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Full Length Research Paper

Effect of intra-row spacing on yield of three onion (*Allium cepa* l.) varieties at Adami Tulu agricultural research center (mid rift valley of Ethiopia)

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An experiment to asses the Effect of plant density (intra-row spacing) on yield and yield components (bulb diameter, bulb weight, marketable and unmarketable bulb yield and total bulb yield Q/ha) of onion (*Allium cepa* l.) varieties (Bomby red, Adama red and Nasic red) were conducted in 2007 and 2008 at Adami Tulu Agricultural Research center, on horticulture research field, in mid rift valley of Ethiopia with the objective of; to identify optimum spacing between two consecutive plants and to recommend the best spacing combination for those three morphologically different varieties independently. The experiment was conducted using randomized complete block design with three replicates. Area occupied by a single plot is 4 x 3 m and with a spacing of 1.5 x 1 m between block and plot respectively. There are a total of 12 treatments. The analyzed result using SAS soft ware shows significance difference among those varieties with different spacing level like (4, 6, 8, 10 cm) by using 10 cm as check or control. For Adama red, A4 gave best marketable yield (220.55 ± 84 q/ha) followed by A6 (201.45 ± 60 q/ha) and for Bomby red B4 out yielded much better than the rest spacing (301.58 ± 77 q/ha). For the third variety N4 gave (324 ± 65 q/ha) marketable yield followed by N6 (251.5 ± 126 q/ha).Generally evaluating the three varieties with different spacing, Nasic red (N4) performs better followed by bomby red (B4). Among the three varieties, Adama red (A8) gave less yield performance than the rest varieties.

Key words: Intra row, marketable, spacing, yield.

INTRODUCTION

At present following tomato, onion (*Allium cepa*) is one of the most popular vegetables in the world. It is the recently introduced bulb crop in the agricultural community of Ethiopia and it is rapidly becoming a popular vegetable among producer and consumer. Onion is valued for its distinct pungency or mild flavor and form of essential ingredients of many dishes. It is consumed universally in small quantities and used in many home almost daily, primarily as a seasoning for flavoring of dishes, sauces, soup, and sandwiches in many countries of the world. Onion also contains Vitamin B, Vitamin C, carbohydrate and small percent of proteins (lemma et al., 1994).

Onion contributes substantially to the national economy apart from overcoming local demand. Product like bulbs and cut flower are exported to different countries of the world. According to marketing report (ETFRUIT, 1985 - 87) the average annual scale of onion was estimated about 1.5 milliun birr. Cut flower also exported to European countries. This indicates that Ethiopia has high potential to benefit from onion crop. In view of this onion is one of the most important cash generating crops for farmers especially around east shoa zone (Central Statistical Authority, 2002).

However, one of the major problems to its production is improper agronomic practice used by farmers. The use of appropriate agronomic management has an undoubted contribution in increasing crop yield. The optimum level of any agronomic practice such as plant population, planting date, harvesting date, and fertilizer of the crop varies with environment, purpose of the crop and cultivar. Thus it

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Abrevations: Q/ha; quintal per hectare, **SAS;** statistical analysis system, **M;** meter, **Cm;** cent meter, **A;** Adams red, **B;** Bombay red, **N;** nasic red, **Mm;** millimeter, **E;** east, **Masl;** meters above sea level, **N;** north, **Gm;** gram, **CV;** coefficient of variation, **A;** Adama red variety, **B;** Bomby red variety, **N;** Nasic red variety.

very difficult to give general recommendation that can be applicable to the different agro ecological zone (Upper Awash Agro-Industry Enterprise., 2001) where major growing area of onion. So that to optimize onion productivity, full package of information is required (Gupta et al., 1994; Lemma and shimeles, 2003).

