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Investigating the Changes of Growth Pattern in Three Morphotypes of Gholi-Gheseh Zanjan Onion Cultivars

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ABSTRACT

The growth stages and indices of three onion cultivars (GholiGhesehLeft-Left, GholiGheseh 87, and GholiGhese 88) in three row spacings(10, 20 and 30 cm) in a split plot design based on randomized complete blocks with three replications in the field of East Azerbaijan Research Center were investigated. The results showed that among the morphotypes under study, the highest yield was obtained in 10-cm row spacing in GholiGheseh selection 88 morphotype, which is due to its growth rate and relative growth rate. GholoGheseh selection 87 in its growth period had the highest level of net assimilation. In 10-cm row spacing, the highest index of leaf surface, and in 30-cm row spacing, the highest level of net assimilation and plant growth were observed.
KEYWORDS: crop growth rate, relative growth rate, net assimilation rate, row spacing, yield

1. INTRODUCTION

Methods used for quantitative analysis of growth factors are known as growth analyses. The growth of a plant or any plant organs can be modeled using regression based on a temporal variable. Through this method, a better understanding of the distribution and accumulation of photosynthetic materials in different organs are obtained. A large part of photosynthetic materials is used for the growth of leaf. This increase in leaf surface is proportionate to and associated with increase in energy intake, as surrounding plants are so small that their shadows are inconsiderable and the weight of each plant increases every day with a fixed ration leading to exponential growth. After creation of constant vegetation, excessive growth of the leaves does not lead to more attraction of radiation, so the growth rate remains constant and plant weight increases linearly. In the last stage, aging of leaves results in decreasing rate. A large part of dry matter accumulation of agricultural crops occurs in growth period. By increasing the length of growth period, increasing weight not only leads to receiving a higher amount of active photosynthetic radiation, but also provides the opportunity of more nitrogen and other nutrients intake, especially at the times of input shortage (Gardner, et al., 2012).

Regarding growth indices, using one heat index instead of time calendar is more reliable. Also, many studies have proved usefulness of heat indices like growth level, growth day, photothermal unit or other heat units for predicting and estimating growth period of agricultural crops (Tehrani, 1998).

The growth of agricultural crops in field condition is usually determined through the analysis of dry mater accumulation. Since crop yield is estimated in unit area, analysis of crop growth in unit area is more important that analysis of growth on the basis of plant (Gardner, et al., 2012).

The main goal of calculating growth equations is explaining plant's reaction to environmental condition. Since crop yield is normally estimated in unit area, analysis of growth index requires measuring leaf surface and dry weight of the plant. The net assimilation rate is investigated by calculating production of dry matter which is called quantitative analysis of growth (Hant, 1993).

The simplest way for analyzing growth is measuring two parameters in relative large number of plants in rather long time intervals (1-2 weeks). Another way is to measure dry weight and leaf surface of plant in shorter time intervals (2-3 days) in smaller number of plants. In both methods, the average changes occurring during a specific time interval are obtained. The second method in which sampling of plant population is done more frequently is recommended as it provides the researcher with better use of materials and time (Koochaki and RashedMohassel, 1995). In this respect, the aim of this study is to investigate the effect of plant density on growth, yield, and growth analyses of various onion morphotypes in GholiGheseZanjan cultivar.

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2. MATERIALS AND METHODS

Growth pattern of three morphotypes, i.e. GholiGhesehLeft-Left, GholiGhese selection 87 and GholiGhese selection 88 was studied in three row spacing's of 10, 20, and 30 cm in split plot design based on randomized complete blocks with three replications in the Agriculture and Natural Resources of East Azerbaijan. Morphotypes were considered in major plots and row spacing was studied in minor plots. Every plot consisted of six 4-meters-long lines and the space between plants in a row was 8 cm. The first sampling was done two weeks after compete germination of seeds. 5 plants were randomly selected from each plot. Next samples were collected every fourteen days. In each sampling, the traits of leaf surface, wet weight of plant, and dry weight of the plant were measured. In this measurement, the basic temperature of onion (T-base) was considered to be 3°C. Bulb harvesting was done at the time of physiological maturity when 80% of plant neck was soft and fell over.

