



## Effect of bio and nano phosphorus on yield, yield attributes and oil content of groundnut (*Arachis hypogaea. l*)

M. Swetha Kumari, P. C. Rao, G. Padmaja, V. Ramulu, J. D. Saritha and K. Ramakrishna

Received: 10.05.2017

Revised: 10.07.2017

Accepted: 28.07.2017

### Abstract

Leguminous crops suffer severely in soils poor in phosphorus. The experiment was conducted in college form college of agriculture, Rajendranagar, Hyderabad to explore the effect of Bio and Nano P fertilizer (soil application of bio and nano P @65 kg ha<sup>-1</sup> and foliar application of bio Phosphorus @2 and 4ml l<sup>-1</sup> and nano Phosphorus @1 and 2ml l<sup>-1</sup> respectively) in terms of yield and yield attributes and quality of Groundnut (*Arachis hypogaea* L). DAP was applied as basal dose, while bio and nano phosphorus was applied according to the treatments. Concerning the main effects, bio phosphorus proved superior or equivalent to nano phosphorus gave the greatest values for yield and yield parameters.

**Key words:** *Arachis hypogaea*, bio phosphorus and nano phosphorus, yield and yield parameters

### Introduction

A low level of soil phosphorus is a great obstruction to the growth and development of leguminous crops (Walley *et al.* 2005). In leguminous crops, phosphorus promotes root nodulation, nitrogen fixation, nutrient-use efficiency, efficient partitioning of photosynthates between source and sink, and biomass production (Gitari and Mureithi 2003; Ogola *et al.* 2012). However, phosphatic fertilizers are not only costly but also their supply is lower than their demand. Hence, it is highly desirable to explore the possibilities of saving phosphatic fertilizers without sacrificing economic yields. In order to reduce the use of chemical fertilizers, nano and bio phosphatic fertilizers could play a crucial role by increasing the availability of phosphorus and other nutrients to the crops (Selvakumar *et al.* 2012). For enhancement the efficiency of amendments that should increase contact of fertilizer with plant leading to increase in nutrient uptake, minimize of particle size, resulting in increased number of particles per unit of weight and specific surface area of a fertilizer that should increase contact of fertilizer with plant leading to increase in nutrient uptake (Brady, 1983).

The particles below 100 nm as nano-particles could make plants use fertilizer more efficiently, more environmentally friendly through hamper of pollution and, dissolve in water more effectively thus increase their absorption and distribution (Zheng *et al.* 2005). Therefore, nanotechnology such as using Nano scale fertilizer may offer new techniques to be used for crop management. Phosphorus plays an important role in Agricultural production. Agriculture is the major user of phosphorus resources (P), accounting for 80–90% of the world demand for P (Gitari and Mureithi 2003). However, application of P fertilizers aggravates eutrophication problem in surface waters (Badsra and Chaudhary, 2001). Thus, numerous regulations, best management practices (Singh and Singh, 1988) and remediation technology (Devi *et al.*, 2012) have been proposed to reduce P fertilizer application to prevent the applied P from entering water bodies. However, few work on attempting to solve the eutrophication problem via the modifications of the chemical properties of fertilizers (e.g., reducing the fertilizer mobility in the soil or decreasing bioavailability of nutrients to the algae. The nano-scaling of a fertilizer is considered a mitigation method to get an effective fertilizer as well as reduces the risk of eutrophication. The experiment was conducted with the aim of effect of nano and bio phosphorus on yield and yield parameters of groundnut.

### Author's Address

<sup>1</sup>Department of Soil Science and Agricultural Chemistry  
College of Agriculture Professor Jayashankar Telangana State  
Agricultural University Telangana India.  
E-mail: swethassac92@gmail.com



