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Response of onion (*Allium cepa* L.) to phosphorus and sulphur application in an acid soil

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Abstract

Field experiments were conducted on a silty clay loam soil at the experimental farm of CSK Himachal Pradesh Krish Vishvavidyalaya, Palampur, during Rabi 2001-02 and 2002-03, to study the response of phosphorus and sulphur on growth, productivity and nutrient uptake of onion. The treatments were taken in factorial combination of four levels of P (0, 50, 75 and 100 kg P_2O_5/ha) and three levels of S (0, 25 and 50 kg/ha) applied through diammonium phosphate and gypsum, respectively. The growth parameters viz. Number of bulb per kg, diameter of bulb, fruit weight of bulb, dry weight of leaves per plant onion bulb yield and phosphorus and sulphur uptake increased significantly with the increasing application of P and S. The highest bulb yield and P and S uptake were obtained with the application of 100 kg P_2O_5 along with 50 kg S/ha in 2001-02 and 2002-03, respectively. The highest P and S uptake by onion was also observed with the combined application of 100 kg P_2O_5 and 50 kg S/ha during both the year.

Key words: Phosphorus, sulphur, onion yield, P uptake, S uptake, acid soil.

Introduction

Onion is one of the most important bulb vegetable crops grown in India and cultivated in an area of 449 thousand hectare with an estimated production of 4721 thousand tonnes accounting for 16.6 per cent of the world area and 10.1 per cent of the world production of onion (Singh, 2002). In Himachal Pradesh, onion is grown as Rabi crop in low and mid hills and during summer in high hills in an area of about 7270 ha with a production of 79.06 thousand tonnes and an average productivity of 30.8 t/ha (Arya and Sant Parkash, 2002). However, per unit yield of onion bulbs in the state is low as compared to other states of the country and one of the reason for low productivity of the crop in the state is that the soils of this region are low to medium in available P and S. Sulphur deficiency is becoming widespread in the state with increasing use of S-free fertilizers, leaching and insufficient use of crop residues and other manures. Onion is typically an important S-loving crop; where it improves not only the yield but also quality, especially pungency and flavors (Jaggi, 2005). Phosphorus is also one of the limiting nutrients in acid soils because of its high fixation and very low recovery of the applied phosphorus from the soils. Since inadequate information is available regarding the response of P and S fertilization in onion bulb production under acid soil conditions, the present investigation was, therefore, undertaken to study the response of P and S on growth, productivity and nutrient uptake of onion bulb.

Material and Methods

Field experiment was conducted on a Typic Hapludalf silty clay loam soil at the experimental farm of the department of Soil Science, CSK, Himachal Pradesh Krishi Vishvavidyalaya, Palampur, during Rabi season of 2001-02 and 2002-03. The soil had pH 5.6, organic carbon 8.3 g/kg, CEC 10.3 c mol (p+)/kg, available P 13.7 kg/ha, available S 8.6 mg/kg and available N, and K were 221.3, and 207.0 kg/ha, respectively. The available S in soil was extracted using 0.15% CaCl2 solution (Williams and Steinbergs, 1959) and the S content in the extract was further determined using the turbidimetric method of Chesnin and Yien(1951).The soil properties and other nutrients were determined as described by Jackson, 1973. The experiment with three replication was laid out in a factorial combination in plot size 10 m2 with four levels of P (0, 50, 75 and 100 kg/ha) and three levels of S (0, 25 and 50 kg/ha) applied through di-ammonium phosphate (DAP) and gypsum ($CaSO_4$. $2H_2O$), respectively. A uniform dressing of N (125 kg/ha) and K_2O (60 kg/ha) were

applied through urea and muriate of potash, respectively. The amount of N supplied by DAP which was used as a source of P was calculated and adjusted in the amount applied through urea. Half of the N and full dose of Phosphorus and potash were drilled as basal at the time of transplanting and remaining quantity of N was applied in two equal split at monthly interval after irrigation. The onion seedlings (var.N-53) were transplanted in 15x10 cm spaced during last week of December in both the years.

At maturity growth parameter and yield of bulbs were recorded. The bulbs samples were taken for determination of P and S contents. The ground samples were digested in diacidic mixture of HNO_3 and $HClO_4$ (4:1) and the total P was determined by Vanadomolybdo phosphoric acid yellow colour method (Jackson, 1973) and total S content was determined turbidimetrically (Chesnin and Yien,1951).

Results and Discussion

Growth Parameters

Number of bulbs per kg, diameter of bulb, fresh weight of bulb and dry weight of leaves per plant increased significantly with the application of phosphorus and sulphur (Table 1).

Table1. Effect of phosphorus and sulphur application on growth and yield attributes of onion

Treatment P/S levels (kg/ha)	No of bulb/ kg	Dia. of bulb (cm)	Fruit wt. of bulb (g)	Dry wt. of leaves/ plant (g)
P0S0	31	4.58	32.3	2.72
P50S0	26	4.70	37.1	3.32
P75S0	24	5.03	41.6	3.83
P100S0	24	5.12	44.0	4.35
P0S25	26	4.82	37.2	3.53
P50S25	25	4.91	42.2	3.92
P75S25	25	5.16	46.4	4.16
P100S25	25	5.30	51.2	4.92
P0S50	25	5.01	38.2	4.11
P50S50	23	5.06	44.6	4.29
P75S50	22	5.23	49.3	5.06
P100S50	21	5.32	54.4	5.19
CD (P=0.05)	0.91	0.16	2.11	0.22

Application of phosphorus alone and in combination with sulphur significantly decreased the number of bulb from 31 (control) to 21 per kg weight (P100 S50). This indicates that the weight of the bulb increased with the application of P and S. Furthermore a significant increase in the diameter of bulb from 4.58 to 5.32 cm, fruit weight of bulb from 32.3 to 54.4 g and dry weight of leaves per plant from 2.72 to 5.19 g were recorded with the application of P and S. The increase in growth parameters might be due to increased supply of phosphorus and sulphur which favored better nutritional environment. Singh *et al.* (1999), Jaggi and Dixit (1999) and Sharma *et al.* (2002) have also reported a significant increase in yield and yield attributes following S application.

