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Determination of appropriate planting time for better seed yield of onion (*Allium cepa*) varieties at selected districts of Gamo Zone, Southern Ethiopia

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Abstract

Onion is among the important vegetable crops commercially grown both by large and small scale farmers in Ethiopia as well as Arba Minch area. Its seed production (high seed yield and quality) depends on a number of factors such as planting date, bulb size, varieties, soil fertility, growing environments, plant population and adequate plant protection measures. Among these factors, planting time, varieties and growing environment are believed to have a remarkable influence on seed production of onion. The main objective of this study is to determine appropriate planting time for onion seed production and to select high seed yielder onion variety. Mother bulb was produced during June to August and the bulbs are stored in diffused light storage (DLS) about 3o days. Field experiment was conducted in Gamo Zone, Mirab Abaya woreda for two successive years (2021 - 2022) using spacing of 40cm x 20cm in Plot size of 3m x 2m.The experiment consisted of two varieties (Bombay red & Nafis) and four planting times (Mid September, Early October, Late October & Early November) in completely randomized block design in factorial arrangement replicated three times. ANOVA revealed that highly significant differences among treatments ($P<0.01$) were observed for most characters studied. Mean performance of combined result indicated that variety Bombay red planted in mid October gave highest seed yield (1178.3 kg/ha) whereas the lowest seed yield was recorded from the same variety planted at early October (415.0 kg/ha). Therefore, variety mid October is recommended as a suitable planting time of seed production for variety Bombay red and to be popularized in the study area for better onion seed yield production.

Keywords: Mid October; Onion seed; Seed Quality; Planting time; Seed Yield; Variety

1. Introduction

Onion (*Allium cepa* L.) is the most common member of the family *Alliaceae* and the widely grown biennial vegetable crop originated in Iran to Pakistan (Bassett, 1986; Brewster, 1994). It is one of the most important vegetable crops grown in Ethiopia. It also occupies an economically important rank among vegetable crops in the country. According to CSA (2018) data, total annual production of onion was 293,887.6 tons from an area of 31,673.21 hectares with the average productivity of 9.3 t ha^{-1}. Seed is the basic and essential input for any crop production (Karim et al, 1999).The price of onion botanical seed remains high in the season of onion cultivation. Seed production is a vital part in onion growing and is highly specialized business (FAO, 2013). The yield of onion seed in our country varies from 1000 - 1300 kg ha-1 (Dessagn *et al*. 2006), 116.32 -118.2 kg ha-1 (Tesema, 2006), 75.15 - 1155.75 kg ha-1 (Ashagrie, 2014) and 748.9 - 879.4 kg ha-1 (Amare, 2014) which is very low compared to the average seed yield in some other countries of the world, 600 - 2000 kg ha-1 (Chadha et al, 1997) and 828 - 1446 kg ha-1 (Aminpour & Mortzavi Bak, 2004).

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Onion is mostly grown under irrigation condition and the amount of land under onion cultivation is steadily increasing in Ethiopia mainly because of expanding irrigation systems, high profitability, and ease of production (Olani and Fikre, 2010). Similarly, the demand for quality onion seed is steadily increasing over time (Amsalu *et al*., 2014) in major crop growing areas of Ethiopia including Gamo zone. However, onion seed in Ethiopia is either imported or produced by informal seed producers. As a result, inadequate seed supply, high price and lack of quality seed are becoming the major bottlenecks in onion production (Olani and Fikre, 2010); farmers in the study areas are facing a challenge with spending more time in searching onion seeds.

Onion seed production (high seed yield and quality) depends on a number of factors such as planting date, bulb size, varieties, soil fertility, growing environments, plant population and adequate plant protection measures (Lemma and Shimelis, 2003; Olani and Fikre, 2010). Among these factors, planting time, varieties and growing environment have marked influence on seed production of onion. Although Gamo zone, especially Arba Minch area has very suitable agro-ecology and irrigation facilities for seed production, studies on the effect of planting time on onion seed production are limited which calls for area specific research work. As far as onion seed production is concerned, identification of suitable environments for onion varieties (open pollinated) and selection of appropriate planting time to synchronize the crop growth stages (time of flowering and maturity) during dry season is crucial for high quality seed yield. Therefore, this study was initiated with following objectives.

