Growth and development of groundnut (*Arachis hypogaea* l.) as influenced by different levels and timing of phosphogypsum nutrition

ABSTRACT

Aims: A field experiment entitled "Growth and development of groundnut (*Arachis hypogaea* L.) as influenced by different levels and timing of phosphogypsum nutrition" was planned to ascertain the role of phosphogypsum an industrial by product in promoting growth of groundnut.

Study design: Experiment was carried out at Agronomy field unit, Zonal Agricultural Research Station, University of Agricultural Sciences, GKVK, Bangalore, during *kharif* 2019. Experiment was planned with eleven treatments of which eight received sulphur through phosphogypsum at different levels (50, 75, 100 and 125 kg S eq ha^{-1}) as basal and split (30 DAS) and one through gypsum (500 kg ha^{-1}) as basal. Whereas, other two treatments with NPK and NK alone are included for comparison. Design of the experiment is RCBD with eleven treatments replicated thrice.

Results:Among different treatments, application of phosphogypsum 125 kg S eq ha^{-1} in split recorded highest growth parameters like plant height (42.49 cm), leaf area (1137 cm^2 $plant^{-1}$), dry matter per plant (29.30 g) and number of branches $plant^{-1}$ (8.62). Whereas, application of phosphogypsum 100 kg S eq ha^{-1} in split found on par with 125 kg with respect to all growth parameters. While lowest values of all the parameters were noticed in treatment receiving N and K fertilizer alone.

Keywords: development, groundnut, growth, Phosphogypsum plant height.

I. Introduction

For the population of the south, tasting peanuts during the day is part of the culture. Perhaps the day starts with tasty peanut chutney early in the morning and goes on interceding in different ways. Thanks to Spaniards for introducing, it into country, right from the early days of its introduction people accepted it and has spread very rapidly. Area under peanut has increased from 1600 ha in 1850-1851 to about 4.8 m ha in 2018. In India peanut contribute to 17.3 and 24 per cent, of area and production, respectively to total oilseed statistics. Groundnut is valued for its wealthy source of oil (45–50%) and protein (25–28%) in the kernels. They provide 564 Kcal of energy per 100 g of kernels (Jambunathan 1991). For any oilseed crop, sulphur particularly becomes most essential nutrient (Meena *et al.* 2007) as it aids in biosynthesis of oil (Yadav *et al.* 2019). Sulphur is the fourth major plant nutrient followed by N, P and K thus making it an important part of equitable fertilization and nutrition for oilseed crops in general and groundnut in particular. There are many sources of sulphur which are in use, one such source is phosphogypsum.

Phosphogypsum is a solid waste by-product of wet phosphoric acid production from rock phosphate. It supplies sulphur (13-16%), calcium (21%) in significant quantities. Unlike other sulphur sources which needs microbial action, phosphogypsum provides readily available sulphate form of sulphur (Biswas and Sharma 2008). Relative low solubility of phosphogypsum made it a long-lasting mineral with residual effect of nutrients on succeeding crops (Rashid *et al*., 1989). Having all these beneficial properties it has created interest in us to study the response of groundnut to phosphogypsum as a fertilizer, so as to ascertain its worthiness.

II. Materials and methods

Experiment was conducted at Zonal Agricultural Research Station (ZARS), Gandhi Krishi Vignana Kendra (GKVK), University of Agricultural Sciences (UAS), Bangalore, Eastern Dry Zone (Zone - V) of Karnataka which is located in between 12º 58" N Latitude and 77º 33' Longitude at an altitude of 930 m above mean sea level (MSL). Soil of the experimental site was red sandy loam with 6.1 pH, with nutrient composition of 247.6, 36.14, 278.41 and 18 kg ha^{-1} of NPK and S, respectively. Experiment was carried out with eleven treatments replicated thrice in RCBD design.

Urea, Single super phosphate and Muriate of potash were used as source of NPK, respectively. An ICRISAT variety ICGV-91114 was used in the study. Growth parameters like plant height, leaf area, number of branches $plant^{-1}$ and dry matter accumulation $plant^{-1}$ at 30, 60, 90 DAS and at harvest were recorded.

