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Phosphorus and sulphur releasing pattern and their availability for maize cultivation

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Maize is the third most important cereal crop next to rice and wheat in the world as well as in India. Maize has the higher yield potential and responds greatly to applied fertilizers especially in the irrigated conditions in Tamil Nadu. Phosphorus and sulphur are the major yield limiting factors after nitrogen in the study area (Sivagangai district of Tamil Nadu) and proper management of nutrients is essential to realize the maximum potential of the crop and to get higher economic benefit. This study aimed at investigating the releasing pattern of P and S from the experimental soil at different incubation period. The experiment was laid out in Completely Randomized Design replicated thrice. The soil samples were collected from the experimental plots and used for incubation studies. There were five levels of P and five levels of S analysed in 15, 30, 45 and 60 days of incubation period. The results found that with progress of time (15 to 60 days of incubation), increasing levels of P and sulphur and their interaction significantly increased the phosphorous release from the soil. Similarly, sulphur availability was also influenced by S levels and P levels, with maximum release of S from 15 days to 30 days.

Key words: Maize, phosphorus, sulphur, releasing pattern, incubation periods.

INTRODUCTION

Globally, maize is known as queen of cereals because of its highest genetic yield potential among the cereals. It is cultivated on nearly 171 m ha in about 160 countries having wider diversity of soil, climate, biodiversity and management practices that contributes 36% (885 m t) in the global grain production (Agricultural Statistics, 2013). In India, maize is the third most important food crops after rice and wheat, grown for food, feed and several industrial purposes. Maize is cultivated both in irrigated and rainfed situations in India. In India, maize occupies 8.55 million hectare producing 22 million tonnes with productivity of 2540 kg ha^{-1} (Agricultural Statistics, 2012). Maize contributes nearly 9% in the national food basket and more than Rs. 100 billion to the agricultural GDP at current prices apart from the generating employment to over 100 million man-days at the farm and downstream agricultural and industrial sectors. In addition to staple food for human being and quality feed for animals, maize

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serves as a basic raw material as an ingredient to thousands of industrial products that includes starch, oil, protein, alcoholic beverages, food sweeteners, pharmaceutical, cosmetic, film, textile, gum, package and paper industries etc. In India, maize is used as human food (23%), poultry feed (51%), animal feed (12%), industrial (starch) products (12%), beverages and seed (1% each). In Tamil Nadu, between 2012 and 2013 it is cultivated over an area of 0.33 million hectare with the production of 1.19 million tonnes and the average productivity of 6042 kg ha^{-1} (Agricultural Statistics, 2013). Soil fertility management is very important to ensure the supply of nutrients in sufficient amounts and desirable proportions to improve the crop productivity. Among the major nutrients, phosphorus ranks next to nitrogen in importance on account of its vital role in major life processes. Its availability to the growing crop in required level is of prime importance in soil fertility. Phosphorus fertilization is imminent to all crops for maximizing crop yield. Application of fertilizer P in balanced proportion with other essential nutrients produces higher crop yields and ensures more profit to farmers (Kumaresan and Doraisamy, 2005). Phosphorus is the most critical element in highly weathered tropical and subtropical soils and percent utilization of applied P by the crops is very low.

Sulphur is now recognized as the 4^{th} major plant nutrient along with N, P, and K. In early 1990s, it was estimated in 130 districts of India where sulphur application was needed to obtain higher yields. But S deficient becomes prominent and has increased to more than 200 districts in 2001. This list is increasing as more results of research become available. Therefore, sulphur is now very much a part of a balanced fertilization and soils should be supplied with sulphur for increasing yield. This necessitates the study on the response of crop to different levels of fertilizer. Maize has high yield potential and responds greatly to applied fertilizers. Therefore, proper management of nutrients is essential to realize the maximum potential of the crop and to get higher economic benefit. This study aimed at investigating the releasing pattern of P and S from the experimental soil at different incubation period.

MATERIALS AND METHODS

An incubation experiments was conducted to study the releasing pattern of P and S at different incubation period from the experimental soil where hybrid maize was grown. The soil was collected from farmer's field in Sivagangai district which is brought under sub zone V of Southern zone, as per Agro climatic zone grouping. The mean annual rainfall in Sivagangai block is 912 mm, which has been distributed during southwest monsoon (348 mm), northeast monsoon (411 mm), winter rains (29 mm) and summer rains (124 mm). The soil moisture regime is Ustic, with mean temperature varying from 25.5°C in January to 31.5°C during April to July.

