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EFFECT OF DIFFERENT LEVELS OF ROCK PHOSPHATE SULPHUR GRANULE ON GROWTH AND YIELD OF ONION AND BLACK GRAM

U. Bagavathi Ammal, K.K. Mathan and S. Mahimairaja
Tamil Nadu Agricultural University, Coimbatore 641 003, India

Abstract: Pot experiments conducted to study the effect of rock phosphate - elemental sulphur granule (RP-S^0 G) on the yield attributes and yield of onion and black gram in *Typic Haplustalf* soil revealed that the application of **RP-S°** G at the rate of 60 kg P_2O_5 ha^{-1} recorded the highest yield for both the crops. Better residual effects were reflected in black gram yield and uptake of nutrients. RP-S^0 G @ 75 kg P_2O_5 ha^{-1} also performed well, but its effect was on par with that of 75 kg P_2O_5 ha^{-1}.

Key words: Black gram, elemental sulphur, rock phosphate, nutrient uptake, onion, yield.

INTRODUCTION

During 1990s, the consumption of phosphate and potash fertilizers in India was adversely affected by a substantial reduction in the subsidies for these products. Between 1991-92 and 1995-96, phosphate consumption fell from 3.4 to 2.9 Mt P_2O_5. The $N:P_2O_5:K_2O$ ratio diminished from 6 : 2.4 : 1 in 1990-91 to 8.5 : 2.5 : 1 in 1995-96, compared with the ideal of 4:2:1 (Johntson and Syers, 1998). As a result, fertilizer consumption, which was already imbalanced, has become more so now. In this context, direct use of rock phosphate which is a cheaper and environmental friendly source of phosphatic fertilizer could perhaps be encouraged in conjunction with iron pyrite / elemental sulphur / organic manures to increase the P use efficiency to sustain food grain production and productivity. The objective of this study was to evaluate the efficiencies of rock phosphate elemental sulphur granule (RP-S^0G) with other P sources in onion - black gram cropping system.

MATERIALS AND METHODS

The soil was Typic Haplustalf, sandy clay loam in texture, pH 7.7, organic carbon 0.43 per cent, available N 230 kg ha^{-1}, available P 10.1 kg ha ' and available K 616 kg ha^{-1}. The treatment includes different levels of RP-S^0 G viz., 0, 15, 30, 45, 60 and 75 kg P_2O_5 ha^{-1}, and was supplemented with basal dose of N (30 kg ha^{-1}) and K (30 kg ha^{-1}) and the remaining 50 per cent of N was applied one month after planting. Each treatment was replicated four times and experiment was laid out in a randomized block design. Five onion bulbs (var. Co 4) were planted in each pot. The onion crop was harvested at 65 days and yield of bulb was recorded. After the harvest of onion, a residual crop of black gram (var Co 5) was raised. Four plants per pot were maintained and during the harvest, pod yield was recorded. Biometric observations were recorded at harvest stage. The N, P, K and S contents in onion bulb and black gram grain were estimated with standard procedures and uptake values were calculated.

RESULTS AND DISSCUSSION

Growth characteristics and yield

Application of RP-S^0 at 60 P_2O_5 ha^{-1} recorded the highest values for all the growth and yield attributing characters of onion viz., plant height (34.7 cm), shoot girth (13.7 cm), leaf length (34.3 cm), leaf number (21.8), bulb length (4.6 cm), bulb girth (8.1 cm), bulb number per plant (5.9), fresh bulb weight per clump (59.6 g) and fresh yield of bulb (282 g pot^{-1}). In most of the characters, addition of 75 kg P_2O_5 ha^{-1} was on par with RP-S^0 G @ 60 kg P_2O_5 ha^{-1}. The slow and continuous release of P from RP due to the oxidation of S° could be attributed to the better growth of onion. This work confirms the earlier findings of Kandaswamy *et al.* (1985). However, a decline in crop growth at 75 kg P_2O_5 ha^{-1} may be due to lesser dissolution of RP at higher level (Mahimairaja *et al.*, 1995). Yield attributes and yield of onion bulbs were impressively increased by RP-S^0 G application. It may be due to higher level of nutrient availability in soil and uptake of nutrients particularly P and S by onion resulting in significant influence on yield. Similar results were reported by Montagu and Goh (1990).

