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EFFECT OF BULB SIZE AND PLANT SPACING ON SEED YIELD AND ECONOMICS OF ONION (*ALLIUM CEPA* L.) SEED PRODUCTION

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Abstract

The present investigation was conducted at the Sagdividi Farm, Department of Seed Science and Technology, College of Agriculture, Junagadh Agricultural University, Junagadh during *rabi* 2016-17 with an aim to study the effect of bulb size [B_1 (25 ± 5 g, small size), B_2 (50 ± 5 g, medium size) and B_3 (75 ± 5 g, large size)] and plant spacing [S_1 (30 cm × 30 cm), S_2 (30 cm × 40 cm), S_3 (45 cm × 30 cm), S_4 (45 cm × 40 cm), S_5 (60 cm × 30 cm) and S_6 (60 cm × 40 cm)] on seed yield and economics of onion seed production cv. Gujarat Junagadh White Onion 3 (GJWO 3). Significantly the highest seed yield per plant of 8.05 g and 7.55 g was obtained in the plants raised from the largest bulb size 75 ± 5 g (B_3) and at the spacing of 60 cm × 40 cm (S_6), respectively. Seed yield per hectare recorded significantly high in largest bulb size (288.78 kg/ha) and in medium spacing of 45 cm × 30 cm (S_3) (435.09 kg/ha). The treatment combination $B_3 \times S_3$ (bulb size 75 ± 5 g planted at the spacing of 45 cm × 30 cm) produced the maximum seed yield per hectare (526.71 kg/ha). The highest gross return (421368 ₹ /ha) was obtained from the seed harvested from bulb size (75 ± 5 g) planted at a spacing of 45 cm ± 30 cm ($B_3 \times S_3$) and it was followed by $B_3 \times S_1$ treatment combination (bulb size 75 ± 5 g and spacing 30 cm × 30 cm) with gross return 418496 ₹ /ha. The highest net return (288922 ₹ /ha) was obtained from the seed harvested from bulb size (75 ± 5 g) planted at a spacing of 45 cm × 40 cm ($B_3 \times S_4$) and it was followed by $B_3 \times S_3$ treatment combination (bulb size 75 ± 5 g and spacing 45 cm × 30 cm) with net return 285245 ₹ / ha. The highest benefit cost ratio (3.39) was obtained from the seed harvested from bulb size (75 ± 5 g) planted at a spacing of 45 cm × 40 cm ($B_3 \times S_4$) and it was followed by $B_3 \times S_6$ treatment combination (bulb size 75 ± 5 g and spacing 60 cm × 40 cm) with benefit cost ratio of 3.26.

Key words : Bulb size, plant spacing, seed yield, seed production, *Allium cepa* L.

Introduction

Onion (*Allium cepa* L.) is one of the most important commercial vegetable crop belongs to family *Amaryllidaceae* (*Alliaceae*) cultivated extensively in India. The name "Onia" is probably ranked to a city built by Onia in 1703 BC near the Gulf of Suez (Dawar *et al*., 2007). In India, onion has been grown from very ancient times, as it is mentioned in the *Charaka Samhita*, a famous early medical treatise of India (Anonymous, 2018). Onion is different from the other edible species of *Alliums* for its single bulb and is usually propagated by true botanical seed. Onion is an indispensable item in every kitchen as condiment and vegetable. Therefore, onion is popularly referred as *"Queen of Kitchen"*.

Generally, onion seed is produced from planting mother bulbs. The onion seed yield and high economic return is still dealt by small farmers, who have inadequate knowledge for selecting proper grade of the bulbs and plant spacing. Large size bulbs produced higher yield compared to smaller one but large bulb may not be always economic in respect of return (Rahim, 1991). Significant influences of bulb size on the number of umbels and seed yield of onion (Mollah *et al*., 1987). According to Mondal and Choudhury (1980), onion seed price is directly proportional to onion bulb price used for growing seed crop. The present study was, therefore, undertaken to find out the optimum mother bulb size and intra-row

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spacing needed to achieve the higher and economically feasible seed yield of onion cv. GJWO 3 for the Saurashtra area.

