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Effect of sulphur and boron on growth and quality of onion (*Allium cepa* L.)

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Abstract
The investigation was conducted during *rabi* seasons of 2017-18 at the horticulture farm nursery, College of Agriculture, Gwalior. The study involve Sixteen treatment combinations consisting of four sulphur levels viz. S_0: Control, S_1: 20 kg S ha^{-1}, S_2: 40 kg S ha^{-1}, S_3: 60 kg S ha^{-1} and four doses of Boron, i.e. B_0: Control, B_1: 0.5 kg B ha^{-1}, B_2: 1.0 kg B ha^{-1} and B_3: 2.0 kg B ha^{-1} in factorial randomized block design with three replications. The recommended dose of fertilizer (RDF) adopted was 100:60: 80 kg of N: P: K ha^{-1}. The increasing level of sulphur and boron up to 60 kg ha^{-1} and 2.0 kg B ha^{-1} increased growth and bulb quality significantly over control respectively

Keywords: Cucumber, boron, yield, quality, konkan

Introduction
The growing of vegetable is the most intensive, profitable and remunerative hence it may be adopted with small holders with profitable and gaining business. Apart from this, vegetables have an excellent dietary value and may be known as protective foods.

Onion (*Allium cepa* L.) is one of the oldest bulb crop consumed worldwide. It is one of the most important commercial vegetable crop grown in India and believed to be originated in Central Asia. It is valued for its distinct pungent flavour and is an essential ingredient for the cuisine of many regions. Onion is the queen of the kitchen (Selvaraj, 1976) [15]. The onion is preferred mainly because of its green leaves, immature and mature bulbs are either eaten raw or cooked as a vegetable. Mild flavoured and low pungent bulbs are often chosen for salads. The bulbs are used in soups, sauces, condiments, spices, medicines, seasoning of many foods and for the preparation of value added edible products like powder and flakes. A distinct characteristic of onion is its alliaceous odour, which accounts for their use as food. The pungency in onion is due to a volatile compound allyl propyl disulphide.

Onion has many uses as folk medicine and recent reports suggest that onion plays an important role in preventing heart diseases and other ailments. It is one of the richest sources of flavonoids which reduce risk of cancer, heart disease and diabetes. Flavonoids are not only anti-cancer but also known anti-bacterial, antiviral and anti-allergenic. Onion contains 11 amino acids. Hundred gram of raw onion bulb contains about moisture 86.8 g, carbohydrate 11.0 g, protein 1.2 g, fibre 0.6 g, minerals 0.4 g, thiamine 0.08 mg, vitamin c 1 mg, calcium 180 mg, phosphorus 50 mg and riboflavin 0.01 mg which make up the dry matter of the bulb (Boss *et al.*, 2003) [1]. The major Onion producing states are Maharashtra, Madhya Pradesh, Karnataka, Gujarat, Rajasthan, Bihar, Haryana, Andhra Pradesh, Tamil Nadu, and West Bengal in the country. These States account for almost 90% of the total onion production of the country. The production of onion during the year 2017-18 (First Advance Estimate) is estimated to be 4.5% lower as compared to the previous year. However as compared to past 5 year's average production, it is 8.6% higher. (NHB data base, 2018) [13].

In Madhya Pradesh, onion is cultivated in an area of 120.14 thousand hectares with production of 37.21 lakh tones and the average productivity is 18.40 tones per hectare which is low compared to world average. In the year 2017, India exported about 84.70 MT of fresh onion fetching about Rs. 9761.11 crores, besides meeting the demand for internal consumption. (NHB Data base, 2017) [12]. With the increase of 30% the production of onion in the current year is estimated at 216 lakh tones as against 209 lakh tones in 2015-16.

Similarly the area under onion crop in the current year is estimated at 12.7 lakh hectares as against 13.2 lakh hectares in 2015-16 i.e. decline of about 4%over the previous year.

