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Interaction effect of sulphur and potash on growth, bulb yield and nutritional values of onion (*Allium cepa* L.)

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Abstract
A field experiment was conducted during rabi season, 2012-13 at Nursery, Rajaula Agriculture Farm, Mahatma Gandhi Chitrakoot Gramodaya Vishwa Vidhyalaya, Chitrakoot, Satna (M.P.). In this investigation, the treatments consisting of four levels of sulphur (0, 20, 40 and 60 kg/ha) and four levels of potash (0, 40, 80 and 120 kg/ha) were tested in factorial randomized block design with three replications to study the interaction effect of sulphur and potash on growth, bulb yield and nutritional values of onion. The study revealed that crop fertilized with sulphur (60 kg/ha) coupled with potash (80 kg/ha) had brought significant effect in the interaction effect of both level to recorded maximum mean horizontal diameter of onion bulb, mean vertical diameter of onion bulb, mean dry weight of onion bulb and yield were recorded in sulphur application (60 kg/ha). Similar trends were also noted in phosphorous, potassium and sulphur in bulb. Thus, onion fertilized with (60 kg/ha) in combination with potash @ 80 kg/ha proved to be most affected to recorded growth, bulb yield and nutritional values of onion.

Keywords: sulphur level, potash level onion growth parameters, nutritional value and yield

Introduction
India is the second largest producer of onion in the world, next to China, accounting for 22.18 per cent of the world area and 18.78 per cent of the world production. In India, onion is being grown in an area of 0.83 million hectares with production of 13.57 million tonnes and the productivity is 16.30 tonnes per hectare which is low. Maharashtra is the leading onion growing state and other important states are Karnataka, Gujarat, Bihar, Madhya Pradesh, Andhra Pradesh, Rajasthan, Haryana, Uttar Pradesh and Tamil Nadu. In Karnataka, onion is cultivated in an area of 1.65 lakh hectares with production of 30.32 lakh tonnes and the average productivity is 18.40 tonnes per hectare which is low compared to world average. In the year 2008-09, India exported about 16.70 lakh metric tonnes of fresh onion fetching about Rs. 1827.50 crores, besides meeting the demand for internal consumption (Bijay Kumar, 2010) [2] Madhya Pradesh soils are generally low in nitrogen, low to medium in phosphorus, high in potassium and deficient in sulphur due to increasing availability of irrigation cropping intensity, use of high analysis fertilizers, availability of high yielding varieties and control on use of sulphur containing fertilizer, pesticides and insecticides pollution of sulphur in atmosphere. There is a good scope of increasing onion yield and quality for which nutrient management is one of the most important considerations (Pandey *et al*., 2009) [8]. Sulphur deficient plants had poor utilization of nitrogen, phosphorus and potash and a significant reduction of catalase activities at all age (Nasreen *et al*., 2003) [5]. Intensive cropping and use of high-grade fertilizers have caused the depletion of sulphur in soils.

Now a days, it has been established that nutrition plays an important role in the improvement of onion yield. Fertilizer being a costly input the grower always wants optimum use of fertilizer for maximum return. Among the major nutrients, nitrogen, phosphorus, potassium and sulphur are required in plenty by the plants. They have manifold functions which they perform in the biological architecture of the plant, with the cultivation of high yielding varieties and adoption of multiple cropping patterns (Pandey and Sarkar, 2005) [7]. Therefore, existing study was deliberate to assess the interaction effect of sulphur and potash on growth, bulb yield and nutritional values of onion.

Materials and Methods
Experimental details and site description
The present investigation was carried out at Nursery, Rajaula Agriculture Farm, Mahatma

Gandhi Chitrakoot Gramodaya Vishwa Vidhyalaya, Chitrakoot, Satna (M.P.) during Rabi season, 2012-13. Chitrakoot is situated between 25°10' to 25°15' north latitude and 80°80' to 80°85' east longitude. The climate of Chitrakoot is subtropical. The annual average rainfall is 950 mm, most of which received from first week of July to last week of September, with a few showers occur during winter also. The experimental trial was well drained, sandy loam in texture (46.1 % sand, 18.6 % silt and 17.2 % clay, hydrometer method) and slightly alkaline in reaction (pH 7.3, Glass electrode pH meter). It was medium in organic carbon available nitrogen and available phosphorus, whereas high in available potassium with an electrical conductivity (1:2, soil: water suspension, Solbridge conductivity meter method) and Bulk density, Core sampler method of 1.61 dS/m and 1.41 Mg/m^3, respectively. All the soil properties were analyzed as per the standard procedures adopted by Page (1982) [6]. The experiment was laid out with four levels of sulphur (0, 20, 40 and 60 kg/ha) and four levels of potash (0, 40, 80 and 120 kg/ha) were tested in factorial randomized block design with three replications. The onion variety Nasik Red was sown in nursery on 22nd October 2012. The 42 days old seedlings were transplanted in main field on 3rd December, 2012. The row to row and plant to plant distances were 15 cm and 10 cm, respectively. Proper water management, plant protection and weed control measures were followed uniformly in all the treatment as per recommendation for onion. The First irrigation was given just after transplanting and subsequent irrigation were given at the requirement of field experiment. Whereas, First weeding was done at 27 DAT and second weeding was done at 42 DAT.