The experiment was laid out in Completely Randomized Design replicated thrice. The soil samples were collected from the experimental plots and used for incubation studies. The initial soil samples were analysed for available P before incubation. 200 g of soil was used with the dose optimized from the field experiment. Phosphorus was applied as Di-ammonium phosphate while sulphur was applied as gypsum. Total five levels of P_2O_5 were used for incubation study as; P_1: 0 g P_2O_5 per 200 g of soil; P_2: 0.0097 g P_2O_5 per 200 g of soil; P_3: 0.0145 g P_2O_5 per 200 g of soil; P_4: 0.0194 g P_2O_5 per 200 g of soil. Similarly, five levels of sulphur were used for incubation study as; S_1: 0 g S per 200 g of soil; S_2: 0.0089 g S per 200 g of soil; S_3: 0.0178 g S 200 g of soil; S_4: 0.0267 g S 200 g of soil. The soil was incubated in 250 ml polyethylene cups at room temperature for a period of 75 days, maintaining the moisture at field capacity. The soil samples were analyzed for releasing pattern and interaction effect of P and S were analyzed for 15, 30, 45 and 60 days of incubation.

The experimental field had pH of 7.3 and electrical conductivity of 0.37 dSm^{-1}. The cation exchange capacity (CEC) of the soil was 7.6 cmol (p^+) kg^{-1}. The available N, P and K status of the soil were 182, 10.11 and 274 kg ha^{-1}, respectively. The available S status of the soil was 14.2 mg kg^{-1}. The experimental site belonged to the order Alfisol (TypicHaplustalf) as per the soil taxonomy.

RESULTS AND DISCUSSION

Phosphorus release pattern

With progress of time (15 to 60 days of incubation), increasing levels of P and S and their interaction significantly increased the phosphorous release from the soil (Table 1). Phosphorous availability increased with increasing phosphorous levels and with increasing time, maximum at 60 days of incubation. Similarly, phosphorous availability increased with increasing sulphur levels and time, maximum available at 60 days. The interaction effects of phosphorus and sulphur levels on phosphorous availability were also positive and maximum at higher levels and at 60 days. It might be due to the fact that the amount of phosphate sorption and desorption increased with increase in amount of P added and it varied with various soil properties viz., clay, $CaCO_3$, Fe and Al oxides etc similar trend of results were reported by Dhillion et al. (2004). And also due to the fact that the sulphur applied is converted into sulphuric acid which might have favoured the release of phosphorus from its adsorption sites.

Sulphur release pattern

Sulphur availability increasing sharply from 15 days to 30 days and then increasing with decreasing trend and became static from 45 to 60 days (Table 2). Sulphur availability increased with increasing sulphur levels. Sulphur availability was higher at low phosphorous levels such as P_1 and P_2 than no P_3 and P_4 at higher levels in all incubation periods. Interaction effect of P and S was positive and maximum availability found at combination

Table 1. Effect of phosphorus and sulphur levels on availability of phosphorus (mg kg^{-1}) at different incubation periods.

Treatments	Phosphorus (mg kg^{-1})											
	15 DOI						30 DOI					
Phosphorus levels	Sulphur levels						Sulphur levels					
	S_0	S_1	S_2	S_3	S_4	Mean	S_0	S_1	S_2	S_3	S_4	Mean
P_0	5.87	6.54	6.86	7.28	7.58	**6.82**	6.32	6.99	7.31	7.73	8.03	**7.27**
P_1	9.01	10.55	11.07	11.65	12.11	**10.87**	9.46	11.00	11.52	12.10	12.56	**11.32**
P_2	13.31	14.80	16.06	19.66	22.87	**17.34**	13.76	15.25	16.51	20.11	23.32	**17.79**
P_3	31.40	32.89	35.22	37.96	41.72	**35.84**	31.85	33.34	35.67	38.41	42.17	**36.29**
P_4	35.85	37.12	39.61	41.30	42.98	**39.37**	36.30	37.57	40.06	41.75	43.43	**39.82**
Mean	**19.09**	**20.38**	**21.76**	**23.57**	**25.45**		**19.54**	**20.83**	**22.21**	**24.02**	**25.90**	
		P	**S**	**P x S**				**P**	**S**	**P x S**		
SEd		0.34	0.34	0.77				0.38	0.38	0.87		
CD (0.05)		0.71	0.71	1.59				0.80	0.80	1.79		
Treatments	**Phosphorus (mg kg^{-1})**											
	45 DOI						60 DOI					
Phosphorus levels	Sulphur levels						Sulphur levels					
	S_0	S_1	S_2	S_3	S_4	Mean	S_0	S_1	S_2	S_3	S_4	Mean
P_0	7.02	7.69	8.01	8.43	8.73	**7.97**	7.67	8.34	8.66	9.08	9.38	**8.62**
P_1	10.16	11.70	12.22	12.80	13.26	**12.02**	10.81	12.35	12.87	13.45	13.91	**12.67**
P_2	14.46	15.95	17.21	20.81	24.02	**18.49**	15.11	16.60	17.86	21.46	24.67	**19.14**
P_3	32.55	34.04	36.37	39.11	42.87	**36.99**	33.20	34.69	37.02	39.76	43.52	**37.64**
P_4	37.00	38.27	40.76	42.45	44.13	**40.52**	37.65	38.92	41.41	43.10	44.78	**41.17**
Mean	**20.24**	**21.53**	**22.91**	**24.72**	**26.60**		**20.89**	**22.18**	**23.56**	**25.37**	**27.25**	
		P	**S**	**P x S**				**P**	**S**	**P x S**		
SEd		0.38	0.38	0.87				0.34	0.34	0.78		
CD (0.05)		0.80	0.80	1.79				0.72	0.72	1.61		

Table 2. Effect of phosphorus and sulphur levels on availability of sulphur (mg kg^{-1}) at different incubation periods.

