fed^{-1} resulted in a significant increase in growth characters in chickpea over control. Kumar et al. (2009) reported that application of P at 50 kg P_2O_5 ha^{-1} significantly increased the branches per plant, number of pods per plant, number of grains per pod, test weight, grain and straw yield in chickpea over control.

Meena et al. (2010) observed that the increasing levels of P up to 30 kg P_2O_5 ha^{-1} significantly increased the growth attributes in moth bean viz., plant height, branches per plant, dry matter accumulation and chlorophyll content as compared to preceding levels. Singh et al. (2010) observed that the application of 20 and 40 kg P_2O_5 ha^{-1} enhanced dry weight of root and shoot over no application of P in chickpea. Thenua et al. (2010) reported that application of P as single super phosphate (SSP) recorded significantly higher plant height, branches per plant and dry matter accumulation in chickpea.

EFFECT OF PHOSPHORUS ON YIELD AND YIELD ATTRIBUTES

On loamy sand soils of Jobner, Meena et al. (2001) reported that the application of 40 kg P_2O_5 ha^{-1} significantly increased pods per plant, seeds per pod, test weight, seed and straw yield of chickpea over control. They reported that application of 40 kg P_2O_5 ha^{-1} significantly increased number of pods per plant, number of seeds per pod, test weight, grain and straw yield over control and 20 kg P_2O_5 ha^{-1}. However, application of 60 kg P_2O_5 ha^{-1} remained at par with 40 kg P_2O_5 ha^{-1}. Singh and Vaishya (2001) reported that the grain yield increased significantly with increasing P dose and was recorded maximum at 60 kg P_2O_5 ha^{-1} over control in chickpea. Tiwari et al. (2001) also reported that the grain production of chickpea increased with increasing levels of P viz., 0, 40, 60 kg P_2O_5 ha^{-1} and maximum yield was observed at 60 kg P_2O_5 ha^{-1} which was 23.1% higher over no P application. Arya et al. (2002) in a field experiment on chickpea reported that the application of 60 kg P_2O_5 ha^{-1} significantly increased number of pods per plant, number of seeds per pod, test weight, grain and straw yield over control and 30 kg P_2O_5 ha^{-1}. A field experiment conducted by Meena et al. (2002) during the winter season of 1997-1998 and 1998-1999 at IARI, New Delhi reported that the application of P at 60 kg P_2O_5 ha^{-1} significantly increased yield attributes viz., number of nodules per plant and dry weight of nodules in chickpea over control. Lakpale et al. (2003) reported that application of 25.8 kg P_2O_5 ha^{-1} significantly increased number of pods per plant and higher seeds of gram over control. Application of 25.8 kg P_2O_5 ha^{-1} significantly increased the seed yield over control, but remained at par with 12.9 kg P_2O_5 ha^{-1}. Pramanik and Singh (2003) reported that the application of P_2O_5 at 60 kg ha^{-1} significantly increased yield attributes and yield over control in chickpea. Jat and Ahalawat (2004) also reported that the pods per plant, seed and straw yield of chickpea significantly increased with the application of 26.4 kg P_2O_5 ha^{-1} over 0 and 13.2 kg P_2O_5 ha^{-1}.

Meena et al. (2004) reported that the number of grains per pod, grain weight per plant, test weight and straw yield of chickpea increased significantly up to 60 kg P_2O_5 ha^{-1} over control and 30 kg P_2O_5 ha^{-1}. However, application of 60 kg P_2O_5 ha^{-1} significantly increased the seed yield over control, but remains at par with 30 kg P_2O_5 ha^{-1}. Shivakumar et al. (2004) reported that number of grains per pod, grain weight per plant, test weight, grain and straw yield of chickpea significantly increased with each level of P up to 80 kg P_2O_5 ha^{-1}. Choudhary and Goswami (2005) reported that the application of P at 60 and 90 kg P_2O_5 ha^{-1} significantly increased the grain yield of chickpea over control. Kumar and Sharma (2005) reported that each successive increase in levels of P up to 40 kg P_2O_5 ha^{-1} significantly increased the number of pods per plant, number of seeds per pod, test weight, seed and straw yield of chickpea but found statistically at par with 60 kg P_2O_5 ha^{-1}. Tiwari et al. (2005) reported that yield attributes of chickpea like number of pods per plant, test weight, grain and straw yield and harvest index augmented significantly with application of P up to 50 kg P_2O_5 ha^{-1} over 0 and 25 kg P_2O_5 ha^{-1}.

