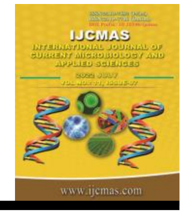
Int.J.Curr.Microbiol.App.Sci (2022) *11*(07): 206-211

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 11 Number 07 (2022)**
Journal homepage: http://www.ijcmas.com



Original Research Article https://doi.org/10.20546/ijcmas.2022.1107.025

Effect of Sources and Levels of Sulphur on Quality of Onion (*Allium cepa* L.)

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Keywords

Elemental sulphur, phenols, flavonoids, ascorbic acid, and pyruvic acid

Article Info

Received: 10 June 2022
Accepted: 30 June 2022
Available Online: 10 July 2022

A B S T R A C T

The field experiment on effect of sources and levels of sulphur on soil nutrient availability, yield, quality and uptake of nutrients of bellary onion. Total treatments were 14 with three replications in randomized block design. The treatment consist of three sulphur levels @ 30, 45, and 60 kg ha^{-1} in presence of *Thiobacillus thiooxidens*, sources of sulphur as elemental sulphur along with recommended dose of fertilizer (110:40:60 kg ha^{-1} N, P_2O_5 & K_2O + 15 t ha^{-1} FYM). The application of RDF + S @ 60 kg ha^{-1} as elemental sulphur + *Thiobacillus thiooxidens* - nutripellet pack and was significant for phenol (4.70 mg 100 g^{-1}), flavonoids (327 µ mole g^{-1}), ascorbic acid (4.69 mg 100 g^{-1}), pyruvic acid (2.64 µ mole g^{-1}) and TSS (12.93^{0} brix). It was statistically on par with treatment RDF + S@ 45 kg ha^{-1} as elemental sulphur + *Thiobacillus thiooxidens* - nutripellet pack and RDF + S@ 60 kg ha^{-1} as elemental sulphur + *Thiobacillus thiooxidens* – soil application for phenol (4.69 and 4.67 mg 100 g^{-1}), flavonoids (319 and 317 µ mole g^{-1}), ascorbic acid (4.49 and 4.42 mg 100 g^{-1}), pyruvic acid (2.46 and 2.41 µ mole g^{-1}) and TSS (12.74 and 12.66^{0} brix).

Introduction

India is the second largest onion growing country in the world. Indian onions are famous for their pungency and are available round the year. Onion is a temperate crop but can be grown under a wide range of climatic conditions such as temperate, tropical and subtropical climate. The best performance can be obtained in a mild weather without the extremes of cold and heat and excessive rainfall. Maximum onion production takes place in Maharashtra (4905.0 thousand tons) state followed by Karnataka (2592.2 thousand tons), Gujarat (1514.1 thousand tons.), Bihar (1082.0 thousand tons.), Madhya Pradesh (1021.5 thousand tons.) There is a lot of demand of Indian onion in the world, the country has exported 15,78,016.59 MT of fresh onion to the world for the worth of Rs. 2,826.50 crores/ 378.49 USD Millions during the year 2020-21.(APEDA,2022). In India the yield of onion is very low as compared to the world average yield of 19.1t ha^{-1}. Intensive cropping, imbalanced fertilization and minimal usages of micronutrients and limited application of organic manures have resulted in the depletion of soil fertility in India. Maharashtra is leading state in onion production in India. Total area was 441.9 thousand ha, production was 5362 thousand MT and productivity was 12.13t ha^{-1}. Onion has its own distinctive flavour and is widely grown in almost all over the world. It is used in soups, different dishes, sandwiches and is also cooked alone as a vegetable. Onion is a temperate crop but can be grown under a wide range of climatic conditions such as temperate, tropical and subtropical climate. The best performance can be obtained in a mild whether without the extremes of cold and heat and excessive rainfall. In India, short day onion is grown in the plains and requires 10-12 hours day length. Its pungency is due to the presence of *allyl propyl disulphide*, a volatile oil (Malik, 1994). Onion can be grown in all types of soils such as sandy loam, clay loam, silt loam and heavy soils. However, the best soil for successful onion cultivation is deep, friable loam and alluvial soils with good drainage, moisture holding capacity and sufficient organic matter. In heavy soil, the bulb produced may be deformed. The optimum pH range, regardless of soil type, is 6.0 to 7.5, but onion can also be grown in mild alkaline soils. At present, pungency in onion is decreased and similarly taste and quality of bulb is also hampered due to the application of imbalanced chemical fertilizers. The pungency in onion is due to the presence of sulphur bearing compound in the volatile oil known as allyl-propyl disulphide ($C_6H_{12}S_2$).The colour of the outer skin of onion bulb is due to the presence of quercetin, catechol is a phenolic factor present in onion which has anti fungal properties. Onion is known to possess several medicinal and therapeutic properties, its effectiveness range against common cold to diabetes, heart diseases, ostreoporosis and diseases, Sulphur is associated with the production of crop of superior nutritional and market quality. Sulphur is also required for the synthesis of three important essential amino acids such as cystine (27% S), cysteine (26%S) and methionine (21%S) besides increasing allyl propyl disulphide alkaloid (43%S) and the capsaicin, the principle alkaloids responsible for pungency in onion (Randle and Bassard,1993).Onion is an important sulphur -loving crop. Sulphur improves the yield and quality of onion. Sulphur is recognized as the fourth major plant nutrient after nitrogen, phosphorus and potassium in crops. Hence the present study was carried out to evaluate the effect of different sources and levels of sulphur on quality of onion.