Lamina surface was estimated by LA=πlw/2 where π is 3.14, LA is lamina surafce, l is the length of green part of lamina, and w is the largeest diamtere of lamina. The important growth indices were caculted by following formulae:

(1) $LAI=[(LA_2+LA_1)/2](1/GA)$
(2) $CGR=(1/GA)\ (W_2-W_1)/(T_2-T_1)$
(3) $RGR=(\ln W_2-\ln W_1)/(T_2-T_1)$
(4) $NAR=\left[\frac{(W_2-W_1)}{(T_2-T_1)}\right]\times\left[\frac{(\ln L_2-\ln L_1)}{(LA_2-LA_1)}\right]$

Where, LAI is leaf surface index, LA_1 and LA_2 are leaf surface in time, T_1 and T_2 are the time, GA is the surface covered by plantt (canopy), CGR is crop growth rate in grams in day in m^2, RGR is relative growth rate in g in g in day, and NAR is net assimilation rate. Using SPSS statistical software, equations and graphs of CGR, RGR, and NAR were developed for each row spacing and morphotype.

3. RESULTS AND DISCUSSION

3.1. Total dry weight

The results obtained by studying the trend of total dry weight in day indicated different growth degree-days (GDD) (Fig. 1). By increasing row spacing of onion plants, and increasing growth degree-days, the total dry weight was raised. In 30 cm row spacing, the highest total dry weight, about 3000, was obtained. In 10 and 20 cm row spacing, no significant difference was obtained among morphotypes under study, but in 30 cm row spacing, the highest increasing trend of total dry weight in morphotype Gholi Ghese selection 88 was achieved. In 30 cm row spacing, after growth degree-day of about 3000, more reduction in total dry weight, compared to 10 and 20 cm row spacing was observed. Researchers have reported that in higher row spacing, due to meeting the needs of plant, the plant grows fasters and ages earlier and its leaves fall (Carmi, et al., 2006).

