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EFFECT OF SULPHUR AND GA_3 ON THE GROWTH AND YIELD OF ONION

M. H. A. Rashid
Department of Horticulture, Bangladesh Agricultural University
Mymensingh-2202, Bangladesh

ABSTRACT

An experiment was conducted at the Horticulture Farm of the Bangladesh Agricultural University, Mymensingh to evaluate the effects of sulphur and GA_3 on the growth and yield performance of onion cv. BARI Peaj-1. The experiment included four levels of sulphur viz., 0 (control), 15, 30 and 45 kg/ha and four concentrations of GA_3 viz., 0 (control), 50, 75, 100 ppm. The experimental findings revealed that sulphur and GA_3 had significant influence on plant height, number of leaves per plant, bulb diameter and length, individual bulb weight, splitted and rotten bulb, bulb dry matter content and bulb yield. The highest bulb yield (13.85 t/ha) was recorded from 30 kg S/ha, while the lowest bulb yield (11.20 t/ha) was obtained from control. Most of the parameters showed increasing trend with the higher concentration of GA_3. Application of GA_3 @ 100 ppm gave the maximum bulb yield (15.23 t/ha), while the minimum value (10.10 t/ha) was observed from control. Almost all the parameters were significantly influenced by combined treatments of sulphur and GA_3 except bulb length of onion. The maximum bulb dry matter content (13.50%) and bulb yield (17.10 t/ha) were produced from the application of sulphur @ 30 kg/ha with 100 ppm GA_3, while the minimum bulb dry matter content (9.23%) and bulb yield (9.33 t/ha) were recorded from control treatment of sulphur with GA_3.

Key Words: Onion, Sulphur, GA_3, Growth, Yield, Quality

INTRODUCTION

Onion (*Allium cepa* L.) belongs to the family Alliaceae is one of the most widely cultivated vegetable and spice crops in the world. It is an integral part of Bangladeshi diet and used in many dishes by rich and poor (Hossain and Islam, 1994). Food and Agriculture Organization (FAO) reported that onion ranks second only to tomato in terms of total annual world production (Pathak, 2000). In 2003-2004, Bangladesh produces 272 thousand tonnes of onion over 31.6 thousand hectares with an average yield of 8.6 t/ha (BBS, 2005) which is very low as compared to world average productivity (15 t/ha) (FAO, 1999). In Bangladesh, onion ranks first in terms of production and second with respect to acreage amongst all spices grown and the total requirement is 480 thousand tonnes with a shortage of 208 thousand tonnes per year (BBS, 2004). However, to meet the demand Bangladesh has to import onion from India and Pakistan every year at the higher cost of foreign currency (Hossain and Islam, 1994). Onion yield and quality is greatly influenced

by inadequate supply of nutrients, particularly sulphur which is essential for building up sulphur containing amino acids, agronomic practices and use of growth regulators during growth and development (Anwar *et al.,* 2001). Onion plants are known for their affinity to sulphur to become a constituent of secondary compounds, i.e. allin, cycloallin, alkaloid (Allyl propyl disulphide) and thiopropanol (Schnug, 1993; Raina and Jaggi, 2008), which are not only govern the taste, pungency and medicinal properties but also important for resistance against pests and diseases (Brown and Morra, 1997). In addition, growth regulators are considered as key factors for vegetative growth, flowering, fruit setting and seed production in plants including onion bulb yield. GA_3 at various concentrations had remarkable effects on bulb initiation, plant height, leaf production, bulb size and quality of onion (El-Habbasha *et al*., 1985). However, the research regarding sulphur requirement for onion production and root soaking in GA_3 before planting in increasing onion yield are very limited, particularly in Bangladesh conditions. Therefore, the present experiment was undertaken to find out the effects of sulphur and GA_3 on the growth, yield and quality of onion to optimum dose, equal distribution and maximum efficiency dose for achieving highest yield as well as quality.

