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Vegetative Growth, Yield and Some Characteristics of Onion (*Allium Cepa* L.) Genotypes As Influenced By Transplant Age in Eastern Regions of Hormozgan Province, Iran

[*]Mohsen Khodadadi[1], Hamed Hassanzadeh Khankahdani[2]
[1](*Vegetable research center/ Horticultural science research institute, Agricultural Research, Education& Extension Organization, Iran)*
[2](*Horticulture crops Research Department, Agricultural and Natural Resources Research and Education Center of Hormozgan, AREEO, Iran)*
Corresponding Author: Mohsen Khodadadi (m.khodadadi@areeo.ac.ir)

Abstract: *In order to determine the best onion transplant age in Minab region of Hormozgan province, Iran, an experiment was performed as factorial arrangement in randomized complete block design with three replications in two successive years. For this purpose, the seeds of Primavera, Texas Early Grano, Early White and native landraces of Jirofti and Baluchi were sown in nursery at 16 and 27 September, 7 and 17 October and then the transplants were planted 40 to 70 days after sowing. Planting system was strip and was irrigated by tape tube. In the present study, planting 40 days transplants was very difficult in due to small size of these transplants and also its mortalities percent and its replanting necessity was very high. Generally, in the conditions of our study, 60 and 70 days transplants had suitable potential to produce bulb and they had no significant difference together. Therefore, regard to the 60 days transplants are planted to main field 10 days earlier than 70 days transplant and it establishes faster, it is recommended as superior transplant age for the all evaluated onion cultivars.*

Keywords: *Baluchi, Minab, Onion native landrace, Primavera*

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I. Introduction

Onion (*Allium cepa* L.) has importance in Iran as a essential vegetable in viewpoint of human health via providing vitamins and major nutrients such as potassium and phosphorous. Land under cultivation and total annual production of onion in Iran is 64 thousands hectares and 2.4 million tonnes, respectively. More than 22.3 thousands hectares onion is planted in south regions of Iran with aiming crop production in winter and continual supplying (Agricultural Statistics, 2016). In these regions is mainly planted the imported cultivars such as Primavera and Texas Early Grano as well as native landraces (Baluchi) by transplanting method. Age and size of transplant are one of the most important factors to survive onion in the field, increasing yield and reducing bolting. In some cases, effect of transplant age has been significant on final yield, so that many experiments reported that the best transplant age is 6-10 weeks for onion (Galmarini and Della- Gaspera, 1995; Leskovar and Vavrina, 1999). In the experiment that was done to improve production method of Rey-Red onion, the results demonstrated that 45 and 55 days old transplants were the best transplants ages (Ghavami and Ghavami, 2013). Koochaknejad (2012) found that delaying in planting and increasing transplant age in autumn season caused to increase onion yield in Gachsaran and Noorabad Mamasani regions. Izadkhah-Shishvan *et al*. (2010) reported that 20-cm length transplants were the best transplant size and Red-Azarshahr cultivar was better than Ghuli-Ghese Zanjan cultivar. In the present study, five onion cultivars and native landraces with four transplant ages assessed for two successive years in Minab region of Hormozgan province, Iran.

II. Materials And Methods

This investigation was performed in Agricultural Research Station of Minab during 2014 and 2016 years. In order to determine the best onion transplant age, an experiment was conducted as factorial arrangement in RCBD with three replications. In the first year, the seeds of Primavera (PR), Texas Early Grano (TEG), Early White (EW) cultivars and native landraces of Jirofti and Baluchi were sown in nursery at four dates with 10 days distances including 16 and 27 September, 7 and 17 October and the transplants were transported to the main field at 26 November. On this basis, the planted transplants had 70, 60, 50 and 40 days old. According to the meteorological information of Minab region in the first year of experiment, growth degree day (GDD) was calculated for different transplant ages by formula (1) (De Ruiter, 1986), so that the 40, 50, 60 and 70 days old

transplants received 1011, 1314, 1616 and 1952 GDD, respectively. Therefore, in the second year, transplants were prepared based on GDD.

$$GDD = \sum\left(\frac{T_{max}+T_{min}}{2}\right) - T_{base} \quad (1)$$

Where T_{max}= maximum daily temperature, T_{min}= minimum daily temperature and T_{base}= base temperature for onion (1.7 °C) (El-Zohiri and Farag, 2014). On this basis, properties of 40-70 days old transplants have been summarized in Table 1.

Table 1- Properties of different transplant ages

Calendar age (day)	40	50	60	70
GDD (°C)	1011	1314	1616	1952
Average leaf number	1.0	2.2	2.6	3.3
Average transplant length (cm)	2.5	10.8	22.4	25.6

Main field preparation and utilization of basic fertilizers was done before planting and 60 kg/ha urea was used before planting. Totally, other 120 kg/ha urea was utilized 20 and 40 days after transplanting. Each experimental plot was consisting two furrows with 30 cm mound and mouth width, which the transplants were planted as bilateral (4 planting line) with 10 cm distance on line. Planting system was strip using tape strip irrigation. The length of each line was 50 m, so that 20 transplants were planted in each experimental plot. During protection stages, to control of the weeds was used Oxyfluorfen (Gol) and Sethoxydim (Nabo-S) herbicides with 1.5 and 1.0 ml/l, respectively. To control onion trips once was sprayed Acetamiprid insecticide. The bulbs were harvested concordant with emptying bulb neck. In this relation some characteristics such as bolting percent, average bulb weight and diameter, bulb neck diameter, leaf number, plant height, edible layer number, dry matter percent and bulb yield were measured. The obtained data from both years were analyzed as combined using SAS 9.1 software and the means were compared by LSD ($p<0.05$).

