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Effect of Planting Dates and Paclobutrazol on Yield and Quality of Onion (*Allium cepa* L.) Seed

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ABSTRACT

A field experiment was carried out at Research Farm of the Department of Vegetable Science, CCS Haryana Agricultural University, Hisar (Haryana) during Rabi season of 2013-14 and 2014-15 to investigate the effect of planting dates and paclobutrazol on yield and quality of onion seed. The treatments comprising three planting dates (D_1: First week of October, D_2: Third week of October and D_3: First week of November) and four levels of paclobutrazol (G_1: Control, G_2: Paclobutrazol 500 ppm, G_3: Paclobutrazol 750 ppm and G_4: Paclobutrazol 1000 ppm) were laid out in randomized block design (factorial). The results of the experiment showed that different planting dates and paclobutrazol levels influenced the yield and quality of onion seed. The onion crop planted on first week of October and sprayed with paclobutrazol 500 ppm found best in days to 50% flowering (102.00 and 99.33 days), number of umbels per plant (12.70 and 13.17), seed yield per plant (19.33 and 21.57 g), test weight (3.84 and 3.92 g), seed germination (82.67 and 85.20%), seed vigour index I (329.39 and 371.40), seed vigour index II (1176.87 and 1198.69) and EC of seed leachates (0.22 and 0.19), while the crop planted on first week of October and sprayed with paclobutrazol 1000 ppm resulted in minimum number of lodged seed stalks (7.80 and 7.40) during both the years.

Key words: *Planting dates, paclobutrazol, seed yield, seed quality and onion*

INTRODUCTION

Onion (*Allium cepa* L.), a member of Alliaceae family, is one of the most important commercial vegetable crops grown in almost all parts of the world and believed to be originated from Central Asia. India is the second largest producer of onion bulbs in the world, as onions have wider use in the preparation of soups, ketchups, pickles, onion flakes (dehydrated) and food seasoning besides being used as salad. As the area under onion crop is increasing year after year due to its increasing demand, the demand for quality seed is also increasing fast. One of the major problems in onion production is lack of high quality seeds and improper agronomic practices used by farmers.

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Onion seed production might be increased by increasing the area with good variety and changing the existing management practices. Among the various cultural practices followed for the production of onion seed, planting time is one of the most important factors that greatly influence the growth and seed yield of onion. The variation in planting time affects the plant vigour and spread, which further affect the seed yield and quality. If planting time coincides with optimum ecological conditions for better germination, it may lead to better development of plants and ultimately higher yield of good quality seed. Growth regulators are considered the key factor in vegetative growth, flowering, fruit setting and seed production in plants. Growth regulators are used to overcome the factors limiting the growth and yield to harness maximum benefit from seed production. Growth retardants induce various plant responses such as shoot growth reduction, develop plant hardiness, enhance flowering and improve seed setting[7]. The aim of this study was to find out the suitable planting date and paclobutrazol dose for higher yield and quality of onion seed.

MATERIAL AND METHODS

The experiment comprising of three planting dates (D_1: First week of October, D_2: Third week of October and D_3: First week of November) and four levels of paclobutrazol (G_1: Control, G_2: Paclobutrazol 500 ppm, G_3: Paclobutrazol 750 ppm and G_4: Paclobutrazol 1000 ppm) was conducted at Research Farm of the Department of Vegetable Science, CCS Haryana Agricultural University, Hisar (Haryana) during *Rabi* season of 2013-14 and 2014-15. The treatments were laid out in randomized block design (factorial) with three replications of each treatment. The onion bulbs of Hisar-2 variety were planted at 45x45 cm spacing in plot of 3.6x3.6 m size. The observations were recorded on days to 50% flowering, seed stalk diameter (cm), number of umbels per plant, disease incidence (%), number of lodged seed stalks, seed yield per plant (g), test weight (g), seed germination (%), seed vigour index I, seed vigour index II and EC of seed leachates (dS/m/seed). The paclobutrazol was applied as foliar spray 45 days after planting. The crop was fertilized with rotten FYM @ 200 q/ha at the time of field preparation. The inorganic fertilizers in the form Urea DAP and MOP were applied @ 100 kg nitrogen, 50 kg phosphorus and 50 kg potash per hectare in individual plots before the planting of bulbs. Half of the recommended dose of nitrogen and whole dose of phosphorus and potash were applied as basal dose. Rest half of the nitrogen was applied at the time of flowering as top dressing. Weeding was done thrice at different intervals during the period of crop growth to keep the crop weed free. Irrigations were applied as per the crop requirement. All other cultural practices as recommended in *Package of Practices for Vegetable Crops* were followed from time to time to ensure a healthy crop stand. Data on different yield contributing characters were recorded and analyzed statistically as described by Panse and Sukhatme[11] for randomized block design (factorial).