Materials and methods

The experiment entitled "Impact of sulphur, boron and its combinations on growth and yield of onion (*Allium cepa* L.)" was carried out, during *Rabi* season of 2017-18 at the horticulture nursery, College of Agriculture, Gwalior. The soil of the experimental field was alluvial, sandy clay loam in texture. The field of research farm having homogenous fertility and uniform textural make up was selected for the field experimentation. The experiment was conducted at the Horticulture Nursery, college of agriculture, Gwalior, during the *rabi* seasons of 2017-18 with 16 treatments (Combination of 4 levels of each S and B). During the research Agri Found Light Red variety was transplanted with the spacing of 15cm row to row and 10 cm plant to plant. The treatments included in the investigation comprised of the sixteen combinations of 4 doses of sulphur with four doses of boron. A recommended nursery beds (2.0 m x 1.0 m) were raised 15 cm above the soil surface in the departmental nursery field at the end of November of 2017. Then the prepared bedding mixture was evenly spread in the form of 5.0 cm thick layer over the nursery. Rows were made 1.5 to 2.0 cm deep at 10.0 cm apart and seeds sown, covered and watered. The seedlings became ready for transplanting at 45 Days after Sowing (DAS).

Table 1: Treatments detail combination

Factor		Notation
A.	**Sulphur Doses**	
	Control	S_0
	20 kg ha^{-1}	S_1
	40 kg ha^{-1}	S_2
	60 kg ha^{-1}	S_3
B.	**Boron Doses**	
	Control	B_0
	0.5 kg ha^{-1}	B_1
	1.0 kg ha^{-1}	B_2
	2.0 kg ha^{-1}	B_3

Table 2: Treatment

T_1: S_0B_0	T_5: S_1B_0	T_9: S_2B_0	T_{13}: S_3B_0
T_2: S_0B_1	T_6: S_1B_1	T_{10}: S_2B_1	T_{14}: S_3B_1
T_3: S_0B_2	T_7: S_1B_2	T_{11}: S_2B_2	T_{15}: S_3B_2
T_4: S_0B_3	T_8: S_1B_3	T_{12}: S_2B_3	T_{16}: S_3B_3

Result and discussion

The data recorded from the field experiment entitled **"Effect of sulphur and boron on growth and storage quality of onion (*Allium cepa* L.)"** carried out during the *rabi* season of 2017-18 at at the horticulture nursery, College of Agriculture, Gwalior. Observations pertaining to growth and quality parameters were subjected to statistical analysis and the results pertaining to each character are interpreted in ensuring on following tables.

Growth parameters

Effect of sulphur on length of leaves

Length of leaves was found in the range of 6.20 to 6.36, 10.69 to 12.81, 15.18 to 18.14 and 20.66 to 25.86 under different level of sulphur at 30, 60, 90 and 120 DAP stages, respectively. It is revealed that sulphur applied treatments recorded significantly more length of leaves as compared to control. However, maximum length was observed with 60 kg S ha 1 which was significantly higher to control. and 20 kg S ha 1 but was statistically at par with 40 kg S ha 1 treatment at 60, 90 and 120 DAP stages. Our results confirm the finding of Sharma *et al.* (2002) [16], Joshi *et al.* (2005) [6], and Mishu *et al*. (2013) [9]. Earlier Salimath (1990) [14], Nagaich *et al.* (1999) [10], and Singh *et al*. (1996) [17] also observed that the application of sulphur in onion @ 40 and 60 kg ha^{-1} significantly increased bulb yield and its attributes.

Effect of boron on length of leaves

length of leaves was noted in the range of 6.23 to 6.32, 8.33 to 9.74, 9.99 to 12.05 and 11.03 to 13.57 under different levels of boron at 30, 60, 90 and 120 DAP stages, respectively. Application of boron at different levels produced significantly higher length of leaves as compared to control. Maximum leaves recorded with 2.0 kg B ha-1 treatment were comparable with 1.0 kg B but significantly superior to control and 0.5 kg B treatments at 60, 90 and 120 DAP stages.

Interaction effects:

The interaction effect due to sulphur and boron on length of leaves was found statistically non- significant at 30, 60, 90 and 120 DAP stage.

