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Effect of Phosphorus and Sulphur Levels on Growth and Yield of Sunflower (*Helianthus annuus* L.)

Md Farhat Kousar, P A Visalakshi Devi, Ch Sujani Rao and M Sree Rekha

Department of Soil Science and Agricultural Chemistry, Agricultural College, Bapatla, A. P.

ABSTRACT

A field trial was conducted on sandy clay soil of Agricultural College Farm, Bapatla, during *rabi,* 2018 with three levels of phosphorus in combination with three levels of sulphur with a single control. The results revealed that, among the three phosphorus and sulphur levels, application of 135 kg P_2O_5 ha^{-1} and 30 kg S ha^{-1} recorded the highest drymatter accumulation (kg ha^{-1}), yield attributes (head diameter, number of filled seeds head^{-1}, 1000 seed weight, seed and stover yield).

Key words: *Sunflower, phosphorus levels, sulphur levels, drymatter accumulation, yield attributes,seed yield, stover yield*

Sunflower gained popularity because of its excellent oil quality and higher oil yield per unit area, short duration, higher water use efficiency, drought tolerance, wide adaptability to soil and climatic conditions. In India, it is grown in an area of 0.38 million hectares with a production of 0.25 million tonnes and productivity of 660 kg ha^{-1}. In Andhra Pradesh, it is grown in an area of 0.21 million hectare with a production of 0.2 million tonnes and productivity of 1000 kg ha^{-1} (Ministry of Agriculture, Govt. of India, 2016-17). Phosphorus, helps in alleviating the yield and its attributes by supplying energy required for metabolic processes. Majority of soils contain substantial reserves of total phosphorus but most of it remains relatively inert with only less than 10 per cent of soil phosphorus entering the plant-animal cycle thereby reducing the effectiveness of phosphorus fertilization (Kucey *et al*., 1989).

Sulphur plays a predominant role in improving the grain quality of sunflower crop and also the use efficiency of nitrogen and phosphorus. The essentiality of sulphur in the biosynthesis of oil in sunflower has been established by Bhagat *et al*. (2005). Therefore, phosphorus and sulphur management is essential for greater productivity in sunflower.

MATERIAL AND METHODS

A field trial was conducted on sandy clay soil of Agricultural College Farm, Bapatla, during *rabi,* 2018. The soil was neutral in reaction with a pH of 7.1, electrical conductivity of 0.15 dSm^{-1}, medium in organic carbon (0.51 g kg^{-1}), available nitrogen (203 kg ha^{-1}), available phosphorus (26.5 kg P_2O_5 ha^{-1}), available potassium (224 kg K_2O ha^{-1}) and deficient in sulphur (9.2 mg kg^{-1}). The soil was sufficient in all the cationic micronutrients except zinc (0.67 mg kg^{-1}) and manganese (1.19 mg kg^{-1}). The treatments comprised of three levels each of phosphorus (P_{45}, P_{90} and P_{135}kg P_2O_5 ha^{-1}) and sulphur (S_{10}, S_{20} and S_{30} kg S ha^{-1}) and a single control. Thus 10 treatments were tested in randomized block design with factorial concept. A uniform dose of 75 kg N and 30 kg K_2O ha^{-1} was applied through urea and muriate of potash as basal dose to all the plots. Phosphorus and sulphur were applied through di-ammonium phosphate and elemental sulphur as per required P and S levels. Nitrogen was applied through urea, after deducting the nitrogen supplied through di-ammonium phosphate. Phosphorus, potassium and sulphur were applied as basal dose while nitrogen was applied in two splits *i.e.*, one as basal and other at flowering stage. The data on drymatter production, yield attributes and yield were recorded as per standard statistical procedures. The data was analyzed by following the analysis of variance (ANOVA) for randomized block design with factorial concept as suggested by Panse and Sukhatme (1978).

