P-ISSN: 2305-6622; E-ISSN: 2306-3599

International Journal of Agriculture and Biosciences

www.ijagbio.com; editor@**ijagbio**.com

Research Article

Effect of Different Planting Time on Seed Yield and Quality of Onion (*Allium cepa* L.) in Tigrai Region, Northern Ethiopia

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Article History: Received: April 21, 2020 Revised: August 23, 2020 Accepted: October 10, 2020

ABSTRACT

Yield and quality of onion seeds is highly affected by environmental conditions during growth and development. Therefore, field experiment was conducted in Axum district for two consecutive years from 2016 to 2017 cropping season to assess influence of bulb planting time (September 30, October 15, October 30, November 15, November 30, December 15 and December 30) on growth, yield and seed quality of onion. The experiment was laid out in a randomized complete block design with three replications. The combined analysis revealed that planting time of onion bulb influenced all the parameters scored significantly ($P<0.01$). Delaying planting time of onion bulb significantly enhanced earliness of both days to bolting and flowering, where the maximum values was observed in planting time of October 15 (69.92 and 84.89, respectively). Thus, planting time of September 30 induce late maturity (144.83). On the other hand, their minimum days were obtained from late planting time of December 30 (56.67, 65.67 and 128.00 respectively). In line with this, across the different planting time highest values of plant height, stalk height, flower stalk per plant, stalk diameter, umbel diameter, yield, seed yield per plant and thousand seed weight (83.35 cm, 76.90 cm, 7.73, 7.05 mm, 58.55 mm, 27.72 qt/ha, 13.59 g/plant and 3.4 gram respectively) was observed in planting time of September 30. However, their least values (67.93 cm, 67.93 cm, 6.75, 5.83 mm, 48.40 mm, 14.65 qt/ha, 6.05 g/plant and 2.27 gram respectively) was attained in the planting time of December 30. As recommendation, early planting time of September 30 was appropriate planting time to produce high and quality seed yield of onion in Central Zone of the Tigray region.

Key words: Onion, Planting time, Seed yield, Quality and maturity.

INTRODUCTION

Onion (*Allium cepa* L.) is the one of the most economically important members of the family Alliaceae and widely grown herbaceous biennial vegetable crop. It has a cross pollination and monocotyledonous behavior having diploid chromosome number (2n=16) (Bassett, 1986). Onion is different from the other edible species of Alliums for its single bulb and is usually propagated by true botanical seed. In Ethiopia, onion can grow between 500 and 2400 meter above sea level but the suitable growing altitude so far known is between 700 and 1800 m.a.s.l (Lemma *et al*., 1994). Suitable soil PH for onion ranges between 6.2 and 6.8 (Karim and Ibrahim, 2013). Onion contributes significant nutritional value to the human diet and has medicinal properties and is primarily consumed for its unique flavor or for its ability to enhance the flavor of other foods (Randle, 2000).

Onion seed production is a vital part in onion growing and a highly specialized business requiring particular knowledge and training. Steady supply of good quality seed is a prerequisite for the successful accomplishment of high production of acceptable onions as fresh bulbs or dehydrated, either for local consumption or for export. The production of onion seed with highly depends on a number of factors. The most important one includes storage methods, bulb size, planting time and harvesting time. Moreover, onion seed production varies with cultivar, location, growing season and adequate plant protection measures (Lemma and Shimeles, 2003).

Lack of cool weather condition to induce flowering is the main constraints of onion seed production in many tropical countries where the winter season provides the chilling requirements for flowering. Mother bulb size and planting time has markedly influenced onion seed production. An increase in bulb size results in higher seed yield although large sized bulbs need a very high seed rate (Khokhar, 2000).

Cite This Article as: Tekle G, F Belay and S Chernet, 2020. Effect of different planting time on seed yield and quality of onion (*Allium cepa* L.) in tigrai region, Northern Ethiopia. Int J Agri Biosci, 9(5): 216-220. www.ijagbio.com

Central Zone of Tigray has enormous potential irrigation water for vegetable production especially onion and hence, growers are using different onion varieties in the different irrigation schemes. Bombay red is the widely used variety by farmers in the areas. It is known that using improved seed plays key role in enhancing production and productivity of crops. However, most of the growers are obtaining seed through the informal system mainly from the local market (unknown source) where seed purity and quality is often compromised. Nevertheless, domestic seed production and formal seed sources has advantages over the imported seed. Accordingly, farmers can get seed with reasonable price and reduce risk of introducing unknown diseases, higher adaptability performance and germination percentages. Having under consideration of this, growers of the Zone try to multiply and maintain their own seed source in the different irrigation schemes. However, onion seed production requires specific planting time for the production of higher seed yield, hence the study was conducted to assess the effect of different bulb planting time on seed yield and quality of onion under Central Zone environmental condition.