Jarande et al. (2006) conducted a field experiment at Agronomy Farm, College of Agriculture, Nagpur, and reported that the application of P at 37.5 kg P_2O_5 ha^{-1} + vermicopost + PSB + *Rhizobium,* recorded higher yield contributing parameters viz., dry matter per plant, number of seeds per plant, grain yield ha^{-1} and straw yield ha^{-1} in chickpea over control. Sune et al. (2006) conducted a field experiment at College of Agriculture, Nagpur, and reported that the application of 40 kg P_2O_5 ha^{-1} recorded higher value of yield contributing parameters viz., number of capsules per plant, number of seeds per capsule, seed yield and straw yield over control in linseed. Sharma and Abrol (2007) reported that the maximum grain yield of was observed with 60 kg P_2O_5 and 5 kg Zn ha^{-1} over control in chickpea. An investigation was carried out by Singh and Prasad (2008) at Kanpur and they reported that the application of diammonium phosphate (DAP) up to 180 kg ha^{-1} increased the grain yield (20.29 qha^{-1}) and straw (24.69 qha^{-1}) over control in chickpea. Verma and Singh (2008) observed that grain and straw yield of moong bean significantly increased with the application of P (0 to 75 kg P_2O_5 ha^{-1}) along with *Rhizobium* inoculation. Similar results were also observed by Narolia et al. (2013) in isabgol and Pingoliya et al. (2014a, b) in chickpea. A field experiment was conducted by Kumar et al. (2009) at Kanpur and they concluded that the application of 50 kg P_2O_5 ha^{-1} significantly increased average grain yield of chickpea over control. Srividya et al. (2009) conducted a field experiment at Agricultural College Bapalta, India and they concluded that the recommended dose of P at 50 kg P_2O_5 ha^{-1} was supplied through SSP, high grade rock phosphate (P_2O_5 20% by weight) and DAP produced the maximum number of pods per plant, seeds per plant, seed and straw yield of chickpea over control. Meena et al. (2010) revealed that the yield component of moth bean viz., pods per plant, seeds per pod, pod length and test weight increased significantly with increasing levels of P up to 30 kg P_2O_5 ha^{-1} but it remained at par with 45 kg P_2O_5 ha^{-1}. Meena et al. (2010) reported that the application of P at 30 kg P_2O_5 ha^{-1} being at par with 45 kg P_2O_5 ha^{-1} significantly increased the seed yield of moth bean representing an increase of 57.54 and 15.56% over control and 15 kg P_2O_5 ha^{-1} respectively. Rathore et al. (2010) observed that the application of farmyard manure (FYM) at 5 tha^{-1}, 40 kg P_2O_5 ha^{-1} and dual seed inoculation with PSB + vesicular arbuscular mycorrhiza (VAM) significantly increased the seed and stover yield over control in urdbean. Singh et al. (2010) observed that the application of 20 kg P_2O_5 ha^{-1} increased the grain yield in chickpea over no P application.

