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Original Research Article

Effect of Different Levels of Sulphur on Yield and Quality of Onion

Sanjivani P. Gondane[1*], P.M. Chandan[2] and K.N. Panchal[1]

[1]Department of Horticulture, Vegetable Science, Dr. PDKV, Akola-444 104, India
[2]Vegetable Science, Department of Horticulture, MPKV, Rahuri 413722, India
**Corresponding author*

Keywords

Weeds, Herbicides, Weed control efficiency, Cane yield and seasonal sugarcane

A B S T R A C T

An field experiment was carried out during *rabi* season in the year 2013-2014 at Main Garden, Department of Horticulture, Dr. PDKV, Akola with the objectives, to study the effect of sulphur application on yield and quality parameters of onion and to find out optimum dose of sulphur for better yield and quality of onion. The sulphur levels were found to be varied in yield and quality parameter. The sulphur application @ 40 kg ha^{-1} found to be better in yield contributing characters like weight of fresh as well as cured bulb, diameter of bulb, number of marketable bulbs, weight of marketable bulb per plot, total yield per plot and total yield per hectare. The same treatment was also responsible for exhibiting significantly minimum splitting and bolting percentage and days required for maturity. However, better bulb quality parameters *viz.*, Total soluble solid, chlorophyll content and oleoresin content was observed superior in 60 kg S ha^{-1}.

Introduction

Onion (*Allium cepa* L.) often called as Queen of the kitchen belongs to the family *Amaryllidaceae* having chromosome no. 2n=16 and originated from Central Asia. It is one of the most commercial vegetable cum spice crop. Onion is known for its flavour, pungency which is due to sulphur containing compound allyl propyl disulphide and also eco-friendly stored grain protectant (Jaggi, 2005). Onion is mainly used as salad and cooked in various ways in curies, fried, boiled, baked and used in soup making and preparation of pickles.

Besides fresh consumption, onion used as raw material for processing industry for dehydration as processed the various dehydrated products like dehydrated powder, rings, shreds, flour, flakes, paste etc. Onion is also known to possess several medicinal and therapeutic properties; Onion contains a chemical compound quercetin believed to have anti-inflammatory, anti-cholesterol, anticancer and antioxidant properties.

In India it is grown in an area of 11.73 lakh hectare with production of 187.77 lakh metric tons and productivity of 16 metric tons/ha (Anon, 2014). Thus, India tops second in both area and production next only to China, in the world. Among fresh

vegetables, onion is a pride item of agricultural export, earning valuable foreign exchange to the country. In India onion is mainly grown in the state of Maharashtra, Karnataka, Gujarat, Bihar, Andhra Pradesh, Utter Pradesh, Orissa and Madhya Pradesh. Maharashtra is the leading state in area and production. Area under cultivation is 4.68 lakh hectare with production of 58.67 lakh metric tons and 14.3 metric tons/ha productivity (Anon, 2014). In Maharashtra, Nasik, Ahmednagar, Pune and Satara are the major onion producing districts. In Maharashtra onion is commercially grown in three seasons, i.e. *kharif* (May-July to Oct-Dec.) late-*kharif* (Aug-Sep. to Jan-Mar) and *rabi* (Oct-Nov. to April-June).

Onion is a sulphur loving plant and is required much for proper growth and yield of onion (Kumar and Singh, 1995). Sulphur has been recognized as an important nutrient for higher yield and quality of onion bulbs. Sulphur is essential for building up sulphur containing amino acids and also for a good vegetative growth and bulb development in onion.

The efficient utilization of N, P, K fertilizer and secondary nutrients is obtained only in presence of adequate quantities of available micronutrients in soil. Because of changing trend in agricultural, yield target concept and fertilizer recommendation for maximum profit per hectare become more promising. Yield target concept has the added advantage in which target can be fixed by taking into consideration the resources available. Therefore, it is essential to find out the best and optimum level of sulphur for soil application and its effect on yield and quality of onion. Hence the present study was conducted with the objectives to find out optimization of sulphur dose for better yield and quality parameters of onion.

