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Seed Yield Components of Onion (*Allium cepa* var. C*epa*) as Influenced by Spacing Patterns and Bulb Treatment at Larena, Southern Ethiopia

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Abstract
Field experiment was conducted at Humbo Larena, wolaita zone during the 2012/2013 dry season, to study the effect of bulb treatment and spacing patterns on seed yield components of onion in the semi-arid zone of Ethiopia. Treatments consisted of a factorial combination of four levels of bulb types [whole bulbs, cut (topped) bulbs, ash-treated cut (topped) bulbs, and fungicide-treated cut (topped) bulbs] and four levels of spacing patterns (50 x 30 x 20 cm, 60 x 30 x 20 cm, 40 x 20 cm, and 50 x 20 cm) laid out in randomized complete block design replicated three times. The onion variety known as Bombay Red was used as a test crop. Results revealed that a day to 50% flowering was significantly influenced by bulb treatments but not spacing patterns. The main effects of bulb treatment and spacing pattern significantly influenced, plant height, number of umbels per plant and umbel diameter. Treatments were interacted to significantly influence percent stand count and number of flowering stalks per plant.
Keywords: "Onion (*Allium cepa* var. C*epa*)", "Bulb Treatment", "Spacing Patterns", "Ethiopia"

Introduction

Onion is one of the most important vegetable crops in Ethiopia which is used almost daily as a spice and vegetable in the local dish regardless of religion, ethnicity, and culture (CSSE, 2006). The diverse agro-climatic conditions that prevail in the country provide the opportunity of producing onion bulb, seeds and cut flower for local use and export market (CSSE, 2006). Onions are usually grown from seed, and flowering and seed production are important for crop production (Brewster, 1994). There are clearly enormous differences in average seed yields observed depending on genotype, locality, season, soil type, and method of seed production (Jones, 1963; Brewster, 1994).

As an important factor in determining seed yield of onion, plant spacing, varies from place to place as well as from variety to variety (Lemma and Shimeles, 2003). In addition, traditionally farmers cut off 1/3rd of the upper portions of mother bulbs before planting to encourage more sprouts per bulb and for early breakage of bulb dormancy, enhancing maturity and uniform flower stalk formation.

However, research in Southern Ethiopia as a whole and particularly at Wolaita zone has not yet recommended cutting and treating the seed bulbs before planting. Hence, it is vital to scientifically establish appropriate plant spacing and bulb treatment for maximizing onion seed yield. Therefore, determining effects of bulb treatment and spacing patterns on seed yield components of onion is the objective of the study presented in this paper.

Materials and Methods

Description of the study area

Field experiment was conducted at Humbo Larena, Wolaita Zone, Southern Ethiopia. It is located at 6^0 49'N and 37^0 45'E and lies on an altitude of 1483 meters above sea level. The annual average temperature of the zone is 20^{0}C and the mean annual rainfall ranges from 1200 to 1300 mm. The rainfall has a bi-modal distribution pattern with small rains from March to May and long and heavy rains from June to September. The zone covers an area of 44,721 km^2 and found in the altitude range of 1500 – 2100 masl. (Hailu *et al*., 2011).

Experimental Materials

An improved onion variety named Bombay Red was used for the study. This variety was released in 1980 by Melkassa Research Centre. The variety is adapted to areas with altitudes ranging between 700-2000 m above sea level (EARO, 2004).

Treatments and Experimental Design

The treatments consisted of planting bulbs that received four treatments [(whole bulbs cured for a week, cut (topped) bulbs cured for a week, cut (topped) bulbs rubbed with ash and cured for a week, and cut (topped) bulbs treated with a fungicide and cured for a week)] and four plant spacing patterns (50 x 30 x 20 cm double rows, 60 x 30 x 20 cm double rows, 40 x 20 cm single row, and 50 x 20 cm single row). The experiment was laid out as a randomized complete block design (RCBD) in a factorial arrangement, and replicated three times per treatment.

The plot size was 2.6 m x 3 m. A distance of 1 m was left between adjacent plots and a distance of 1.5 m was left between adjacent blocks.

Experimental Procedure

The bulbs were sorted for suitable size (medium/50-60mm diameter) and freedom from diseases as well as against early sprouts, split bulbs, and off types. The upper 1/3rd potions of the selected onion bulbs, other than the ones to be planted whole, were cut off using a sharp knife disinfected with alcohol. The lower 2/3rd portions of bulbs were rubbed with ash or a fungicide named Ridomil according to the planned bulb treatment. The ash or Ridomil powder was rubbed on to the cut surfaces of the bulbs in the same thickness of approximately 1-2mm. Curing was done before planting and immediately after treating the mother bulbs.