## Resources and methods

Field experiment was conducted during kharif season of 2015 at the college farm college of agriculture, Pjtsau Rajendranagar. The soil of the experimental field was sandy loam in texture. The chemical composition of the soil was slightly alkaline in reaction (Ph8.1) with low in nitrogen ( $256 \text{ kg ha}^{-1}$ ) and phosphorus ( $22 \text{ kg ha}^{-1}$ ) medium in potassium ( $376 \text{ kg ha}^{-1}$ ) The experiment was laid out in randomized block design with nine treatment combinations and replicated three times. The plot sizes were  $6.00 \text{ m} \times 4.00 \text{ m}$ , respectively. Urea and muriate of potash were the sources of Nitrogen and potash, respectively. Full amount of N and K according to treatments was applied at the time of sowing. The uniform application of Phosphorus @  $40 \text{ kg ha}^{-1}$  as basal dose through DAP was applied to groundnut. The treatments comprised of T<sub>1</sub>- Control (no fertilizers were applied), T<sub>2</sub>- RDF N, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O @  $20:40:50 \text{ kg ha}^{-1}$ , T<sub>3</sub>- RDF NK + Soil application of Nanophos @  $65 \text{ kg ha}^{-1}$  at sowing, T<sub>4</sub>- RDF NK + Soil application of biophos @  $65 \text{ kg ha}^{-1}$  at the time of sowing and T<sub>5</sub>- RDF NK + foliar application of P as 1% DAP, T<sub>6</sub>- RDF NK + foliar application of Nanophos @  $1 \text{ ml l}^{-1}$ , T<sub>7</sub>- RDF NK + foliar application of nanophos @  $2 \text{ ml l}^{-1}$ , T<sub>8</sub>- RDF NK + foliar application of biophos @  $2 \text{ ml l}^{-1}$ , T<sub>9</sub>- RDF NK + foliar application of nanophos @  $4 \text{ ml l}^{-1}$  foliar treatments were given at flowering and pod formation stages. The nanophos soil and foliar formulation had P content of  $90 \text{ mg kg}^{-1}$  and biophos soil and foliar formulation contains 5% P<sub>2</sub>O<sub>5</sub>. The crop was sown on 17th July, 2015 at  $30 \times 10 \text{ cm}$  spacing. The observations on growth parameters were recorded periodically and yield contributing characters and yield at harvest.

## Results and Discussion

The results of the present study are given in table number 1 to table number 4.

**Yield attributes:** At harvest, the plants of each plot were harvested above ground to measure the yield attributes, viz. pod yield and total biomass per plant, 100-seed weight, and number of pods per plant.

### Yield and yield attributes

It can be reported that the application of phosphorus increase pod yield and oil content of

groundnut. There was a significant difference observed among the treatments and highest pod yield was recorded in the treatment receiving RDF NK + soil application of biophos @  $65 \text{ kg ha}^{-1}$  ( $1607 \text{ kg ha}^{-1}$ ) was followed by RDF NK + soil application of nanophos @  $65 \text{ kg ha}^{-1}$  ( $1556 \text{ kg ha}^{-1}$ ), which was on par with the treatment receiving RDF NK + foliar application of biophos @  $4 \text{ ml l}^{-1}$  ( $1506 \text{ kg ha}^{-1}$ ). Lowest was recorded in the control ( $745 \text{ kg ha}^{-1}$ ). Yield attributing characters like dry matter production, no. of pods per plant, no. of filled pods per plant and hundred kernel weight all those parameters were recorded highest in the treatment receiving soil application of bio phosphorus @  $65 \text{ kg ha}^{-1}$ . The higher haulm yield was recorded in the treatment receiving RDF NK + soil application of biophos @  $65 \text{ kg ha}^{-1}$  ( $2820 \text{ kg ha}^{-1}$ ) which was followed by RDF NK + soil application of nanophos @  $65 \text{ kg ha}^{-1}$  ( $2618 \text{ kg ha}^{-1}$ ) and RDF NK + foliar spray of biophos @  $4 \text{ ml l}^{-1}$  ( $2545 \text{ kg ha}^{-1}$ ) this two were on par with each other. Lowest was recorded in control ( $1102 \text{ kg ha}^{-1}$ ) The increasing in oil content and oil yield was reported in the treatment receiving RDF NK + soil application of biophos @  $65 \text{ kg ha}^{-1}$  ( $40.46 \%$  and  $650.19 \text{ kg ha}^{-1}$ ) this was followed by RDF NK + soil application of nanophos @  $65 \text{ kg ha}^{-1}$  ( $40.34 \%$  and  $637.52 \text{ kg ha}^{-1}$ ). The RDF NK + foliar spray of biophos @  $4 \text{ ml}$  and  $2 \text{ ml l}^{-1}$  ( $40.27 \%$  and  $40.11 \%$ ) also shows higher oil content. Lowest was seen in control ( $36.11 \%$ ). Leguminous crops require more phosphorus than other crops to attain optimum growth and productivity (Gitari and Mureithi 2003). Therefore, the application of phosphorus has a dramatic effect on legumes when it is applied to soils low in phosphorus. Phosphorus helps leguminous plants in root-nodulation, efficient use of nutrients, nitrogen fixation, and efficient partitioning of photosynthates from vegetative to reproductive parts (Gitari and Mureithi 2003). As indicated by the main effects of phosphorus, bio phosphorus gave the highest values for pod yield, and number of pod per plants. The application of biophos and nanophos showed on initial burst and subsequently slow release even up to 60<sup>th</sup> day as compared to the commercial fertilizers which released phosphorus heavily in the initial stages followed by low and non-uniform quantity until around 30 days. There is a possibility that the bio and nano phosphatic



