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Estimating Variation in the Production, Quality and Economics of Onion in Response to Transplanting Dates and Sulphur Fertilization

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Abstract:

A field experiment was conducted to assess the response of three planting dates and two forms of sulphur fertilization on physical and bio-chemical traits of onion cultivar 'Pusa Red' during rabi season of 2012-13. The experiment comprises three planting dates namely, 15th November 2012, 15th December 2012 and 15th January 2013, and three doses of elemental sulphur and gypsum each 20kg/ha, 40kg/ha and 60kg/ha, respectively. The experiment was laid out in factorial randomized block design with three replications. The data clearly revealed that early date of planting i.e. 15th November with 40 kg/ha of elemental sulphur significantly influenced the growth, yield and yield attributing characters i.e. plant height, number of leaves, neck thickness, bulb length, bulb diameter, bulb size and bulb weight of onion compared to other two planting dates, sulphur and gypsum levels. However, it was at par with early date of planting i.e. 15th November with 60kg/ha elemental sulphur. Similarly, higher TSS and ascorbic acid content in bulb were recorded in early planting (15th November with 60kg/ha and 40kg/ha), respectively and significantly higher reducing sugar, non-reducing sugar and total sugars were obtained with early planting i.e. 15th November with 20kg/ha of elemental sulphur, while higher content of pyruvic acid was found in late planting (15th January with 60kg/h of elemental sulphur) of the crop.

Key words: Onion, Planting dates, Elemental Sulphur, Gypsum, Pyruvic acid, Reducing sugar, Non-reducing sugar, Total sugars, 15th November.

Introduction

Onion is one of the most important commercial vegetable crops grown in India. It is an important crop used raw, as a vegetable and spice all over the world. It is a bulbous biennial or perennial herb. It is extremely important vegetable crop not only for internal consumption but also as highest foreign exchange earner among the fruits and vegetables.

In India, onion (*Allium cepa* L.) ranks first in area and production among the various vegetable crops grown. The productivity of onion 13.20 tones/ ha in the country is very low compared to world average productivity (19.10 tons per hectare). The reasons for low productivity are mainly attributed to improper planting schedule and inadequate supply of balanced nutrients, particularly sulphur. Onion is a temperature and photoperiod sensitive crop. Early transplanting results in higher yield but majority of the bulb undergoes to bolting due to low temperature during the early stage of its development, while later transplanting results in low yield. Bolted onion decreases the marketable value of the bulbs. So, it requires a proper time adjustment of their transplanting without affecting the yield. Sulphur deficiency in Indian soils adversely affects crop production besides recommended dose of NPK fertilizers application. Today, the use of gypsum as a source of sulphur fertilization not only harm the soil but also unavailable to the crop because of its low solubility in the soil. Elemental sulphur (S°) has the advantages of ready supply, lower production costs and, because of its high analysis, lower transportation cost and fewer drill fills during field operations. Yearly and regional variation in the flavor potential of onion can be a problem for growers wishing to produce a consistent product and for the consuming public. Though, the limits of flavor potential are ultimately determined by genetics, multiple environmental factors can act to influence flavor within physiological limits. Flavor intensity of a given onion cultivar can vary depending on the region where it is grown (McCallum, *et al.* 2001).Yearly differences in flavor intensity have also been observed (Vavrina and Smittle, 1993). The purpose of my investigations was to determine how different transplanting time, two form of sulphur (elemental sulphur and gypsum) and their different doses and transplanting time X sulphur fertility interacted to influence flavor development in onion. I hoped to gain a better understanding of how these environmental factors would affect yield and flavor so that in the future we can make better decisions with respect to onion production in different growing temperature condition.

