IJPS INTERNATIONAL JOURNAL OF PLANT SCIENCES
e ISSN-0976-593X Volume **10** | Issue 2 | July, 2015 | 108-112

DOI: 10.15740/HAS/IJPS/10.2/108-112
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RESEARCH ARTICLE

Influence of planting dates and sulphur fertilization on physical and chemical traits of onion cv. PUSA RED

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SUMMARY

The present experiment was carried out on the planting dates and forms of sulphur on chemical characteristics of 'Pusa Red' cultivar of onion (*Allium cepa* L.) during *Rabi* season of 2013-14 at three different dates, *viz.*, 15th November 2013, 15th December 2013 and 15th January 2014 and three doses of elemental sulphur and gypsum each 20, 40 and 60 kg/ha at Horticultural Research Farm of the Department of Applied Plant Science, School for Bio science and Biotechnology, Babasaheb Bhimrao Ambedkar University, Lucknow (U.P.). The experiment was laid out in Factorial Randomized Block Design with three replications. The data clearly revealed that higher TSS, ascorbic acid content in bulb were recorded in early planting (15th November with 60 kg/ha and 40 kg/ha), respectively and significantly higher reducing sugar, non-reducing sugar and total sugars were obtained with early planting *i.e.*, 15th November with 20 kg/ha of elemental sulphur, while higher content of pyruvic acid was found in late planting (15th January with 60 kg/h of elemental sulphur) of the crop.

Key Words : Elemental sulphur, Gypsum, Planting dates, Onion

How to cite this article : Bharti, Navaldey and Ram, R.B. (2015). Influence of planting dates and sulphur fertilization on physical and chemical traits of onion cv. PUSA RED. *Internat. J. Plant Sci.*, **10** (2): 108-112.

Article chronicle : Received : 01.05.2015; **Revised :** 01.06.2015; **Accepted :** 10.06.2015

Onion is one of the most important commercial vegetable crops grown in India. It belongs to family Alliaceae. It is predominantly, a *Rabi* season crop, although, it is also being grown as *Kharif* crop and most onion cultivars are sensitive to photoperiod and their range of adaptation is limited. Bulb quality influences onion consumer acceptance, preference for traits contributing to bulb quality depends on cultural demand and intended use. Commercial onions are normally grown on soil with sufficient S to provide the need for both growth and flavour precursor accumulation**.** Bulb flavour intensity in onion depends on their inherent genetic potential and the environment in which they are grown. It is also true that onion pungency can be modified by environment especially, the temperature in which they are grown**.** Yearly differences in flavour intensity have also been observed. Therefore, the purpose of this study was to investigate the effect on chemical constituents under different planting dates and sulphur application.

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MATERIAL AND METHODS

A field experiment was conducted to optimize planting time and evaluate the perfect dose of two forms of sulphur on the quality attributes in onion cv. Pusa Red at the Babasaheb Bhimrao Ambedkar University, Lucknow, India, during 2013-14. Pusa Red cultivar of onion was opted because it is a less bolting type variety. The experiment was laid out in Factorial RBD Design with three replications having three transplanting dates (15th November 2013, 15th December 2013 and 15th January 2014) as one factor and three doses of each of gypsum and elemental sulphur (20 kg/ha, 40 kg/ha and 60 kg/ha) as another factor. Seedlings of same age (8-week old) were transplanted with a spacing of 15×10 cm. Recommended dose of fertilizer NPK (120:60:60) in the form of urea, single super phosphate and muriate of potash were applied to grow the crop. Urea was applied in three split doses, first used along with phosphorus and potash at the time of soil preparation and remaining 2/3rd in later stages. Data were recorded after harvesting on total soluble solids (^{0}Brix), ascorbic acid (mg/100g), pyruvic acid (µm/g), total sugars (%), reducing sugar (%) and non-reducing sugar (%). TSS was analyzed by Hand Refractrometer, indolphenol method was used for the determination of ascorbic acid while pyruvic acid analysis was performed according to (Schwimmer and Weston, 1961) and total, reducing and non-reducing sugars were analyzed by Lane and Eynon (1923) method.