Data collection

The various observations on mean horizontal diameter of onion bulb, mean vertical diameter of onion bulb, mean dry weight of onion bulb were recorded as per standard procedure. Moreover, yield of onion bulb (q/ha) was worked out in different plot of the experimental field.

Plant sampling and analysis

The plants measured for growth and yield were used for analyzing the P, K and S content in bulb. The samples were dried at 70 °C in a hot air oven. The dried samples were ground in a stainless steel Thomas Model 4 Wiley ® Mill. The P content in plant was determined by the vanadomolybdo-phosphoric yellow colour method and the K content was analyzed in di-acid (HNO_3 and $HClO_4$) digests by the flame photometeric method (Page, 1982) [6]. Sulphur content was determined by Turbidemetric method.

Statistical analysis

The data on various parameters were exposed to statistically analyze as drew by Gomez and Gomez (1984). The treatment variances were tested by using "F" test and critical differences (at 5 per cent probability).

Results and Discussion

Interaction effect of sulphur (60 kg/ha) coupled with potash on growth attributes

Statistically analysis data presented in Table 1-3 revealed that crop treated with sulphur (60 kg/ha) coupled with potash (80 kg/ha) had brought significant interaction effect of both level in which maximum mean horizontal diameter of onion bulb, mean vertical diameter of onion bulb, mean dry weight of onion bulb had recorded in the treatments where sulphur (60 kg/ha) coupled with potash (80 kg/ha) had been applied, followed by treatments S_2K_2 and S_3K_3. This was 22.2, 19.6 and 14.5 % higher over the treatments where no fertilizers used irrespective of different treatments. The minimum mean horizontal diameter of onion bulb, mean vertical diameter of onion bulb, mean dry weight of onion bulb of onion bulb was produced under S_0K_0 as against rest of the treatments. This might be due to increased level of sulphur and potash resulting in better photosynthesis and accumulation of photosynthates leading to more nutritional values. Similar results were also obtained by Sampathkumar Setty (1988) [10] and Thimmiah (1989) [12].

Table 1: Mean horizontal diameter of onion bulb (cm) as influenced by sulphur and potash levels

Sulphur levels	Potash levels				Mean
	K_0	K_1	K_2	K_3	
S_0	4.82	4.96	5.30	5.24	5.08
S_1	4.95	5.18	5.38	5.32	5.21
S_2	5.07	5.28	5.39	5.36	5.27
S_3	5.16	5.30	5.40	5.38	5.31
Mean	5.00	5.18	5.37	5.32	5.22
SE(m) ±	0.02				
CD at 5%	0.06				

Table 2: Mean vertical diameter of onion bulb (cm) as influenced by sulphur and potash levels

Sulphur levels	Potash levels				Mean
	K_0	K_1	K_2	K_3	
S_0	3.92	3.96	4.18	4.12	4.04
S_1	4.06	4.10	4.19	4.16	4.13
S_2	4.09	4.18	4.26	4.24	4.19
S_3	4.16	4.22	4.33	4.30	4.25
Mean	4.06	4.11	4.24	4.20	4.15
SE(m) ±	0.013				
CD at 5%	0.039				

Table 3: Mean dry weight of onion bulb per 100g fresh weight as affected by sulphur and potash levels

Sulphur levels	Potash levels				Mean
	K_0	K_1	K_2	K_3	
S_0	9.12	9.24	9.64	9.92	9.48
S_1	9.28	9.42	10.16	10.34	9.80
S_2	9.32	9.80	10.48	10.64	10.06
S_3	9.52	10.24	10.86	10.94	10.39
Mean	9.31	9.67	10.28	10.46	9.93
SE(m) ±	0.03				
CD at 5%	0.10				