**Table.1. Effect of different sources and methods of application of phosphorus on dry matter production in groundnut at different growth stages**

	Treatment	Dry matter production (kg ha <sup>-1</sup> )			
		30DAS	60DAS	90DAS	Harvest
T <sub>1</sub>	Control (no fertilizers were applied)	745	1126	1999	2120
T <sub>2</sub>	Recommended dose of N:P <sub>2</sub> O <sub>5</sub> :K <sub>2</sub> O @20:40:50 Kg ha <sup>-1</sup>	901	2254	2537	2630
T <sub>3</sub>	RDF NK +Soil application of nanophos as impregnated granules@65 Kg ha <sup>-1</sup> at sowing	984	3125	3370	3500
T <sub>4</sub>	RDF NK + Soil application of biophos @65 Kg ha <sup>-1</sup> at sowing	1100	3546	4128	4353
T <sub>5</sub>	RDF NK + foliar application of 1% P as DAP	821	2297	2724	2914
T <sub>6</sub>	RDF NK + foliar application of nanophos @1 ml l <sup>-1</sup>	853	2300	2864	2940
T <sub>7</sub>	RDF NK + foliar application of nanophos @2 ml l <sup>-1</sup>	896	2394	2919	3034
T <sub>8</sub>	RDF NK + foliar application of biophos @2 ml l <sup>-1</sup>	933	2524	3125	3200
T <sub>9</sub>	RDF NK + foliar application of biophos @4 ml l <sup>-1</sup>	962	2950	3130	3333
	SE(m) ±	62	186	271	114
	CD	186	553	807	340

**Table.2. Effect of different sources and methods of application of phosphorus on yield attributes in groundnut**

S.No	Treatment	No. of pods plant <sup>-1</sup>	No. of filled pods plant <sup>-1</sup>	No. of kernels plant <sup>-1</sup>	Hundred kernel weight
T <sub>1</sub>	Control (no fertilizers were applied)	9.6	9.1	15.0	27.9
T <sub>2</sub>	Recommended dose of N:P <sub>2</sub> O <sub>5</sub> :K <sub>2</sub> O @20:40:50 Kg ha <sup>-1</sup>	10.6	10.2	18.0	28.3
T <sub>3</sub>	RDF NK +Soil application of nanophos as impregnated granules@65 Kg ha <sup>-1</sup> at sowing	16.2	15.7	29.7	42.1
T <sub>4</sub>	RDF NK + Soil application of biophos @65 Kg ha <sup>-1</sup> at sowing	18.0	17.0	31.3	47.3
T <sub>5</sub>	RDF NK + foliar application of 1% P as DAP	12.4	12.2	20.7	32.4
T <sub>6</sub>	RDF NK + foliar application of nanophos @1 ml l <sup>-1</sup>	13.1	12.8	21.0	34.3
T <sub>7</sub>	RDF NK + foliar application of nanophos @2 ml l <sup>-1</sup>	13.9	13.1	24.1	35.5
T <sub>8</sub>	RDF NK + foliar application of biophos @2 ml l <sup>-1</sup>	14.1	13.8	25.0	37.9
T <sub>9</sub>	RDF NK + foliar application of biophos @4 ml l <sup>-1</sup>	14.9	14.0	25.7	39.5
	SE(m) ±	0.8	0.5	1.0	1.4
	CD (P=0.05)	2.4	1.6	3.0	4.1



**Table.3.Effect of different sources and methods of application of phosphorus on pod and haulm yield (kg ha<sup>-1</sup>)**