MATERIALS AND METHODS

Description of the study area

The study site is located at La'elay Maichew Woreda, Central Zone of the Tigray region. It is located at latitude of 13^0 15' N and longitude of $38^0$34' E with an altitude of 2148 m.a.s.l. in semi-arid tropical belt of Ethiopia with "W*eina dega*" agro climatic zone. The rainy season is mono-modal concentrated in one season from July to September and the average rain ranges from 700-800mm per annum. The mean minimum and maximum temperature ranges from 8.7^0C to13.2^0C and 24.4^0C to 31.4^0C respectively.

Experimental materials, treatments and design

Bombay red onion variety was used in this study. The experimental was laid out in a randomized complete block design (RCBD) using three replications. The treatments consisted of seven planting time (September 30, October 15, October 30, November 15, November 30, December 15 and December 30). Following the usual tillage practice the experimental field was harrowed to a fine tilth before planting the bulbs. Each planting time was assigned to the experimental units randomly. The blocks were separated by 1.5 m width whereas the spacing between each plot within a block was 1 m. The spacing between furrows, spacing between rows on the ridge and plants was kept at 50 cm, 30 cm and 20 cm respectively. The plot size was 2 meter by 2 meter (4 m^2).

Fertilizer of Diamonium Phosphate (DAP) was applied in the rate of 200kg/ha for all plots uniformly. The nitrogen source, Urea (150 kg/ha) was applied. All phosphorus fertilizer was applied at planting as a single application and incorporated to the soil on the prepared ridges in bands. Nitrogen was side dressed in two splits of equal amounts after 3 and 6 weeks of bulb planting. Weeding and hoeing was done manually by hand weeding and hoeing. The crop was harvested when 80% of the flower stalk matured.

Data collection

Data on yield and yield components and related traits consisting of days to bolting, days to flowering, days to maturity, plant height, flower stalk height, umbel diameter, number of flower stalk per plant, weight of seeds per umbel, seed yield per plant, seed yield per hectare, weight of thousand seeds was collected.

Data analysis

The data were subjected to analysis of variance (ANOVA) using SAS version 9.1.3 computer software (SAS Institute Inc., 2004). List Significant Difference (LSD) was used to separate and compare treatment means at 5% probability level of significance.

RESULTS AND DISCUSSION

Days to bolting

The analysis of variance revealed that there was statistically highly significant ($P<0.01$) difference among the different planting time of onion in days to bolting (Table 1). The highest days to bolting was obtained from onion bulbs planted during both November 15 (69.92) and September 30 (68.17). On the other hand, the earliest (56.67) in days to bolting was observed during the late planting time of December 30. The delay in days to bolting in response to the early planting time of onion may be attributed to the availability of suitable condition for growth which leads to growth of vegetative instead of growing the flower stalk, which in turn extends vegetative growth as a result of which it leads to delayed bolting.

Days to flowering

Planting time had highly significant ($P<0.01$) effects on the days to 50% flowering. The onion planted on October 15 captured the longest (84.89) days to 50% flowering (Table 1). However, this was not statistically significant difference with the planting time of September 30 (83.67 days) and November 15 (81.11 days). On the contrary, December 30 planted onion bulbs took the shortest time (65.78 days) for 50% flowering which did not statistically significantly different with planting time of December 30 and November 30. The delay in days to flowering at onion bulbs planted during the September 30 and October 15 might be due to suitable growing condition for vegetative growth and finally leads to delay in development of flower stalk. This result is concordant with the findings of Anisuzzamani (2009) who reported that highest days to flowering of onion were recorded from planting time of October 30 as compared with planting time of November 10 and November 21.

Days to maturity

The combined analysis variance of onion planting time indicated that there was statistically significant ($P<0.01$) difference among the different planting time in days to maturity (Table 1). Delaying planting time markedly shortened the days to maturity of the onion crop across the planting time. Planting during September 30 and October 15 has led to significantly delayed in maturity time (144.83 days) and (142.67 days) (Table 1) respectively. On the other hand, the shortest (128.00 days) in days to maturity was attained in bulb planting time of December 30.