Materials and Methods

The investigation entitled "Effect of different levels of sulphur on growth, yield and quality of onion" was carried out at Main garden, University Department of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, during the *rabi* season of 2013-14. The experiment was laid out in Randomized Block Design with nine levels of sulphur viz. (0, 10, 20, 30, 40, 50, 60, 70 and 80 kg S ha^{-1}) which was replicated three times. Seeds of Akola Safed variety were sown in raised nursery beds in lines spaced at 5-7 cm distance on 15th November 2013 in *rabi* season. Transplanting of 45 days old onion seedling were done on 17 January 2014 in the main field with gross plot size of 2 × 1.8 m2, Net plot size = 1.8 × 1.5 m^2 with the spacing: 15 X 10 cm. The crop was fertilized with recommended nitrogen, phosphorus and potassium@ 100:50:50 kg NPK per hectare in the form of urea, single superphosphate and muriate of potash, respectively. Out of recommended dose, 50 per cent of N and full dose of P and K was applied as a basal dose and remaining 50 per cent of N was applied after one month of transplanting as top dressing. Whereas sulphur was applied in the soil as basal dose through gromer. The treatments were allotted randomly into blocks. Light Irrigation was given immediately after transplanting and then experimental plots were irrigated on weekly interval basis. Subsequently, plots were irrigated depending upon the weather and soil condition. Four hand weeding were carried out during the crop growth period and plots were kept weed free. The crop was harvested at maturity when the plants turned yellowish with necrotic leaf tips coupled with neck fall in more than 50% -75%. The plants were uprooted from the net plot area of each treatment separately and the soil adhered to the bulbs was removed. Then the

tops were removed and bulbs were cured under shade for 8-10 days. Harvesting was done on 3rd May 2014. For bulb yield parameters five representative plants were selected randomly in each plot. All the observations were recorded in the plot. The effect of these doses on the yield and quality of onion was recorded.

Estimation of quality parameters

Splitting percentage (%): Number of splitted bulb were counted from each treatment and expressed in percentage.

Bolting percentage (%): Flowering plants from each plot were counted and average was worked out computed. It was expressed in percentage.

Total soluble solids (ºBrix): Total soluble solid content of bulbs was recorded with the help of hand refractometer.

Chlorophyll content (mg/100 g): Chlorophyll content of onion leaves was measured at 30, 60, 90 days after transplanting. The chlorophyll content in leaf was estimated by adopting the procedure given by Hiscox and Israelstam (1979) and extraction of Chlorophyll was done with DMSO (Dimethyl sulphoxide) methods.

Oleoresin content (%): The estimation of oleoresin from the powder of dried onion bulbs was carried out by Soxlet apparatus method. The average was worked out from randomly selected five plants for further statistical computation. The test of significance (F test) and critical difference (CD) were read at 0.05 probabilities (Sunderaraj *et al.*, 1972).

Results and Discussion

Yield parameters

Yield is the single most important parameter which decides the acceptance of a particular practice, field attributing characters (bulb diameter, bulb weight) mainly contributes for yield per unit area. In the present study levels of sulphur influenced yield parameters significantly and are presented in Table 1.

Days required for maturity

The data obtained in respect of days required for maturity as influenced by various levels of sulphur are presented in Table 1. the day required for maturity from the date of transplanting indicates that the treatment T_5 application of sulphur @ 40 kg ha^{-1} (113) recorded lowest day for maturity which was found to be at par with treatment T_6 application of sulphur @ 50 kg ha^{-1} (113.36), Maximum day required for maturity was noticed in control treatment T_1 (122). The diameter of bulb (cm) *i.e.* polar and equatorial was increased significantly due to different levels of sulphur over control Table 1.