MATERIALS AND METHODS

The experiment was carried out at the Horticulture Farm of the Bangladesh Agricultural University, Mymensingh to examine the effects of sulphur and GA_3 on the growth and yield performance of onion cv. BARI Peaj-1 during the period from October, 2007 to March, 2008. The experimental site was medium high land belonging to the Old Brahmaputra Floodplain under the Agro-Ecological Zone 9 having non-calcareous dark-gray flood plain soil (UNDP, 1988). Four levels of sulphur viz., 0 (control), 15, 30 and 45 kg/ha and four concentrations of GA_3 viz., 0 (control), 50, 75, 100 ppm were used. The two-factor experiment was laid out in randomized complete bock design (RCBD) with three replications and altogether 16 treatment combinations in this experiment. Forty days old seedlings were soaked in different solutions of GA3 concentrations for over-night and then transplanted on 15 December, 2007 at a spacing of 15 cm × 10 cm. The size of each unit plot was l.0 m x l.0 m. The spacing of plot to plot was 50 cm and block to block was 1.0 m. Sulphur was applied to different unit plots before planting of seedlings in the form of gypsum and then it was incorporated into the soil carefully. Other recommended dose of fertilizer (150-100-180 kg ha^{-1} NPK) in the form of urea, triple super phosphate and muriate of potash was applied to grow the crop. Nitrogen was applied in two splits, the first along with phosphorus and potash at the time of soil preparation while the remaining half was applied as top dressed. Data on growth and yield parameters were recorded from ten randomly selected plants from each plot. Collected data were analyzed statistically using MSTAT computer program. The significance of difference between pair of means was tested by the least significant differences (LSD) test at 5% level of probability (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Effects of sulphur

Sulphur showed influence on all the growth and yield parameters of onion cv. BARI Peaj-1. At 60 DAT, the maximum plant height (44.48 cm) and number of leaves per plant (11.72) were recorded from 15 and 30 kg S/ha, respectively, while the minimum plant height (40.92 cm) and number of leaves per plant (10.69) were obtained form the control (Table 1). The plant height and number of leaves per plant linearly increased up to the maximum vegetative growth stage (60 DAT) and increasing S reaching the maximum at 30 kg S/ha thereafter reduced. Jana and Kabir (1990) reported that increase in plant height and number of leaves per plant with application of sulphur might be due to its role in the synthesis of chloroplast. The maximum bulb diameter (4.67 cm), bulb length (5.70 cm) and individual bulb weight (41.56g) were obtained from 30 kg S/ha, while the minimum bulb diameter (3.98 cm), bulb length (4.31 cm) and individual bulb weight (35.54 g) were recorded from the control (Table 1).

Table 1. Individual effects of sulphur and GA3 on the growth, yield and quality characters of onion

Treatment	Plant height at 60 DAT (cm)	Number of leaves/plant at 60 DAT	Bulb diameter (cm)	Bulb length (cm)	Individual bulb wt. (g)	Splitted bulb (%)	Rotten bulb (%)	Bulb dry matter (%)
Sulphur levels								
S_0	40.92	10.69	3.98	4.31	35.54	44.43	25.23	10.12
S_1	44.48	11.57	4.25	5.00	37.82	43.60	16.68	11.39
S_2	44.17	11.72	4.67	5.70	41.56	41.05	18.51	11.76
S_3	44.15	11.65	4.50	5.25	41.23	42.87	15.77	11.87
GA_3 concentrations								
G_0	37.88	9.54	4.06	4.47	34.87	46.55	23.73	10.06
G_1	43.21	11.21	4.33	4.98	37.70	43.90	19.69	10.95
G_2	45.45	12.23	4.47	5.25	41.05	41.19	16.79	11.92
G_3	47.17	12.65	4.53	5.55	42.52	40.30	15.99	12.20
$LSD_{(0.05)}$	0.593	0.195	0.105	0.229	0.734	0.551	1.395	0.401

S_0 = 0, S_1 = 15 kg S/ha, S_2 = 30 kg S/ha, S_3 = 45 kg S/ha, G_0 = 0, G_1 = 50 ppm GA_3, G_2 = 75 ppm GA_3, G_3 = 100 ppm GA_3

Overall increase in growth attributes of the plants might be due to the increased uptake of sulphur and were used in photosynthesis. The highest splitted bulb (44.43%) and rotten bulb (25.23%) were produced from the control treatment while the lowest splitted bulb (41.05%) and rotten bulb (15.77%) were observed with the application of 30 and 45 kg S/ha, respectively (Table 1). The maximum dry matter content of the bulb (11.87%) was obtained from 45 kg S/ha, while the minimum value (10.12%) was recorded with

control (Table 1). Sulphur application of 30 kg/ha gave the highest bulb yield (13.85 t/ha), while the lowest bulb yield (11.20 t/ha) was obtained from control (Fig. 1). It was observed that bulb dry matter and yield were increased with successive increase in the levels of sulphur up to 30 kg/ha and thereafter decreased. Peterson (1979) also reported the increase in bulb yield with increase in sulphur level in onion and Singh *et al.* (1995) in garlic. This yield increase was due to the increase in bulb size and weight. Plants grown without added sulphur produced consistently lowest bulb. This result thus suggested that sulphur deficiency has adverse effect on growth and yield of onion.