Treatment details:

T_1: Recommended dose of NPK + 500 kg ha^{-1} of gypsum (PoP)

T_2: 50 kg S eq ha^{-1} (100 % at the time of sowing)

T_3: 75 kg S eq ha^{-1} (100 % at the time of sowing)

T_4: 100 kg S eq ha^{-1} (100 % at the time of sowing)

T_5: 125 kg S eq ha^{-1} (100 % at the time of sowing)

T_6: 50 kg S eq ha^{-1} (50 % at the time of sowing + 50 % at 30 days after sowing)

T_7: 75 kg S eq ha^{-1} (50 % at the time of sowing + 50 % at 30 days after sowing)

T_8: 100 kg S eq ha^{-1} (50 % at the time of sowing + 50 % at 30 days after sowing)

T_9: 125 kg S eq ha^{-1} (50 % at the time of sowing + 50 % at 30 days after sowing)

T_{10}: Recommended dose of fertilizers (NPK only)

T_{11}: Recommended dose of fertilizers (N and K only)

(**Note**: - In T_2 to T_9 Phosphogypsum was used as source of sulphur along with NPK)

(POP: package of practice, eq: equivalent, S: sulphur)

(Recommended dose includes 25:75:37.5 kg ha^{-1} of N:P_2O_5:K_2O)

III. Results and discussion

a. Growth and development

At 30 DAS, application of 125 kg S eq ha^{-1} of phosphogypsum as basal recorded highest plant height (9.26 cm), dry matter accumulation (2.21 g) (Table 1), number of branches (4.11) and leaf area (286 cm^2 plant^{-1}) (Table 2). Whereas at 60, 90 DAS and at harvest application of 125 kg S eq ha^{-1} of phosphogypsum in split recorded significantly higher plant height (36.61, 40.82 and 42.49 cm respectively), dry matter accumulation (21.63, 26.29 and 29.30 g respectively), number of branches (8.56, 8.62 and 8.62, respectively) and leaf area (1137, 762 and 157 cm^2 plant^{-1}, respectively). With the application of phosphogypsum 125 kg S eq in split, sufficient quantities of calcium and sulphur were ensured throughout crop growth along with NPK which promoted rapid growth of plant. Since, calcium enhances cell division in apical region which promotes rapid growth of plants. More importantly calcium is essential to plant at peg initiation, fruit formation and pod maturation (Kabir *et al.*, 2013) without of which new tissue development is inhibited and pod filling is incomplete. Sulphur has role in both protein synthesis and photosynthesis which lead to rapid expansion of leaf and higher dry matter production. This ultimately ended up in giving highest yield (Anthati 2011). Compared to basal application of same amounts, split application recorded highest growth parameters right from its application compared to basal application it is because when entire quantities of phosphogypsum was applied as basal alone, there may be leaching losses at the time of excess rainfall events, which are most familiar during *kharif*. Moreover, greater quantity of sulphur is used at peg initiation so application of phosphogypsum at times of requirement is more essential, which was also supported by Sakal *et al*. (1998); Sivakumar and Dash (2014); Rout and Jena (2009).

Table 1. Plant height and dry matter of groundnut at different stages as influenced by different levels and time of phosphogypsum nutrition

Treatments	Plant height (cm)				Dry matter production (g plant^{-1})			
	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest
T_1	9.17	31.79	38.02	39.03	1.91	18.70	22.82	25.81
T_2	7.22	27.69	32.04	33.03	1.59	12.85	18.37	22.43
T_3	8.12	29.10	34.43	34.06	1.80	15.18	19.41	23.74
T_4	8.89	31.21	38.00	38.91	2.06	18.89	22.82	26.37
T_5	9.26	32.01	38.41	39.54	2.21	20.26	23.22	27.44
T_6	7.10	30.48	34.68	33.72	1.32	14.74	19.15	23.33
T_7	7.59	31.06	36.00	35.41	1.41	15.59	20.26	24.46
T_8	7.88	35.06	40.01	41.95	1.62	20.59	25.10	28.11
T_9	8.24	36.61	40.82	42.49	1.72	21.63	26.29	29.30
T_{10}	6.26	25.71	29.43	30.33	1.30	12.38	16.61	20.18
T_{11}	6.13	23.77	28.28	29.55	1.18	10.26	13.66	16.93
S.Em±	**0.34**	**0.87**	**0.67**	**0.99**	**0.06**	**0.68**	**0.87**	**0.67**
C.D. (p=0.05)	**1.01**	**2.57**	**1.99**	**2.93**	**0.19**	**2.01**	**2.58**	**1.97**