Materials and Methods

To standardize the planting time and evaluate the perfect dose of two form of sulphur on the quality attributes in onion a field experiment was conducted at the Babasaheb Bhimrao Ambedkar University, Lucknow, U.P. India, during 2012-13. Pusa Red cultivar of onion was opted because it is a less bolting type variety. The experiment was conducted in factorial RBD Design with three replications having three transplanting dates (November 15, December 15 and January 15) as one factor and different doses 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 15x10 cm. Recommended dose of fertilizer (150:60:60) in the form of Urea, Single Super Phosphate and muriate of potash was applied to grow the crop. Urea was applied in three split doses, first along with phosphorus and potash at the time of land preparation and remaining 2/3rd in later stages. Data were recorded after harvesting on plant height (cm), number of leaves, neck thickness (cm), bulb weight (g), bulb length (cm), bulb diameter (cm), bulb size (cm^2), bolting percentage (%), Yield per plot (kg), yield per hectare (t/ha), benefit: cost ratio, total soluble solids (^{0} Brix), ascorbic acid (mg/100g), pyruvic acid (µm/g), total sugars (%), reducing sugar (%) and non- reducing sugar (%). TSS were analysed by Hand Refractrometer, Indolphenol method was used for the determination of Ascorbic acid, pyruvic acid analysis was performed according to (Schwimmer and Weston, 1961) and total, reducing and non-reducing sugars were analysed by method of (Lane and Eynon, 1923).

Results and Discussion

The data showed that there was a significant effect of different planting dates on the vegetative growth of the crop (Table. 1). Maximum plant height (73.18 cm), number of leaves (10.48), neck thickness (2.44 cm), bulb weight (75.47 g), bulb length (6.17 cm), bulb diameter (6.84 cm), bulb size (41.53 cm^2), bolting percentage (6.19 %), yield per plot (5.45 kg) and yield per hectare (363.3 q/ha) were recorded in early planting date i.e. 15th November which was followed by planting date of 15th December (64.35 cm, 8.80, 2.35 cm, 65.75 g, 5.44 cm, 6.07 cm, 33.28 cm^2 5.00 %, 4.72 kg and 315.2 q/ha respectively). Minimum figure were recorded for these parameters i.e. plant height (60.39 cm), number of leaves (7.26), neck thickness (2.23), bulb weight (51.12 g), bulb length (4.81 cm), bulb diameter (5.38 cm), bulb size (27.28), bolting percentage (0.28 %), yield per plot (3.76 kg) and yield per hectare (250.8 q/ha) in late planting i.e. 15th January. The maximum benefit:cost ratio (3.15) was observed in early planting due to maximum yield and this ratio was decreased as the planting delayed. Similarly, chemical properties were significantly influenced by the planting dates (Table.2). Early planting (15thNovember) resulted in higher content of TSS (14.78 ^{0}Brix), ascorbic acid (12.45 mg/100g), total sugars (11.57%) and reducing sugar (5.14 %) followed by second planting date (15th December) having TSS (13.20 ^{0}Brix), ascorbic acid (11.25 mg/100g), total sugars (11.03%) and reducing sugar (4.32 %). The minimum values for these traits (TSS, ascorbic acid, total sugars and reducing sugar) were recorded (12.03 ^{0}Brix, 8.21 mg/100g, 9.11% and 2.71%, respectively) in late planting (15th January). In contrast to these observations, maximum pyruvic acid (7.04μm/g) was recorded in late planting date (15th January) and non-reducing sugar (6.75%) was in second planting date (15th December).

Two-form of sulphur (elemental sulphur and gypsum) each having three doses (20, 40 and 60 kg/ha) showed significant effect on the vegetative characters of the crop and qualitative characters of onion bulb (Table. 1). Application of elemental sulphur upto 40 kg/ha significantly increased the plant height (68.26 cm), number of leaves (10.20), neck thickness (2.48 cm), bulb weight (70.36 g), bulb length (5.82 cm), bulb diameter (6.51 cm), bulb size (37.66 cm^2), yield per plot (4.99 kg/ha), yield per hectare (332.5 q/ha). There is reduction in the growth and yield at higher level of sulphur application. Further increase in the value of these characters were not observed as increase in the dose of sulphur application (60 kg/ha). Minimum growth and yield i.e. plant height (64.51 cm), number of leaves (8.16), neck thickness (2.29 cm), bulb weight (60.47 g), bulb length (5.32 cm), bulb diameter (6.02 cm), bulb size (32.44 cm^2), yield per plot (4.52 kg), yield per hectare (301.3 q/ha) were observed in gypsum (20 kg/ha) except no sulphur application in control. Bolting percentage was not significantly affected by the sulphur application. Maximum benefit cost ratio was found on application of elemental sulphur (40 kg/ha) and this ratio decreased on further increase in the dose of elemental sulphur and gypsum both. Similarly, both forms of sulphur and their doses has also significant effect on the bio-chemical contents of bulb (Table.2). Maximum TSS