S.No.	Treatment	Pod yield (kg ha <sup>-1</sup> )	Haulm yield (kg ha <sup>-1</sup> )
T <sub>1</sub>	Control (no fertilizers were applied)	7451.6	1102
T <sub>2</sub>	Recommended dose of N:P <sub>2</sub> O <sub>5</sub> :K <sub>2</sub> O @20:40:50 Kg ha <sup>-1</sup>	1246	1944
T <sub>3</sub>	RDF NK +Soil application of nanophos as impregnated granules@65 Kg ha <sup>-1</sup> at sowing	1556	2618
T <sub>4</sub>	RDF NK + Soil application of biophos @65 Kg ha <sup>-1</sup> at sowing	1607	2820
T <sub>5</sub>	RDF NK + foliar application of 1% P as DAP	1355	2152
T <sub>6</sub>	RDF NK + foliar application of nanophos @1 ml l <sup>-1</sup>	1408	2230
T <sub>7</sub>	RDF NK + foliar application of nanophos @2 ml l <sup>-1</sup>	1455	2351
T <sub>8</sub>	RDF NK + foliar application of biophos @2 ml l <sup>-1</sup>	1459	2419
T <sub>9</sub>	RDF NK + foliar application of biophos @4 ml l <sup>-1</sup>	1506	2545
	SE(m) ±	25	44
	CD (P=0.05)	51	126

**Table.4.Effect of different sources and methods of application of phosphorus on oil content and oil yield (kg ha<sup>-1</sup>)**

S. No.	Treatment	Oil content (%)	Oil yield (kg ha <sup>-1</sup> )
T <sub>1</sub>	Control (no fertilizers were applied)	36.11	238.50
T <sub>2</sub>	Recommended dose of N:P <sub>2</sub> O <sub>5</sub> :K <sub>2</sub> O @20:40:50 Kg ha <sup>-1</sup>	38.21	476.09
T <sub>3</sub>	RDF NK +Soil application of nanophos as impregnated granules@65 Kg ha <sup>-1</sup> at sowing	40.34	637.52
T <sub>4</sub>	RDF NK + Soil application of biophos @65 Kg ha <sup>-1</sup> at sowing	40.46	650.19
T <sub>5</sub>	RDF NK + foliar application of 1% P as DAP	39.72	508.42
T <sub>6</sub>	RDF NK + foliar application of nanophos @1 ml l <sup>-1</sup>	36.58	538.20
T <sub>7</sub>	RDF NK + foliar application of nanophos @2 ml l <sup>-1</sup>	38.28	556.97
T <sub>8</sub>	RDF NK + foliar application of biophos @2 ml l <sup>-1</sup>	40.11	585.29
T <sub>9</sub>	RDF NK + foliar application of biophos @4 ml l <sup>-1</sup>	40.27	606.46
	SE(m) ±	0.24	0.77
	CD (P=0.05)	0.68	2.33

fertilizers synchronised release of phosphorus with uptake by crop there by preventing losses into soil (De Rose *et al*, 2010) and also observed that the application of nano and biophos could increase in dry matter production. The bio and nano phosphatic fertilizers caused increased chlorophyll content they have observed a positive correlation between phosphorus and chlorophyll content. In present study also the increase in dry matter production at various stages could be the resultant effect of slow

and steady release of phosphorus from the bio and nano engineered particles. The use of nano and bio formulation and promote plant growth the foliar application of nano and bio formulations can be explained on basis that the nano composite particles may get observed through the stomata of the leaf and translocated in the plant. Phosphorus uptake leads to increased net CO<sub>2</sub> fixation with increased rate of photosynthesis and thereby more photosynthates to develop more number of pods per



plants (Badsra and Chaudhary, 2001). The selective indicated by Dhoke *et al.*(2012) suggested that nano particles have high reactivity because of large surface area, more density of reactive area and increases reactivity of these area on the particles surface and there features simply their absorption in plants (Zheng *et al.*2005). The components of pod yield comprises of number of pods per plant, number of kernels per plant and hundred kernel weight, in all those characteristics application of phosphorus at 40kg ha<sup>-1</sup> and application of bio and nano formulations increased the number of pods per plant, number of kernels per plant, hundred kernel weight by 8.4%, 16.3% and 19.4% over control. Similarly application of nanophos at 65 kg ha<sup>-1</sup> resulted in increase in the number of pods per plant, number of kernels per plant, hundred kernel weights by 6.6%, 14.7% and 14.2% over control and this was followed by foliar application of biophos@4 ml l<sup>-1</sup> and 2 ml l<sup>-1</sup>. The improvement in these attributes could be ascribed to the overall improvement in vigour and crop growth since, an adequate supply of phosphorus during early stages of growth is considered important in promoting growth and branching by influencing cell division and cell elongation in meristematic cells thereby increasing the sink in terms of flowering and seed setting. The favourable effect of P fertilization on yield attributes like pods per plant, seeds per pod and test weight might be attributed to the fact that phosphorus is known for its role as “Energy currency” and plays a key role in energy transformation in various metabolic processes (Brady, 1983). Beneficial effect of phosphorus in the fruiting of plants and ascribed this beneficial effect to better translocation of desired metabolites