Objectives

- To determine appropriate planting time for onion seed production for the study areas,
- To select high seed yielding onion variety/ies.

2. Material and methods

2.1. Description of the study area

Field experiment was conducted in Mirab Abaya woreda of Gamo Zone, Southern Ethiopia for two consecutive years (2021-2022). The study site is found in an altitude range of 1001 to 3000 m.a.s.l. Mirab Abaya is located between 6˚38'-6˚64'N latitude and 37˚54'- 37˚82'E.longitude with an average annual rain fall of 801-1600 mm. The area's mean temperature ranges between 15.1 – 25 ˚C.

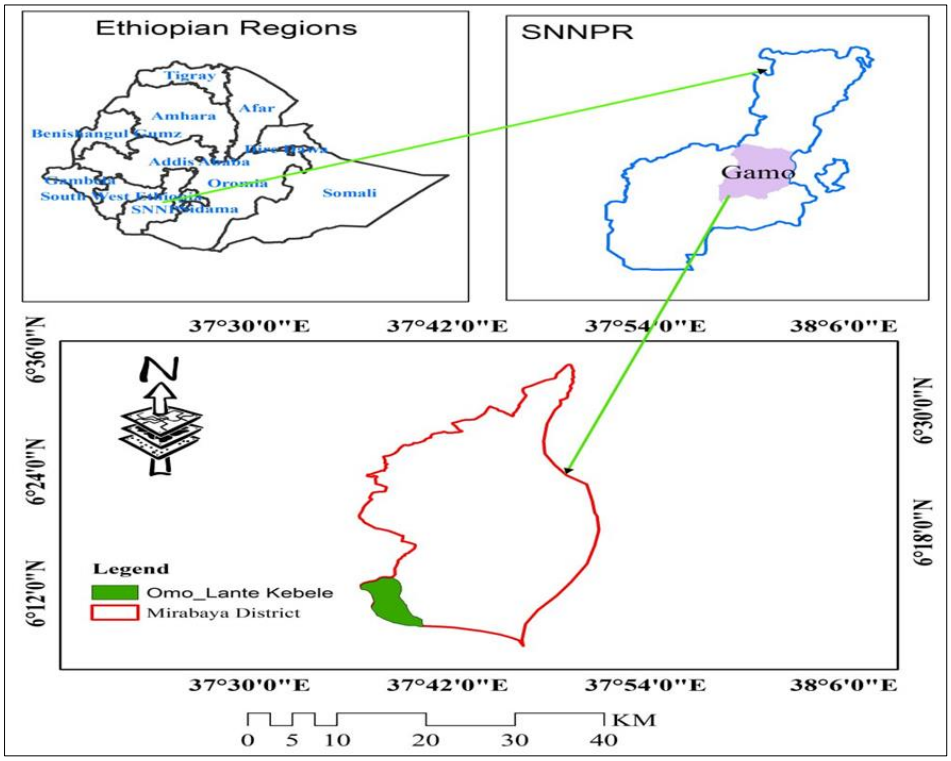

Figure 1 Map of the study area

2.2. Experimental Materials, Design and Trial Management

For mother bulb production seeds of two onion varieties (Bombay red and Nafis) were sown in separate seedbeds and grown at the nursery for 50 days. Uniformly grown seedlings of 13-15 cm height were selected, hardened and transplanted in to two large plots using spacing of 40cm X 10cm between rows respectively. After harvesting, medium sized mother bulbs were selected and kept in diffused light storage (DLS) room until planting. A total of eight treatment combinations (two varieties and four planting times; namely, Mid September, Early October, Mid October and Early November) were laid out in randomized complete block design (RCBD) with three replications in factorial arrangement. Finally, sprouted mother bulbs were planted using spacing of 40cm X 20cm on 3m X 2m sized plot. A gang way of 2 m and 1.5 m was maintained between replications and plots. All appropriate agronomic practices were conducted uniformly both at the nursery and experimental field as per recommendation.