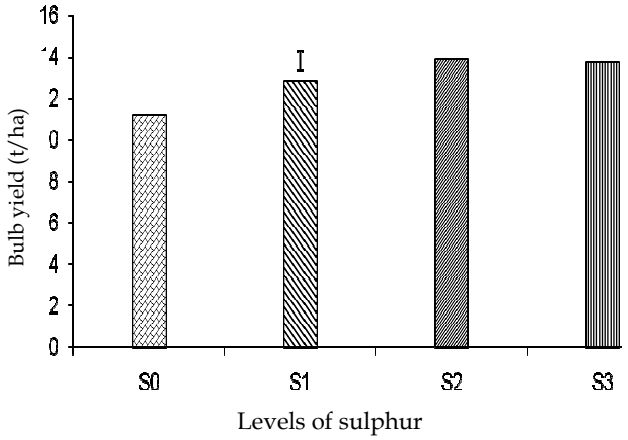

Fig. 1. Effect of different levels of sulphur on the bulb yield of onion. The vertical bar represents LSD at 5% level of probability (S_0 = Control, S_1 = 15 kg/ha, S_2 = 30 kg/ha, S_3 = 45 kg/ha)

Effects of GA_3

The result demonstrated that GA_3 had significant influence on all the growth and yield parameters of onion cv. BARI Peaj-1. The plant height and number of leaves per plant linearly increased up to the maximum vegetative growth stage (60 DAT) and thereafter decreased possibly due to the the senescence and drying up of the tips of the leaves. The highest plant height (47.17 cm) and number of leaves per plant (12.65) were obtained from 100 ppm GA_3, while the lowest plant height (37.88 cm) and number of leaves per plant (9.54) were recorded with the control (Table 1). This might be due to the rapid increment and expansion of plant cells for proper plant growth by the increased concentrations of GA_3. Likewise, maximum bulb diameter, bulb length and individual bulb weight showed upward trend with the increase in GA_3 concentrations which could be due to the rapid cell division and elongation leading to longer bulb formation. The maximum bulb diameter (4.53 cm), bulb length (5.55 cm) and individual bulb weight (42.52 g) were recorded with 100 ppm GA_3 application, while the minimum bulb diameter (4.06 cm), bulb length (4.47 cm) and individual bulb weight (34.87 g) were obtained from the control, respectively (Table 1). The highest splitted (46.55%) and rotten bulb (23.73%) were observed with control, while the lowest splitted (40.30%) and rotten

bulb (15.99%) were recorded with 100 ppm GA_3, respectively (Table 1). The highest bulb dry matter content (12.20%) was recorded from 100 ppm GA_3, while the lowest value (10.06%) was observed with control which possibly be due to bigger bulb size enhanced by GA_3 (Table 1). GA_3 concentration of 100 ppm gave highest bulb yield (15.23 t/ha), while the lowest bulb yield (10.10 t/ha) was observed with control (Fig. 2).

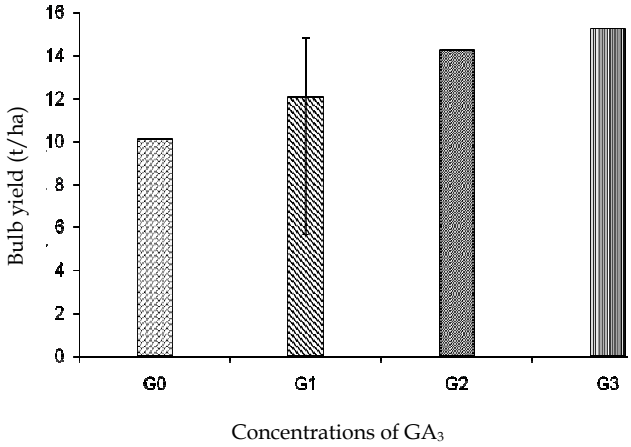

Fig. 2. Effect of different concentrations of GA_3 on the bulb yield of onion. The vertical bar represents LSD at 5% level of probability (G_0 = Control, G_1 = 50 ppm, G_2 = 75 ppm, G_3 = 100 ppm).