EFFECT OF PHOSPHORUS ON NUTRIENT CONTENT, UPTAKE AND QUALITY

Ingale and Deshmukh (1986) reported that increasing rates of applied P from 0 to 25 kg P_2O_5 ha^{-1} increased N, P and K uptake and protein content in seeds of chickpea. Raju et al. (1991) reported that increasing levels of P from 20 to 40 kg P_2O_5 ha^{-1} brought about a corresponding significant increase in uptake of N, P and K. Singh and Ram (1992) conducted a field experiment for 2 years (1981-1982 and 1982-1983) with chickpea crop and concluded that application of P up to 60 kg ha^{-1} significantly increased Mn and Fe contents and their uptake in grain and straw, but decreased with further addition of P that is, 90 kg P_2O_5 ha^{-1}. Contents of zinc and copper decreased linearly with increasing levels of P. However, uptake of zinc and copper by grain and straw increased up to 60 kg P_2O_5 ha^{-1} and with further increase in the level of P, there was an appreciable reduction. Singh et al. (1993) conducted a field experiment and concluded that the iron content in grain and straw increased consistently by application of Fe but decreased with P addition (0 to 100 mg kg^{-1}). Enania and Vyas (1994) conducted a field experiment at Udaipur on clay loam soil and revealed that uptake of P increased significantly up to 50 kg P_2O_5 ha^{-1} and zinc up to 25 kg ha^{-1}. Krishna and Yadav (1997) conducted a field experiment with chickpea and concluded that the copper content decreased progressively with increasing doses of P and accordingly minimum Cu content was obtained at 90 kg P_2O_5 ha^{-1} in both grain and straw. Mn and Fe uptake in both seed and straw increased significantly up to 60 kg P_2O_5 ha^{-1} and thereafter decreased. Reddy and Ahlawat (1998) reported that the application of 40 kg P_2O_5 ha^{-1} increased the yield attributes, grain and straw yield, N, P, Zn uptake and protein content in chickpea crop. A field experiment was conducted at agronomy farm, Jobner and found that the application of 45 kg P_2O_5 ha^{-1} significantly increased the N and P content in grain and straw and their uptake by cowpea crop over control (Kumar, 2000). Dadheech (2001) reported that the application of P at 60 kg ha^{-1} significantly increased the N and P content in grain and straw, N and P uptake by grain and straw and protein content in grain over their lower doses in black gram crop. Meena et al. (2001) reported that the protein content in seeds was significantly higher with the application of 60 kg P_2O_5 ha^{-1} over control in chickpea. Patel et al. (2001) also observed that the application of 40 kg P_2O_5 ha^{-1} gave the maximum grains protein and nutrient uptake was also enhanced significantly due to P levels up to 60 kg P_2O_5 ha^{-1} in black gram. Ram and Dixit (2001) conducted a field experiment at Faizabad, and results showed that the application of P at 60 kg P_2O_5 ha^{-1} gave significantly higher value of protein content over control in green gram. Tiwari et al. (2001) reported that the grain production of chickpea increased due to increase in P levels from 0 to 60 kg ha^{-1}. Maximum production was recorded at 60 kg P_2O_5 ha^{-1} over control; similarly, increase in P uptake was also observed due to 40 and 60 kg P_2O_5 ha^{-1} over no P application. Yadav et al. (2002) conducted a field experiment during *Kharif* season of 1997 with mung bean crop and they concluded that P content and uptake by seed and straw and micronutrients (Fe, Mn, Cu and Zn) in seed increased significantly with increasing levels of P but decreased the content and uptake of Fe in seed and straw of mung bean crop. Mishra (2003) conducted a field experiment at Bulandshahar (U.P.) and concluded that P markedly improved the quality of cowpea in terms of protein yield in seeds with increasing levels of P from 0, 30, 60, and 90 kg ha^{-1}. A similar trend was notified for protein yield in stover and total production. A field experiment was conducted by Pramanik and Singh (2003) at IARI, New Delhi and they reported that the application of P significantly increased the P uptake up to 60 kg P_2O_5 ha^{-1} in the 1st year and up to 30 kg ha^{-1} in the 2nd year in chickpea. Singh et al. (2003) found that the application of P up to 40 kg P_2O_5 ha^{-1} significantly increased the uptake of N and P in grain and straw of chickpea over control and 20 kg P_2O_5 ha^{-1}. Sunder et al. (2003) observed that the application of 40 kg P_2O_5 ha^{-1} significantly increased the protein content in seed over control and 20 kg P_2O_5 ha^{-1} in cluster bean. Jat and Ahalawat (2004) reported that application of P up to 26.4 kg P_2O_5 ha^{-1} significantly increased the total uptake of N and P by chickpea over control. Meena et al. (2004) in a field experiment on chickpea crop also found that the application of P up to 60 kg P_2O_5 ha^{-1} significantly increased the uptake of N, P and K and protein content in chickpea over control and 30 kg P_2O_5 ha^{-1}. Shivakumar et al. (2004) conducted a field experiment at IARI, New Delhi and they concluded that the increasing levels of P up to 80 kg P_2O_5 ha^{-1} recorded significantly higher uptake of P with each successive level in chickpea. Meena et al. (2005) in a field experiment conducted at IARI, New Delhi during 1997-1998 and 1998-1999 and they reported that the increasing levels of P up to 60 kg P_2O_5 ha^{-1} resulted in a significant increase in P content, uptake and seed yield of chickpea over control.