Bulb planting and cultural practices

Prior to planting the bulbs, the selected experimental land was ploughed. Planting the bulbs was done on 15 November 2012. The bulbs were planted at the specified spacing on ridges to the depth of about 5 cm and covered with soil. Fertilizer was applied at the rate of 92 kg N ha^{-1} and 138 kg P_2O_5 ha^{-1} using Urea and DAP (Diammonium Phosphate), respectively. The necessary cultural practices were employed uniformly.

Plant Data Collection and Analysis

Data were collected on days to 50 % flowering, % stand count, plant height, number of umbel per plant, umbel diameter and number of flower stalks per plant. From each plot, fifteen plants were randomly selected from the middle rows for collecting data to be expressed on plant basis.

Data were subjected to analysis of variance (ANOVA) procedure using (SAS, 2003). Differences between treatment means were separated using the Least Significant Difference (LSD) test at 5% level of significance.

Results and Discussion

Days to 50% flowering

The number of days required to reach 50% days to flowering was significantly ($P < 0.01$) affected by the main effect of bulb treatment but not to spacing patterns. Plants grown from whole bulbs flowered significantly earlier (68.50) than plants grown from cut or topped bulbs treated with ash or those treated with the fungicide (Table 1). This result is also in agreement with that of Rashid and Singh (2000) reported that topped bulb had more vigorous sprouting.

Plant height (cm)

Bulb treatment and spacing patterns significantly ($P < 0.05$) affected plant height. The tallest (83.37 cm) and the shortest (76.92 cm) plant height were obtained from fungicide-treated topped bulbs and whole bulbs, respectively. And also the tallest (83.03 cm) and the shortest (76.87 cm) plant height were recorded from single row spacing 50 x 20 and from double row spacing 50 x 30 x 20, respectively (Table 1). This could be attributed to the potency of the chemical in killing fungal pathogens or rot organisms. Similarly, Asare-Bediako *et al.,* (2007) reported that Benlate (a fungicide) completely inhibited rot pathogens growth in yam (*Dioscorea alata* Poir).

Stand count (%)

The interaction effects of bulb treatment and spacing patterns significantly ($P < 0.05$) affected stand count percentages .The highest (97.07 and 92.83) stand count percentages were recorded from the interaction of planting fungicide-treated cut (topped) bulbs at the single-row spacing of 50 x 20 cm and 40 x 20 cm, respectively. The lowest (39.18 and 43.90) stand count percentages were recorded from planting whole bulbs at the two double row spacing of 60 x 30 x 20 cm and 50 x 30 x 20 cm, respectively (Table 2). This effect could be attributed to interplant competition among plants for space, light, moisture, and nutrients at the higher population densities. Similarly, Higgins (1968) reported that in the narrow intra-row spacing, smaller plants were crowded out and they disappeared.

Number of flower stalks per plant

The interaction effects of bulb treatment and spacing patterns significantly ($P < 0.05$) affected number of flower stalks per plant. The highest(16.50) number of flower stalks per plant was, recorded from the interaction effect of planting fungicide-treated cut bulbs at the sparsest plant population density 50 x 20 cm and the lowest (10.03) number was recorded from the interaction effect of planting the whole bulbs at double row spacing 60 x 30 x 20 cm (Table 3). This effect could be due lower competition among flower stalks for growth resources. This result is concurrent with the findings of Ogundana (1971), who reported that yam tubers treated with fungicides such as Benlate and Captan were reported to be free from fungal rots.

Table 1. Main effects of bulb treatment and spacing arrangements on days to 50% flowering and plant height in onion seed production of variety Bombey red

Treatment	Days to 50% flowering	Plant height (cm)
Bulb treatments		
Whole bulb	68.50b	76.92b
Cut bulb	68.58b	77.85b
Ash-treated cut bulb	68.83b	79.66b
Fungicide-treated cut bulb	71.08a	83.37a
F-test	**	*
LSD (5%)	1.071	3.279
Spacing (cm)		
50 x 30 x 20	69.58	76.87c
60 x 30 x 20	69.33	77.36bc
40 x 20	69.17	80.53ab
50 x 20	68.92	83.03a
F-test	Ns	*
LSD (5%)	1.071	3.279
CV (%)	1.9	4.9

Means followed by the same letter within a column are not significantly different at 5% level of significance; Ns = non significant; *, ** = significant at 5% and 1% levels of significance, respectively; LSD = least significant difference at 5% level of significance; CV = Coefficient of variation

Table 2. Interaction effect of bulb treatment and spacing patterns on percent plant stand count in onion seed production of variety Bombey red.