Plant population is one of them that need to be optimized. The optimum use of spacing or plant population has dual advantage. It also avoids strong competition between plants for growth factor such as water, nutrient, and light. Conversely optimum plant population enables efficient use of available crop land without wastage (Zubelidia and Gases., 1977). Before 20 years it was recommended that 10 cm between two consecutive plant while transplanted to permanent field (FAO production yearbook., 1995). But evaluating the real situation what has adopted by farmers where a bit far from the recommendation. The reason mentioned is that difference in root and foliage growth system among the varieties, development of over sized bulbs that doesn't get customer, land wastage. Therefore it is a high time to respond those problems using the objective of:

- To identify optimum spacing between consecutive plants
- To recommend the best combination of those spacing for different varieties of onion

MATERIAL AND METHODS

Description of the study area

Adami Tulu Agricultural Research Center is located in the mid rift valley (MRV), 167km south of Addis Ababa on Awassa road. It lies at a latitude of 7° 9'N and 38°7'E longitude .It has an altitude of 1650 m.a.s.l. and a bimodal unevenly distributed average annual rainfall of 760 mm. Rain fall extends from February to September with a dry period in May to June, which separates the preceding ''short'' rains from the following ``long'' rains. The pH of soil is 7.88 fine sandy loams with sandy clay in proportion of 34, 48 and 18 respectively (Adami Tulu Research Center profile, 1998).

Experimental methodology

The experiment was conducted at Adami Tulu Agricultural Research Center for the past two consecutive years (2007 and 2008) during off season using irrigation. Three onion varieties having different root and leaf growth system (Adama Red, Bombay Red and Nasik Red) planted with the spacing of 20cm between row and (10, 8, 6 and 4) between plant in this trial. Other agronomic and crop protection Practice (weeding, watering, recommended fertilizer application, application of chemicals as per as required and etc) was adopted uniformly as per recommended for onion Production.

The experiment was conducted using randomized complete block design with three replications. Area occupied by a single plot is 4 x 3 m and with a spacing of 1.5 x 1 m between block and plot respectively.

Statistical analysis

The collected data were subjected to SAS software using Duncan multiple range taste for total average yield obtained in quintals hectare^{-1}, marketable and unmarketable yield in quintals hectare^{-1}, bulb weight plant^{-1}(gm), bulb diameter in Cm at alpha P = 0.05 level of significance difference.

RESULT AND DISCUSSION

Statistical analysis in Table 1 shows that all the three varieties, Bulb diameter in (cm) and unmarketable yield q/ha in first year (2007 cropping season) shows non significant difference at 5 % significant level among treatments. And the remaining parameters (Bulb weight /plant (gm), Marketable yield q/ha and Total yield q/ha) shows significance difference among treatments at $P < 0.05$ (Table 1). From the result of first year, Nasic red (N4) gave the maximum marketable yield (354.4 aq/ha) followed by N6 (288.7 q/ha). And for Bomby red B4 out yielded 323.17 q/ha followed by B10 and B8 (288.8 and 266.3 q/ha) respectively. For Adama red, A6 gave the highest markatable yield (188.8q/ha) followed by A4 (172.2 q/ha).Among the three varities Nasic red (N4) gave the maximum markatable bulb yield (354.4q/ha) followed by bombey red(B4) 323.17 q/ha while adam red (A10) gave the least markatable bulb yield (133.3 q/ha).

Statistical analysis in Table 2 shows that Bulb weight /plant (gm), Bulb diameter (cm), unmarketable bulb yield q/ha and Total yield q/ha shows significance difference among treatments at 5% significance level. While Marketable bulb yield q/ha shows non significance difference at $p < 0.05$ significance level, even if marketable yield shows non significance difference there is a clear average mean difference among treatments that is N4 gives the highest marketable bulb yield (294.6 q/ha) followed by N6(214.3 q/ha) and N10 gives the list marketable yield(195.7 q/ha).for Bomby red variety B4 gives the higher marketable yield(280.0 q/ha) followed by B6(244.9 q/ha) and B10 gives the list marketable yield (146.6 q/ha. For Adama red variety A4 gives higher marketable yield (268.9 q/ha) followed by A6 (214.1 q/ha) and A8 gives the list marketable bulb yield. When we compare the three varieties with different intra row spacing, Nasic red (N4) gives the maximum marketable yield (294.6 q/ha) among all treatments followed by B4 and A4 (280.0 and 268.9 q/ha) respectively. While B10 gives the list marketable bulb yield (146.6q/ha) among all treatments.