Bulb diameter

The result indicated that, the highest polar diameter (5.10 cm) recorded in T_5 40 kg S ha-1 which was found to be at par with application of sulphur @ 50 kg ha^{-1} (5.07cm) and 30 kg ha^{-1} (5 cm) and equatorial diameter 5.56 cm was recorded in T_5 sulphur @ 40 kg ha^{-1} which was found to be at par with T_6 sulphur @ 50 kg ha^{-1} (5.42 cm). The diameter was significantly increased with the application of sulphur upto 40 kg ha^{-1} and then decreased. The similar result was reported by Nasreen *et al.*, (2007), Hasan *et.al.* (2013) and Bharti and Ram (2014) in onion.

Fresh bulb weight

Application of sulphur @ 40 kg ha^{-1} (T_5) recorded significantly maximum (75.17 g) fresh bulb weight which was found to be at par with 50 kg S ha^{-1} (T_6) (73.80 g). The minimum fresh weight of bulb was recorded in the treatment T_1 (59.86 g) control.

Cured bulb weight

Application of sulphur @ 40 kg ha^{-1} recorded maximum (32.26 g) weight of cured bulb which was found to be at par with T_6 (31.89 g). The lowest cured weight of bulb (29.26 g) was recorded in T_1 (control). Weight of bulbs was significantly increased with the application of sulphur upto 40 kg ha^{-1} and then decreased. It might be attributed due to sulphur supplies to the onion than other crops or for the synthesis of coenzyme A and amino acid for protein elaboration and for the formation of certain disulphide linkages that have been associated with structural characteristics of plant protoplasm. Similar result was reported by Ahmad *et al.*, (2009).

Bulb yield

There was a significant difference among the treatment with respect to bulb yield per plot of onion due to levels of sulphur (Table 1). The significantly, highest bulb yield/ plot (5.81 kg) was obtained in T_5 (40 kg S ha^{-1}), which was found to be at par with T_6 (5.74 kg) as compared to control. The significantly higher bulb yield (215.18 q ha^{-1}) was obtained in the treatment T_5 sulphur @ 40 kg ha^{-1}, followed by in T_6 (212.59 q ha^{-1}) and T_4 (210 q ha^{-1}). The enhancement of yield of onion due to sulphur application in addition to recommended dose of fertilizer *i.e.* NPK may be attributed to the fact that sulphur play a vital role in plant nutrition uptake and use. Increase in bulb yield under treatments 40 and 50 kg S ha^{-1} might be due to production of taller plants with higher number of leaves leading to increase formation of vegetative structure for nutrient absorption and photosynthesis and increased production of assimilates to fill the sink, resulting in increased bulb size and weight. Bulb yield of onion was increased with the increase of sulphur application up to certain limit. Bulb yield was increased with successive increase in the levels of sulphur upto 50 kg ha^{-1} and thereafter decreased. Similar result was reported by Narseen *et al.*, (2007), Ullah *et al.*, (2008) and Bharti and Ram (2014) in onion.

Marketable bulb yield

The data in regard to number of marketable bulbs and weight of marketable bulb/plot (kg) as influenced by various sulphur levels was graphically shown in Figure 1 and 2.

The significantly maximum number of marketable bulbs (157) was recorded with application of sulphur @ 40 kg ha^{-1} which was found to be at par with T_6 (155) sulphur application @ 50 kg ha^{-1}. The minimum number of marketable bulbs (143) was recorded in control (T_1). The data presented graphically shown in Figure 1, revealed that, the weight of marketable bulb yield per plot were significantly influenced by the different levels of sulphur. (T_5) sulphur application @ 40 kg ha^{-1} recorded maximum (5.06 kg) marketable yield per plot which was found to be at par with T_6 (4.94 kg). Whereas, minimum (4.18 kg) marketable bulb yield per plot was recorded in control (T_1). The influence of S on the marketable yield of onion bulb could be attributed to an important role of sulphur in plant protein and some hormones formation, also sulphur is necessary for enzymatic action,

chlorophyll formation, synthesis of certain amino acids and vitamins, hence it helps have a good vegetative growth leading to get high weight of marketable bulb in onion. Similar result found by Ahmad *et al.*, (2009) in onion.