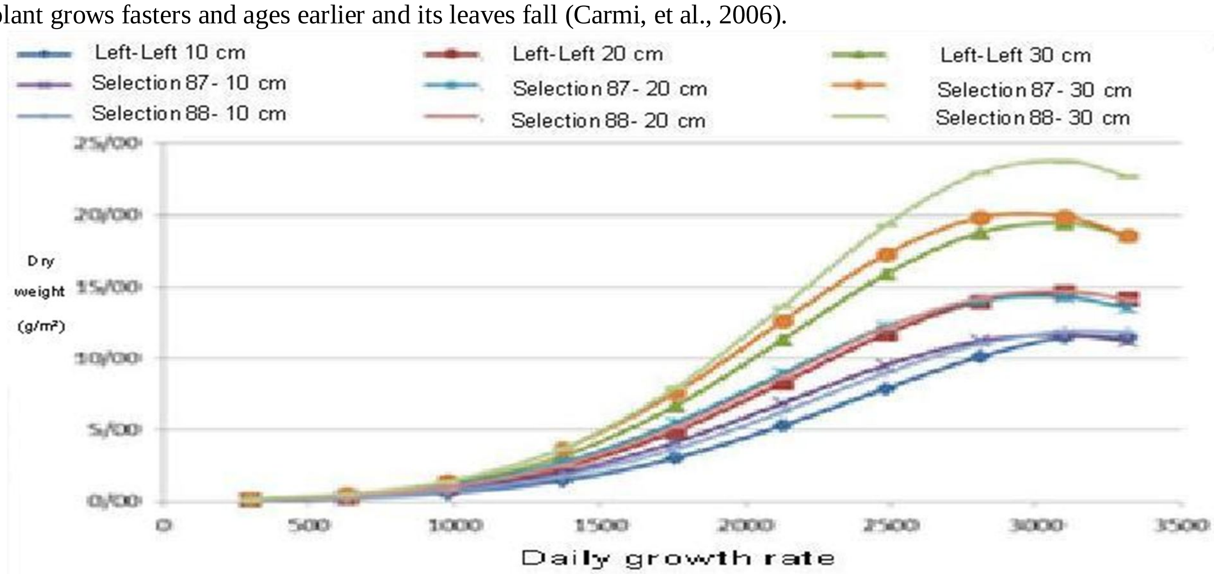

Fig 1. Studying the trend of dry weight in GholiGhesemorphotypes

3.2. Leaf surface index

Studying the trend of leaf surface index in the morphotypes of GholiGhese cultivars in various GDDs (Fig. 2) indicated that there is no significant difference in 30 and 20 cm row spacing in low GDDs, but by increasing GDD, morphotype selection 87 had higher leaf surface index. The highest leaf surface index trend was obtained 10 cm row spacing. In this row spacing, up to GDD of 1750, morphotype selection 87 and 88 had higher leaf index than Left-Leftmorphotype; however, from GDD of 175 the increasing trend of selection 88 morphotype declined. From GDD of 2500, this morphotype showed a significant decline falling below two other morphotypes, whereas morphotype selection 87 in GDD of 3000, showed the highest leaf surface index (Fig. 2).