Statistical analysis in Table 3 shows that average bulb diameter (cm) for consecutive year's (2007 and 2008) have non significance difference at 5% significance level. Even though the result shows non significant difference, the average means of treatments shows clear mean difference in bulb diameter among all treatments. From the tretments bomby red, B10 gave the highest bulb diameter (5.82 ± 0.92a) followed by B4 (5.48 ± 0.53a) and for Adama red,A10 gaves the highest bulb diameter (5.78 ± 0.46a) followed by A8 and A6 (5.65 ± 0.29a and 5.28 ± 0.38a) respctively.For Nasic red variety N10 gaves the highest bulb diameter(5.645 ± 0.86a) followed by N8

Table 1. Some Onion traits as affected with different treatments for year 2007 (first year).

Treatments	Bulb diameter (cm)	Bulb weight /plant (gm)	Marketable yield q/ha	Unmarketable yield q/ha	Total yield q/ha
A4	5.03 ± 0.21a	53.3 ± 7.64c	172.2 ± 34.69cd	16.67 ± 16.67a	189.89 ± 41.94bc
A6	5.2 ± 0.5a	68.97 ± 9.49abc	188.8 ± 53.58bcd	5.56 ± 9.62a	194.44 ± 50.92bc
A8	5.8 ± 0.26a	74.5 ± 4.92abc	166.6 ± 0.0cd	27.78 ± 9.62a	194.44 ± 9.62bc
A10	5.5 ± 0.52a	93.2 ± 17.16a	133.3 ± 50.00d	38.89 ± 41.94a	172.22 ± 9.62c
B4	5.5 ± 0.66a	57 ± 7.94c	323.17 ± 57.99ab	37.94 ± 23.88a	361.11 ± 48.11a
B6	5.1 ± 0.04a	58.33 ± 2.89bc	247.2 ± 66.74abcd	13.91 ± 12.04a	261.11 ± 67.36abc
B8	5.1 ± 0.69a	65.67 ± 22.12abc	266.3 ± 123.19abcd	5.91 ± 5.13a	272.22 ± 118.24abc
B10	5.04 ± 0.52a	74.33 ± 3.06abc	288.8 ± 9.59abc	16.68 ± 28.90a	305.56 ± 38.49abc
N4	5.3 ± 0.31a	57.33 ± 9.29c	354.4 ± 53.40a	17.78 ± 2.04a	372.22 ± 53.58a
N6	4.96 ± 0.80a	54.67 ± 20.50c	288.7 ± 146.13abc	27.92 ± 15.28a	316.67 ± 160.73ab
N8	4.7 ± 0.40a	55 ± 4.36 c	283.4 ± 78.99abc	33.23 ± 43.42a	316.67 ± 76.38ab
N10	5.09 ± 0.92a	87 ± 35.38ab	277.7 ± 83.89abc	44.44 ± 76.98a	322.22 ± 50.92ab
CV%	10.83	23.0	29.7	121.8	26.9

*Means followed by different letter(s) are significantly different at 5%level of significance
*A-Adama red variety, B-bomby red variety, N-Nasic red variety
*4 = 4 cm, 6 = 6 cm, 8 = 8 cm, 10 = 10 cm.

Table 2. Some Onion traits as affected with different treatments for year 2008 (second year).