RESULTS AND DISCUSSION

Effect of planting date

The planting dates had significant effect on 50% flowering, seed stalk diameter (cm), number of umbels per plant, disease incidence (%), number of lodged seed stalks, seed yield per plant (g), test weight (g), seed germination (%), seed vigour index I, seed vigour index II and EC of seed leachates (dS/m/seed) during both the years. The minimum number of days to 50% flowering (103.83 and 101.08 days) was recorded in plots where the crop was planted on first week of October (D_1), which might be due to the prevalence of low temperature during flowering stage of crop and the maximum number of days to 50% flowering (112.58 and 108.25 days) was

recorded in plots where the crop was planted on first week of November (D_3). The results confirm the findings of Anisuzzaman *et al*[1]., who found that days taken to 50% flowering were less in 30 October planted crop as compared to 21 November planted crop. Similar effect of planting time on days to 50% flowering was reported by Vianney *et al*[14]., and Ashagrie *et al*[2]. The significantly highest mean value for seed stalk diameter (5.79 and 5.92 cm) was recorded with crop planted on first week of October (D_1) followed by third week of October (5.63 and 5.73 cm), while the lowest value for seed stalk diameter (5.06 and 5.38 cm) was recorded with crop planted on first week of November (D_3) The results are in close conformity with the findings of Helaly and Karam[8], who recorded the maximum seed stalk diameter when the crop was planted early and minimum when the crop was planted late. The maximum number of umbels per plant (12.08 and 12.48) was observed in crop planted on first week of October (D_1). This might be because of low temperature and long day conditions received by the October planted crop during December-January since by this time, the plants reached to a stage of good growth, which might have contributed the highest number of umbels per plant. Mehri *et al*[10]., obtained the significantly maximum number of umbels per plant from the crop planted on 22 September and minimum from the crop planted on 5 November. The results of present study confirm the findings of Helaly and Karam[8]. The minimum incidence of disease (10.56 and 8.32%) was observed in crop planted on first week of October (D_1), while the maximum incidence of disease (13.73 and 13.13%) was observed in crop planted on first week of November (D_3), which might be due to coinciding with the period of rainfall, high humidity and high temperature especially during seed development stage, leading to severe disease prevalence, which resulted in drastic reduction in seed yield. The minimum mean number of lodged seed stalks (9.17 and 8.91) was recorded when the crop was planted on first week of October (D_1), which might be due to proper growth and development of the plants under favourable conditions, resulting in good crop stand, while the maximum (12.22 and 12.48) was recorded from crop planted on first week of November (D_3). The seed yield per plant decreased with the delay in planting. The crop planted on first week of October (D_1) resulted in maximum seed yield per plant (17.11 and 18.75 g), which might be due to the favourable climatic conditions for pollination, thereby more number of seed set per umbel and hence resulted in higher seed yield per plant, while the crop planted on first week of November (D_3) resulted in minimum seed yield per plant (11.71 and 13.60 g), which might be due to higher temperature and rainfall adversely affecting the pollination and seed set, resulting in lesser seed yield per plant. The reduction in seed yield in late-planted crop might also be due to flower abortion[8]. Similar results were reported by Helaly and Karam[8] and Ashagrie *et al*[2]. The maximum test weight (3.59 and 3.71 g) was registered with planting date first week of October (D_1) followed by third week of October planting (3.48 and 3.61 g), whereas, the minimum test weight (3.18 and 3.36 g) was registered with the planting date first week of November (D_3), which might be due to the fact that longer time was available for the development of seeds in early planted crop as compared to late planted crop, thereby resulting in bolder seeds. The results are in close conformity with the findings of Khan[9] and Uddin *et al*[13]., who reported that early planting of crop resulted in production of bolder seeds as compared to late planted crop. The maximum germination (80.59 and 82.81%) was observed in seeds harvested from the first week of October planting date (D_1) followed by third week of October planting date (D_2), while the minimum germination (73.88 and 77.17%) was observed in seeds harvested from the first week of November