Table 1. Effect of different levels of rock phosphate - elemental sulphur granule (RP-S° G) on yield and nutrient uptake (mg pot^{-1}) of onion (var. Co 4) at harvest

Treatments	Fresh bulb weight/clump,g	Fresh yield of bulb, g pot^{-1}	Total uptake of nutrients (leaf and bulb), mg pot^{-1}			
			N	P	K	S (bulb)
T] Control	33.9	135	730.6	118.6	773.0	180.6
T_2 RPS° G @ 15 kg P_2O_5 ha^{-1}	43.8	215	1220.3	255.4	1322.3	310.3
T, RPS° G @ 30 kg P_2O_5 ha^{-1}	54.9	236	1386.0	359.3	1509.7	329.3
T_4 RPS° G @ 45 kg P_2O_5 ha^{-1}	55.5	252	1650.2	488.0	1662.6	385.4
T_5 RPS° G @ 60 kg P_2O_5 ha^{-1}	59.6	282	1844.0	562.7	1914.1	465.5
T_6 RPS° G @ 75 kg P_2O_5 ha^{-1}	57.0	275	1772.9	507.0	1838.5	456.7
SE (d)	1.70	8.6	53.6	19.7	54.7	20..2
CD (0.05)	3.60	18.4	114.3	42.0	116.6	42.7

Table 2. Effect of different levels of RP-S° G on quality parameters of onion bulb (var. Co 4) at harvest

Treatments	Total soluble solids (°Brix)	Reducing sugar, %	Non-reducing sugar, %	Total sugar, %	Pyruvic acid, $\mu M\ g^{-1}$	Sulphur, %
T_1	8.98	3.33	1.41	4.74	2.45	0.34
T_2	8.95	3.45	1.51	4.95	2.51	0.39
T_3	10.30	3.73	1.66	5.39	2.56	0.40
T_4	11.75	3.84	1.62	5.50	2.17	0.41
T_5	11.13	3.93	1.72	5.60	2.71	0.44
T_6	10.73	3.87	1.65	5.51	2.72	0.45
SE (d)	0.16	0.50	0.03	0.07	0.01	0.02
CD (0.05)	0.33	0.09	0.05	0.15	0.30	0.05

Table 3. Residual effect of different levels of RP-S° G on yield and uptake of nutrients of black gram (var. Co 5) at harvest

Treatments	Grain yield, g pot^{-1}	Stover yield, g pot^{-1}	Total uptake of nutrients (root, grain and stover), mg pot^{-1}					
			N	P	K	Ca	Mg	S
T_1	8.2	11.7	294.6	41.6	185.1	83.1	47.8	33.9
T_2	9.2	12.8	336.3	52.5	216.3	91.7	53.8	47.4
T_3	9.6	13.0	347.5	53.9	219.6	96.1	55.3	54.9
T_4	10.0	12.9	363.6	55.5	233.3	98.0	56.2	65.3
T_5	10.6	13.2	385.5	58.8	247.8	102.8	59.1	77.5
T_6	10.5	13.0	378.3	58.7	244.8	101.7	58.3	72.9
SE.(d)	0.11	0.30	4.73	1.30	7.92	6.81	2.26	5.09
CD (0.05)	0.23	0.63	10.08	2.90	16.87	14.50	4.83	10.85

Nutrient uptake in onion leaf and bulb

The N, P, K and S uptake in onion leaf and bulb were significantly influenced by addition of RP-S° G at 60 kg P_2O_5 ha^{-1} All the uptake values by the addition of 75 kg P_2O_5 ha^{-1} were on par with that of 60 kg P_2O_5 ha^{-1} (Table.2).

