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RESEARCH ARTICLE :

Effect of phosphorus fertilizers on oil seed crops

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SUMMARY : Phosphorus is an important primary nutrient and enhances root growth there by facilitating absorption of water and nutrients from deeper layers. Phosphorus stimulates not only root growth but also hastens the maturity of oilseed crops. This nutrient required for synthesis of oils, proteins, nucleic acids and is also involved in the formation of glucosinolates, which on hydrolysis increases the oil content which intern influences the final pod yield and oil yield (Jeetarwal *et al.*, 2015). When applied to the soil, the applied P get fixed in the form of iron and aluminium phosphates in acid soils and as calcium phosphates in the saline or calcareous soils, there by the efficiency of applied P seldom to exceed 10-30 % (Swarup, 2002).

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BACKGROUND AND OBJECTIVES

Phosphorus plays an important role in the growth and development, as well as maturity of all crops. An adequate supply of P in the early stages helps in initiating its reproductive parts. It hastens the maturity and improves the quality of seeds. In legumes, P plays a major role in the formation and effective fixation of N by plant nodulation. The P requirement of oilseeds and pulses is relatively high as it plays an important role in plant metabolism (Kubsad *et al*., 2008).

Oilseeds respond well to applied P in most of the Indian soil types. In oilseeds, uptake of P_2O_5 per tonne of economic produce ranges between 8.4 kg for safflower seed to 30.9 kg for soybean (FAI, 2014). The share of major nutrients in the total uptake pattern of oilseeds is 48% N, 16% P_2O_5 and 37% K_2O. The higher requirement of phosphorus by oilseeds are well documented (Tandon, 2002). The efficiency of applied phosphorus is 15-20% in oilseed crops the reaming P gets fixed into unavailable form, there is a need to improve the efficiency of applied phosphorus in acid soils the applied phosphorus get fixed as insoluble and iron phosphates and in saline soils it get fixed as insoluble calcium phosphates hence there is a need to improve the efficiency of applied phosphorus. Available literature on the effect of phosphorus in oilseed and in general groundnut particularly is presented under following sub-heads.

Effect of Phosphorus on growth and yield of oil seed crops :

Growth parameters :

In groundnut, phosphorus deficiency is

known to reduce flower production, size of pods and adversely affect the formation of root nodules. Phosphorus promoted shoot growth and a more extensive root system thus widening the root-shoot ratio which enable the plants to extract more moisture and nutrients from deeper depths (Arnon, 1975 and Ahlawat and Saraf, 1982).

Karunakaran *et al*. (2010) observed that application of 125 per cent recommended dose of fertilizers (17:34:54 kg N, P_2O_5, K_2O ha^{-1}) increased plant height (51.8 cm) than that of RDF treatment (48.3 cm) at Karaikal, Tamil Nadu in coastal deltaic alluvial soils.

Salve and Gunjal (2011) reported that the application of 50 and 75 kg P_2O_5 ha^{-1} to groundnut were at par with each other but 50kg P_2O_5 ha^{-1} significantly increased plant height as compared to application of 75 kg P_2O_5 ha^{-1}

Dry matter production :

Kausale *et al*. (2009) reported that dry matter $plant^{-1}$ was increased in groundnut with application of 100 per cent RDF (25:50 N and P_2O_5 kg ha^{-1}) along with 10 tonnes of FYM ha^{-1} and Rhizobium or PSB seed inoculation in clay soils of Navasari, Gujarat.

Karmakar *et al.* (2005) revealed that application of RDF (30:60:20 kg N, P_2O_5, K_2O ha^{-1}) increased the dry matter accumulation (6.79 t ha^{-1}) at harvest of groundnut variety JL-24 in acid lateritic clay loam soils of West Bengal.

Mukherjee and Rai (2000) observed that the Maximum dry matter accumulation was found with the residual effect of 60 kg P_2O_5 ha^{-1} as rock phosphate + PSB. The increase in dry matter production with P solubilizers along with rock phosphate might be due to better nodulation of chickpea owing to better availability of P. the improvement in nodulation might have resulted in higher amount of nitrogen fixation and there by better vegetative growth and dry matter production.

Gangawar and Parameswaran (1976) observed enhancement in total photosynthetic area with increasing levels of phosphorus which ultimately produced higher dry matter.

Dry matter accumulation increased with increasing levels of nitrogen and phosphorus. Maximum accumulation was recorded with application of 60 kg N and 80 kg P_2O_5 ha^{-1} and was significantly higher than their respective lower levels. This could be ascribed to increased cell division and cell enlargement and better root growth which finally reflected into higher dry matter production (Hanumanthapa *et al*., 1998 and Sexena *et al*., 2001).