(14.67 ^{0}Brix) and pyruvic acid (6.57 μmol/g) were found in $S^0$60 kg/ha which was followed by $S^0$40 kg/ha (14.10 ^{0}Brix) and Gy 60 kg/ha (6.33 μmol/g), respectively. Maximum ascorbic acid (11.86 mg/100g) was found in $S^0$40 kg/ha followed by $S^0$60 kg/ha (11.74 mg/100g) and Gy 40 kg/ha (11.52 mg/100g). While, maximum total sugars (11.53%), reducing sugar (4.61%) and non-reducing sugar (6.92%) were found in $S^0$20 kg/ha which is at par with Gy 20 kg/ha.

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 (11.70), bulb weight (83.22 g), bulb length (6.39 cm), bulb diameter (7.15 cm) were found in early planting i.e. 15th November with application 40 kg/ha elemental sulphur which is at par with 15th November planting with gypsum 40 kg/ha for number of leaves (11.46) and bulb weight (80.45 g) and 15th November planting with elemental sulphur 60 kg/ha for bulb length (6.31 cm) and bulb diameter (6.98 cm), while there was a non-significant interaction found in other parameters. Minimum values, for number of leaves (6.56), bulb weight (49.48 g), bulb length (4.60 cm) and bulb diameter (5.27 cm), were found in late planting at 15th January with the application of 20 kg/ha gypsum except control (15th Jan with no sulphur). Interaction treatments had a significant effect on benefit: cost ratio which is maximum (3.48) in early planting i.e. 15th November with 40 kg/ha elemental sulphur while minimum benefit cost ratio (1.70) was found in late planting i.e. 15th January with elemental sulphur 20 kg/ha except no sulphur application (control). 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 (15.97 ^{0}Brix) and ascorbic acid (13.39 mg/100g) were 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 (11.30 ^{0}Brix) and ascorbic acid (7.26 mg/100g) were recorded in15th January with Gy 20 kg/ha and 15th January with S^{0}20 kg/ha, respectively except control. The highest content of pyruvic acid (8.11 µmol/g) was found in 15th January with S^{0}60 kg/ha. Similarly, maximum total sugars (12.64%), reducing sugar (5.81%) were also found in 15th November with S^{0}20 kg/ha and non-reducing sugar (7.24%) was found in 15th December with S^{0}20 kg/ha, while minimum pyruvic acid (4.49 µmol/g), total sugars (8.43%), reducing sugar (2.34%) and non-reducing sugar (5.53%) were also observed in15th November planting with S^{0}20 kg/ha, whereas 15th January planting with S^{0}60 kg/ha, 15th January planting with Gy 60 kg/ha and 15th November planting with Gy 60 kg/ha, respectively except controls (Table. 4).

These results are might be due to low average temperature in early planting date and high average temperature in late planting date during the growth period which led to decrease in yield as the planting is delayed. The latest planting date showed the lowest growth parameters values, may be due to the short period allowed for growth which is in conformity of the findings of (Al.-Moshileh, 2007) who reported that early planting showed significantly higher growth values than the later planting in the two growing seasons. (Neeraja *et al.,* 2000) indicated that enhanced crop growth rate of onion resulted in efficient metabolism, thereby increased the sink capacity. Higher metabolism greater photosynthates mobilization and better source sink relationship helped to produce higher yield by planting on 16th November. But, (Madisa amd Midmore, 1997) reported that percentage of bolting was highest in early planting and decreased as the planting is delayed. With the delay in planting TSS, ascorbic acid, total sugars and reducing sugar were gradually decreases. These results are in agreement with the findings of other workers. The soluble solid content of mature bulbs had a negative linear response to increasing temperature (Coolong and Randle, 2003). 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 (Lee and Suh, 2009). 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 (Jeong *et al.*, 1996). (Lee and Suh, 2009) reported that pyruvic acid content is highest at temperature condition 20^0C because biosynthesis of cysteine activates effectively at temperature condition of 20^0C (Choi and Yang, 1974). But, this result is different due to onion pungency increases which are broadly due to high temperature at late planting (Platenius and Knott, 1941). 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. Ascorbic acid is found in plants where it is synthesis from glucose (Stone, 1972).