Materials and Methods

The present investigation was conducted at the Sagdividi Farm, Department of Seed Science and Technology, College of Agriculture, Junagadh Agricultural University, Junagadh during *rabi* 2016-17 with an aim to study the effect of bulb size [B_1 (25 ± 5 g, small size), B_2 (50 ± 5 g, medium size) and B_3 (75 ± 5 g, large size)] and plant spacing [S_1 (30 cm × 30 cm), S_2 (30 cm × 40 cm), S_3 (45 cm × 30 cm), S_4 (45 cm × 40 cm), S_5 (60 cm × 30 cm) and S_6 (60 cm × 40 cm)] on seed yield and economics of onion cv. Gujarat Junagadh White Onion 3 (GJWO 3). The experiment was laid out in field as per randomized block design (Factorial) with three replications. Seed yield was recorded on per plant basis and it was converted to per hectare basis. The cost of production was worked out in order to find out the most economic treatment of bulb size and spacing. All input cost included the cost for lease of land and interests on running capital in computing the cost of production. The economics was calculated according to the procedure prescribed by Alam *et al.* (1989).

Results and Discussion

Seed yield per plant (g)

The results presented in table 1 revealed that different levels of bulb size exerted significant effect on seed yield per plant (g). Significantly the highest seed yield per plant (8.05 g) was obtained in the plants raised from the largest bulb size 75 ± 5 g (B_3), whereas the lowest seed yield per plant (4.45 g) was obtained in the plants from the smallest bulb size 25 ± 5 g (B_1). Higher number of flowers per umbel and per plant caused by the highest sized bulbs increased the seeded fruits and finally seed weight per umbel as well as per plant. The determined results are in agreement with the results of Maria and Roman (2013), Jagtap *et al*. (2014) and Debashis *et al*. (2016) in onion. A gradual increase in seed yield per plant was recorded with the increase in plant spacing. Significantly the highest seed yield per plant (7.55 g) was produced by the bulbs spaced at the widest spacing of 60 cm × 40 cm (S_6) and the lowest seed yield per plant (5.23 g) was obtained from the bulbs having the closest spacing of 30 cm × 30 cm (S_1). The widest spacing 60 cm × 40 cm (S_6) was at par with 60 cm × 30 cm (S_5) with 7.25 g seed yield per plant. Widest spacing produced the largest length and diameter of umbel by uptake of more nutrients, which ultimately encourage the production of the highest number of flowers per umbel, number of seeded fruits per umbel and ultimately the seed weight per umbel and seed yield per plant. Mahadeen (2004), Elhag and Osman (2013) and Kumar *et al*. (2015) observed significantly the maximum seed yield per plant in wider spacing as against closest spacing. The interaction effect of bulb size and spacing on seed yield per plant was found to be non-

Table 1 : Effect of bulb size and spacing on seed yield per plant and seed yield per hectare (kg).