Materials and Methods

A field experiment was conducted at National Institute on Abiotic Stress Management (ICAR-NIASM), Malegaon Kurd, Baramati, Pune, Maharashtra during *rabi* season 2017-18 and 2018-19 with onion cv. Bhima Kiran. The soil of the experimental field was clay loam in texture, and had pH (1:2.5) 8.2, electrical conductivity 0.26 dSm^{-1} organic carbon 4.40 g kg^{-1} soil, available N 93.99 kg ha^{-1}, P 10.75 kg ha^{-1}, K 277 kg ha^{-1} and S 6.30 ppm. The irrigation water contained 1.6 ppm of sulphur. Four levels of sulphur (0, 30, 45 and 60 kg ha^{-1}) were applied through elemental sulphur (80 % bentonite clay), potassium schoenite (22%) and ammonium sulphate (24%) The experiment comprised 14 treatments: T_1- Absolute Control; T_2-RDF + S @30 kg ha^{-1} soil application; T_3-RDF+S@45kgha^{-1}aselementalS+ *Thiobacillus* -Soil application; T_4- RDF + S@60 kg ha^{-1}aselemental S+ *Thiobacillus* - Soil application; T_5- RDF+S@45 kg ha^{-1} as elemental S +*Thiobacillus* –Nutripellet Pack; T_6 -RDF+S@60 kgha^{-1}as elemental S+ *Thiobacillus* –Nutripellet Pack; T_7 -RDF +S@45 kg ha^{-1} as Potassium Schoenite-Soil application; T_8 - RDF +S@60 kg ha^{-1} as Potassium Schoenite-Soil application; T_9 - RDF +S@45 kg ha^{-1} as Potassium Schoenite - Nutripellet Pack; T_{10} - RDF +S@60 kg ha^{-1} as Potassium Schoenite - Nutripellet Pack ; T_{11}-RDF +S@45 kg ha^{-1} as Ammonium Sulphate -Soil application ; T_{12} - RDF +S@60 kg ha^{-1} as Ammonium Sulphate -Soil application; T_{13} -RDF +S@ 45 kg ha^{-1} as Ammonium Sulphate - Nutripellet Pack; T_{14} - RDF +S@6 0 kg ha^{-1} as Ammonium Sulphate - Nutripellet Pack. The experiment was laid out in randomized block design with three replications. Individual plot size was 3 x

4 m and plant spacing was 15 x 10 cm. a uniform recommended dose of N: P_2O_5: K_2O (110:40:60 kg ha^{-1}) was applied to all the plots except control. The sources of nitrogen, phosphorus and potassium were Urea, Dia ammonium phosphate and Murate of potash respectively. Half dose of nitrogen and full dose of phosphorus, potassium and sulphur was applied at the time of transplanting. Remaining nitrogen was applied two equal splits at 30 and 45 days after transplanting.