Yield attributes and yield :

The yield and most of the yield attributing characters were increased with increasing fertilizer level. The increase in yield due to P fertilizer may be attributed to the activation of metabolic processes, where its role in building phospholipids and nucleic acid is known. Moreover P is an important nutrient for all the crops in general and legumes in particular, it is a key constituent of ATP and plays significant role in energy transformation in plant and also roles in seed formation. Application of P, Ca and B fertilizers increased nutrients availability to the crop during the growing season which leads to greater utilization of assimilates into the pods and ultimately increased number of filled pods and shelling percentage (Rezaul *et al*., 2013).

Phosphorus fertilizer application significantly enhanced the vegetative and yield parameters of sesame was recorded at 45 kg P ha^{-1} for plant height, number of branches per plant and number of leaves. Number of pods, seed yield and dry matter yields were significantly higher at 45 kg P ha^{-1} than at 22.5 kg P ha^{-1} (Togay *et al*., 2008)

Kumaran (2001) revealed that application of RDF (34:17:54 kg N, P_2O_5, K_2O ha^{-1}) + FYM @ 12.5 t ha^{-1} as basal + 17 kg P_2O_5 ha^{-1} at 30 DAS produced significantly more no of pods (14.95 $plant^{-1}$) when compared to the only application of RDF(12.17 $plant^{-1}$) by groundnut variety. TMV-7 in sandy loam soils of Killikulam, Tamil Nadu.

100 Kernel weight :

Application of 40kg P_2O_5 ha^{-1} increased the number of branches per plant, pods per plant and seed per pod and 100-seed weight significantly over no application of phosphorus (Shivran *et al*., 2000).

Kumaran (2001) revealed that application of RDF (34:17:54 kg N, P_2O_5, K_2O ha^{-1}) + FYM @ 12.5 t ha^{-1} as basal + 17 kg P_2O_5 ha^{-1} at 30 DAS produced significantly more 100 kernel weight (30.23 g) when compared to the application of RDF (27.60 g) alone in groundnut variety CV. TMV-7 on sandy loam soils of Killikulam, Tamil Nadu.

Pod and haulm yield :

Increasing the P application rate from 9 kg ha^{-1} to 27 kg^{-1} ha significantly increased the yield of groundnut. Among the P levels, application of 27 kg P ha^{-1} recorded significantly higher number pods/plant, pod and haulm yields as compared to the levels of P application (Rao and Shaktawat, 2005).

El-far and Ramadan (2000) indicated that application of 46.6 kg P_2O_5 and 36 kg K_2O ha^{-1} gave the highest effect on yield and its attributes. Similarly, Ali and Mowafy (2003) found that adding phosphorus fertilizer caused significant increase in seed yield and all their attributes. Mishra *et al*. (1994) observed that the application of 60 kg P_2O_5 ha^{-1} resulted in maximum harvest index.

Khan and Datta (1993) observed higher pod yield of groundnut (3.1 t ha^{-1}) with application of 70 kg P_2O_5 ha^{-1} as compared to the application of 40 kg P_2O_5 ha^{-1} under irrigation condition.

Application of RDF (30:60:20 kg N, P_2O_5, K_2O ha^{-1}) increased the pod yield(2715 kg ha^{-1}) and haulm yield (4643 kg ha^{-1}) of groundnut variety JL-24 in acid lateritic clay loam soils of West Bengal (Karmakar *et al.*, 2005).

Basu *et al*. (2007) observed that application of recommended dose of fertilizers (20:40:40 kg N, P_2O_5, K_2O ha^{-1}) recorded the highest pod yield (1465 kg ha^{-1}) of groundnut variety AK 12-24 at Kharagpur.

From their results Mohamed *et al*. (2005) concluded that the application of 60 kg P_2O_5 ha^{-1} could improve the vegetative growth, yield and seed quality of groundnut.

Effect of phosphorus on oil content and oil yield of groundnut:

Sharma and Verma (1982) observed that the oil content in seed reduced significantly with the increasing levels of nitrogen. Contrary to this phosphate fertilizer improved the oil Contentsignificantly.Singh and Singh (1989) reported that application of 40 kg P_2O_5 ha^{-1} increased the oil content in seed as compared with no phosphorus.

Higher oil content and oil yield were noticed in split application of recommended dose of nitrogen with basal application of P and K than other nutrient management practices. The increase in oil content and oil yield is attributed to the application of higher level of NPK to the crop. Total oil yield obtained with optimum recommended dose of fertilizers to oil seed crops were higher (Priya *et al*., 2009).

Singh *et al*. (1994) observed that groundnut crop applied with 60 kg P_2O_5 ha^{-1} recorded higher oil content of 51 per cent as compared to application of 30 kg P_2O_5 ha^{-1} during *Kharif* season.