planting date (D_3). The higher seed germination in early-planted crop might be due to favourable temperature and other climatic conditions for setting seeds and their development. These results corroborate the findings of Khan[9], Helaly and Karam[8] and Ashagrie *et al*[2]., who noticed significant effect of planting time on seed germination and recorded maximum germination of seeds harvested from early planted crop. The maximum value for vigour index-I (301.55 and 333.51) and vigour index-II (1088.06 and 1113.07) was registered in seeds extracted from the crop planted on first week of October (D_1). The highest vigor index in seeds obtained from early-planted crop might be due to their larger size caused by favourable conditions during growth and development of the crop. Similar results were also observed by Helaly and Karam[8] and Ashagrie *et al*[2]., who recorded the highest vigor index with seeds harvested from early-planted crop. The lowest value for electrical conductivity (0.26 and 0.23) was registered in seeds extracted from the crop planted in first week of October (D_1) followed by third week of October (0.27 and 0.24), which might be due to favourable conditions during growth and development of the seed crop, while the highest value for electrical conductivity (0.34 and 0.30) was recorded in seeds extracted from the crop planted in first week of November (D_3).

Effect of paclobutrazol

The different level of paclobutrazol showed significant differences in all the growth parameters except seed stalk diameter (cm) and disease incidence (%) during both the years. The minimum days to 50% flowering (106.44 and 102.89 days) was recorded under the treatment paclobutrazol 500 ppm (G_2) and it was found statistically at par with paclobutrazol 750 ppm- G_3 (107.89 and 104.33 days), whereas, the significantly maximum days to 50% flowering (110.44 and 107.44 days) was recorded under the treatment paclobutrazol 1000 ppm (G_4). Banko and Bir[4] and Burnett *et al*[6]., reported that the paclobutrazol has been shown to promote earlier flowering and increase the number of flowers in some plants. The maximum number of umbels per plant (11.92 and 12.41) was obtained from the crop sprayed with paclobutrazol 500 ppm (G_2) and the minimum number of umbels per plant (10.80 and 11.26) was obtained from the crop sprayed with paclobutrazol 1000 ppm (G_4). The results of present study are similar to the findings of Ashrafozzaman *et al*[3]., who noticed the significant decline in number of umbels per plant with increasing levels of paclobutrazol. The minimum mean number of lodged seed stalks (8.58 and 8.49) was recorded in plots where the crop was sprayed with paclobutrazol @ 1000 ppm (G_4), which might be due to the reason that paclobutrazol significantly reduced the plant height, resulting in minimum lodging of seed stalks. The maximum seed yield per plant (16.90 and 18.84 g) was recorded when paclobutrazol was sprayed at the rate of 500 ppm (G_2)), while the minimum (12.54 and 13.98 g) was recorded when paclobutrazol was sprayed at the rate of 1000 ppm (G_4). The results are in conformity with the findings of Ashrafozzaman *et al*[3]., who found that the increasing concentration of paclobutrazol had an inhibitory effect on seed yield, which decreased significantly with the increase in paclobutrazol concentration. The maximum test weight (3.65 and 3.80 g) was recorded when the plants were sprayed with paclobutrazol 500 ppm (G_2), whereas, the minimum test weight (3.12 and 3.29) was registered with the application of paclobutrazol 1000 ppm (G_4). The results are similar to the findings of Ashrafozzaman *et al*[3]., who observed that increase in levels of paclobutrazol reduced the test weight noticeably. The highest germination (80.11 and 83.07%) was recorded in seeds extracted from the crop sprayed with paclobutrazol 500 ppm (G_2), whereas, the lowest germination (75.67 and 77.31%) was recorded in seeds