	Stand count (%)			
	Bulb treatment			
Spacing (cm)	Whole bulb	Cut bulb	Ash-treated cut bulb	Fungicide-treated cut bulb
50x30x20	43.90fg	50.67ef	55.79de	76.64b
60x30x20	39.18g	59.92de	62.38cd	79.34b
40 x 20	71.95bc	74.08b	77.08b	92.83a
50 x 20	81.38b	81.26b	81.06b	97.07a
F-test	*			
LSD (B x S) (5 %)	4.897			
CV (%)	8.4			

Means followed by the same letter are not significantly different at 5% level of significance. *= significant at 5% level of significance; LSD (5%) = least significant difference at 5% level of significance; B = Bulb treatment; S = Spacing; CV = Coefficient of variation

Table 3. The interaction effect of bulb treatment and spacing patterns on the number of flower stalks per plant and seed yield per ha of variety Bombay red onion seed.

	Number of flower stalks plant^{-1}			
	Bulb treatment			
	Whole bulb	Cut bulb	Ash-treated cut bulb	Fungicide-treated cut bulb
Spacing (cm)				
50 x 30 x 20	10.67efg	11.33c-g	10.00g	11.70c-g
60 x 30 x 20	10.03fg	11.90c-f	11.67c-g	12.87bcd
40 x 20	11.00d-g	12.10b-e	13.87b	12.90bc
50 x 20	12.83bcd	12.80bcd	12.77bcd	16.50a
F-test			*	
LSD (B x S)			0.938	
CV (%)			9.2	

Means followed by the same letter are not significantly different at 5% level of significance. * = significant at 5% and 1% levels of significance; LSD = least significant difference at 5 % level of significance; B = Bulb treatment; S = Spacing; CV = Coefficient of variation

Number of umbels per plant

Bulb treatment and spacing patterns significantly ($P < 0.01$) affected the number of umbels per plant. The highest (8.2) and the lowest (4.71) number of umbels per plant were recorded from fungicide-treated topped bulbs and whole bulbs, respectively. And also the highest (7.23) and the lowest (4.95) number of umbels per plant were recorded from 50 x 20 spacing and from 50 x 30 x 20 spacing, respectively (Table 4).This may be attributed to the growth of more shoot primordia in cut-and fungicide-treated bulbs due to removal of apical dominance. Similarly, Asare-Bediako *et al.* (2007) who reported that plants raised from Benlate (fungicide)-treated minisetts of yam (Dioscorea alata Poir) were more vigorous than those raised from minisetts sterilized only with distilled water.

Umbel Diameter (cm)

Bulb treatment and spacing patterns significantly ($P < 0.05$) affected umbel diameter. The widest (6.48 cm) and the lowest (5.39 cm) umbel diameter were recorded from fungicide-treated cut bulbs and whole bulbs, respectively. And also the widest (6.25 cm) and the lowest (5.47) umbel diameter were recorded from 50 x 20 spacing and from 50 x 30 x 20 spacing, respectively (Table 4). Similarly, Asare-Bediako *et. al.* (2007) who stated that yam tubers were treated with Benomyl as a protective and eradicant fungicide with systemic activity and effective against a broad range of fungi.

Table 4.The main effects of bulb treatment and spacing arrangement on number of umbels per plant, umbel diameter, and seed weight per umbel of variety Bombay red onion seed.

Treatment	Umbel no. plant^{-1}	Umbel diameter (cm)
Bulb treatment		
Whole bulb	4.71c	5.39b
Cut bulb	5.43bc	5.55b
Ash-treat.cut bulb	5.93b	5.76b
Fung.-tr. cut bulb	8.20a	6.48a
F-test	**	*
LSD (5%)	0.982	0.5485
Spacing (cm)		
50 x 30 x 20	4.95b	5.47b
60 x 30 x 20	5.01b	5.49b
40 x 20	7.08a	5.96ab
50 x 20	7.23a	6.25a

F-test	**	*
LSD (5%)	0.982	0.5485
CV (%)	19.4	11.4

Means followed by the same letter within a column are not significantly different at 5% level of significance. *'** = significant at 5% and 1% levels of significance; LSD = least significant difference at 5% level of significance

Conclusion

The maximum onion seed yield components were obtained from planting fungicide-treated cut bulbs with the single row spacing (50 cm x 20 cm). And the lowest was obtained from planting whole bulbs with the double row spacing (50 x 30 x 20 and 60 x 30 x 20). On the other hand, the earliest days required to 50% flowering was obtained from untreated whole bulb.

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