DAS: Days after sowing

T_1: Recommended dose of NPK + 500 kg ha^{-1} of gypsum (PoP), T_2: 50 kg S eq ha^{-1}, T_3: 75 kg S eq ha^{-1}, T_4: 100 kg S eq ha^{-1}, T_5: 125 kg S eq ha^{-1}, T_6: 50 kg S eq ha^{-1}, T_7: 75 kg S eq ha^{-1}, T_8: 100 kg S eq ha^{-1}, T_9: 125 kg S eq ha^{-1}, T_{10}: NPK and T_{11}: N and K.

(In T_2 to T_5 entire dose of recommended phosphogypsum was applied as basal and in T_6 to T_9 phosphogypsum was applied in split (basal and 30 DAS) 50:50 proportion)

Table 2. Number of branches and leaf area plant^{-1} at different growth stages of groundnut as influenced by different levels and time of phosphogypsum nutrition

Treatments	Number of branches plant^{-1}				Leaf area (cm^2 plant^{-1})			
	30 DAS	**60 DAS**	**90 DAS**	**At harvest**	**30 DAS**	**60 DAS**	**90 DAS**	**At harvest**
T_1	4.00	7.23	7.42	7.42	279	962	638	133
T_2	3.70	6.41	6.51	6.51	188	800	528	123
T_3	3.69	6.64	6.73	6.73	198	828	547	125
T_4	4.08	7.12	7.32	7.32	275	959	619	128
T_5	4.11	7.34	7.60	7.60	286	1038	655	139
T_6	3.34	6.78	6.58	6.58	167	811	529	131
T_7	3.41	6.88	6.73	6.73	174	893	587	130
T_8	3.52	8.42	8.51	8.51	179	1064	706	148
T_9	3.61	8.56	8.62	8.62	180	1137	762	157
T_{10}	3.49	6.21	6.23	6.23	149	717	453	111
T_{11}	3.33	6.03	6.12	6.12	137	641	418	110
S.Em±	**0.18**	**0.18**	**0.34**	**0.34**	**7**	**27**	**21**	**3**
C.D. (p=0.05)	**0.54**	**0.52**	**1.01**	**1.01**	**21**	**82**	**64**	**11**

T_1: Recommended dose of NPK + 500 kg ha^{-1} of gypsum (PoP), T_2: 50 kg S eq ha^{-1}, T_3: 75 kg S eq ha^{-1}, T_4: 100 kg S eq ha^{-1}, T_5: 125 kg S eq ha^{-1}, T_6: 50 kg S eq ha^{-1}, T_7: 75 kg S eq ha^{-1}, T_8: 100 kg S eq ha^{-1}, T_9: 125 kg S eq ha^{-1}, T_{10}: NPK and T_{11}: N & K.

(In T_2 to T_5 entire dose of recommended phosphogypsum was applied as basal and in T_6 to T_9 phosphogypsum was applied in split (basal and 30 DAS) 50:50 proportion)

DAS: Days after sowing

IV. Conclusion:

Though phosphogypsum is a by-product obtained from phosphorus industry, it can be valued as important fertilizer to those crops which require sulphur and calcium in greater quantities or in soils with poor nutrient status. Application of phosphogypsum 125 kg S eq ha^{-1} in split yielded best results in terms of plant height, branching, leaf area and dry matter production which were on par with 100 kg S eq ha^{-1} in split. When same quantity of nutrients was applied as basal alone, then results were significantly lower, suggesting the importance of nutrition timing.

V. Literature cited

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