Treatments	Bulb diameter (cm)	Bulb weight/plant (gm)	Marketable yield q/ha	Unmarketable yield q/ha	Total yield q/ha
A4	5.13 ± 0.46d	66.47 ± 14.88b	268.9 ± 97.06ab	27.04 ± 27.12b	295.9 ± 99.61ab
A6	5.36 ± 0.31bcd	72.43 ± 22.98b	214.1 ± 74.25ab	1.6 ± 2.77b	215.7 ± 71.59ab
A8	5.5 ± 0.26bcd	80.17 ± 9.77b	173.1 ± 45.77ab	16.84 ± 14.65b	190.02 ± 59.58a
A10	6.06 ± 0.15abcd	101.3 ± 14.72ab	183.1 ± 22.89ab	46.61 ± 43.31b	231.71 ± 59.66ab
B4	5.46 ± 0.51bcd	76.27 ± 19.98b	280.0 ± 100.28ab	26.29 ± 43.33b	306.34 ± 70.45a
B6	5.8 ± 0.82abcd	101.3 ± 36.42ab	244.9 ± 22.05ab	57.97 ± 57.13b	302.88 ± 36.17a
B8	5.76 ± 0.42abcd	96.13 ± 20.27b	206.6 ± 46.64ab	28.52 ± 47.96b	235.17 ± 55.47a
B10	6.6 ± 0.20a	135.23 ± 15.95a	146.6 ± 32.49b	163.0 ± 72.38a	309.68 ± 60.70a
N4	5.2 ± 0.52d	76.27 ± 10.57b	294.6 ± 69.91a	33.64 ± 29.14b	328.32 ± 80.93a
N6	5.26 ± 0.32cd	66.93 ± 14.78b	214.3 ± 119.22ab	1.52 ± 2.63b	218.8 ± 118.99a
N8	6.3 ± 1.18ab	69.9 ± 6.67b	181.7 ± 9.15ab	37.78 ± 22.37b	219.51 ± 16.77a
N10	6.2 ± 0.26abc	97.7 ± 25.73b	195.7 ± 60.93ab	25.58 ± 44.30b	221.29 ± 50.53a
CV%	8.83	22.9	31.5	102.56	27.28

*Means followed by different letter(s) are significantly different at 5%level of significance
*A-Adama red variety, B-Bomby red variety, N-Nasic red variety
*4 = 4 cm, 6 = 6 cm, 8 = 8 cm, 10 = 10 cm.

Table 3. Some Onion traits as affected with different treatments for year for combination years (2007 and 2008).

Treatments	Bulb diameter(cm)	Bulb weight/plant (gm)	Marketable yield q/ha	Unmarketable yield q/ha	Total yield q/ha
A4	5.08 ± 0.33a	59.885 ± 13d	220.55 ± 84bc	21.855 ± 21b	242.35 ± 90 bc
A6	5.28 ± 0.38a	70.7 ± 16cd	201.45 ± 60bc	3.58 ± 6.7b	205.05 ± 57c
A8	5.65 ± 0.29a	77.335 ± 7.6bcd	169.85 ± 29c	22.31 ± 13b	192.21 ± 38c
A10	5.78 ± 0.46a	97.25 ± 15ab	158.2 ± 44c	42.75 ± 39b	201.96 ± 50c
B4	5.48 ± 0.53a	66.635 ± 17d	301.58 ± 77ab	32.115 ± 32b	333.72 ± 62ab
B6	5.45 ± 0.61a	79.815 ± 33bcd	246.05 ± 44abc	35.94 ± 44b	281.99 ± 53abc
B8	5.43 ± 0.62a	80.9 ± 25bcd	236.45 ± 89abc	17.215 ± 33b	253.69 ± 85abc
B10	5.82 ± 0.92a	104.78 ± 35a	217.7 ± 81bc	89.87 ± 94a	307.59 ± 46ab
N4	5.25 ± 0.39a	66.8 ± 14d	324.5 ± 65a	25.71 ± 20b	350.26 ± 66a
N6	5.11 ± 0.57a	60.8 ± 17d	251.5 ± 126abc	14.72 ± 17b	267.7 ± 137abc
N8	5.5 ± 9.6a	62.45 ± 1.2d	232.55 ± 75abc	35.505 ± 31b	268.06 ± 73abc
N10	5.645 ± 0.86a	92.35 ± 28abc	236.7 ± 80abc	35.01 ± 57b	271.75 ± 72abc
CV%	9.83	22.95	30.6	112.1	26.69

*Means followed by different letter(s) are significantly different at 5%level of significance
*A-Adama red variety, B-bomby red variety, N-nasic red variety
*4 = 4 cm, 6 = 6 cm, 8 = 8 cm, 10 = 10 cm.