RESULTS AND DISCUSSION

Drymatter accumulation (kg ha^{-1})

The data pertaining to drymatter accumulation is presented in table 1. At harvest stage higher dry matter accumulation (6722 kg ha^{-1}) was obtained with application of 135 kg P_2O_5 ha^{-1} over corresponding lower level of 45 kg P_2O_5 ha^{-1} but was on par with 90 kg P_2O_5 ha^{-1} and lowest drymatter accumulation (4848 kg ha^{-1}) was observed in control. The drymatter production at harvest increased by 12, 33 and 38 per cent with P_{45}, $P_{90}$and P_{135}, respectively over P_0. The overall increase in drymatter accumulation could be ascribed to the improvement in plant vigour due to increased availability of phosphorus that resulted in higher production of photosynthates and their translocation to

Table 1. Variation in drymatter accumulation (kg ha^{-1}) at harvest and yield attributes of sunflower as influenced by phosphorus and sulphur levels

Treatments	Drymatter accumulation	Head diameter (cm)	Number of filled seedshead^{-1}	1000 seed weight (g)
Phosphorus levels (kg P_2O ha^{-1})				
P_{45}	5472	15.14	462	50.34
P_{90}	6488	16.17	495	52.07
P_{135}	6722	16.81	515	52.83
SEm±	128.24	0.28	8.6	0.41
CD (P=0.05)	381.02	0.83	25.54	1.21
Sulphurlevels (kg ha^{-1})				
S_{10}	5571	14.94	461	50.34
S_{20}	6289	16.04	488	51.6
S_{30}	6926	17.14	522	53.31
SEm±	128.24	0.28	13.6	0.41
CD (P=0.05)	381.02	0.83	39	NS
Control				
Control	4848	13.55	426	48.3
SEm±	165.6	0.36	11.1	0.52
CD (P=0.05)	491.9	1.08	32.97	1.56
Interaction (P × S)				
SEm±	4.31	0.49	14.89	
CD (P=0.05)	NS	NS	NS	NS
CV%	8.44	7.33	8.4	16.7

Table 2. Variation in seed and stover yield (kg ha^{-1}) of sunflower as influenced by phosphorus and sulphur levels.

Treatments	Seed Yield (kg ha^{-1})	Stover Yield (kg ha^{-1})
Phosphorus levels (kg P_2O ha^{-1})		
P_{45}	1433	4013
P_{90}	1629	4440
P_{135}	1750	4780
SEm±	44.18	114.65
CD (P=0.05)	131.26	340.65
Sulphur levels (kg ha^{-1})		
S_{10}	1470	3877
S_{20}	1604	4266
S_{30}	1737	5090
SEm±	144.8	114.65
CD (P=0.05)	131.26	340.64
Control		
Control	1263	3363
SEm±	57.03	148.01
CD (P=0.05)	169.45	439.76
Interaction (P × S)		
SEm±	76.52	198.58
CD (P=0.05)	NS	NS
CV%	9.44	8.99

sink. These results are in conformity with Tamak *et al.* (1997).

Application of 30 kg S ha^{-1} recorded higher dry matter accumulation (6722 kg ha^{-1}) over 10 and 20 kg S ha^{-1} whereas, the lowest drymatter accumulation (1149.82 kg ha^{-1}) was observed in plots with no sulphur application. The increase in drymatter accumulation due to sulphur application might be due to its role in formation of amino acids, synthesis of proteins, vitamins and chlorophyll apart from increased plant height. These results were in conformity with the findings of Rani *et al*. (2009).