Table.1 Yield and yield attributing characters in onion as influenced by application of different levels of Sulphur

Treatments	Days for maturity	Bulb diameter		Weight of fresh bulb (g)	Weight of cured bulb (g)	Yield per plot (kg)	Yield per hectare (q)
		Polar	Equatorial				
T_1 - 0 kg ha^{-1} S	122.00	4.44	4.97	59.86	29.26	5.27	195.18
T_2 - 10 kg ha^{-1} S	119.00	4.61	5.12	63.01	30.44	5.48	202.96
T_3 - 20 kg ha^{-1} S	116.00	4.76	5.14	66.73	31.05	5.59	207.03
T_4 - 30 kg ha^{-1} S	115.00	5.00	5.30	70.22	31.52	5.67	210.00
T_5 - 40 kg ha^{-1} S	113.00	5.10	5.56	75.17	32.26	5.81	215.18
T_6 - 50 kg ha^{-1} S	113.36	5.07	5.42	73.80	31.89	5.74	212.59
T_7 - 60 kg ha^{-1} S	115.00	4.90	5.27	72.15	31.10	5.56	205.92
T_8 - 70 kg ha^{-1} S	117.40	4.80	5.18	69.81	30.32	5.46	202.22
T_9 - 80 kg ha^{-1} S	118.79	4.68	5.01	67.09	29.63	5.33	197.40
'F' test	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE (m)±	0.28	0.04	0.05	0.61	0.14	0.03	0.87
C.D.at 5%	0.84	0.11	0.16	1.82	0.42	0.08	2.61

Table.2 Quality parameters in onion as influenced by application of different levels of Sulphur

Treatments	Splitting (%)	Bolting (%)	Chlorophyll content (mg/100 g)	Total soluble solid (^{0}Brix)	Oleoresin content (%)
T_1 - 0 kg ha^{-1} S	2.60	1.10	0.37	11.33	9.00
T_2 - 10 kg ha^{-1} S	2.45	1.06	0.39	11.58	9.37
T_3 - 20 kg ha^{-1} S	2.39	1.00	0.41	11.60	9.64
T_4 - 30 kg ha^{-1} S	2.17	0.47	0.42	11.63	10.09
T_5 - 40 kg ha^{-1} S	1.69	0.46	0.44	11.71	10.50
T_6 - 50 kg ha^{-1} S	2.07	0.56	0.45	11.80	10.93
T_7 - 60 kg ha^{-1} S	2.24	0.58	0.48	11.97	11.17
T_8 - 70 kg ha^{-1} S	2.47	0.59	0.43	11.49	10.59
T_9 - 80 kg ha^{-1} S	2.57	1.06	0.40	11.38	10.44
'F' test	NS	NS	Sig	Sig	Sig
SE (m)±	0.26	0.19	0.01	0.11	0.17
C.D.at 5%	-	-	0.04	0.33	0.52

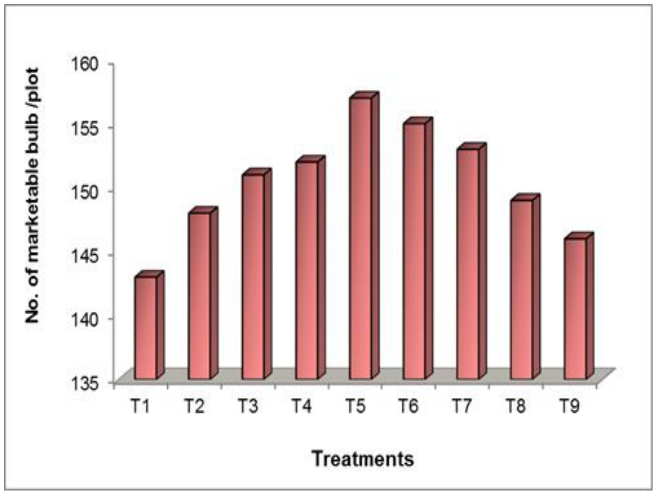

Fig.1 Number of marketable bulb/plot influenced by application of different levels of sulphur