The response of gypsum mediated sulphur fertilization is lower as compared to elemental sulphur because low solubility of gypsum in the soil and as in turn less availability of SO_2^{-4} for crop because of leaching loss and (Singh, 2008) reported that maximum increase in growth and bulb yield of the crop was evident upto 40 kg/ha elemental sulphur as compared to gypsum. (Ahmad and Abdin, 2000) demonstrated that high S fertilization increases Rubisco, chlorophyll, and protein contents in fully expanded upper leaves of *Brassica juncea* L. which implies a better photosynthetic activity in comparison with plants grown with low or without sulphur. A similar result in increase of bulb yields and sulphur uptake by onion and garlic with sulphur has also been reported by (Jaggi, 2004). (Randle, 1992a) showed that 'Granex 33' bulbs accumulated more sucrose, glucose and fructose when grown with low than high sulphur nutrition. Onion becomes "saturated" when S is supplied in sufficiently in high amount.

At high levels, pungency no longer responds to increase in sulphur fertility (Hamilton, *et al.* 1998). Although, synthesis of ascorbic acid is not directly affected by sulphur fertilization but the status of sulphur affect the N uptake and metabolism in plants (Janzen and Bettany, 1984), which is responsible for sugar and ascorbic acid synthesis.

Conclusions

The overall results obtained from this study clearly revealed that early planting (15th November) supplemented with elemental sulphur 40 kg/ha is 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.

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Table 1. Effect of Planting Dates and forms of Sulphur on growth and yield of onion bulb (2012-13)

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)	Benefit: Cost ratio
Planting time											
Nov 15, 2012	**73.18**	**10.48**	**2.44**	**75.47**	**6.17**	**6.84**	**41.53**	**6.19**	**5.45**	**363.3**	**3.15**
Dec 15, 2012	64.35	8.80	2.35	65.75	5.44	6.07	33.28	5.00	4.72	315.2	2.47
Jan 15, 2013	60.39	7.26	2.23	51.12	4.81	5.38	27.28	0.28	3.76	250.8	1.77
C.D. (P=0.05)	2.09	0.15	0.06	1.30	0.11	0.09	0.88	0.74	0.10	0.66	0.05
SE(d)	1.03	0.07	0.03	0.64	0.05	0.04	0.43	0.36	0.04	0.32	0.02
Two-form of sulphur doses											
RDF (control)	63.00	7.38	2.09	55.83	4.75	5.32	27.60	3.44	4.27	285.0	2.17
S^0 20 Kg/ha	65.64	8.57	2.34	62.56	5.56	6.11	33.96	**3.55**	4.53	301.9	2.37
S^0 40 Kg/ha	**68.26**	**10.20**	**2.48**	**70.36**	**5.82**	**6.51**	**37.66**	**3.55**	**4.99**	**332.5**	**2.75**
S^0 60 Kg/ha	67.37	9.48	2.40	66.37	5.68	6.37	36.08	4.22	4.82	321.7	2.65
Gy 20 Kg/ha	64.51	8.16	2.29	60.47	5.32	6.02	32.44	4.00	4.52	301.3	2.31
Gy 40 Kg/ha	66.96	9.60	2.40	68.05	5.66	6.20	35.84	4.00	4.74	316.4	2.52
Gy 60 Kg/ha	66.08	8.51	2.37	65.12	5.53	6.13	34.64	4.00	4.64	309.6	2.45
C.D. (P=0.05)	3.20	0.23	0.10	1.99	0.18	0.13	1.35	NS	0.15	1.01	0.07
SE(d)	1.58	0.11	0.05	0.98	0.08	0.06	0.66	0.56	0.07	0.50	0.03

S^0 = Elemental sulphur
Gy = Gypsum

Table 2. Effect of Planting Dates and forms of Sulphur on quality (bio-chemical) attributes of onion bulb (2012-13)