Table 1: Effect of onion bulb planting time on phenology and growth parameters of onion seed yield

Planting time	Days to bolting	Days to flowering	Days to maturity	Plant height (cm)	Stalk height (cm)	Number of umbel per plant
November 15	69.92a	81.11a	133.25c	77.22c	66.59cd	7.10ab
September 30	68.17ab	83.67a	144.83a	83.35a	76.90a	7.73a
October 30	66.83bc	75.33b	137.67b	79.95bc	70.77bc	7.32ab
October 15	66.50bc	84.89a	142.67a	82.63ab	74.33ab	7.28ab
November 30	64.75c	69.78c	133.50c	72.53d	64.53de	6.97ab
December 15	61.00d	66.56c	131.83c	71.48d	63.77de	7.05ab
December 30	56.67e	65.78c	128.00d	67.93e	61.42e	6.75b
CV (%)	5.72	5.70	2.54	5.25	7.50	14.95
LSD (5%)	3.03	4.09	2.82	3.28	4.19	0.88

Table 2: Effect of onion planting time on the stalk diameter, yield and seed yield of onion

Planting time	Stalk diameter (mm)	Umber diameter (mm)	Yield (qt/ha)	Seed yield per plant (gram)	Thousand seed weight (g)
November 15	6.19cd	52.83b	18.12c	10.77ab	2.83cde
September 30	7.05ab	58.55a	27.72a	13.59a	3.4ab
October 30	6.66bc	56.57a	22.02b	10.07b	3.03bcd
October 15	7.29a	56.07a	25.12a	10.15b	3.33abc
November 30	6.30cd	49.02c	16.62cd	6.24c	2.67def
December 15	6.10d	49.12c	17.80c	7.89bc	2.43ef
December 30	5.85d	48.40c	14.65d	6.05c	2.27f
CV (%)	9.99	6.84	16.23	37.62	10.35
LSD (5%)	0.53	2.96	2.70	3.32	0.53

The earlier days to maturity depicted from late planting treatments might be due to unavailability of suitable environmental condition for growth and development of the vegetative part and then plants tends to escape from the bad weather conditions and diseases, hence tends to quickly reach maturity. This result is consistent with the findings of Laskowska*et al*. (2012) who reported late maturity in onion plants in response to the earlier planting time.

Plant height (cm)

The analysis of variance revealed that the effects of planting time had statistically significant ($P<0.01$) influence on plant height of the onion bulb plants (Table 1). Delaying the planting time significantly decreased onion plant height. Thus, planting time of September 30 attained the highest plant height (83.35 cm). However, the shortest plant height (67.69 cm) was recorded for onion bulb plants planted at late planting of December 30. The lowest plant height achieved during late planting might be due to less suitable environmental conditions for growth and development of the onion plants and instead the plants forced to maturity which shortens the plant height. Consistent with the results of this study, Ud-Deen (2008) indicated that shorter plant height of onion was belonged to late planting of November 30 (56.26 cm) as compared with early planting time of November 15 (59.29 cm) and October 30 (62.29 cm).

Stalk height (cm)

Increasing the planting time of onion from September 30 to December 30 has led to a highly significantly ($P<0.01$) decrease in stalk height (Table 1). Thus, the highest stalk height was observed from earlier planting time of September 30 (76.90 cm) and followed by October 15 (74.33 cm) but these two mean values were not statically different from each other (Table 1). On the other hand, the lowest stalk height was achieved at planting time of December 30 (61.42 cm). However, this planting time was statistically different to planting time of both November 30 and December 15. The reason for maximum stalk height achieved during the planting time of September 30 might be due to environmentally suit for growth and development of the vegetative part and finally the stalk height reaches maximum. The result of this study is in accord with the study of Asgharzadeh (2016) who reported that maximum stalk height was attained during early planting time as compared with late planting.

Number of umbels per plant

The effects of planting time showed highly significant ($P<0.01$) difference on number of umbels per plant (Table 1). Planting time of September produced the maximum (7.73) number umbel per plant (Table 1). On the other hand, the minimum (6.75) number of umbel per plant was recorded from onion bulbs planted during the delay planting time of December 30. The maximum umbel number per plant obtained from the early planting of September 30 might be due to production of high number of bolters in this treatment which resulted in a greater number of flower stalk. The present finding is in agreement with the results of Ud-Deen (2008) who indicated that higher number of umbel per plant was obtained were found in 30 October planting time, which was significantly higher than other two late planting dates.