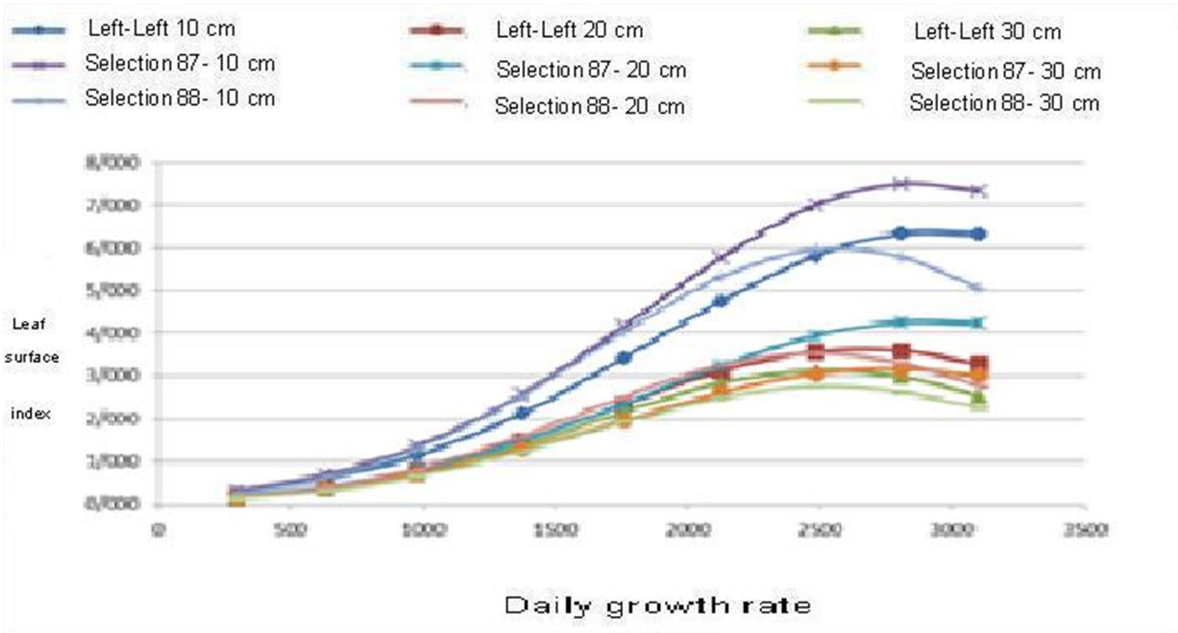

Fig 2. Studying the trend of leaf surface index in GholiGhesemorphotypes

3.3. Plant growth rate

Monitoring the trend of plant growth rate in GholiGhesemorphotypes in different row spacing revealed that there was no significant difference among morphotypes, but in the later stages of the experiment, GholiGheseLeft-Leftmorphotype with 10-cm row spacing showed the highest growth rate. This morphotype had higher peak of GDD compared to other morphotypes and its growth rate continued for a longer time. For these reasons, this morphotype which had lower growth rate at the beginning enjoyed a higher growth rate at the end of the experiment. This is while in the middle of growth period or in GDD of 1750 to 2500, GholiGhese selection 88 which had the highest growth rate in 30-cm row spacing had a growth rate similar to other cultivars at the end of growth period due to significant decline of growth. However, GholiGhese selection 87 morphotype which had higher growth rate in the middle of growth period in 30 cm row spacing, had lower growth rate compared to other morphotypes at the end of growth period due to earlier growth and steep slope of decline.

In higher densities, plants' competition for light increases. In appropriate densities of planting, plants completely use environmental factors (water, air, light, and soil resources) and inter-species and intra-species competition is at minimum (Rahnavard et al., 2010). Thus, plants' responses to different densities depend on the efficiency of their use of resources and completive power. In this study, it was observed that different morphotypes show different reactions to row spacing.