RESULTS AND DISCUSSION

It is clearly revealed from the data that there was a significant effect of different planting dates on the vegetative growth of the crop (Table 1). Maximum plant height (73.50 cm), number of leaves (10.40), neck thickness (2.53 cm), bulb weight (77.52 g), bulb length (6.30 cm), bulb diameter (6.94 cm), bulb size (42.66 cm^2), bolting percentage (6.28 %), yield per plot (5.27 kg) and yield per hectare (351.7 q/ha) were recorded in early planting date *i.e.*, 15th November which was followed by planting date of 15th December (65.01 cm, 8.84, 2.37 cm, 67.94 g, 5.70 cm, 6.15 cm, 34.27 cm^2 4.90 %, 4.71 kg and 314.3 q/ha, respectively). Minimum figure were recorded for these parameters *i.e.*, plant height (61.07 cm), number of leaves (7.21), neck thickness (2.24), bulb weight (56.12 g), bulb length (5.07 cm), bulb diameter (5.52 cm), bulb size (27.45), bolting percentage (0.04 %), yield per plot (3.88 kg) and yield per hectare (259.9 q/ha) in late planting *i.e.*, 15th January. These results are might be due to low average temperature while early transplanting and gradual increase in average temperature during delayed transplanting results decreased yield. The latest planting date showed that the lowest growth parameters values may be due to the short period allowed for growth which is also in conformity of the findings of Sawant *et al*. (2002) who reported that early planting showed significantly higher growth values than the later planting in the two growing seasons. Similarly, chemical

Table 1 : Effect of planting dates and forms of sulphur on growth and yield of onion bulb (2013-14)

Treatments	Plant height (cm)	No. of leaves	Neck thickness (cm)	Bulb weight (g)	Bulb length (cm)	Bulb diameter (cm)	Bulb size (cm^2)	Bolting percentage (%)	Yield/plot (kg)	Yield (q/ha)
Planting time										
Nov 15, 2013	73.50	10.40	2.53	77.52	6.30	6.94	42.66	6.28	5.27	351.7
Dec 15, 2013	65.01	8.84	2.37	67.94	5.70	6.15	34.27	4.90	4.71	314.3
Jan 15, 2014	61.07	7.21	2.24	56.12	5.07	5.52	27.45	0.04	3.88	259.9
C.D. (P=0.05)	1.93	0.18	0.04	1.74	0.15	0.11	1.19	0.51	0.06	0.43
S.E. ±	0.95	0.09	0.02	0.86	0.07	0.05	0.59	0.25	0.03	0.21
Two-form of sulphur doses										
RDF (control)	63.92	7.32	2.19	53.93	4.08	5.11	24.26	3.66	4.25	283.7
S^0 20 kg/ha	66.17	8.51	2.36	65.52	5.85	6.03	33.62	3.88	4.59	306.0
S^0 40 kg/ha	68.99	10.13	2.54	75.91	6.17	6.80	40.68	3.11	4.93	329.1
S^0 60 kg/ha	68.03	9.45	2.45	71.07	5.92	6.59	38.47	3.44	4.74	318.1
Gy 20 kg/ha	64.72	8.15	2.29	62.47	5.41	6.04	33.12	4.55	4.43	295.5
Gy 40 kg/ha	67.38	9.46	2.46	72.61	5.93	6.51	37.72	4.00	4.75	317.0
Gy 60 kg/ha	66.46	8.71	2.38	68.81	5.75	6.33	35.69	3.55	4.67	311.1
C.D. (P=0.05)	2.95	0.27	0.07	2.66	0.23	0.17	1.82	0.78	0.09	0.66
S.E. ±	1.45	0.13	0.03	1.31	0.11	0.08	0.90	0.38	0.04	0.33

Table 2 : Effect of planting dates and forms of sulphur on quality (bio-chemical) attributes of onion bulb (2013-14)