Onion cultivar Bhima Kiran was grown as study material. Transplanting of onion was done on 20^{th} January, 2018. Standard package of practices were followed to grow onion crop. The crop was harvested at 120 days after transplanting on 20^{th} May, 2018. Bulbs were covered by its top and left in the field for curing for 3-4 days. After neck cutting, bulb yield was recorded. Representative bulb samples were collected for the biochemical and nutritional analysis. Chopped bulb samples were dried in oven at 60^0 C till the constant weight was attained. While the plant samples were digested using nitric acid and perchloric acid mixture.

The plant digests and soil extractant were used for estimating the sulphur content using Turbidimetric method (Chesnin and Yien, 1950). The total soluble solid (TSS) of onion bulbs were estimated using hand refractometer and the percent TSS was noted down. Pyruvic acid content was estimated using dinitro phenyl hydrazine (DNPH) reagent method. Two opposite quarters of onion bulbs were selected and made into pieces after removing the neck, basal plate, and skin.

The onion tissues were crushed in a stainless steel mixer grinder without adding water. Bulb tissues were blended with equal volumes of water for 10 minutes. The homogenate was filtered through Whatman No. 4 filter paper and the filtrate was used for pyruvic acid analysis (Schwimmer and Weston, 1961). The data recorded on various parameters were subjected to statistical analysis as per the procedure suggested by Sukhatme and Amble (1995)

Results and Discussion

Sulphur is constituent of secondary compounds and essential for synthesis of proteins, oils and vitamins. It also increased allyl propyl disulphide alkaloids, the principle alkaloids, responsible for pungency in onion. The phenols, flavonoids and ascorbic acids are important constituents to decide the quality of onion. The phenols, flavonoids and ascorbic acids content of onion bulb was significantly influenced by the sources and levels of sulphur.

The sulphur application @ 60 kg ha^{-1} as elemental sulphur + *Thiobacillus thiooxidens* nutripellet pack along with recommended dose of fertilizers application recorded significantly higher content of phenols (4.70 mg 100 g^{-1}) and statistically on par with all treatments except control. The results revealed that the sulphur is essentially required for phenol content in onion. The similar treatment recorded the highest value for flavonoids (327 µ mol $g^{-1)}$ and ascorbic acid (4.69 mg 100 g^{-1}). It was closely followed and statistically on par with RDF + S @ 45 kg ha^{-1} as elemental sulphur + *Thiobacillus thiooxidens* nutripellet pack, RDF + S @ 60 kg ha^{-1} as elemental sulphur + *Thiobacillus thiooxidens* – soil application and RDF + S@ 45 kg ha^{-1} as elemental sulphur + *Thiobacillus thiooxidens* soil application for phenol (4.69, 4.67 and 4.65 mg100 g^{-1} respectively), flavonoids (321, 319 and 317 mol g^{-1} respectively) and ascorbic acid (4.57,4.49 and 4.42 mg 100 g^{-1} respectively). The phenol, flavonoide and ascorbic acid content of onion are increased with sulphur sources as elemental sulphur @ 45 and 60 kg ha^{-1} with *Thiobacillus thiooxidens* as nutripellet pack and soil application. The presence of *Thiobacillus thiooxidens* oxidized the elements sulphur to sulphate sulphur which can easily absorbed by the plant. The absorbed sulphate enhanced the organic constituent contents in onion. Similar results was also recorded by Poornima (2007); Channagoudra *et al.*, (2009) and Thangasamy *et al.*, (2013). These treatment (T_6, T_5 and T_4) showed the similarly trend for pyruvic acid (2.64, 2.46 and 2.41 µ mol g^{-1} respectively) and TSS (12.93, 12.88, and 12.66 ^{0}brix respectively).