Yield attributes

Among different phosphorus levels greater head diameter was recorded with application of 135 kg P_2O_5 ha^{-1} (16.81cm) over corresponding lower levels of 45 kg P_2O_5 ha^{-1} but was on par with 90 kg P_2O_5 ha^{-1} and lowest head diameter (13.55 cm) was observed in control (Table 1).The greatest head diameter was recorded with application 30 kg S ha^{-1} (17.14 cm) and lowest in control (13.55 cm). However, there was marked increase in head diameter with increasing levels of sulphur from 0 to 30 kg S ha^{-1}. Among the P levels, 135 kg P_2O_5 ha^{-1} and 0 kg P_2O_5 ha^{-1} produced significantly maximum and minimum number of filled seeds $head^{-1}$. However, number of filled seeds $head^{-1}$ @ 135 kg P_2O_5 ha^{-1} were on par with 90 kg P_2O_5 ha^{-1}. With, respect to sulphur levels 30 kg S ha^{-1} recorded maximum number of filled seeds (522.91) and lowest in control (426.20). Phosphorus and sulphur levels could not reach the level of significance with regard to 1000 grain weight (g).These results were in line with those documented by Tamak *et al*. (1997), Nawaz *et al*. (2003) Sarkar and Mallick (2010) and Sadazoi *et al*. (2013) who found that phosphorus and sulphur levels significantly increased head diameter. The increase might be due to more nutrients uptake by the crop from root zone that resulted in higher production of photosynthates and their translocation to sink.

Yield (kg ha^{-1})

Seed yield differed significantly among the different levels of phosphorus and sulphur (Table 2). Application of 135 kg P_2O_5 ha^{-1} being on par with 90 kg P_2O_5 ha^{-1} recorded significantly higher seed yield (1750 kg ha^{-1}) over corresponding lower level of 45 kg P_2O_5 ha^{-1} and lowest seed yield (1263 kg ha^{-1}) was observed in control. The percent increase in seed yield with P_{45}, P_{90} and P_{135} over control was 13, 29 and 38, respectively. With respect to sulphur, application of 30 kg S ha^{-1} recorded significantly higher seed yield (1737 kg ha^{-1}) over 10 and 20 kg S ha^{-1}. Whereas, the lowest seed yield (1263 kg ha^{-1}) was observed in plots with no sulphur. The percent increase in seed yield was 16, 27, 45, with S_{10}, S_{20} and S_{30}, respectively over no sulphur application.

Seed yield is the function of several yield attributing characters viz., head diameter, number of filled seeds and test weight of seed. Increase in head diameter and number of filled seeds $head^{-1}$ due to adequate nutrition of phosphorus might have resulted in the production of higher seed yield. Head diameter is the most important yield attributing character, which improves the seed yield by providing maximum number of florets for higher seed set. The cumulative effect of all these growth and yield components was reflected on seed yield and effect of adequate phosphorus supply was well marked. Higher seed yields at higher levels of phosphorus were also reported by Tamak *et al*. (1997), Patel and Thakur (2003) and Sarkar and Mallick (2010).

Among different phosphorus levels the highest stover yield was obtained with application of 135 kg P_2O_5 ha^{-1} (4780.67 kg ha^{-1}) over corresponding lower level of 45 kg P_2O_5 ha^{-1} but significant variation was observed upto 90 kg P_2O_5 ha^{-1} and lowest stover yield (3363 kg ha^{-1}) was observed in control. This was probably due to availability of sufficient amount of phosphorus during crop growth and developmental stages, which boosted stover yield significantly. These results were in consonance with the findings of Singh *et al.* (1998)

Application of 30 kg S ha^{-1} recorded significantly higher stover yield (5090.67 kg ha^{-1}) over 10 and 20 kg S ha^{-1} whereas, the lowest stover yield (3363 kg ha^{-1}) was observed in plots with no sulphur application. Sulphur application at higher level (30 kg ha^{-1}) might have favourably influenced higher dry matter assimilation due to increased photosynthetic activity and also due to higher plant height. These results corroborate with the findings of Agrawal *et al.* (2000).

CONCLUSION

In conclusion, application of 135 kg P_2O_5 ha^{-1} resulted in higher yields but it was found to be on par with 90 kg P_2O_5 ha^{-1} and with respect to sulphur levels, application of 30 kg S ha^{-1} recorded significantly higher yields. However, interaction was found to be non significant.

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