2.3. Data Collection

Data on plant height (cm), days to50% flowering (days) , number of leaves, number of umbels, umbel diameter (cm), number of capsules per umbel, number of seeds per umbel and seed yield (kg/ha) were collected.

2.4. Statistical Analysis

Data on agronomic and yield components were subjected to analysis of variance (ANOVA) using SAS soft ware ((SAS, 2008, version 9.2). If there exists a significant difference among the treatment means the Least Significant Difference (LSD) test at $P<0.05$ level of probability was used to compare treatment means.

3. Results and discussion

3.1. Analysis of Variance

Analysis of variance was conducted to examine whether the varieties, planting times and their interaction differ significantly for the evaluated traits. Because of the homogeneity of error variance, combined analysis over years was done. The result of analysis for plant height (cm), days to50% flowering (days) , number of leaves, number of umbels, umbel diameter (cm), number of capsules per umbel, number of seeds per umbel and seed yield is presented in Table 1. Analysis of variance showed that highly significant difference (at $P\leq0.01$ level of probability) was observed among the tested onion varieties, planting time and their interaction for almost all traits studied except for number of leaves.

3.2. Growth and phenology traits

Plant Height: Table 2 shows combined mean plant height of onion varieties grown in Mirab Abaya woreda of Gamo zone, Ethiopia during 2021-2022 off seasons. Variety “Bombay red” planted in mid October had the highest plant height of 69.33cm, which differed significantly ($P<0.05$) from the variety “Nafis” planted at all planting times. Ibrahim (2010) as well as Trivedi and Dhumal (2010) also observed differences in plant height amongst onion genotypes which is in agreement with our result.

Days to 50% flowering: Result of combined analysis revealed that day to flowering was significantly influenced by varieties. Accordingly, variety Bombay red planted in mid September took the longest time (110.0days) to become mature while the shortest maturity time was exhibited by variety Bombay red planted in mid October. Thus, early maturity coupled with higher seed yield was noticed in mid October for variety Bombay red. Maturity time is an important trait for most plants for escaping moisture stresses.

3.3. Seed yield and related traits

Umbel diameter: The biggest umbel diameter of 18.7cm was recorded from variety Bombay red which is not statistically different from variety Nafis planted at mid October. On the other hand, the smallest umbel diameter (12.6cm) was shown by variety Nafis planted at mid September. Research reports indicated that seed yield was increased and positively correlated the increase in umbel diameter which confirms our result.

Number of Seeds per Umbel: result in table 2 showed that highest, but statistically similar number of seeds per umbel (522.3) was recorded by variety Nafis followed by variety Bombay red planted at mid October. The lowest (341.0) seed number per umbel was shown by Nafis which was planted during early October. Number of seeds in an umbel is a quantitative trait governed genetically having a direct attribute to seed yield in onion.

Table 1 Analysis of variance (Mean squares) for the 8 traits of onion varieties evaluated at Mirab Abaya, (2021-2022)