The significant influence of the levels of P on nitrogen uptake might be due to the synergistic effect of phosphate on nitrogen (Ahlawat *et al.*, 1976; Dwivedi and Dwivedi, 1992). The P uptake was remarkably influenced by RP-S° G. The beneficial effect of S on the solubility of PO_4 in RP may be attributed largely to the production of H_2SO_4, following oxidation of S° by *Thiobacillus* leading to higher uptake (Bhujbal, 1989). The uptake of K by leaf and bulb are influenced by RP-S° G addition at 60 kg P_2O_5 ha^{-1} which may be due to the influence of P on root growth and increased yield as a result of which uptake of K

was enhanced. Addition of RP-S^0 G at 60 kg P_2O_5 ha^{-1} increased the available S in soil, leading to higher S uptake. Similar result was obtained by Jana and Kabir (1990). Irrespective of nutrients, the uptake values were higher up to 60 kg P_2O_5 ha^{-1} and afterwards, some what declining trend was noticed at 75 kg P_2O_5 ha^{-1}. This may be due to lesser dissolution of rock phosphate at higher level (Mahimairaja 1995).

Quality parameters of onion bulb

The total soluble solids (TSS), sugar, sulphur, and pyruvic acid contents were significantly influenced by RP-S^0 G addition (Table.3). A linear increase in the concentration of TSS and phosphorus was noticed. These findings are in agreement with the observations of Singh (1979).

Reducing and non-reducing sugar content exhibited significant increase with increasing levels of phosphorus (Sharma *et al.*, 1974; Singh and Rajput, 1992). The pungent flavor of onion is produced when the cells of the onion are ruptured and the enzyme allinase reacts with the flavor precursors, S-alk (en) yl cysteine sulfoxides, to produce many volatile sulphur compounds, pyruvic acid and ammonia (Lancaster, and Boland, 1990). There was an increase in pyruvic acid content with increase in S application and this may be due to increased synthesis of volatile sulphur compounds (Balasubramanian *et al.*, 1978; Singh and Pandey, 1995). Flavor strength and pungency levels increased with increasing S levels (Brain *et al.*, 1998). Addition of RP-S^0 G also increased the S content in onion bulb (Vavrina and Smittle, 1989; Randle and Bussard, 1993).

Residual effect on black gram yield

The yield attributing characters were significantly influenced by the addition of RP-S° G @ 60 P_2O_5 ha^{-1}, but it was on par with addition of 75 kg P_2O_5 ha^{-1} (Table 4). These results indicate the capability of RP in sustaining available P for longer time and better residual effect (Chandrasekaran, 1989). The continuous supply of P due to dissolution of RP synchronizing with critical stages of growth would have exerted positive effect on the yield characters (Sasirekha, 1997).

The increase in yield and yield attributing characters due to P may be due to the fact that P plays a vital role in root proliferation, seed production, soil structure improvement, enhancing water use efficiency and improving protein content of seed (Singaram and Kothandaraman, 1993).

Residual effect on nutrient uptake

The results from the present study indicated that application of RP-S^0 G at 60 kg P_2O_5 ha^{-1} recorded the higher values of uptake of nutrients compared to other levels of P addition (Table 5). The increased P uptake may be due to increase release of P from RP with time (Bharadwaj *et al.*, 1996). The Ca uptake of the crop was improved may be due to the release of Ca from the dissolution of RP and solubilisation of insoluble tricalcium phosphate by the acids released during oxidation of S^0 (Vasanthi, 1986). The increase in Mg and S uptake with increased P application was in conformity with the results of Lutz (1974). This may be due to increased supply of available Mg and S (Table.6).

It may be concluded that the application of RP-S^0 G at 60 kg P_2O_5 ha^{-1} increased the growth and yield of onion, nutrient uptake in black gram, and quality parameters of onion.

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REFERENCES

Ahlawat, R.P.S., Saxena, M.C. and Sharma, K.C. 1976. Pattern of N and P concentration and accumulation as effected by N and P fertilization in spring maize. *Indian J. Agron.* 21: 17-23

Balasubramaniam, A.S., Kothandaraman, G.V., and Krishnamoorthi, K.K. 1978. Effect of sulphur application on the yield and quality of onion. *Agric. Res. J. Kerala* 17 : 138-140

Bhardwaj, S.K., Sharma, C.M. and Kanwar, K. 1996. Effect of rock phosphate on yield and nutrient up-

take in rice and its residual effect on linseed. *Indian J.Agron.* 41 : 35-37

Bhujbal, B.M. 1989. Studies on the influences of compost and pyrite addition on dissolution of Indian phosphate rocks in acid soil. *Indian. J. agrl. Chem.* 23 (2&3): 180-186