harvested from the crop sprayed with paclobutrazol 1000 ppm (G_4). Pasian and Bennett[12] also reported reduced seed germination in ornamental kale and pepper with the increase in paclobutrazol concentration. The maximum value for vigour index I (307.26 and 342.06) and vigour index II (1113.59 and 1141.37) was registered with seeds extracted from crop sprayed with paclobutrazol 500 ppm. Berberich *et al*[5]., reported that increasing level of paclobutrazol resulted in a significant reduction in root and shoot length in passion flower. The lowest electrical conductivity (0.25 and 0.22) was recorded in seeds extracted from the crop sprayed with paclobutrazol 500 ppm (G_2) followed by no application of paclobutrazol (0.28 and 0.24), whereas, the highest electrical conductivity (0.33 and 0.32) was recorded in seeds harvested from the crop sprayed with paclobutrazol 1000 ppm (G_4) during the year 2013-14 and 2014-15, respectively.

Combined effect of fertilizers and plant spacing

The interaction effect of planting dates and paclobutrazol was statistically non-significant on seed stalk diameter (cm) and disease incidence (%), however, remarkable effect was observed on days to 50% flowering, number of umbels per plant, number of lodged seed stalks, seed yield per plant (g), test weight (g), seed germination (%), seed vigour index I, seed vigour index II and EC of seed leachates (dS/m/seed) during both the years. The crop planted on first week of October and sprayed with paclobutrazol 500 ppm (D_1xG_2) took the minimum number of days to 50% flowering (102.00 and 99.33 days), while the maximum (115.33 and 111.33 days) was registered with the crop planted on first week of November and sprayed with paclobutrazol 1000 ppm (D_3xG_4). The maximum number of umbels per plant (12.70 and 13.17) was recorded under the treatment combination first week of October and application of paclobutrazol 500 ppm (D_1xG_2), while the minimum (9.97 and 10.27) was recorded under first week of November and application of paclobutrazol 1000 ppm (D_3xG_4). The minimum number of lodged seed stalks (7.80 and 7.40) was recorded in crop planted on first week of October and sprayed with paclobutrazol 1000 ppm (D_1xG_4). The treatment combination first week of October and paclobutrazol 500 ppm (D_1xG_2) resulted in maximum seed yield per plant (19.33 and 21.57 g), while the treatment combination first week of November with paclobutrazol 1000 ppm (D_3xG_4) resulted in minimum seed yield per plant (9.67 and 11.07 g). The treatment combination first week of October planting with the application of paclobutrazol 500 ppm (D_1xG_2) showed the highest level of interaction effect on test weight (3.84 and 3.92 g), while the treatment combination first week of November planting and the application of paclobutrazol 1000 ppm (D_3xG_4) showed the lowest level of interaction effect on test weight (2.93 and 3.05 g). The maximum germination (82.67 and 85.20%) was recorded in seeds harvested from the crop planted on first week of October and sprayed with paclobutrazol 500 ppm (D_1xG_2), whereas, the minimum germination (70.67 and 73.43) was recorded in seeds extracted from the crop planted on first week of November and sprayed with paclobutrazol 1000 ppm (D_3xG_4). The maximum vigour index-I (329.39 and 371.40) and vigour index-II (1176.87 and 1198.69) was recorded in seeds extracted from the crop planted on first week of October and sprayed with paclobutrazol 500 ppm (D_1xG_2). The treatment combination first week of October planting with paclobutrazol 500 ppm (D_1xG_2) resulted in minimum electrical conductivity of seed leachates (0.22 and 0.19), whereas, the treatment combination first week of November planting with paclobutrazol 1000 ppm (D_3xG_4) resulted in the maximum electrical conductivity of seed leachates (0.37 and 0.38), during the year 2013-14 and 2014-15, respectively.