Table.1 Effect of sources and levels of sulphur on quality parameters of onion bulb at harvest stage (Mean of three replications)

Treatments		Phenols (mg 100 g^{-1})	Flavonoide (µmol g^{-1})	Ascorbic acid (mg 100 g^{-1})	Pyruvic acid (µmole g^{-1})	TSS (^{0}Bx)
T_1	Control	2.34	261	2.44	0.64	9.70
T_2	RDF + elemental S @ 30 kg ha^{-1} soil application + FYM @ 15 t ha^{-1}	4.38	295	3.45	1.96	11.38
T_3	RDF + S @ 45 kg ha^{-1} as elemental S+ *Thiobacillus thiooxidans* -Soil application	4.65	317	4.42	2.13	12.66
T_4	RDF + S @ 60 kg ha^{-1} as elemental S + *Thiobacillus thiooxidans*- Soil application	4.67	319	4.49	2.41	12.74
T_5	RDF + S @ 45 kg ha^{-1} as elemental S + *Thiobacillusthiooxidans*–Nutripellet Pack	4.69	321	4.57	2.46	12.88
T_6	RDF + S @ 60 kg ha^{-1} as elemental S + *Thiobacillus thiooxidans*–Nutripellet Pack	4.70	327	4.69	2.64	12.93
T_7	RDF + S@ 45 kg ha^{-1} as Potassium schoenite-Soil application	4.48	307	4.55	2.38	11.68
T_8	RDF + S @ 60 kg ha^{-1} as Potassium schoenite-Soilapplication	4.52	310	4.58	2.40	12.73
T_9	RDF + S @ 45 kg ha^{-1} as Potassium schoenite – Nutripellet Pack	4.60	312	4.62	2.42	12.84
T_{10}	RDF + S @ 60 kg ha^{-1} as Potassium schoenite – Nutripellet Pack	4.63	315	4.65	2.60	12.90
T_{11}	RDF + S @ 45 kg ha^{-1} as Ammonium sulphate – Soil application	4.40	289	3.43	2.33	11.40
T_{12}	RDF + S @ 60 kg ha^{-1} as Ammonium sulphate – Soil application	4.42	293	3.47	2.36	11.43
T_{13}	RDF +S @ 45 kg ha^{-1} as Ammonium sulphate – Nutripellet Pack	4.47	300	3.51	2.38	11.57
T_{14}	RDF +S @ 60 kg ha^{-1} as Ammonium sulphate – Nutripellet Pack	4.51	305	3.54	2.40	11.64
	SEd	**0.25**	**19.0**	**0.29**	**0.14**	**0.70**
	CD (p=0.05)	**0.54**	**39.2**	**0.61**	**0.29**	**1.45**

Fig.1 Effect of sources and levels of sulphur on quality parameters of onion bulb at harvest stage