(5.5 ± 9.6a).from all spacing level and varities bomby red, B10 gaves the highest bulb diameter (5.82 ± 0.92a) followed by adama red, A10(5.78 ± 0.46a).Among all tretments Adama red (A4) gives the list bulb diameter (5.08 ± 0.33a) Table 3.

The average weight of bulb plant^{-1} was significantly affected by plant density at $P < 0.05$ significance level. The average mean result of two years shows that the weight of bulb plant^{-1} ranges from 104.78 - 59.885 (gm) (Table 3). From this, bomby red variety (B10) gains the highest bulb weight plant^{-1}(104.78±35) followed by B8 and B6(80.9 ± 25bcd and 79.815 ± 33bcd) respectively. For Adama red variety (A10) gives the maximum bulb weight plant^{-1} (97.25 ± 15ab) followed by A8 (77.335 ± 7.6bcd). in case of Nasic red (N10) gives the maximum bulb weight plant^{-1}(92.35 ± 28abc) followed by N4 (66.8 ± 14d).among all varieties and spacing level bomby red (B10) earns the maximum bulb weight plant^{-1} (104.78 ± 35a) followed by adama red (A10) 97.25 ± 15ab and N10 (92.35 ± 28abc).among all tretments A4 earns the list bulb weight plant^{-1}(59.885 ± 13d) (Table 3).

Marketable yield was significantly affected by both varietals difference and plant density. Among the cultivars and spacing level, N4 shows maximum marketable bulb yield (324.5 ± 65a) followed by B4, N6 and B6 (301.58 ± 77ab, 251.5 ± 126abc, 246.05 ± 44abc) respectively. From all treatments A8 and A10 gave the list marketable yield (169.85 ± 29c, 158.2 ± 44c) respectively (Table 3). from this parameter it show us that varieties planted with wider spacing gives maximum bulb diameter which resulting in increment in unmarketable yield and decrease the marketable yield . This result shows us that plant density have effect on marketable yield by affecting bulb diameter that is which result in increase in both under size and oversize(unmarketable yield) that leads to lack of demand on market for produced bulb.

From the result shown unmarketable bulb yield gives non significant difference at 5 % significance level. Even if it shows non significant difference, there is a mean bulb yield difference across the treatments. From this, B10 gives the maximum unmarketable yield (89.87 ± 94a) followed by A10, B6 and N8 (42.75 ± 39b, 35.94 ± 44b and 35.505 ± 31b) respectively. Among all treatments A6 gives the list unmarketable bulb yield (3.58 ± 6.7b). From this result we observe that varieties with wider spacing gives maximum unmarketable yield due to it gives higher bulb diameter that result in oversize bulb diameter(unmarketable yield). From this it indicates that the lower unmarketable bulb yield, the better the produced bulb got demand on market (Table 3).

The total bulb yield of onion was significantly affected by planting density as seen from SAS 1999-2000 version analysis result for both conse--

cutive years (2007 and 2008) at 5% significance level. Amongst the cultivars and plant density N4 earns the maximum total bulb yield (350.26 ± 66a) followed by B4 and B10 (333.72 ± 62ab, 307.59 ± 46ab) respectively. From all treatments A10 and A8 gives the lowest average total bulb yield (201.96 ± 50c and 192.21 ± 38c) respectively (Table 3).

Conclusion and Recommendation

The higher yield and better control of over or under bulb size could be obtained if plants are grown at optimum density. The control of plant spacing is vulnerable way of controlling bulb size, shape and yield. From this experiment different spacing have effect on different cultivars as different varieties have different root and leaf growth habit as general it is concluded that different spacing have effect on different varieties of onion, finally for areas like Adami Tulu (central rift valley of Ethiopia) intra row spacing of 4 cm for Nasik red variety, 6cm for bomby red variety and 4 cm for adama red variety is highly recommended to earn maximum marketable yield and to reduce unmarketable bulb yield.

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