Onion bulb yield

The onion bulb yield increased significantly with increasing levels of phosphorus as well as sulphur.This showed the additive effect of phosphorus and sulphur on the bulb yield in both the years indicating that there was a positive interaction between phosphorus and sulphur (Table 2).The per cent increase in onion bulb yield due to phosphorus in 2001-02 and 2002-03 varied from 15.5 to 46.4 and 12.7 to 42.8, respectively. The increase in bulb yield due to phosphorus application could be attributed to its important role in rapid cell-division and elongation in meristematic region and development and proliferation of the roots .The onion bulb yield increased from 20.1 to 33.2 and 20.6 to 36.3 per cent due to sulphur application in 2001-02 and 2002-03, respectively. Furthermore, there was a synergistic effect of phosphorus and sulphur interaction on onion yield and it was highest at 100 kg P_2O_5 x 50 kg S/ha followed by 75 kg P_2O_5 x 50 kg S/ha. These response might be due to the synergistic effect of P and S in utilizing large quantities of nutrients through their well developed root system which might have resulted in better plant root development and ultimate higher yield at low initial status of P (Olsen's P 13.7 kg/ha) and S content ($CaCl_2$ soluble S 8.6 mg/kg) in the experimental soil.

Table 2. Effect of phosphorus and sulphur application on onion bulb yield (q/ha)

S levels (kg/ha)	Rabi 2001-2002					Rabi 2002-2003				
	P levels (kg/ha)				Mean	P levels (kg/ha)				Mean
	P0	P50	P75	P100		P0	P50	P75	P100	
S0	112	139	162	171	146	103	122	167	181	143
S25	147	164	180	210	175	142	163	183	203	173
S50	158	178	211	230	194	172	187	210	213	195
Mean	139	161	184	203		139	157	190	199	
CD (P=0.05)	P= 5.5		S= 4.9PxS= 8.9			P=6.2		S=5.4 PxS= 10.7		

These results confirm the earlier work of Jana and Kabir (1990), Dixit and Sharma (2004) and Jaggi (2005) who reported S response in onion up to 45 kg/ha.

Uptake

Phosphorus uptake by onion bulb increased significantly with the application of phosphorus as well as sulphur in both the years (Table 3).Total P uptake by onion bulb due to P application varied from 8.1 to 12.7 kg in 2001-02 and 7.3 to 12.2 in 2002-03. The corresponding per cent increase in P uptake ranged from18.4 to 56.4 and 25.2 to 65.8. The increase in P uptake due to sulphur application ranged from 9.3 to 11.5 and 8.7 to10.8 kg/ha in first and second year, respectively. The interaction between P and S was significant in term of P uptake. The highest P uptake 13.9 kg/ha in 2001-02 and 13.1 in 2002-03 was observed with 100 kg P_2O_5 and 50 kg S/ha. Total S uptake by onion bulb due to P application significantly increased from 12.4 to 20.0 kg/ha in 2001-02 and 11.2 to 18.6 in 2002-03 (Table 4). The corresponding increase in S uptake due to sulphur application varied from 14.5 to 17.7 and 13.4 to 16.0 kg/ha. Maximum sulphur uptake by onion bulb 21.9 kg/ha in 2001-02 and 20.0 in 2002-03 was recorded with the combined application of 50 kg S and 100 kg P_2O_5/ha. These findings are in confirmation with those of Sharma *et al.* (2002) and Dixit and Sharma (2004).

Table 3. Effect of phosphorus and sulphur application on P uptake (kg/ha) by onion

S levels kg/ha	Rabi 2001-2002					Rabi 2002-2003				
	P levels (kg/ha)				Mean	P levels (kg/ha)				Mean
	P0	P50	P75	P100		P0	P50	P75	P100	
S0	7.1	8.7	10.1	11.4	9.3	6.2	8.1	9.4	11.0	8.7
S25	8.3	9.4	11.2	12.9	10.5	7.7	9.1	11.0	12.5	10.1
S50	8.8	10.7	12.7	13.9	11.5	8.2	10.4	11.7	13.1	10.8
Mean	8.1	9.6	11.3	12.7		7.3	9.2	10.7	12.2	
CD (P=0.05)	P= 0.19	S=0.16	PxS= 0.33			P=0.44	S=0.39	PxS= 0.77		

Table 4. Effect of phosphorus and sulphur application on S uptake (kg/ha) by onion

S levels kg/ha	Rabi 2001-2002					Rabi 2002-2003				
	P levels (kg/ha)				Mean	P levels (kg/ha)				Mean
	P0	P50	P75	P100		P0	P50	P75	P100	
S0	11.	13.7	15.8	17.5	14.5	10.1	12.0	15.0	16.4	13.4
S25	12.9	15.9	17.1	20.7	16.6	11.4	14.4	16.5	19.3	15.4
S50	13.2	16.6	19.1	21.9	17.7	12.1	15.3	16.7	20.0	16.0
Mean	12.4	15.4	17.3	20.0		11.2	13.9	16.0	18.6	
CD (P=0.05)	P= 0.24	S=0.21	PxS= 0.43			P=0.52	S=0.45	PxS= 0.90		

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