Treatments	TSS (^{0}Brix)	Ascorbic acid (mg/100g)	Pyruvic acid (µm/g)	Total Sugars (%)	Reducing sugar (%)	Non-reducing sugar (%)
Planting dates						
Nov 15, 2012	**14.78**	**12.45**	4.80	**11.57**	**5.14**	6.02
Dec 15, 2012	13.20	11.25	5.57	11.03	4.32	**6.75**
Jan 15, 2013	12.03	8.21	**7.04**	9.11	2.71	6.41
C.D. (P=0.05)	0.18	0.12	0.12	0.08	0.17	0.07
SE(d)	0.08	0.06	0.06	0.04	0.08	0.03
Two-form of sulphur doses						
RDF (control)	11.71	8.48	3.97	9.67	3.44	5.84
S^0 20 Kg/ha	13.41	9.84	5.77	**11.53**	**4.61**	**6.92**
S^0 40 Kg/ha	14.10	**11.86**	6.09	10.83	4.20	6.58
S^0 60 Kg/ha	**14.67**	11.74	**6.57**	10.05	4.00	6.12
Gy 20 Kg/ha	12.65	10.17	5.62	11.19	4.49	6.84
Gy 40 Kg/ha	13.20	11.52	6.29	10.66	3.94	6.37
Gy 60 Kg/ha	13.63	10.84	6.33	10.08	3.72	6.08
C.D. (P=0.05)	0.27	0.19	0.19	0.22	0.26	0.11
SE(d)	0.13	0.09	0.09	0.11	0.13	0.05

S^0 = Elemental sulphur
Gy = Gypsum

Table 3. Interaction effects of different planting dates and forms of Sulphur on growth and yield of onion bulb (2012-13)

Planting dates	Sulphur doses	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)	Bolting percentage (%)	Yield (q/ha)	Benefit: Cost ratio
Nov 15, 2012	RDF (Control)	70.89	8.80	2.20	65.57	5.76	6.31	35.85	5.04	5.66	336.1	2.82
	RDF + S^0 20 Kg/ha	72.86	9.73	2.41	72.66	6.17	6.75	40.12	5.40	5.33	359.5	3.12
	RDF + S^0 40 Kg/ha	**75.72**	**11.70**	**2.63**	**83.22**	**6.39**	**7.15**	**44.84**	**5.84**	6.33	**389.4**	**3.48**
	RDF + S^0 60 Kg/ha	73.95	11.36	2.50	78.58	6.31	6.98	43.56	5.64	7.00	376.1	3.30
	RDF + Gy 20 Kg/ha	71.51	10.13	2.36	70.39	6.14	6.83	41.02	5.22	6.66	347.9	2.94
	RDF + Gy 40 Kg/ha	74.68	11.46	2.53	80.45	6.22	6.88	42.79	5.55	6.00	369.9	3.24
	RDF + Gy 60 Kg/ha	72.65	10.16	2.48	77.44	6.20	6.96	42.55	5.47	6.33	364.6	3.18
Dec 15, 2012	RDF (control)	61.87	7.26	2.11	55.56	4.35	5.15	26.6	4.31	4.00	287.2	2.11
	RDF + S^0 20 Kg/ha	64.36	8.60	2.32	64.35	5.66	6.24	34.47	4.54	5.00	303.0	2.30
	RDF + S^0 40 Kg/ha	66.55	10.33	2.48	73.29	5.81	6.42	37.29	5.08	3.66	338.9	2.85
	RDF + S^0 60 Kg/ha	65.96	9.63	2.40	68.59	5.74	6.35	35.34	4.97	5.33	331.7	2.80
	RDF + Gy 20 Kg/ha	63.21	7.80	2.31	61.55	5.23	5.97	30.78	4.62	5.33	308.1	2.29
	RDF + Gy 40 Kg/ha	64.38	9.83	2.43	69.38	5.71	6.33	35.47	4.87	6.00	324.6	2.52
	RDF + Gy 60 Kg/ha	64.14	8.13	2.39	67.50	5.59	6.05	33.01	4.69	5.66	312.6	2.41
Jan 15, 2013	RDF (control)	56.24	6.10	1.96	46.37	4.14	4.51	20.37	3.47	0.66	231.7	1.58
	RDF + S^0 20 Kg/ha	59.70	7.40	2.29	50.66	4.84	5.36	27.28	3.65	0.33	243.2	1.70
	RDF + S^0 40 Kg/ha	62.50	8.56	2.34	54.56	5.26	5.96	30.85	4.04	0.66	269.2	1.94
	RDF + S^0 60 Kg/ha	62.21	7.46	2.32	51.93	4.98	5.78	29.34	3.86	0.33	257.2	1.86
	RDF + Gy 20 Kg/ha	58.82	6.56	2.20	49.48	4.60	5.27	25.53	3.72	0.00	247.9	1.72
	RDF + Gy 40 Kg/ha	61.83	7.50	2.24	54.34	5.05	5.41	29.26	3.82	0.00	254.8	1.80
	RDF + Gy 60 Kg/ha	61.44	7.23	2.25	50.50	4.81	5.39	28.35	3.78	0.00	251.7	1.77
C.D. (P=0.05)		NS	0.15	NS	3.46	0.31	0.23	NS	NS	NS	NS	0.13
SE (d)		2.73	0.07	0.08	1.70	0.15	0.11	1.15	0.13	0.97	0.86	0.06