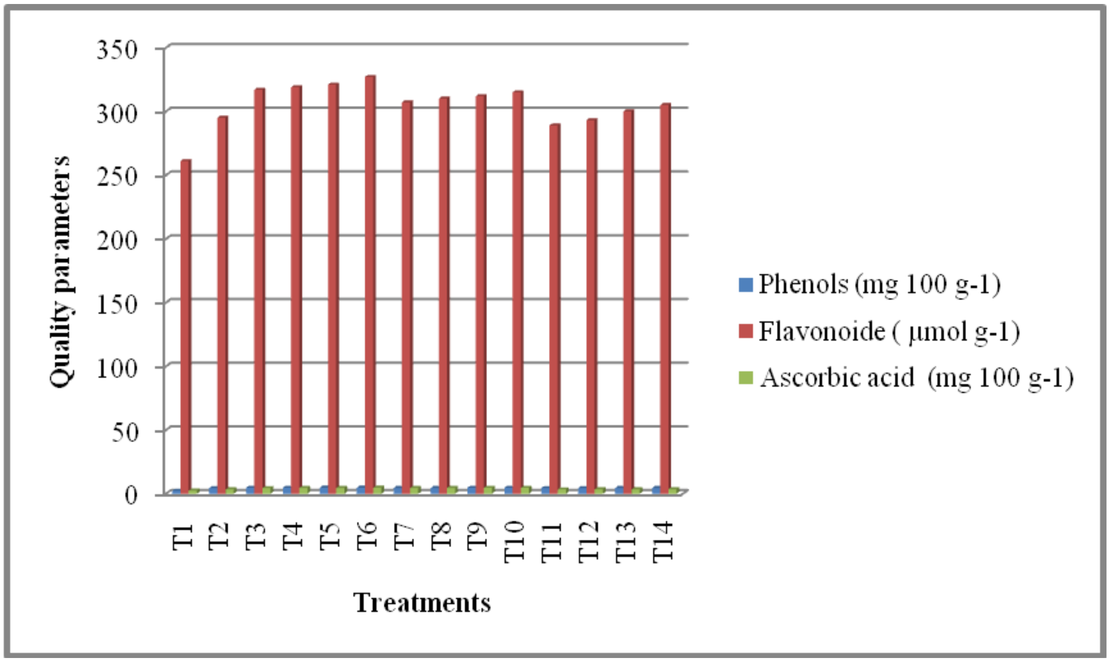
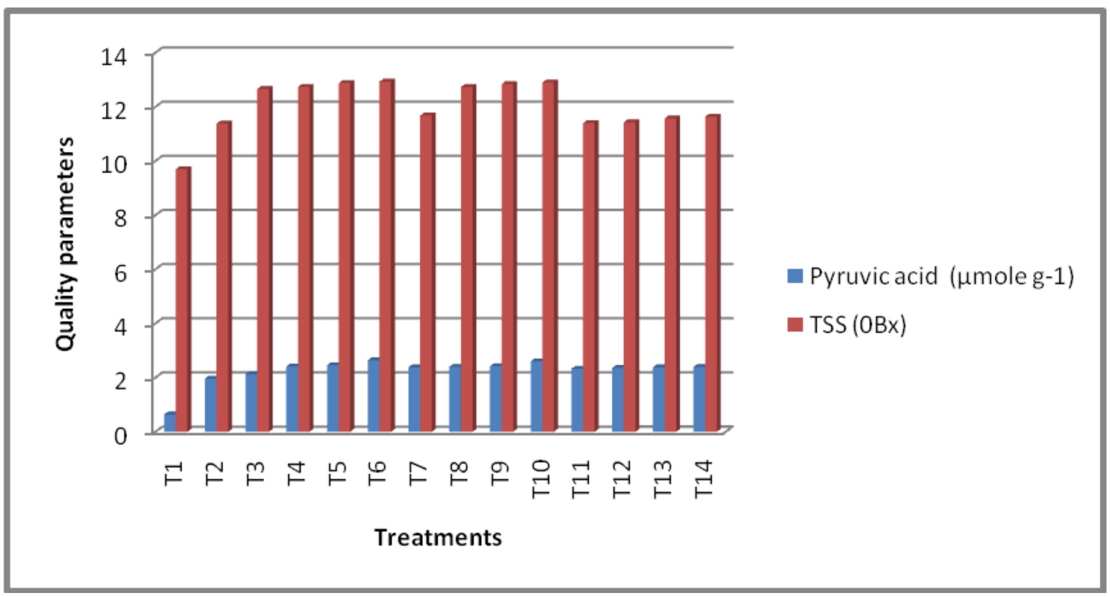


Fig.2 Effect of sources and levels of sulphur on quality parameters of onion bulb at harvest stage



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How to cite this article:

Bhoite Vivek and Backiyavathy, M. R. 2022. Effect of Sources and Levels of Sulphur on Quality of Onion (*Allium cepa* L.). *Int.J.Curr.Microbiol.App.Sci.* 11(07): 206-211.
doi: https://doi.org/10.20546/ijcmas.2022.1107.025