Tiwari et al. (2005) reported that application of P up to 26.4 kg P_2O_5 ha^{-1} significantly increased the uptake of N, P and K in grain and straw by chickpea over control and 25 kg P_2O_5 ha^{-1}. Gupta et al. (2006) reported that the response of urdbean to P fertilization was significant up to 60 kg P_2O_5 ha^{-1} for seed and straw yield over control. Phosphorus application also increases the seed protein content, N and P uptake in seed and straw. Kahlon et al. (2006) reported that the application of 50 kg P_2O_5 ha^{-1} resulted in a better uptake of N, P, K, S, Zn, Fe and Cu as compared to other treatments. Kumar and Kushwaha (2006) conducted a field experiment at M.P. during rainy season in 1999-2000 and they concluded that the application of P up to 80 kg P_2O_5 ha^{-1} significantly increased the total P uptake over control in pigeon pea. Bhunia et al. (2006) conducted a field experiment at Sriganganagar, Rajasthan on fenugreek crop and they observed that the application of P increased the N, P and K uptake up to 40 kg P_2O_5 ha^{-1}.

A pot experiment was conducted by Srinivasarao et al. (2007) and they concluded that the application of P up to 27.0 mg kg^{-1} soil significantly reduced the Fe concentration in the plant. Up to 13.5 mg kg^{-1} P application, the Cu concentration increased and thereafter it decreased, while the concentration gradually increased with increasing P levels. Sharma and Abrol (2007) conducted a field experiment at Jammu and they concluded that the uptake of P by chickpea is significantly increased by increasing levels of P up to 60 kg P_2O_5 ha^{-1} over control. Singh and Prasad (2008) reported that the application of P up to 180 kg ha^{-1} by DAP significantly increased the N and P uptake by chickpea over 120 kg DAP ha^{-1}. A field experiment was conducted at Institute of Agricultural Sciences, BHU, Varanasi by Singh and Yadav (2008) and they reported that the maximum N and P uptake were recorded with 60 kg P_2O_5 ha^{-1} which was found significantly superior to the remaining levels except 45 and 30 kg P_2O_5 ha^{-1} by pigeon pea. Kumar et al. (2009) reported that the application of 50 kg P_2O_5 ha^{-1} significantly increased P uptake by grain and straw in chickpea over control.

Meena et al. (2010) observed that the nitrogen content in seed and straw, P content in straw as well as protein content in the seed were significantly higher with 30 kg P_2O_5 ha^{-1} as compared with preceding levels in moth bean. Patel et al. (2010) observed that higher yield as well as nutrient uptake and protein content in seed were recorded with the application of 50 kg P_2O_5 ha^{-1} and FYM at 10 tha^{-1} + seed treatment with *Rhizobium* in cluster bean. Rathore et al. (2010) observed that the higher uptakes of N, P and K in urdbean were recorded by the application of 40 kg P_2O_5 ha^{-1}.

CONCLUSIONS

The growing Indian population enhanced the pulses demand. The burgeoning human population in India needs higher pulses production for fulfilling the dietary protein requirement. It requires to mitigating the demand of protein. In coming years, we will produce the more amounts of pulses. Phosphorus fertilizer increases the cost of production because it is an import fertilizer. We should focus on production of new fertilizer having higher use efficiency. Develop varieties which are heavy higher yield potential with higher resistance to insect-pest and disease. However, a concerted effort by farmers, researchers, development agencies, and government are needed to ensure that India becomes self-sufficient in pulses in the future.

Conflict of Interest

The author(s) have not declared any conflict of interest.

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