Treatments	TSS (^{0} Brix)	Ascorbic acid (mg/100g)	Pyruvic acid (µm/g)	Total sugars (%)	Reducing sugar (%)	Non-reducing sugar (%)
Planting dates						
Nov 15, 2013	15.42	12.64	4.74	11.59	5.07	6.06
Dec 15, 2013	13.78	11.62	5.47	11.08	4.31	6.80
Jan 15, 2014	12.40	8.27	6.78	9.10	2.74	6.38
C.D. (P=0.05)	0.11	0.39	0.11	0.07	0.17	0.08
S.E. ±	0.05	0.19	0.05	0.03	0.08	0.04
Two-form of sulphur doses						
RDF (control)	12.20	8.85	4.02	9.69	3.41	5.88
S^0 20 kg/ha	13.48	10.25	5.50	11.50	4.57	6.96
S^0 40 kg/ha	14.48	11.96	6.19	10.87	4.22	6.60
S^0 60 kg/ha	15.39	11.58	6.72	10.21	4.06	6.17
Gy 20 kg/ha	12.88	10.56	5.13	11.09	4.35	6.81
Gy 40 kg/ha	14.21	11.76	5.75	10.66	3.95	6.32
Gy 60 kg/ha	14.44	10.98	6.32	10.12	3.71	6.14
C.D. (P=0.05)	0.17	0.59	0.18	0.10	0.26	0.13
S.E. ±	0.08	0.29	0.08	0.05	0.12	0.06

Table 3 : Interaction effects of different planting dates and forms of sulphur on growth and yield of onion bulb (2013-14)

Parameters / Treatment combinations		Plant height (cm)	No. of leaves	Neck thickness (cm)	Bulb weight (g)	Bulb length (cm)	Bulb diameter (cm)	Bulb size (cm^2)	Yield/ plot (kg)	Yield (q/ha)	Bolting percentage (%)
Planting dates	Sulphur doses										
Nov 15, 2013	RDF (Control)	70.98	8.70	2.35	60.87	5.23	5.91	30.50	4.91	328.6	6.33
	RDF + S^0 20 kg/ha	73.67	9.86	2.52	77.56	6.56	6.95	43.14	5.27	351.4	5.66
	RDF + S^0 40 kg/ha	76.12	11.53	2.70	87.55	6.79	7.59	49.05	5.67	378.3	5.33
	RDF + S^0 60 kg/ha	74.61	11.23	2.61	82.01	6.65	7.32	46.74	5.42	361.4	6.66
	RDF + Gy 20 kg/ha	71.28	9.76	2.43	68.73	5.78	6.49	39.62	5.02	334.6	7.33
	RDF + Gy 40 kg/ha	74.81	11.13	2.59	84.78	6.62	7.21	45.33	5.35	356.5	6.66
	RDF + Gy 60 kg/ha	73.02	10.60	2.52	81.11	6.51	7.13	44.26	5.27	351.2	6.00
Dec 15, 2013	RDF (control)	62.54	7.06	2.20	51.89	4.82	4.82	22.50	4.24	282.8	4.33
	RDF + S^0 20 kg/ha	64.82	8.43	2.33	62.69	5.86	5.84	31.67	4.68	311.9	6.00
	RDF + S^0 40 kg/ha	67.62	10.50	2.52	78.29	6.14	6.74	40.49	5.03	335.2	4.00
	RDF + S^0 60 kg/ha	66.63	9.46	2.46	73.93	5.91	6.61	38.52	4.83	322.4	3.66
	RDF + Gy 20 kg/ha	63.74	8.06	2.27	65.22	5.52	6.20	33.48	4.49	299.2	6.33
	RDF + Gy 40 kg/ha	65.18	9.90	2.48	74.38	5.90	6.50	37.51	4.91	327.5	5.33
	RDF + Gy 60 kg/ha	64.58	8.46	2.37	69.17	5.76	6.31	35.71	4.82	321.5	4.66
Jan 15, 2014	RDF (control)	58.24	6.20	2.02	49.03	4.37	4.61	19.79	3.59	239.7	0.33
	RDF + S^0 20 kg/ha	60.04	7.23	2.23	56.33	5.14	5.29	26.03	3.82	254.6	0.00
	RDF + S^0 40 kg/ha	63.23	8.36	2.41	61.89	5.59	6.06	32.49	4.11	273.9	0.00
	RDF + S^0 60 kg/ha	62.85	7.66	2.28	57.26	5.21	5.85	30.15	3.96	270.6	0.00
	RDF + Gy 20 kg/ha	59.15	6.63	2.18	53.48	4.93	5.44	26.26	3.79	252.8	0.00
	RDF + Gy 40 kg/ha	62.17	7.36	2.32	58.67	5.28	5.82	30.33	4.00	267.0	0.00
	RDF + Gy 60 kg/ha	61.80	7.06	2.26	56.17	5.00	5.56	27.12	3.92	260.6	00.0
C.D. (P=0.05)		NS	0.48	NS	4.61	0.39	0.30	NS	NS	NS	NS
S.E. ±		2.52	0.23	0.08	2.27	0.19	0.15	1.56	0.08	0.57	0.66