S^0 = Elemental sulphur
Gy = Gypsum

Table 4. Interaction effect of Planting Dates and forms of Sulphur on quality attributes of onion bulb (2012-13)

Planting dates	Sulphur doses	TSS (^{0}Brix)	Ascorbic acid (mg/100g)	Pyruvic acid (µmol/g)	Total sugars (mg/100g)	Reducing sugar (%)	Non-reducing sugar (%)
Nov 15, 2012	RDF (Control)	13.25	10.51	3.71	10.50	4.43	5.44
	RDF + S^0 20 Kg/ha	14.03	11.82	4.49	**12.64**	**5.81**	6.85
	RDF + S^0 40 Kg/ha	15.61	**13.39**	4.80	11.69	5.30	6.25
	RDF + S^0 60 Kg/ha	**15.97**	13.14	5.38	10.99	5.07	5.63
	RDF + Gy 20 Kg/ha	14.32	12.42	4.82	12.23	5.59	6.74
	RDF + Gy 40 Kg/ha	14.72	13.24	5.19	11.55	4.92	5.69
	RDF + Gy 60 Kg/ha	15.58	12.67	5.22	11.40	4.88	5.53
Dec 15, 2012	RDF (control)	11.51	8.28	3.85	10.15	3.87	6.34
	RDF + S^0 20 Kg/ha	13.97	10.46	5.71	11.97	4.75	**7.24**
	RDF + S^0 40 Kg/ha	14.35	12.38	5.77	11.35	4.49	6.86
	RDF + S^0 60 Kg/ha	14.62	12.42	6.22	10.73	4.36	6.45
	RDF + Gy 20 Kg/ha	12.33	10.80	5.33	11.57	4.66	7.05
	RDF + Gy 40 Kg/ha	12.63	12.78	6.19	11.14	4.18	6.91
	RDF + Gy 60 Kg/ha	13.01	11.60	5.93	10.32	3.94	6.41
Jan 15, 2013	RDF (control)	10.36	6.65	4.35	8.35	2.03	5.74
	RDF + S^0 20 Kg/ha	12.25	7.26	7.11	9.97	3.27	6.68
	RDF + S^0 40 Kg/ha	12.35	9.81	7.71	9.46	2.81	6.62
	RDF + S^0 60 Kg/ha	13.41	9.65	**8.11**	8.43	2.58	6.28
	RDF + Gy 20 Kg/ha	11.30	7.28	6.72	9.76	3.24	6.72
	RDF + Gy 40 Kg/ha	12.24	8.54	7.49	9.29	2.72	6.53
	RDF + Gy 60 Kg/ha	12.31	8.26	7.83	8.52	2.34	6.31
C.D. (P=0.05)		0.47	0.34	0.33	0.22	NS	0.19
SE (d)		0.23	0.16	0.16	0.11	0.23	0.09

S^0 = Elemental sulphur
Gy = Gypsum