Interaction effect of sulphur (60 kg/ha) coupled with potash on bulb yields

Data presented in Table 4 disclosed that crop fertilized with sulphur (60 kg/ha) together with potash (80 kg/ha) had brought significant effect in the interaction effect of both level in which maximum yield of onion bulb (346.92 q/ha) had recorded in the treatments where sulphur (60 kg/ha) coupled with potash (80 kg/ha) had been applied, followed by treatments S_2K_2 (341.26 q/ha) and S_3K_3 (340.40 q/ha). The minimum yield of onion bulb (276.32 q/ha) was produced under control. Increased bulb yield were noticed by several workers viz; Varu *et al*. (1997), Singh *et al*. (2001) [11] and Lal *et al*. (2002) [4] with increased nutrient level and The yield parameters like bulb equatorial diameter, polar diameter and bulb weight also increased significantly at higher levels of Sulphur and potash. Significantly higher bulb size was

recorded by Lal *et al*. (2002) [4]. Amanullah *et al*. (2007) [1] reported that, application of increased levels of Sulphur increased the length and girth of the cassava tuber, which corroborate the findings of the present study. The interaction effects between sulphur and potash were found significant for bulb yield. Interaction effects of sulphur and potash were of significant effect in onion was also reported by Singh *et al*. (2001) [11].

Table 4: Yield of onion bulb (q/ha) as influenced by sulphur and potash levels.

Sulphur levels	Potash levels				Mean
	K_0	K_1	K_2	K_3	
S_0	276.32	282.76	302.14	298.52	289.93
S_1	278.66	286.12	305.26	300.28	292.58
S_2	281.42	314.30	341.26	332.62	317.40
S_3	287.10	316.18	346.92	340.40	322.65
Mean	280.87	299.84	323.89	317.95	305.64
SE(m) ±	0.69				
CD at 5%	2.00				

Interaction effect of sulphur (60 kg/ha) coupled with potash on nutritional values in bulb

Table presented in Table 5-7 revealed that crop received sulphur (60 kg/ha) along with potash (80 kg/ha) had recorded significant interaction in phosphorus by 15.2 %, potash by 14.3 % and sulphur by 20 % over the plot received no fertilizer during experiments year. It was closely followed by treatments S_2K_2 (1.2%) and S_3K_3 (1.1 %). The minimum phosphorus, potash and sulphur was noted with S_0K_0 (control) as against rest of the treatments. Therefore, the availability of higher quantity of nutrients, and increased activity of microbes with higher levels of sulphur might have helped in increasing phosphorus, potash and sulphur. Similarly, significantly higher phosphorus in onion with application of vermicompost was reported by Reddy and Reddy (2005) [9]. Higher levels of S significantly increased the potash (Reddy and Reddy, 2005) [9] and sulphur (Lal *et al*., 2002) [4] in onion. It has been reported to contain several plant growth promoters, enzymes, beneficial bacteria and mycorrhizae responsible for improving nutritional values of bulb (Gupta, 2005) [3].

Table 5: Mean phosphorus content (%) of onion bulb as influenced by sulphur and potash levels.

Sulphur levels	Potash levels				Mean
	K_0	K_1	K_2	K_3	
S_0	0.33	0.33	0.36	0.37	0.35
S_1	0.33	0.34	0.37	0.38	0.35
S_2	0.32	0.36	0.40	0.41	0.37
S_3	0.34	0.40	0.43	0.45	0.40
Mean	0.33	0.36	0.39	0.40	0.37
SE(m) ±	0.004				
CD at 5%	0.012				

Table 6: Mean potassium content (%) of onion bulb as influenced by sulphur and potash levels.

Sulphur levels	Potash levels				Mean
	K_0	K_1	K_2	K_3	
S_0	0.92	0.94	0.97	1.00	0.96
S_1	0.98	1.05	1.11	1.16	1.07
S_2	1.06	1.12	1.21	1.26	1.16
S_3	1.08	1.20	1.24	1.27	1.20
Mean	1.01	1.08	1.13	1.17	1.10
SE(m) ±	0.008				
CD at 5%	0.022				

Table 7: Mean sulphur concentration of onion bulb as influenced by sulphur and potash levels.

Sulphur levels	Potash levels				Mean
	K_0	K_1	K_2	K_3	
S_0	0.304	0.322	0.338	0.341	0.326
S_1	0.342	0.354	0.372	0.386	0.364
S_2	0.378	0.403	0.421	0.428	0.408
S_3	0.396	0.418	0.442	0.450	0.426
Mean	0.355	0.374	0.393	0.401	0.381
SE(m) ±	0.002				
CD at 5%	0.006				

Conclusion

Based on the experimental results revealed that onion fertilized with (60 kg/ha) in combination with potash @ 80 kg/ha proved to be most outstanding to recorded mean horizontal diameter of onion bulb, mean vertical diameter of onion bulb, mean dry weight of onion bulb, yield, phosphorous, potassium and sulphur as against rest of the combination. Thus, it will be suggested to onion growers in Madhya Pradesh farmer.

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