NS=Non-significant

properties were significantly influenced by the planting dates (Table 2). Early planting (15th November) resulted in higher content of TSS (15.42 ^{0}Brix), ascorbic acid (12.64 mg/100g), total sugars (11.59%) and reducing sugar (5.07 %) followed by second planting date (15th December) having TSS (13.78 ^{0}Brix), ascorbic acid (11.62 mg/100g), total sugars (11.08%) and reducing sugar (4.31 %). The minimum values for these traits (TSS, ascorbic acid, total sugars and reducing sugar) were recorded (12.40 ^{0}Brix, 8.27 mg/100g, 9.10% and 2.74%, respectively) in late planting (15th January). In contrast to these observations, maximum pyruvic acid (6.78µm/g) was recorded in late planting date (15th January) and non-reducing sugar (6.80 %) was in second planting date (15th December). The soluble solid content of mature bulbs had a negative linear response to increasing temperature. Total sugars and reducing sugar were decreased with delay in planting. Total sugars and reducing sugar content was highest at low temperature and exceptionally low at high growing temperature. Non-reducing sugar content decreased at late planting this might be due to inversion of non-reducing sugar to reducing sugar because of increase in respiration due to high temperature. Pyruvic acid content was highest at temperature condition 20^{0}C because biosynthesis of cysteine activates effectively at temperature condition of 20^{0}C (Lee and Suh, 2009). Maximum content of ascorbic acid in early planting might be due to maximum sugar synthesis (reducing sugar) during photosynthesis which is responsible for the synthesis of ascorbic acid (Stone, 1972). Interaction between different planting times and sulphur forms and their doses had significant effect on the growth and bulb yield of the crop (Table 3). Maximum number of leaves (11.53), bulb weight (87.55 g), bulb length (6.79 cm), bulb diameter (7.59 cm) were found in early planting *i.e.*, 15th November with application 40 kg/ha elemental sulphur which was at par with 15th November planting with gypsum 40 kg/

Table 4 : Interaction effect of planting dates and forms of sulphur on quality attributes of onion bulb (2013-14)