Treatment	Seed yield per plant (g)	Seed yield per hectare (kg)
Bulb size		
B_1 = 25 ± 5 g	4.45	288.78
B_2 =50 ± 5 g	6.91	394.27
B_3 =75 ± 5 g	8.05	501.87
Mean	6.47	394.97
S.Em.±	0.25	14.09
C.D. at 5 %	0.71	40.54
Spacing		
S_1 = 30 cm × 30 cm	5.23	426.77
S_2 = 30 cm × 40 cm	5.54	412.87
S_3 = 45 cm × 30 cm	6.53	435.09
S_4 = 45 cm × 40 cm	6.72	396.23
S_5 = 60 cm × 30 cm	7.25	362.05
S_6 = 60 cm × 40 cm	7.55	336.84
Mean	6.47	394.97
S.Em.±	0.35	19.93
C.D. at 5 %	1.00	57.32
Bulb size × spacing		
$B_1 \times S_1$	3.53	328.95
$B_1 \times S_2$	4.00	300.23
$B_1 \times S_3$	4.34	339.53
$B_1 \times S_4$	4.54	285.93
$B_1 \times S_5$	5.06	244.66
$B_1 \times S_6$	5.22	233.43
$B_2 \times S_1$	5.35	428.26
$B_2 \times S_2$	5.69	419.60
$B_2 \times S_3$	7.03	439.04
$B_2 \times S_4$	7.32	390.53
$B_2 \times S_5$	7.68	357.20
$B_2 \times S_6$	8.36	331.00
$B_3 \times S_1$	6.80	523.12
$B_3 \times S_2$	6.92	518.81
$B_3 \times S_3$	8.21	526.71
$B_3 \times S_4$	8.31	512.21
$B_3 \times S_5$	9.01	484.30
$B_3 \times S_6$	9.08	446.11
Mean	6.47	394.97
S.Em.±	0.60	34.52
C.D. at 5 %	NS	NS
C.V.%	16.12	15.14

significant. The treatment combination $B_3 \times S_6$ produced the maximum seed weight per seed yield per plant (9.08 g) followed by $B_3 \times S_5$ (9.01 g) and $B_2 \times S_6$ (8.36 g). The lowest seed yield per plant was recorded in treatment combination $B_1 \times S_1$ (3.53 g). The results are in akin to the results of Asaduzzaman *et al.* (2012b), Asaduzzaman *et al.* (2015), El-Damarany *et al.* (2015) and Haile *et al.* (2017) in onion.

Seed yield per hectare (kg)

The seed yield per hectare exactly followed the same declining trend with the decrease in bulb size as found in seed yield per plant, because the seed yield per hectare was calculated on the basis of seed yield per plant and converted to seed yield per hectare and analyzed (table 1). The largest bulb 75 ± 5 g (B_3) produced significantly the highest seed yield per hectare (501.87 kg). Higher number of flowers per umbel and per plant caused by the largest sized bulbs increased the seeded fruits and finally seed weight per umbel as well as seed yield per plant, per plot and per hectare. The results are in accordance to the findings of Ali *et al.* (2015), El-Damarany *et al.* (2015), Mollah *et al.* (2015) and Debashis *et al.* (2016), who reported that the large size bulb produced the higher seed yield per hectare. Analysis of data presented in table 1 showed that different plant spacing had produced significant influence on seed yield per hectare. Due to conversion of per plot yield into per hectare yield, seed yield per hectare was found significantly the highest (435.09 kg/ha) in medium spacing of 45 cm × 30 cm (S_3) and it was found at par with spacing of 30 cm × 30 cm (S_1), 30 cm × 40 cm (S_2) and 45 cm × 40 cm (S_4) with 426.77, 412.87 and 396.23 kg/ha seed yield, respectively. The results are in agreement with findings of Asaduzzaman *et al.* (2012a) and El Abas *et al.* (2016). The treatment combination $B_3 \times S_3$ produced the maximum seed yield per hectare (526.71 kg/ha) followed by $B_3 \times S_1$ (523.12 kg/ha) and $B_3 \times S_2$ (518.81 kg/ha). The results are in akin to the results of Asaduzzaman *et al.* (2015) and Haile *et al.* (2017) in onion.

Economics

Seed yield per hectare recorded under the field observations was used for the calculation of economics. Seed cost (Bulb cost) as treatment cost was calculated by multiplying the number of number of bulbs required in kg on hectare basis as per the spacing and average bulb size with its cost. The economic analysis was done to find out the gross and net return and the benefit cost ratio (BCR) in the present experiment and presented in table 2.

Table 2 : Economics of onion seed production.