The higher oil content was responsible for higher oil yield at 60 and 90 kg P_2O_5 ha^{-1} was reported by Virupakshappa and Somasekhara (1997).Higher seed yield and oil content were observed under highest dose of phosphorus 60 kg ha^{-1} and sulphur 30kg ha^{-1} (Satishkumar and Singh 2005)

Oil content in seed increased gradually with increasing level of phosphorus and the highest was recorded with the application of 80 kg P_2O_5 ha^{-1}. Increased oil content in seeds of sunflower with the application of phosphorus (Jones and Sreenivasa, 1993 and Mishra *et al.*, 1994).

Effect of phosphorus on uptake of N, P and K in Oil seed crops:

Rao and Shaktawat (2005) reported the nitrogen, phosphorus, potassium, sulphur concentrations in plant was higher at early stage than later stages. As plant growth advanced, the concentration of these nutrients decreased because of dilution effect. After flowering stage. N and P being mobile nutrients translocated to the fruiting part where they were essentially required in higher amount for protein and lipid synthesis.

The haulm contains considerable concentration of N and P indicating that groundnut crop continued to absorb N and P till maturity. Possibly, as these nutrients were translocated from the leaves to the fruiting body through stem, a part of them might have been retained in the stem (Chahal *et al*., 1983).

Pal (1979) reported that the peak period of P uptake was in between seedling and flowering period. P content in plants increased upto knee high stage and thereafter decreased with crop ontogeny P uptake increased with increasing level of P application (Rao *et al*., 1984 and Hiremath *et al*., 1990).

Recovery of eleven per cent of applied P was registered in vegetative plant parts (Loubser *et al*., 1990). Graded levels of P significantly increased the N and P uptake both in seed and dry matter yield and the maximum uptake of these nutrients was bracketed at 90 kg P_2O_5 ha^{-1}.

According to Kumar *et al*. (1995) phosphorus levels did not show significant effect on P content in both seed and Stover, whereas P uptake increased significantly with 60 kg P_2O_5 ha^{-1} in both seed and Stover due to increase in total dry matter yield.

Application of nitrogen @ 60 or 90 kg ha^{-1} without P did not help in increasing the P uptake. Balanced application of 60 kg N and 30 kg P_2O_5 ha^{-1} increased the total P uptake significantly (Bahl *et al*., 1997).

Hemalatha *et al.* (2013) reported that the per cent P utilization showed a decreasing trend with an increase in P dose. It decreased from 14.9 to 10.7 with an increase in total available phosphorus from 40 to 80 kg ha^{-1} at lower level of P application there was enough competition between the plants to take up P from the limited available P supply leading to higher utilization of the applied P. At higher level, the increased P dose did not lead to proportionate increase in the uptake of applied P leading to lower utilization.

Kumar *et al*. (2008) observed that the total uptake (kernel and haulm) of nutrients was significantly superior with the application of 60 kg P_2O_5 and 60 kg S ha^{-1} with respect to nitrogen (42.62% and 42.83%), phosphorus (42.62% and 38.41%), potassium (45.93% and 41.51%), sulphur (30.41% and 36.21%) uptake.

Singh and Singh (1980) reported that uptake of nitrogen and phosphorus increased with increasing levels of nitrogen and phosphorus application. Sinha *et al.* (1995) observed that total phosphorus uptake by safflower at pre-flowering stage was more or less same at 30 and 60 kg phosphorus ha^{-1}.

Sagare *et al*. (1986)revealed that uptake of nitrogen, phosphorus and potassium was found to be increased with the application of various levels of N and P_2O_5. Significant increase in the uptake of nitrogen and phosphorus was noticed over contr1ol with 25 and 50 kg P_2O_5 $ha^{-1.}$ The highest dose of $P_2O_5$was found superior to lower dose of P uptake.

Singh and Kamath (1988) observed that uptake of phosphorus was found to be increased over control due to varying levels of phosphate application. Kumar *et al*. (1989) reported that the difference between 30 and60 kg P_2O_5 ha^{-1} in respect of P uptake were non-significant.

Tirpathi and Tripathi (1995) reported that the phosphorus uptake by plants increased with advancement of plant age due to increase in dry matter accumulation. A significant higher P uptake was recorded at 60 kg P_2O_5 ha^{-1} at all growth stages except 30 DAS. The uptake increased with increased level of phosphorus and the difference between each level was statistically significant upto 120 days growth stage and all the phosphorus levels were superior over control. At early stages *i.e*. 30 DAS, there was no significant difference between each level, which might be due to slow release of phosphorus to plants (Sudhirkumar *et al*., 1998).

Conclusion :

It is concluded that the application of phosphorus increases the phosphorus content and availability to plant due to slow release of P into the soil. The application of P through different doses increased the pod and haulm yield respectively over normal recommended dose. In general, application of P caused significant improvement in growth and yield of groundnut. Increasing P application rate to 65 kg ha^{-1} significantly increased the yield of groundnut. Among the P levels, application of 65 kg ha^{-1} recorded significantly higher number of pods per plant over rest of the levels of P application.

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