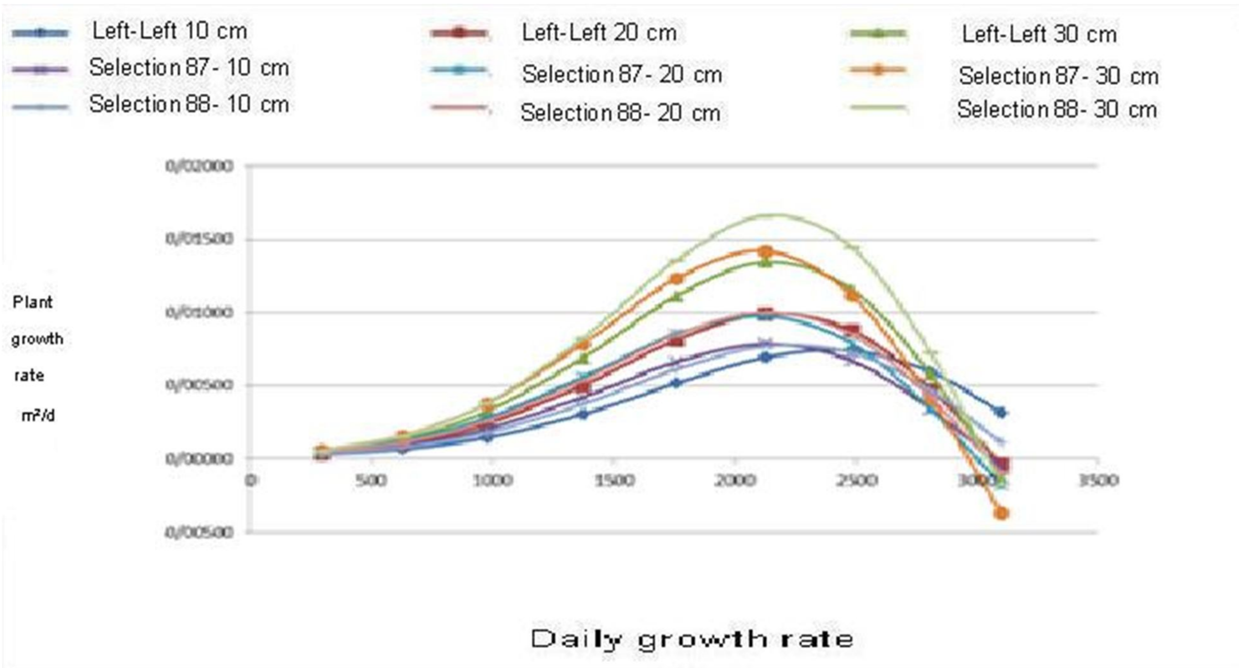

Fig 3. Studying the trend of plant growth rate in GholiGhesemorphotypes

3.4. Relative growth rate

Studying relative growth rate in GholiGhesemorphotypes with different row spacing indicated that the highest relative growth rate at the beginning of growth period belonged to GholiGheseLeft-Left treatment with 30-cm row spacing and the lowest relative growth rate was that of GholiGheseLeft-Left with 10-cm row spacing. However, due to low slope of reduction of relative growth rate in GholiGheseLeft-Left with 10-cm row spacing, this morphotype had the highest relative growth rate at the end of growth period. There is a relative difference among plants with respect to relative growth rate which is caused by differences in plant physiology, morphology, and appropriation of assimilators (Shipley, 2006).