S. no.	Treatments	Bulbs requirement (kg/ha)	Treatment cost (₹)	Common cost (₹)	Total cost (₹)	Seed yield (kg/ha)	Gross return (₹)	Net return (₹)	BCR
1.	$B_1 \times S_1$	2777.77	19444	75012	94456	328.95	263160	168704	2.78
2.	$B_1 \times S_2$	2083.33	14583	75012	89595	300.23	240184	150589	2.68
3.	$B_1 \times S_3$	1851.85	12963	75012	87975	339.53	271624	183649	3.08
4.	$B_1 \times S_4$	1388.90	9722	75012	84734	285.93	228744	144010	2.69
5.	$B_1 \times S_5$	1388.90	9722	75012	84734	244.66	195728	110994	2.31
6.	$B_1 \times S_6$	1041.68	7292	75012	82304	233.43	186744	104440	2.27
7.	$B_2 \times S_1$	5555.55	50000	75012	125012	428.26	342608	217596	2.74
8.	$B_2 \times S_2$	4166.65	37512	75012	112524	419.60	335680	223156	2.98
9.	$B_2 \times S_3$	3703.70	33333	75012	108345	439.04	351232	242887	3.24
10.	$B_2 \times S_4$	2777.80	25000	75012	100012	390.53	312424	212412	3.12
11.	$B_2 \times S_5$	2777.80	25000	75012	100012	357.20	285760	185748	2.86
12.	$B_2 \times S_6$	2083.35	18750	75012	93762	331.00	264800	171038	2.82
13.	$B_3 \times S_1$	8333.33	91667	75012	166679	523.12	418496	251817	2.51
14.	$B_3 \times S_2$	6249.98	68750	75012	143762	518.81	415048	271286	2.88
15.	$B_3 \times S_3$	5555.55	61111	75012	136123	526.71	421368	285245	3.09
16.	$B_3 \times S_4$	4166.70	45834	75012	120846	512.21	409768	288922	3.39
17.	$B_3 \times S_5$	4166.70	45834	75012	120846	484.30	387440	266594	3.21
18.	$B_3 \times S_6$	3125.03	34375	75012	109387	446.11	356888	247501	3.26

Small bulb= 7 Rs/kg Medium bulb= 9 Rs/kg Large bulb= 11 Rs/kg Price of onion seed = 800 Rs. / kg

Combination of different bulb size planted at different spacing showed different gross return. The highest gross return (421368 ₹ /ha) was obtained from the seed harvested from bulb size (75 ± 5 g) planted at a spacing of 45 cm x 30 cm ($B_3 \times S_3$) and it was followed by $B_3 \times S_1$ treatment combination (bulb size 75 ± 5 g and spacing 30 cm × 30 cm) with gross return 418496 ₹ /ha (table 2). The results presented in table 2 showed that combinations of different bulb size planted at different spacing showed different values of net return. The highest net return (288922 ₹ /ha) was obtained from the seed harvested from bulb size (75 ± 5 g) planted at a spacing of 45 cm × 40 cm ($B_3 \times S_4$) and it was followed by B_3 x S_3 treatment combination (bulb size 75 ± 5 g and spacing 45 cm x 30 cm) with net return 285245 ₹ /ha. The results presented in table 2 showed that combinations of different bulb size planted at different spacing showed different benefit cost ratio. The highest benefit cost ratio (3.39) was obtained from the seed harvested from bulb size (75 ± 5 g) planted at a spacing of 45 cm × 40 cm (B_3 x S_4) and it was followed by $B_3 \times S_6$ treatment combination (bulb size 75 ± 5 g and spacing 60 cm × 40 cm) with benefit cost ratio of 3.26.

Conclusion

The highest seed yield per hectare, net return as well as benefit cost ratio was obtained in treatment combination $B_3 \times S_4$ (bulb size 75 ± 5 g planted at the spacing of 45 cm × 40 cm) and it was followed by $B_3 \times S_6$ (bulb size 75 ± 5 g planted at the spacing of 60 cm x 40 cm). Looking to the seed yield per hectare, net return as well as benefit cost ratio, it is suggested that for getting the higher onion seed yield and net return, large size onion bulbs of Gujarat Junagadh White Onion 3 (GJWO 3) should be planted at the spacing of 45 cm × 30-40 cm.

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