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Effect of Phosphorus on Cowpea (*Vigna unguiculata* L. Walp): A review

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Abstract
Genotypes and phosphorus levels of other legume crops were also studied and included in the review. It has been seen that plant height of cowpea increased with application of 40 kg P_2O_5/ha and 90kg P_2O_5/ha. 40 kg P_2O_5/ha and 80 kg P_2O_5/ha recorded significant increased on number of branches per plant. Number of leaves per plant, dry matter accumulation and days to first flowering is enhanced by 90kg P_2O_5/ha, 60 kg P_2O_5/ha and 40 kg P_2O_5/ha respectively. However cowpea different yield attributes are influenced by 75 kg P_2O_5/ha, 60 kg P_2O_5/ha, 50 kg P_2O_5/ha, 60 kg P_2O_5/ha, 70 kg P_2O_5/ha, 80 kg P_2O_5/ha and 30 kg P_2O_5/ha with substantial increase in the growth of different parameters respectively. Hence, application of phosphorus equally influences the growth and yield components of cowpea genotypes.

Keywords: Genotypes, effect, phosphorus, application, accumulation

Introduction
Cowpea (*Vigna unguiculata* L. Walp) is an annual legume crop which belongs to the family Leguminosae and hence, it is cultivated widely in tropics and subtropics during the warm season. It is commercially grown throughout the India for its seed and green pods which are used as vegetable. The leading states in cowpea production in our country are UP, Bihar, Jharkhand, West Bengal, Odisha and so on. In Odisha, the crop is grown in an area of 1.5 million hectares with a production of 0.49 million t. This clearly imposes the need to identify the reasons for such low productivity in Odisha. Genotypes play an important role in crop production and the potential yield of a genotype within the genetic limit is determined by its growing environment. Hence, combination of genotype and environmental factors can bring about increase in production. Legumes are phosphorus loving plants. They require phosphorus for growth and seed development and most especially in nitrogen fixation which is an energy-driving process (Sanginga *et al.*, 2000) [17]. For sustainable food production to meet the increasing population in developing countries, need for phosphorus fertilizer application is expected to increase yield (Brynes and Bumb, 1998) [5]. Phosphorus is known to cause multiples effects on nutrition, increase in seed yield and nodulation process (Singh *et al*. 2011) [21]. Some researchers also reported that phosphorus application will affects the other nutrients in seed and leaves because of its multiple effects on plant nutrition (Shilpa, 2013) [19]. Earlier researches noted the effect of genotype and phosphorus level on growth and productivity of cowpea in different agro-climatic regions (Singh *et al*., 2011) [21]. However, there is insufficient research work on impact of phosphorus level on cowpea genotypes under this agro-climatic region. Hence, the present study has been conducted with the following objectives on evaluation and interactive effect of genotypes and phosphorus levels on growth, yield and quality of seed.

1. Growth of Cowpea as Influenced by Phosphorus Levels
1.1 Effect of Phosphorus Levels on Plant Height of Cowpea
Baboo and Mishra (2001) [3] stated that increasing phosphorus rate up to 90 kg P_2O_5/ha increased the plant height of cowpea. Anil *et al*. (2007) observed that 60 kg P_2O_5/ha significantly increased the plant height of cowpea. Jat *et al.* (2013) [8] found that application up to 40 kg P_2O_5/ha significantly enhanced the plant height of cowpea compared to control and 20 kg P_2O_5/ha.

1.2 Effect of Phosphorus Levels on Number of Branches per Plant of Cowpea

Jat *et al.* (2013) [8] found that application up to 40 kg P_2O_5/ha significantly enhanced number of branches per plant as compared to control and 20 kg P_2O_5/ha. Sharma *et al.* (2015) [18] investigated the effect of nutrients on productivity of cowpea genotype Pusa Komal and in the experiment application of 80kg P_2O_5/ha recorded the maximum number of branches per plant (7.81) at 45 DAS.

1.3 Effect of Phosphorus Levels on Number of Leaves per Plant of Cowpea

Baboo and Mishra (2001) [3] stated that enhancing phosphorus levels up to 90kg P_2O_5/ha increased number of green leaves per plant. Sharma *et al.* (2015) [18] noted that application of 80kg P_2O_5/ha noted the maximum number of leaves per plant (30.82).

1.4 Effect of Phosphorus Levels on Days to First Flowering of Cowpea

Patel and Jadav (2010) [14] observed that application of 40kg P_2O_5/ha along with rhizobium seed inoculation gave significantly less number of days to first flowering.

1.5 Effect of Phosphorus Levels on Dry Matter Accumulation of Cowpea

Bhilare and Patil (2002) [4] conducted an experiment at Rahuri to determine the effect of three levels of phosphorus application (0, 30 and 60kg P_2O_5/ha) on cowpea. Significantly highest dry matter (48.02 q/ha) were obtained with the application of 60kg P_2O_5/ha.

2. Yield Attributes and Yields of Cowpea as Influenced by Phosphorus Levels

2.1 Effect of phosphorus levels on number of pods per plant of cowpea

Kurdikeri *et al.* (1973) [11] recorded more number of pods per plant was produced with the application of 44 kg P_2O_5/ha along with 11 kg N/ha. However, Kumar *et al.* (2001) [10] reported that application of 50 kg P_2O_5/ha to cowpea through di-ammonium phosphate (DAP) exhibited higher number of pods per plant. Khan *et al.* (2002) [9] studied on productivity of cowpea as influenced by phosphorus levels on noted that the maximum number of pods per plant was recorded with phosphorus application 75kg P_2O_5/ha.