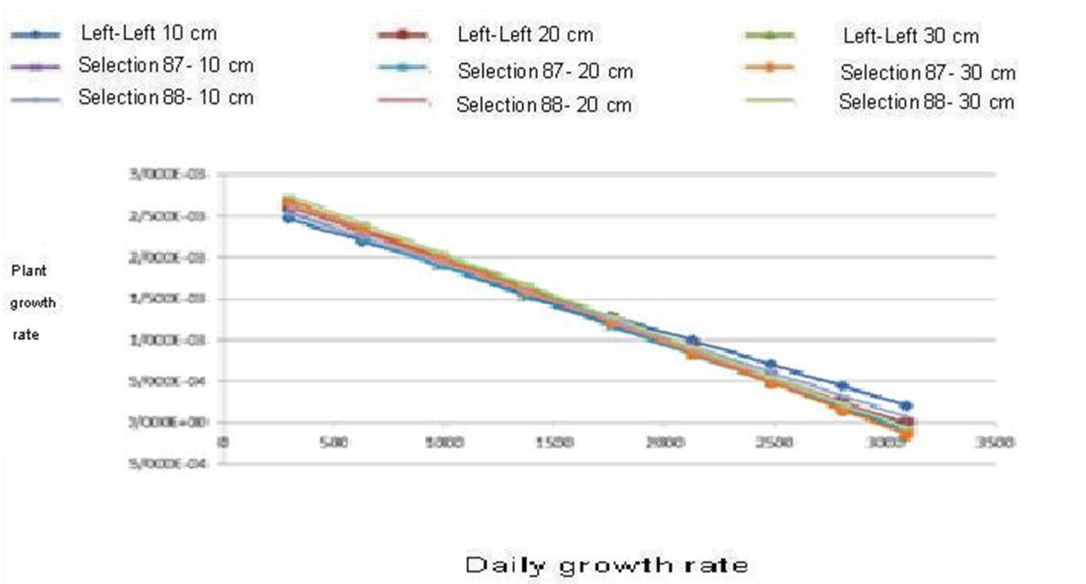

Fig 4. Studying the trend of relative growth in GholiGhesemorphotypes

3.5. Plant net assimilation rate

Investigating the trend of net assimilation rate in different GholiGhesemorphotypes in different row spacing revealed that in 10 cm row spacing, there is no significant difference among morphotypes under study. In 20-cm row spacing, GholiGhese selection 87, almost in all growth stages except beginning of bulb growth, had highest net assimilation rate. In this row spacing, there was more increase and decrease in net assimilation rate, so that in the end of growth period or GDD of 3000, assimilation rate similar to 10-cm row spacing was observed. In row spacing of 30 cm where net assimilation rate was higher than row spacing of 10 and 20 cm except in the end of growth period, in GDD of 3000, the assimilation rate was less than other row spacings. In higher row spacings, every plant receives more light compared to lower spaces, therefore, the level of leaf assimilation is higher. However, light absorption is meant to increase breathing and dead tissues of the plant, as studies have revealed that sunlight stimulates dead tissues like cell membrane reducing assimilatory efficiency of leaf unit area (Richardson, 2006). This finally leads to reduction in net assimilation in low densities, as in high densities, leaves preserve their succulence and have higher assimilation. Generally, in 30 cm row spacing, GholiGhese selection 88 and 87 have higher net assimilation rate, respectively. Factors affecting assimilation rate include temperature, light, carbon dioxide, water, plant age, nutrients, amount of chlorophyll, and genotypes (Hossain, 2005). Considering the differences in genotypes in terms of efficiency in the use of water and nutrients, net assimilation rate of the leaves vary. In this study, it was observed that decreasing row spacing led to decrease in net assimilation rate. Other studies have revealed that in very high densities, the accessible resources decrease which can lead to significant decrease in the growth which cannot be balanced even by increasing plant density (Morteza, et al., 2009).

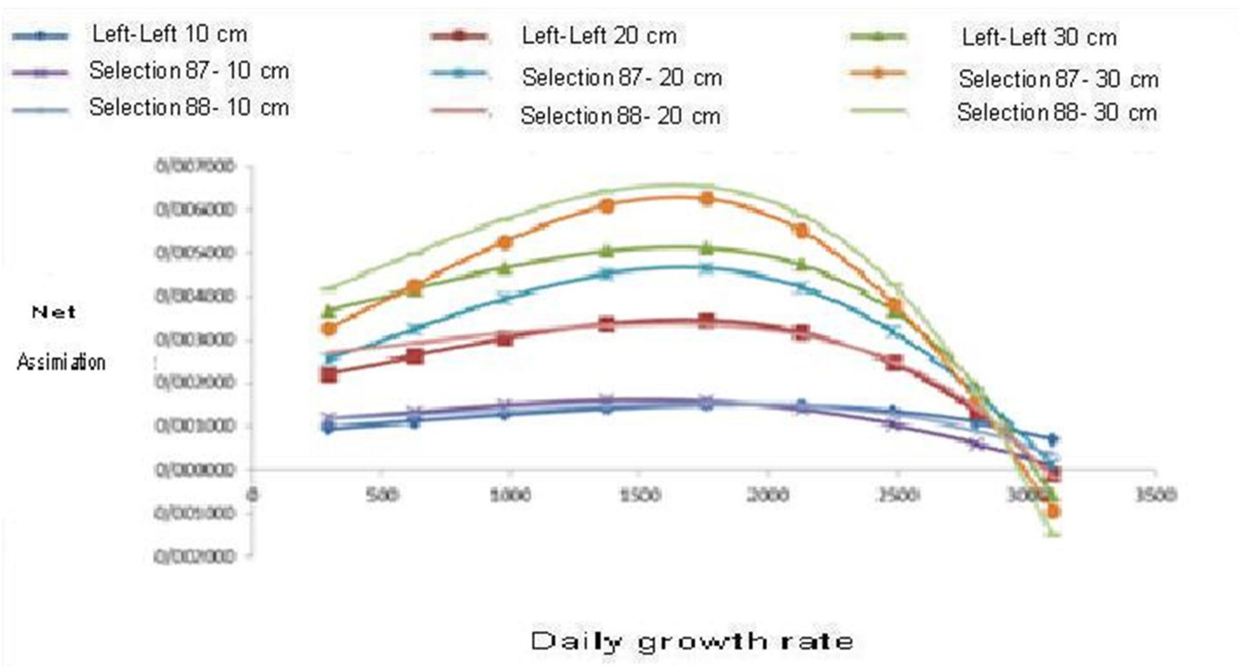

Fig 5. Studying the trend of net assimilation rate of GholiGhesemorphotypes

3.6. Yield

There was a significant difference among different onion morphotypes with different row spacing in terms of yield. The average yield of bulb for different morphotypes indicated that the highest yield belonged to GholiGheseh selection 88 in row spacing of 97.94 ton in hectare and the lowest one was that of GholiGhesehLeft-Leftin30-cm row spacing with 33.01 ton in hectare which can be due to high growth rate of GholiGheseh selection 88 in growth period and early maturity of this morphotype.