Treatments	Sulphur (mg kg^{-1})											
	15 DOI						30 DOI					
Phosphorus levels	Sulphur levels						Sulphur levels					
	S_0	S_1	S_2	S_3	S_4	Mean	S_0	S_1	S_2	S_3	S_4	Mean
P_0	3.22	4.57	12.29	16.56	17.37	**10.80**	4.01	7.81	29.42	41.37	43.64	**25.25**
P_1	3.16	6.12	12.81	16.86	17.68	**11.33**	3.85	12.15	30.86	42.21	44.51	**26.71**
P_2	3.05	6.39	13.01	16.33	17.92	**11.34**	3.55	12.91	31.42	40.73	45.17	**26.75**
P_3	3.36	6.13	12.69	16.10	17.52	**11.16**	4.42	12.15	30.54	40.07	44.05	**26.25**
P_4	3.26	5.26	12.11	15.48	16.91	**10.61**	4.12	9.74	28.92	38.34	42.35	**24.69**
Mean	**3.21**	**5.70**	**12.58**	**16.26**	**17.48**		**3.99**	**10.95**	**30.23**	**40.54**	**43.94**	
		P	**S**	**P x S**				**P**	**S**	**P x S**		
SEd		0.12	0.12	0.28				0.35	0.35	0.79		
CD (0.05)		0.26	0.26	0.58				0.73	0.73	1.64		
Treatments	**Sulphur (mg kg^{-1})**											
	45 DOI						60 DOI					
Phosphorus levels	Sulphur levels						Sulphur levels					
	S_0	S_1	S_2	S_3	S_4	Mean	S_0	S_1	S_2	S_3	S_4	Mean
P_0	4.75	8.55	30.16	42.11	44.38	**25.99**	5.81	9.61	31.22	43.17	45.44	**27.05**
P_1	4.59	12.89	31.60	42.95	45.25	**27.45**	5.65	13.95	32.66	44.01	46.31	**28.51**

Table 2. Contd.

P_2	4.29	13.65	32.16	41.47	45.91	**27.49**	5.35	14.71	33.22	42.53	46.97	**28.55**
P_3	5.16	12.89	31.28	40.81	44.79	**26.99**	6.22	13.95	32.34	41.87	45.85	**28.05**
P_4	4.86	10.48	29.66	39.08	43.09	**25.43**	5.92	11.54	30.72	40.14	44.15	**26.49**
Mean	**4.73**	**11.69**	**30.97**	**41.28**	**44.68**		**5.79**	**12.75**	**32.03**	**42.34**	**45.74**	
		P	**S**	**P x S**				**P**	**S**	**P x S**		
SEd		0.34	0.34	0.77				0.35	0.35	0.79		
CD (0.05)		0.71	0.71	1.60				0.73	0.73	1.64		

of S_4 at P_1 and P_2. It might be due to the reason that the interaction of these nutrients elements may affect the critical level of available S. These lines are in findings of Ijgude and Kadam (2008). Generally, the available S has been observed in high concentration in soils might be due to the addition of higher levels of sulphur containing fertilizers. Similar trend of results were reported by Patel and Patel (1996). The incubation experiment implied that the soil was having low P and high S releasing power and there was a synergistic effect between the availability of P and S in the experimental soil. The study concludes that phosphorus and sulphur availability were increased with increased level of phosphorus and sulphur and maximum availability were found at 60 days of incubation.

Conflict of Interests

The authors have not declared any conflict of interests.

REFERENCES

Agricultural Statistics at a glance (2012).Directorate of Economics and Statistics, Ministry of agriculture, Government of India.http://agricoop.nic.in/agristatistics.htm

Agricultural statistics at a glance (2013).Directorate of Economics and Statistics, Ministry of agriculture, Government of India. http://eands.dacnet.nic.in/latest_2013.htm

Dhillon NS, Dhesi TS, and Brar BS (2004). Phosphate sorption-desorption characteristics of some Ustifluvents of Punjab. J. Indian Soc. Soil Sci. 52(1):17-22.

Ijgude MB, Kadam JR (2008).Effect of sulfur and phosphorus on yield and quality of soybean. An Asian J. Soc. Sci. 3(1):142-143.

Kumaresan, Doraisamy (2005). Sulphur, phosphorus and molybdenum interactions in relation to growth, uptake and utilization of sulphur in soyabean. Soil Sci. 130:26-31.

Patel PC, Patel MS (1996). National seminar on Development in Soil Science, held at GAU, Anand. P 109.