2.2 Effect of Phosphorus Levels on Length of Pods of Cowpea

Anil *et al*. (2007) observed that 60 kg P_2O_5/ha significantly enhanced the length of pod over control. Prasad *et al.* (2008) concluded that the application of VAM (*Gigaspora calospora*), Rhizobium culture and 80kg P_2O_5/ha significantly increased length of pods.

2.3 Effect of Phosphorus Levels on 100-seed Weight of Cowpea

Kumar *et al*. (2001) [10] found that application of 50 kg P_2O_5/ha to cowpea through di-ammonium phosphate (DAP) exhibited highest 100 seed weight.

2.4 Effect of phosphorus levels on pod weight of cowpea

Anil *et al*. (2007) observed that 60 kg P_2O_5/ha significantly increased the pod weight.

2.5 Effect of Phosphorus Levels on Number of Seeds per Pod of Cowpea

Kumar *et al.* (2001) [10] recorded application of 50 kg P_2O_5/ha in cowpea exhibited higher number of seed per pod.

2.6 Effect of Phosphorus Levels on Seed Weight per Pod of Cowpea

Khan *et al.* (2002) [9] recorded that maximum seed weight was observed with application of 75 kg P_2O_5/ha as compared to higher or lower dose. Tajudeen and Oseni (2009) [22] stated that application of phosphorus enhanced seed weight of cowpea at the rate of 40 kg P_2O_5/ha.

2.7 Effect of Phosphorus Levels on Pod Yield of Cowpea

Arup and Dhananjoy (2003) [2] reported that phosphorus fertilizers up to 80 kg P_2O_5/ha significantly increased the pod yield of cowpea.

2.8 Effect of Phosphorus Levels on Seed Yield of Cowpea

Ram and Dixit (2001) [16] states that among different levels of phosphorus, 60 kg P_2O_5/ha produced significantly more seed yield (10.8 q/ha) than control. Application of 60 kg P_2O_5/ha was found better for the production of seed yield. Singh *et al.* (2011) [21] noted that there was significant response to applied phosphorus on the seed yield of cowpea. Significantly higher seed yield was recorded in plots applied with 60 kg P_2O_5/ha (1353 kg/ha) than control plot (1017 kg/ha). Shilpa *et al.* (2015) [20] noted that application of 50 kg P_2O_5/ha recorded significantly higher seed yield (1087 kg/ha) of cowpea compared to 25 and 75 kg P_2O_5/ha. Mawo *et al.* (2016) [12] observed that the application of phosphorus equally influenced the growth and yield components of cowpea at different levels. The results showed the highest seed yield of cowpea was obtained with the application of 30 kg P_2O_5/ha.

2.9 Effect of Phosphorus Levels on Stover Yield (kg/ha) of Cowpea

Bhilare and Patil (2002) [4] conducted experiment at Rahuri to determine the effect of three phosphorus application levels (0, 30 and 60 kg P_2O_5/ha) on cowpea. Significantly highest yields of stover yield (244.10 q/ha) were obtained with the application of 60 kg P_2O_5/ha. Vikrant *et al.* (2005) at Hisar observed that higher stover yield of cowpea were recorded with 60 kg P_2O_5/ha over lower doses of phosphorus.

2.10 Effect of Phosphorus Levels on Biological Yield of Cowpea

Choudhary and Yadav (2011) [6] at Jobner reported that biological yield of cowpea increased significantly with increasing levels of fertility up to 100% RDF (20 kg N + 40 kg P_2O_5/ha).

2.11 Effect of Phosphorus Levels on Harvest Index of Cowpea

IIavarasi *et al*. (2007) [7] at Annamalai nagar reported that application of 70 kg P_2O_5/ha + 70 kg K_2O/ha along with basal dose of 20 kg N/ha recorded maximum harvest index in cowpea over lower doses of fertilizers.

2.12 Effect of Phosphorus Levels on Growth and Yield of Cowpea

Oka *et al.* (2001) [13] worked at Calabar, South Eastern Nigeria four levels of phosphorus fertilizers (10, 20, 40 and 60 kg P_2O_5/ha) and they noted that IT 81-D-1228-14 was able to provide higher green pod yields at 20 kg P_2O_5/ha. Singh *et*

al. (2011) [21] studied the effect of phosphorus on the growth and yield of cowpea. Results showed significant response to applied phosphorus on pods per plant, seed weight and 100-seed weight with highest response to the application of 60kg P_2O_5/ha. Mawo *et al*. (2016) [12] observed that the application of phosphorus equally influences the growth and yield components of cowpea genotypes. The results showed that cowpea gave the highest seed yield with application of 30 kg P_2O_5/ha.

Conclusion

In this review, effect of phosphorus on cowpea, the different yield attributing characters like number of pods per plant, length of pod, pod height, number of seeds, and seed weight per pod were also influenced by the genotypes of cowpea, phosphorus levels and their interaction effects. It has evaluated that application of phosphorus 60kg P_2O_5/ha registered the maximum harvest index than other treatment combinations. From the present study, it may be concluded that the crop may be cultivated with 60 kg P_2O_5/ha to obtained higher yield and superior quality of cowpea during summer season in clay loam soil under south Odisha conditions.

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