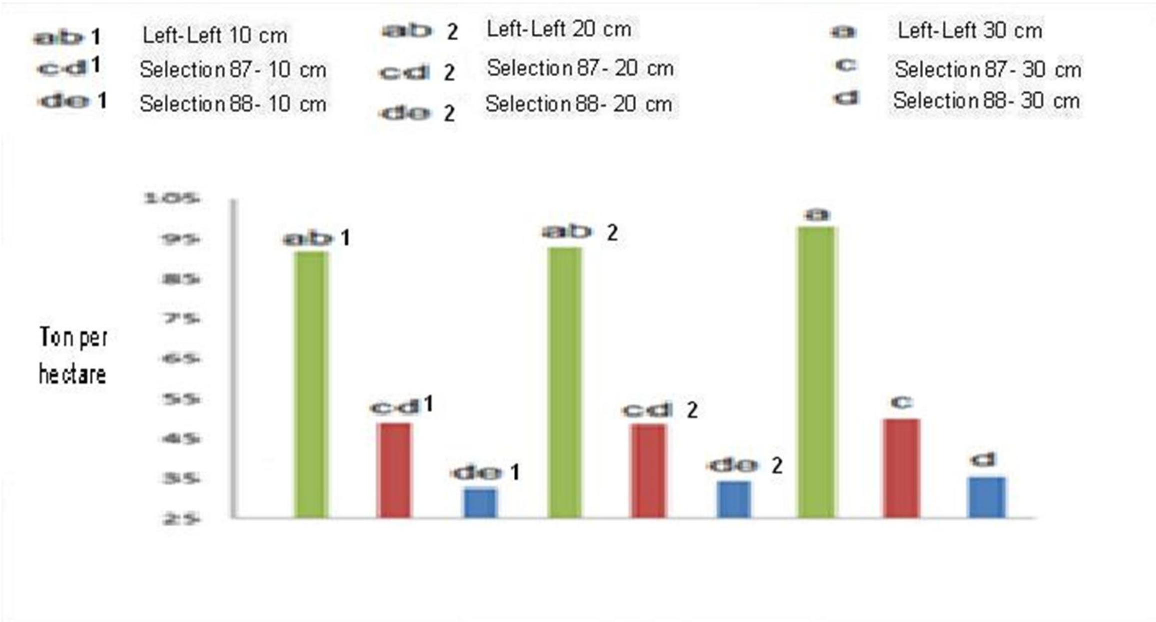

Fig 6. Comparing the mean yield of treatment levels of row spacing in onion morphotypes

4. Conclusion and suggestions

According to the findings of this study, in the most part of growth period of different morphotypes of GholiGheseh in different row spacings, the highest leaf surface index belonged to GholeGheseh selection 87 with row spacings of 10 cm, the highest dry weight was that of GholiGhesehLeft-Leftwith 30-cm row spacing, the highest net assimilation rate belonged to GholeGheseh selection 88 with 30-cm row spacing , and the highest growth rate was observed in GholeGheseh selection 88 with30-cm row spacing. The highest leaf surface index was observed in the 10-cm row spacing, the highest dry weight and net assimilation rate were found in 30-cm row spacing. The highest total dry weight, bulb diameter, bulb dry weight, and bulb weight was observed in GholeGheseh selection 88 in30-cm row spacing. Considering the economic significance of bulb yield, we suggest that GholeGheseh selection 88 be planted with 10-cm row spacing in the area under study.

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