Table: 1. Effect of planting time and paclobutrazol on growth and seed characters of onion

Treatments	Days to 50% flowering		Seed stalk diameter (cm)		Number of umbels per plant		Disease incidence (%)		Number of lodged seed stalks		Seed yield per plant (g)	
	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15
Planting time												
D_1:First week of October	103.83	101.08	5.79	5.92	12.08	12.48	10.56	8.32	9.17	8.91	17.11	18.75
D_2: Third week of October	108.42	105.56	5.63	5.73	11.54	11.95	12.42	11.19	10.11	9.95	15.38	16.92
D_3 :First week of November	112.58	108.25	5.06	5.38	10.64	11.02	13.73	13.13	12.22	12.48	11.71	13.60
C.D. at 5%	1.47	1.66	0.17	0.19	0.21	0.37	1.35	1.40	0.70	0.64	1.14	1.49
Paclobutrazol												
G_1: Control	108.33	105.19	5.67	5.88	11.39	11.69	12.43	10.77	12.64	12.57	15.61	17.14
G_2: Paclobutrazol 500 ppm	106.44	102.89	5.55	5.73	11.92	12.41	12.54	11.41	11.20	11.15	16.90	18.84
G_3: Paclobutrazol 750 ppm	107.89	104.33	5.44	5.61	11.57	11.91	12.17	10.62	9.57	9.57	13.88	15.73
G_4: Paclobutrazol 1000 ppm	110.44	107.44	5.31	5.48	10.80	11.26	11.79	10.72	8.58	8.49	12.54	13.98
C.D. at 5%	1.70	1.92	N.S.	N.S.	0.24	0.42	N.S.	N.S.	0.81	0.75	1.32	1.32

Table: 2. Effect of planting time and paclobutrazol on growth and seed characters of onion

Treatments	Test weight (g)		Seed germination (%)		Seed vigour index I		Seed vigour index II		EC of seed leachates	
	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15
Planting time										
D_1:First week of October	3.59	3.71	80.59	82.81	301.55	333.51	1088.06	1113.07	0.26	0.23
D_2: Third week of October	3.48	3.61	79.25	81.28	284.02	315.99	1034.94	1068.90	0.27	0.24
D_3 :First week of November	3.18	3.36	73.88	77.17	252.49	271.00	950.09	984.22	0.34	0.30
C.D. at 5%	0.14	0.12	1.21	1.47	12.74	16.69	42.29	48.69	0.03	0.02
Paclobutrazol										
G_1: Control	3.49	3.59	78.94	81.61	291.16	323.28	1061.56	1092.04	0.28	0.24
G_2: Paclobutrazol 500 ppm	3.65	3.80	80.11	83.07	307.26	342.06	1113.59	1141.37	0.25	0.22
G_3: Paclobutrazol 750 ppm	3.40	3.52	77.12	79.49	267.76	291.18	1001.18	1036.37	0.29	0.28
G_4: Paclobutrazol 1000 ppm	3.12	3.29	75.67	77.31	250.22	271.82	921.12	951.46	0.33	0.32
C.D. at 5%	0.16	0.14	1.40	1.90	16.72	19.21	51.98	56.78	0.03	0.03

Table: 3. Interaction effect of planting time and paclobutrazol on growth and seed characters of onion