Parameters / Treatment combinations		TSS (^{0}Brix)	Ascorbic acid (mg/100g)	Pyruvic acid (µmol/g)	Total sugars (mg/100g)	Reducing sugar (%)	Non-reducing sugar (%)
Planting dates	Sulphur doses						
Nov 15, 2013	RDF (Control)	13.85	10.17	3.11	10.57	4.31	5.50
	RDF + S^0 20 kg/ha	14.96	12.12	4.82	12.52	5.74	6.78
	RDF + S^0 40 kg/ha	15.91	14.02	5.20	11.79	5.37	6.32
	RDF + S^0 60 kg/ha	16.87	13.71	5.71	11.25	5.23	5.81
	RDF + Gy 20 kg/ha	14.56	12.18	4.25	12.10	5.32	6.63
	RDF + Gy 40 kg/ha	15.76	13.71	4.76	11.61	4.81	5.77
	RDF + Gy 60 kg/ha	16.06	12.60	5.32	11.33	4.69	5.62
Dec 15, 2013	RDF (control)	12.03	9.06	4.15	10.03	3.71	6.28
	RDF + S^0 20 kg/ha	13.55	10.79	5.23	12.06	4.78	7.30
	RDF + S^0 40 kg/ha	14.63	12.42	5.90	11.42	4.53	6.93
	RDF + S^0 60 kg/ha	15.23	12.08	6.48	10.79	4.32	6.55
	RDF + Gy 20 kg/ha	12.94	11.87	4.90	11.62	4.59	7.12
	RDF + Gy 40 kg/ha	13.98	13.02	5.42	11.21	4.21	6.84
	RDF + Gy 60 kg/ha	14.11	12.14	6.23	10.43	4.03	6.57
Jan 15, 2014	RDF (control)	10.73	7.32	4.81	8.48	2.21	5.85
	RDF + S^0 20 kg/ha	11.93	7.83	6.44	9.92	3.21	6.81
	RDF + S^0 40 kg/ha	12.89	9.44	7.48	9.38	2.78	6.55
	RDF + S^0 60 kg/ha	14.08	8.97	7.97	8.58	2.63	6.15
	RDF + Gy 20 kg/ha	11.14	7.62	6.25	9.56	3.14	6.68
	RDF + Gy 40 kg/ha	12.91	8.55	7.08	9.15	2.85	6.37
	RDF + Gy 60 kg/ha	13.15	8.19	7.43	8.60	2.41	6.23
C.D. (P=0.05)		0.30	1.03	0.31	0.18	NS	0.23
S.E. ±		0.14	0.50	0.15	0.09	0.22	0.11

NS=Non-significant

ha for bulb weight (84.78 g) and 15th November planting with elemental sulphur 60 kg/ha for number of leaves (11.23), neck thickness (2.61 cm), bulb length (6.65 cm) and bulb diameter (7.32 cm), while there was a non-significant interaction found in other parameters. Quality traits of the bulb were also significantly affected by the interaction between three planting dates and three doses of two form of sulphur (Table 4). The maximum TSS (16.87 ^{0}Brix) and ascorbic acid (14.02 mg/100g) was found in 15th November planting with $S^0$60 kg/ha and 15th November planting with $S^0$40 kg/ha, respectively which was significantly higher than all other treatments, while minimum TSS (11.14 ^{0}Brix) and ascorbic acid (7.62 mg/100g) were recorded in15th January with Gy 20 kg/ha among other treatment combinations except control. The highest content of pyruvic acid (7.97 µmol/g) was found in 15th January with S^0 60 kg/ha. Similarly, maximum total sugars (12.52 %) was found in 15th November with S^0 20 kg/ha and non-reducing sugar (7.30 %) was found in 15th December with S^0 20 kg/ha. Similar results were previously found by Bharti and Ram (2014). Application of elemental sulphur upto 40 kg/ha significantly increased the plant growth, yield and other bio-chemical parameters as compared to gypsum mediated sulphur fertilization. This might be due to low solubility of gypsum in the soil and as in turn less availability of SO_2^{-4} for crop because of leaching loss (Singh, 2008). Similar findings were also reported by Barman *et al*. (2013), Kumbhkar *et al*. (2012), Kumar and Khajuria (2007) and Nayee *et al*. (2009) and the results found were more of less similar to the present investigation.

Conclusion :

It is concluded after overall interpretation of the findings that early planting (15th November) along with application elemental sulphur 40 kg/ha was much more economical to get higher bulb yield and exhibited better quality of bulbs in comparison to rest of the treatments of delayed planting and gypsum fertilization along with higher doses. So, higher yield and quality of bulbs can be obtained by proper nutrient balance and optimum time adjustment of transplanting.

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