Combined effect of sulphur and GA_3

Almost all the parameters were significantly influenced by the combined effect of different levels of sulphur and GA_3 concentrations except bulb length of onion cv. BARI Peaj-1 (Table 2). The plant height and number of leaves per plant showed increasing trend with the increasing level of sulphur and GA_3 up to 60 DAT and thereafter reduced which might be due to the increased avaiability of soil nutrients and was associated with rapid elongation and cell division of plants. The maximum plant height (49.86 cm), number of leaves per plant (13.73), bulb diameter (5.06 cm) and individual bulb weight (46.46 g) were recorded from the application of sulphur @ 30 kg/ha with 100 ppm GA_3 (S_2G_3), while the minimum plant height (35.70 cm), number of leaves per plant (9.30) bulb diameter (3.85 cm) and individual bulb weight (32.30 g) were obtained form the control treatment (S_0G_0) of sulphur and GA_3 (Table 2). The highest splitted bulb (46.96%) and rotten bulb (29.76%) were obtained from the control treatment of sulphur and GA_3 (S_0G_0), while the lowest splitted bulb (37.83%) and rotten bulb (11.86%) were recorded from application of sulphur @ 30 kg/ha with GA_3 @ 100 ppm and sulphur @ 45 kg/ha with 100 ppm GA_3, respectively (Table 2). The highest bulb dry matter content (13.50%) and bulb yield (17.10%) were obtained from application of sulphur @ 30 kg/ha with 100 ppm GA_3, while the lowest bulb dry matter content (9.23%) and bulb yield (9.33 t/ha) were recorded from control treatment (S_0G_0) of sulphur with GA_3 (Table 2). This is attributed that higher sulphur and GA_3 application enrich the bulbs with sulphur and increase cell division which is responsible for increase in synthesis of volatile sulphur compounds and

production of more pungency and bulb of onion. Stress *et al*. (1978) who reported that higher dry matter content in bulb is conductive to higher pungency.

Table 2. Combined effects of sulphur and GA_3 on the growth, yield and quality characters of onion

Treatment	Plant height at 60 DAT (cm)	Number of leaves/plant at 60 DAT	Bulb diameter (cm)	Bulb length (cm)	Individual bulb wt. (g)	Splitted bulb (%)	Rotten bulb (%)	Bulb dry matter (%)	Bulb yield (t/ha)
S_0G_0	35.70	9.30	3.85	3.99	32.30	46.96	29.76	9.23	9.33
S_0G_1	41.03	10.73	3.94	4.10	34.26	45.33	26.40	9.96	10.33
S_0G_2	41.93	11.16	4.06	4.46	37.30	43.83	21.80	10.43	11.93
S_0G_3	45.05	11.56	4.09	4.68	38.30	41.60	22.96	10.86	13.23
S_1G_0	38.36	9.93	3.96	4.31	33.16	47.63	19.36	10.63	9.86
S_1G_1	44.93	11.46	4.30	5.12	36.26	44.96	17.30	10.46	11.70
S_1G_2	46.80	12.33	4.32	5.02	39.86	41.56	15.56	12.00	14.13
S_1G_3	47.83	12.56	4.44	5.55	42.00	40.23	14.50	12.46	15.76
S_2G_0	38.53	9.46	4.30	5.03	36.53	45.36	25.50	9.60	10.60
S_2G_1	42.36	10.80	4.53	5.46	39.46	41.90	17.86	11.40	13.03
S_2G_2	45.93	12.90	4.77	5.90	43.80	39.10	16.06	12.56	14.70
S_2G_3	49.86	13.73	5.06	6.41	46.46	37.83	14.63	13.50	17.10
S_3G_0	38.93	9.46	4.14	4.57	37.50	46.26	20.30	10.80	10.63
S_3G_1	44.53	11.86	4.55	3.99	40.83	43.43	17.20	12.00	13.20
S_3G_2	47.16	12.53	3.85	4.10	43.26	40.26	13.73	12.70	16.23
S_3G_3	45.96	12.76	3.94	4.46	43.33	41.53	11.86	12.00	14.83
$LSD_{(0.05)}$	0.275	0.090	0.049	-	0.340	0.256	0.647	0.186	0.221

S_0 = 0, S_1 = 15 kg S/ha, S_2 = 30 kg S/ha, S_3 = 45 kg S/ha, G_0 = 0, G_1 = 50 ppm GA_3, G_2 = 75 ppm GA_3, G_3 = 100 ppm GA_3

From the above discussion, the experimental findings indicated that the treatment combination of sulphur @ 30 kg/ha and GA_3 @ 100 ppm was more suitable for higher yield and quality of onion than the rest of the treatment combinations under the soil and climatic conditions of Mymensingh.

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