uptake and translocation of nano particles as in the yield attributing parts of plants (Devi *et al.*, 2012). The increase in oil content was mainly due to increase in glucoside formation (allylthiocyanate) and also the oil content increased successively with increase in P level, probably because it is a constituent of phospholipids and is essential for its synthesis (Singh and Singh, 1988). The increasing in oil content with phosphorus application could be due to the fact that phosphorus helps in synthesis of fatty acids and their esterification by acceleration biochemical reaction in glyoxalate cycle (Dwivedi and Bapat, 1998). The results of investigation clearly suggest that the pod and haulm yield were significantly influenced by the sources and methods of phosphorus application significant response was seen with soil application of biophos @ 65 kg ha<sup>-1</sup> and soil application of nanophos @ 65 kg ha<sup>-1</sup> this was followed by foliar application of biophos @ 4ml l<sup>-1</sup> and 2 ml l<sup>-1</sup> and foliar application of nanophos @ 2ml l<sup>-1</sup> and 1ml l<sup>-1</sup>. Such response to applied phosphorus is possible since the soil was low in available phosphorus. Application of 65 kg ha<sup>-1</sup> biophos significantly increased the pod and haulm yield by 8.62% and 17.18% respectively in comparison to control. The increasing in yield might be directly associated with concomitant increase in growth and yield attributes of plant because of improved nutritional environment in rhizosphere as well as in the plant system leading to higher plant metabolism and photosynthetic activity. The fact that excess assimilate stored in the leaves and later translocated into seeds at the time of senescence, ultimately led to higher yield (Ijgude and Kadam, 2008).

## References

- Badsra, S.R and Chaudhary, L. 2001. Association of yield and its components in Indian mustard (*Brassica juncea* L.). *Agriculture Science Digest.*, 21(2): 83-86.
- Brady, N.C. 1983. The nature and properties of soils. Macmillan Publication Co., *New York and Collier Macmillan Publisher*, London.
- DeRosa, M.R., Monreal, C., Schnitzer, M., Walsh, R. and Sultan, Y. 2010. Nanotechnology in fertilizers. *National Nanotechnology journal.* 5: 91-96.
- Devi, T.S., Singh, T.B and Singh, W.M. 2012. Response of soybean to source and levels of phosphorus. *Journal of Agricultural Science.*, 4: 6-10.
- Dhoke, S.K, Mahajan, P., Kamble, R and Khanna, A. 2012. Effect of nanoparticles suspension on the growth of mung (*Vigna radiata*) seedlings by foliar spray method. *Nanotechnology.*, 3: 1-5.
- Dwivedi, A.K. and Bapat, P.N. 1988. Sulphur phosphorus interactions on the synthesis of nitrogenous fractions and oil in soybean. *Journal of the Indian Society of Soil Science.*, 46: 245-248.



- Gitari, J.N, Mureithi, J.G. 2003. Effect of phosphorus fertilization on legume nodule formation and biomass production in MountKenya Region. *East African Agriculture Journal.*, 69: 183-187.
- Ijgude, M.B and Kadam, J.R. 2008. Effect of phosphorus and sulphur on yield and quality of soybean. *Asian Journal of Soil Science.*, 3: 142-143.
- Ogola A.H, Odhiambo, G.D, Okalebo, J.R andMuyekho, F.N. 2012. Influence of phosphorus on selected disodium growth andnodulation parameters. *ARPAN Journal of Agricultural Biological Science.*, 7: 294-301.
- Selvakumar G, Lenin M, Thamizhiniyan P, Ravimycin, T. 2009. Response of biofertilizers on the growth and yield of black gram (*Vigna mungo* L.).*Recent Research in Science andTechnology.*, 1: 169-175.
- Selvakumar, G., Reetha, S., Thamizhiniyan, P. 2012. Response ofbiofertilizers on growth, yield attributes and associated proteinprofiling changes of blackgram (*Vigna mungo* L.).*World Applied ScienceJournal.*, 16: 1368-1374.
- Singh, V.K and Singh, V. 1988. Response of mustard to phosphorus and sulphur fertilization. *Indian Journal of Agricultural Science.*, 58(10): 754-756.
- Zheng, L.F., Hong, S., Lu and Liu, C. 2005. Effect of nano-TiO<sub>2</sub> on strength of naturally aged seeds and growth of spinach. *Biological Trace Elements Research.*, 104: 83-91.