Stalk diameter (mm)

The combined analysis of variance of indicated that effect of onion bulb planting time had highly significant ($P < 0.01$) differences on flower stalk diameter (Table 2). The maximum stalk diameter of onion was obtained at the planting time of both September 30 (7.05 mm) and October 15 (7.29 mm). However, the lowest stalk diameter was recorded at November 30 planting time. Thus, this planting time was statistically different from the planting time of both December 15 and November 30. The highest stalk diameter obtained at planting time of September 30 and October 15 might be due to the plants received comparatively suitable condition for vegetative growth and leads to wider the flower stalk. Supporting the current study, El-Helaly and Karam (2012) reported that higher values of stalk diameter were observed in earlier planting of onion.

Umbel diameter (mm)

Different planting times of onion showed highly significant (P<0.01) differences on umbel diameter by the combined effects of both year and location (Table 2). Onion bulbs planted at September 30 October 15 and October 30 was produced the highest values of umber diameter. However, onion bulbs planted during December 30 was achieved the lowest umber diameter. However, this was not statistically significant different among the planting time of November 30 and December 15. Production of high umbel diameter planted during the early time of September 30 might be attributed the suitability for growth of the onion. The current result is also similar with Laskowskaet *al*. (2012) who reported that late planting of onion produced less umbel diameter as compared to the earlier planting time.

Seed yield (qt/ha)

The effect of planting time was significantly (P <0.01) influenced the seed yield of onion (Table 2). Bulbs planted during the early time of both September 30 and October 15 produced the maximum of onion seed yield per hectare (27.72qt/ha) and (25.12qt/ha) respectively. On the other hand, the minimum seed yield of onion was attained during December 30 planting. The production of maximum seed yield obtained during the early planting time of September 30 might be associated with suitable growing condition of onion which leads to increment in plant size, umbel number and umbel diameter and higher seed yield per plant; plants of late planting time were also subjected to adverse high temperature during December and January. The current result is supported by El-Helaly and Karam (2012) who reported that minimum seed yield of onion was performed in the late planting time as compared to earlier planting.

Seed yield per plant (gram)

Statistical analysis of variance reflected that different planting time of onion showed highly significant (P<0.01) effect on seed yield of onion per plant (Table 2). The maximum yield of seed per plant was explained in planning time of September 30. However, the minimum seed yield per plant was recorded from the planting time of December 30. The reduction in seed yield as a result of late planting time was might be due to flower abortion and low seed yield per plant. These results are in harmony with (El-Helaly and Karam, 2012) who indicated that the maximum seed yield per plant was recorded from the early planting of onion as compared to the late planting.

Thousand Seed weight

The combined analysis of variance indicated that there was statistically significant (P<0.01) difference in thousand seed weight among the different planting time of onion. Hence, the highest thousand seed weight was observed at earlier planting time of September 30. On the contrary, the minimum thousand seed weight was recorded from late planting time of December 30. The increase in thousand seed weight recorded from the earlier planting time might be due to more favorable environmental condition for development of the flower stalk and leads the seed in the umbel which finally weigh higher. Weight of thousand seed yield of onion decreased with the delay in planting time as reported by Ud-Deen (2008).

Conclusion and recommendations

Planting bulbs at the proper timing is extremely important for its higher seed yield. Onion seed production is a vital part in onion growing and is a highly specialized business requiring particular knowledge and training. Steady supply of good quality seed is a prerequisite for the successful accomplishment of high production of acceptable onions as fresh bulbs or dehydrated either for local consumption or for export. The production of onion seed highly depends on a number of factors. The most important one includes storage methods, bulb size, planting time and harvesting time. Moreover onion seed production varies with cultivar, location, growing season and adequate plant protection measures.

Seed production influenced by many factors (including appropriate planting time) resulted in amount of seed and quality and seriously affected the price of the seed. Thus, higher onion seed yield can be obtained by adjusting appropriate planting time. The present analysis reveals that there was highly significance difference among the different parameters as affected by the different planting time treatments. The delay in planting time of onion shortens the days to bolting, days to flowering and days to maturity. On the contrary, the growth, yield and yield components of onion seed production decreases with delaying in planting time. As recommendation, in Central Zone of the Tigray region, the favorable planting time to produce high seed yield with best quality of onion is on September 30, followed by October 15.

Acknowledgements

Axum agricultural research center is greatly acknowledged for financing expenses of the whole study and supporting transport access for the researchers.

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