Table 3: impact of different levels of sulphur and boron on growth of onion

Treats	Length of leaf (cm)			
	At 30 DAP	**At 60 DAP**	**At 90 DAP**	**At 120 DAP**
B_0: (Control)	6.23	10.83	15.61	21.51
B_1 : 0.5 kg ha^{-1}	6.32	12.04	17.24	23.62
B_2 : 1.0 kg ha^{-1}	6.20	12.56	17.75	25.32
B_3 : 2.0 kg ha^{-1}	6.32	12.52	17.64	24.17
S.E. (m)±	0.10	0.37	0.41	0.59
C.D. (5%)	0.28	1.06	1.18	1.69
S_0: (Control)	6.20	10.69	15.18	15.18
S_1: 20 kg ha^{-1}	6.23	12.00	16.94	16.94
S_2: 40 kg ha^{-1}	6.28	12.45	17.97	17.97
S_3: 60 kg ha^{-1}	6.36	12.81	18.14	18.14
S.E. (m)±	0.10	0.37	0.41	0.59
C.D. (5%)	0.28	1.06	1.18	1.69
S_1B_1	6.28	12.15	16.98	21.93
S_1B_2	6.01	12.98	18.04	26.78
S_1B_3	6.49	11.89	17.48	21.20
S_2B_1	6.41	11.89	18.01	25.39
S_2B_2	6.15	13.10	18.78	26.64
S_2B_3	6.16	13.76	18.72	26.73
S_3B_1	6.42	13.11	18.51	26.62
S_3B_2	6.40	13.35	18.67	26.79
S_3B_3	6.32	13.79	18.70	26.52
S*B	NS	NS	NS	NS
S.E. (m)±	0.20	0.73	0.82	1.18
C.D. (5%)	0.57	2.12	2.36	3.39

The probable reason may be that adequate supply of all the nutrients, particularly sulphur which resulted in greater accumulation of carbohydrates, amino acids and their translocation to the productive organs, which, in-turn improved in all the growth parameters. The present results are in agreement with the findings of Chattopadhyay and Mukhopadhyay (2004) [3], and Begum *et al*. (2015) [1].

Table 4: impact of different levels of sulphur and boron on quality of onion

	Dry weight of bulb				
Treatments	**S_0**	**S_1**	**S_2**	**S_3**	**B-Mean**
B_0: (Control)	8.08	8.20	8.53	8.69	8.38
B_1 : 0.5 kg ha^{-1}	8.37	8.38	9.65	9.83	9.05
B_2 : 1.0 kg ha^{-1}	8.54	9.25	9.60	9.85	9.31
B_3 : 2.0 kg ha^{-1}	8.68	9.38	9.86	9.80	9.43
S-Mean	8.42	8.80	9.41	9.54	
	F-Test	S.E. (m) ±		C.D. (5%)	
S	S*	0.11		0.30	
B	S*	0.11		0.30	
S x B	NS	0.21		0.61	

Qualitative studies

In the present investigation on quality of the produce was estimated in terms of dry weight per 100 g of bulb. Data on dry weight was subjected to statistically analysis and presented in table 4.9.

Effect of sulphur and boron on dry weight of bulb

Under different levels of sulphur dry weight was recorded in the range of 8.42 to 9.54 per cent and sulphur treated plots show significantly higher dry weights compared to control. It is clear from the data that the increasing levels of sulphur up to 40 kg ha^{-1} increased the dry weight significantly but maximum value (9.54 g/100g fresh weight) was recorded with 60 kg S ha^{-1} which was significantly higher to control and 20 kg S ha^{-1} but was statistically at par with 40 kg S ha$^{-1.}$ The increase in leaf length might be due to enhanced availability of nutrients and production of growth promoting substances that might have caused cell elongation and cell multiplication. The findings of present investigation are supported by Meena and Singh (1998) and Jaggi (2005).

Dry weight of bulb observed in the range of 8.38 to 9.43 per cent under different levels of boron. It is inferred from table 4.9, that application of boron produced significantly higher dry weight as compared to control. Application of 1.0 and 2.0 kg B ha^{-1} recorded 9.31 and 9.43 g dry weight per 100 g fresh weight of onion bulb and both were significantly higher as compared to control and 0.5 kg B ha^{-1} treatment. The findings of present investigation are supported by Gamelli *et al*. (2000) [4], Khodadadi (2012) [7] and Mishu *et al*. (2013) [9].

The interaction effect due to sulphur and boron on dry weight was found statistically non- significant.

Conclusion

The experimental evidences warrants the following specific conclusion which may be adopted for quality bulb production of onion. It could be concluded that nutrient management in onion is very efficient and application of 40 kg sulphur and 1.0 kg Boron may be produce good quality of bulb onion in Gwalior district.

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