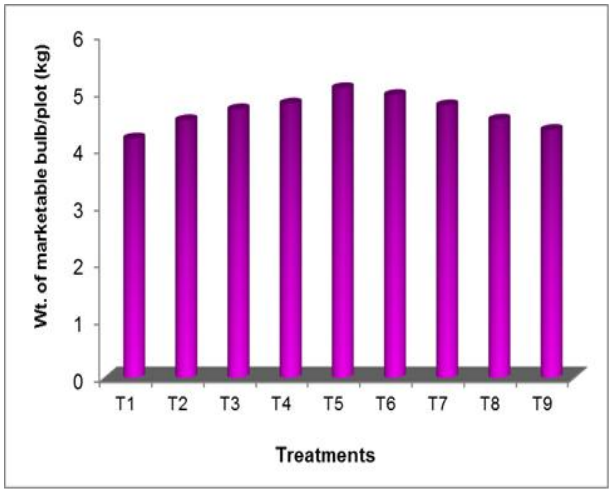

Fig.2 Weight of marketable bulb/plot (kg) influenced by application of different levels of sulphur

Quality parameters

The data presented in the Table 2 indicated that, the effect of different levels of sulphur on splitting and bolting (%) of onion was statistically non- significant.

Chlorophyll content

The data presented in Table 2 revealed that, the chlorophyll content in the onion leaves was markedly influenced by various levels of sulphur at 90 days after transplanting of the seedlings. At 90 DAT the chlorophyll content was significantly influenced by different levels of sulphur. The maximum chlorophyll content (0.48 mg/100g) was recorded in the treatment T_7 which was found to be at par with T_6 (0.45 mg/100g) and T_5 (0.44 mg/100g), whereas, minimum (0.37 mg/100g) chlorophyll content was recorded in the treatment T_1 (control). It was reported to increase the chemical and biological activation of iron in the leaves resulting in increased chlorophyll content. This result found by Neelam Chandra and Panday (2014). Sulphur is the constituent of several enzymes and amino acids which are required for chlorophyll synthesis. Besides it sulphur increases the uptake of N which is a chief constituent of chlorophyll. The similar result are finding by Verma *et al.,* (2013).

Total soluble solids

TSS of onion bulb was significantly influenced due to application of different levels of sulphur. The significantly maximum TSS (11.97°Brix) was recorded in the treatment T_7 (60 kg S ha^{-1}), which were found to be at par with each other T_6 (11.80°Brix) and T_5 (11.71°Brix).

Increase in total soluble solids (TSS) with increase in level of sulphur application was also reported by Kumar and Singh (1992). This might be due to increased synthesis of primary flavour compounds with sulphur containing amino acids whose production increase with increase in S levels as reported by Randle and Bussard (1993). Similar results were also obtained by Thippeswamy (1993) and Bharti and Ram (2014) in onion.

Oleoresin content

The significantly maximum (11.17 %) oleoresin contain in onion plant was recorded in the T_7 receiving application of sulphur @ 60 kg ha^{-1} which was found to be at par with (T_6) sulphur application @ 50 kg ha^{-1} (10.93 %), while T_1 control recorded minimum (9 %) oleoresin content. Oleoresin is the flavouring compound in onion which was significantly increased with sulphur application. This effect might be due to methionine as the source of sulphur and their attribution to biosynthesis of other amino acids as cysteine and glutathione. Glutathione and glutathione S transferase are the immediate source of sulphur. Methionine, cysteine and glutathione are responsible for increase the flavour in onion. These results are in close conformity with the findings of Mohamed *et al.,* (2012).

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