Source of variation	Mean Squares							C.V.
	Planting time (d,f,=3)	Replication (d,f,=2)	Variety (d,f,=1)	Planting time*Rep (d,f,=6)	Variety*Planting time (d,f,=3)	Variety*Rep (d,f,=2)	Error (d,f,=30)	
Plant height	261.9**	307.2**	922.2**	28.4 NS	60.3*	651.0**	18.2	7.47
Days to flowering	2884.7**	14.5NS	261.3**	176.9**	216.6**	10.3 NS	9.8	3.51
Number of leaves	9.7*	1.2 NS	6.7ns	10.6**	5.9 NS	1.5ns	2.34	16.26
Number of umbels	1.25**	0.15 NS	1.33*	0.89**	2.16**	9.52**	0.25	22.8
Umbel diameter	2.30 NS	52.0**	4.08 NS	17.2**	50.08**	54.3**	3.33	11.5
Number of capsules per umbel	864.30 NS	2623.0**	784.1 NS	2174.8**	1017.1*	1104.3 NS	333.6	18.91
Number of seeds per umbel	22639.3**	32123.5**	5292.0 NS	27276.2**	27386.0**	13200.2 NS	4992.2	18.11
Seed yield	554340.4**	173279.2*	1290508.2**	104782.4*	228590.6**	1467743.7**	37121.1	32.1

Note: d.f,=degree of freedom; *=significant at P≤0.05; **= significant at P≤0.01; and NS=non-significant.

Table 2 Combined mean values of interaction effects of varieties and planting days on seed yield and its related traits of onion varieties evaluated at Mirab Abaya (2021-2022)

Treatment	PH (cm)	DF (days)	NL	NU	UD (cm)	NCU	NSU	SYD (kg/ha)
V1D3	69.33a	78.3d	8.1b	3.16a	14.6cd	90.6b	362.6b	1178.3a
V1D2	62.5ab	106.5ab	10.0ab	1.6b	15.3abcd	87.0b	348.0b	415.0c
V1D4	56.66bcd	71.8d	9.6ab	2.0b	16.0abcd	92.0b	371.3b	553.8bc
V1D1	57.16bc	110.0a	11.3a	2.6ab	18.7a	100.6ab	436.6ab	887.5ab
V2D3	58.66bc	75.3d	9.5ab	2.0b	18.3ab	125.6a	522.3a	567.3bc
V2D4	52.23cd	78.5d	8.1b	1.6b	15.0bcd	92.0b	362.0b	272.7c
V2D2	48.33d	94.6c	8.3b	2.5ab	16.3abc	90.6b	341.0b	469.8bc
V2D1	51.36cd	99.5bc	10.16ab	2.0b	12.6d	94.3b	377.3b	277.1c
Grand mean	57.0	89.3	9.41	2.2	15.8	96.6	390.1	577.6
LSD	8.5	7.0	2.2	1.07	3.34	30.1	110.5	425.0

Note: PH=Plant height, DF=days to flowering, NL=number of leaves, NU=number of umbels, UD=umbel diameter, NCU=number of capsules per umbel, NSU=number of seeds per umbel, SYD=seed yield; and V1=variety (Bombay red), V2=variety 2 (Nafis), D1=first planting day (mid September), D2= second planting day (early October), D3=third planting day (mid October) and D4=last planting day (early November).

Seed Yield (kg/ha): Seed yield was measured at plot level by using sensitive balance and converted into kilograms per hectare. Result of combined analysis showed that maximum and statistically similar seed yield (1178.3 kg/ha) was obtained from variety Bombay red planted during mid October followed by the same variety (887.5 kg/ha) planted during mid September. Onion seed production is influenced not only genetically but also environmental factors (temperature, rainfall, soil conditions and presence of beneficial insects). Temperature is major factor for bolting

(flower stalk development) and seed set. Higher temperature can prevent flowering, also results in flower abortion and hence lower seed yield (Olani & Fikre, 2010).

4. Conclusion

ANOVA revealed that statistically significant difference was observed among treatments for all response variables. Maximum number of umbels (3.16) and longest plant height (69.3 cm) was recorded by Bombay red during 3rd planting time (Mid October). Similarly, highest seed yield (1178.3 kg/ha) was recorded by this variety planted during mid October. Thus, mid October is recommended as appropriate planting time for better seed production in Mirab Abaya area including Arba Minch by using variety Bombay red.

Compliance with ethical standards

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Disclosure of conflict of interest

The author declares that there is no competing interest.

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Author's short Biography

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