Brain, K.H., Yoo, K.S. and Pike, L.M. 1998. Changes in pungency of onions by soil type, sulphur and bulb maturity. *Scient. Hon.* 74 : 249-256

Chandrasekaran, N. 1989. Comparative effect of mussorie phos and superphosphate on soil properties, yield and quality of rice and succeeding black gram. M.Sc.(Ag.) thesis, Tamil Nadu Agricultural University, Coimbatore

Dwivedi, G.K. and Dwivedi, M. 1992. Efficacy of Laliput rock phosphate for finger millet - wheat and barnyard millet - wheat sequences on acid soil of Tehri, Garhwal. *J. Indian Soc. Soil Sci.*40: 773-778

Jana, B.K. and Kabir. 1990. Effect of sulphur on growth and yield of onion cv. Nasik Red. *Crop Res.* 3: 241-243

Johntson, A.E. and Syers, J.K. 1998. *Nutrient Management for Sustainable Crop Production in Asia.* Proc. of an International Conference held in Bali, Indonesia, 9-12, December 1996

Kandasamy, D., Samuel, G.M. and Oblisami, G. 1985. Influence of VAM and *Phophobacteria* on the growth of brinjal and chillies in nursery. *South Indian Hon.* 33 : 172-176

Lancaster, J.E. and Boland, M.J. 1990. Flavor biochemistry. *Onions and Allied Crops* (ed. Brewster, J.L. and Rabinowitch, H.D.) CRC Press. Boca Raton, USA. pp 33-72

Lutz, J. A. Jr. 1974. Growth, chemical composition and yield of no-tillage corn as affected by nitrogen, source of phosphorus on rate and source of potassium. *J. Indian Soc. Soil Sci.* 22 : 19-25

Mahimairaja, S., Bolan, N.S. and Hedley, M.J. 1995. Dissolution of phosphate rock during composting of poultry manure: an incubation experiment. *Fert. Res.* 40 *(2):* 93-104

Montagu. K.D. and Goh, K.M. 1990. Effects of forms and rates of inorganic nitrogen fertilizers on the yield and same quality indices of tomatoes. *J. Crop HortScience* 18 : 31-37

Randle, W.M. and Bussard, M.L. 1993. Pungency and sugars of short day onion as affected by S nutrition. *J. Am. Soc. Hon. Sci.* 118: 766-770

Sasirekha. D. 1997. Studies of different rock phosphates as phosphorus sources, their direct and residual effect on Inceptisol under maize-cowpea cropping sequence. M.Sc. (Ag.) thesis, Tamil Nadu Agricultural University, Coimbatore

Sharma C.B.N., Shukia, Subramaniam, T.R. and Srinivasamoorthy, H.K. 1974. Effect of phosphate fertilization on growth and phosphorus uptake in cowpca. *Indian. J. Hon.* 31 : 82-85

Singaram, P. and Kothandaraman, G.V. 1993. Effect of different sources of P on available soil P, yield and nutrient uptake by maize. *J. Indian Soc. Soil Sci.* 41 : 591-594

Singh, V.K. 1979. Studies on the effect on N, Cu and naphthalene acetic acid on the growth performance, yield and quality of onion. Ph.D. thesis, Banaris Hindu University, Banaris

Singh D. and Pandey, R.N. 1995. Effect of applied sulphur and dry matter yield and sulphur uptake by onion in different soil series of Delhi. *Ann. agric. Res.* 16 : 348-350

Singh, B.K. and Rajput, C.B.S. 1992. Effect of nitrogen, phosphorus and malcic hydrazide on the chemical composition of onion bulbs. *Veg. Sci.* 19 : 212-216.

Vavrina, C.S. and Smittlc, D.A. 1989. Sugar and pungency levels in sweet onions as influenced by cultural practices. *HortScience 24* (5): 76

Vasanthi, D. 1986. Iron - phosphorus interaction with organic manure for rice. M.Sc.(Ag.) thesis, Tamil Nadu Agricultural University, Coimbatore