Treatment combinations	Days to 50% flowering		Seed stalk diameter (cm)		Number of umbels per plant		Disease incidence (%)		Number of lodged seed stalks		Seed yield per plant (g)	
	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15
D_1G_1	104.67	101.67	5.90	6.07	12.03	12.33	10.03	7.97	11.17	10.87	18.10	19.47
D_1G_2	102.00	99.33	5.83	5.95	12.70	13.17	11.30	8.63	9.20	9.03	19.33	21.57
D_1G_3	103.33	100.00	5.78	5.90	12.17	12.53	11.10	7.30	8.50	8.34	16.37	17.81
D_1G_4	105.33	103.33	5.65	5.77	11.40	11.90	9.82	9.37	7.80	7.40	14.63	16.17
D_2G_1	109.00	105.57	5.77	5.98	11.53	11.80	13.30	11.03	12.23	11.93	16.23	17.67
D_2G_2	106.67	103.33	5.61	5.80	11.93	12.36	11.70	11.97	10.83	10.66	17.80	19.07
D_2G_3	107.33	105.67	5.59	5.63	11.67	12.03	12.57	11.63	9.10	9.00	14.17	16.23
D_2G_4	110.67	107.67	5.53	5.50	11.03	11.60	12.10	10.13	8.27	8.20	13.33	14.70
D_3G_1	111.33	108.33	5.33	5.59	10.60	10.93	13.97	13.30	14.53	14.90	12.50	14.30
D_3G_2	110.67	106.00	5.20	5.43	11.14	11.70	14.63	13.63	12.57	12.77	13.57	15.90
D_3G_3	113.00	107.33	4.94	5.31	10.87	11.17	12.83	12.93	11.10	11.37	11.10	13.13
D_3G_4	115.33	111.33	4.75	5.17	9.97	10.27	13.47	12.67	9.67	9.87	9.67	11.07
C.D. at 5%	2.94	3.32	N.S.	N.S.	0.41	0.73	N.S.	N.S.	1.40	1.28	2.29	2.98

Table: 4. Interaction effect of planting time and paclobutrazol on growth and seed characters of onion

Treatments	Test weight (g)		Seed germination (%)		Seed vigour index I		Seed vigour index II		EC of seed leachates	
	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15
D_1G_1	3.68	3.76	81.17	83.80	309.77	343.42	1117.07	1155.03	0.23	0.20
D_1G_2	3.84	3.92	82.67	85.20	329.39	371.40	1176.87	1198.69	0.22	0.19
D_1G_3	3.54	3.67	79.87	81.87	292.03	314.92	1085.39	1099.53	0.28	0.24
D_1G_4	3.30	3.44	78.67	80.37	275.01	304.28	972.90	999.03	0.29	0.26
D_2G_1	3.56	3.69	80.40	82.37	296.52	330.77	1068.80	1092.92	0.26	0.23
D_2G_2	3.70	3.88	80.93	83.77	304.42	353.36	1114.63	1148.41	0.24	0.21
D_2G_3	3.48	3.58	78.00	80.27	272.59	298.96	1014.41	1054.19	0.30	0.26
D_2G_4	3.23	3.40	77.67	78.73	262.54	280.89	941.91	980.09	0.31	0.28
D_3G_1	3.28	3.47	75.27	78.67	267.20	292.65	998.81	1028.15	0.31	0.30
D_3G_2	3.40	3.60	76.73	80.23	287.98	301.42	1049.28	1077.02	0.29	0.29
D_3G_3	3.17	3.30	72.83	76.33	238.67	259.65	903.73	956.48	0.34	0.35
D_3G_4	2.93	3.05	70.67	73.43	216.11	230.29	848.54	875.25	0.37	0.38
C.D. at 5%	0.28	0.25	2.42	2.98	25.49	33.39	85.58	97.45	0.05	0.04

CONCLUSION

Based on the experimental results, it can be concluded that the crop planted on first week of October and sprayed with paclobutrazol 500 ppm was found the best for yield and quality of onion seed under semi-arid conditions of Haryana.

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