III. Result

According to the results of combined variance analysis, it was observed significant interaction between transplant age and onion cultivar in the all evaluated parameters.

3.1. Bolting percent

Bolting percent in Jirofti and Baluchi landraces significantly was more than other short-day onion cultivars. It was no observed any bolting in three onion cultivars of PR, TEG and EW in each transplant ages. Altogether, bolting percent enhanced in Jirofti and Baluchi landraces by increasing transplant age (Fig. 1).

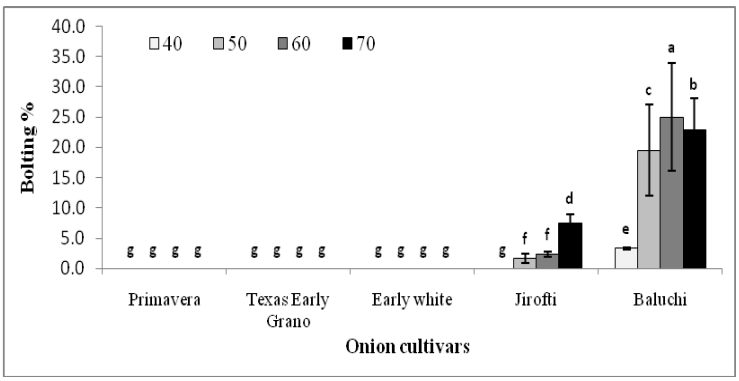

Fig. 1- Effect of transplant age and cultivar on bolting percentage of onion
Columns having same letter are not significantly different according to LSD ($p<0.05$)

Regression coefficient (RC) of bolting percent enhancement in Baluchi landrace was 6.4 by increasing transplant age in which it was more than Jirofti landrace (RC=2.32) (Fig. 2).

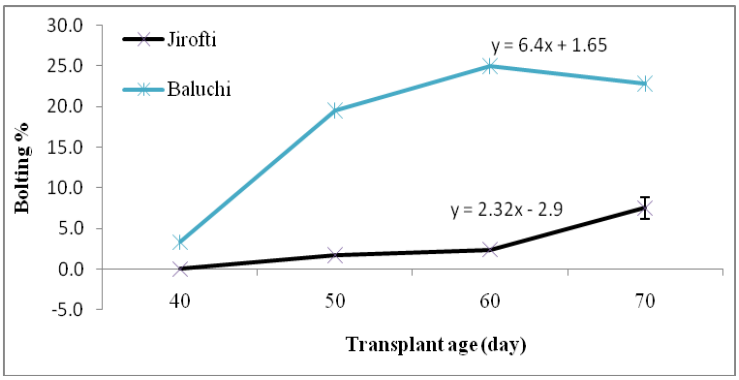

Fig. 2- Changes trend of bolting percent in Jirofti and Baluchi landraces by increasing transplant age.

3.2. Average bulb weight

Generally, Jirofti and Baluchi landraces produced the lightest weight bulb in the all transplant ages. The produced bulb from PR, TEG and EW cultivars significantly were more heavy-weight than native landraces. Average bulb weight enhanced by increasing transplant age but it was no observed any significant difference between 60 and 70 days old transplant, so that 60 days old transplants was superior to 70 days old transplants in PR, TEG and EW cultivars as well as Jirofti landrace. Among short-day onion cultivars, PR cultivar had the highest bulb weight in the all transplant ages (Fig. 3).

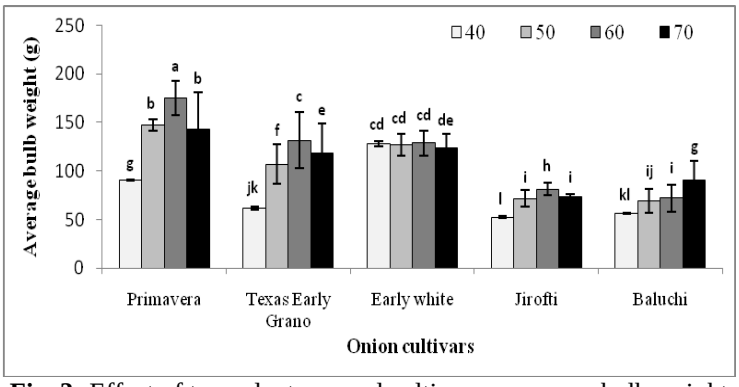

Fig. 3- Effect of transplant age and cultivar on average bulb weight
Columns having same letter are not significantly different according to LSD ($p<0.05$)

Changes trend of bulb weight was ascending by increasing transplant age in the all cultivars and landraces except EW cultivar, so that, the highest and lowest changes was observed in TEG cultivar (RC=19.34) and Jirofti landrace (RC=7.17), respectively. In EW cultivar, bulb weight decreased by increasing transplant age (Fig. 4).

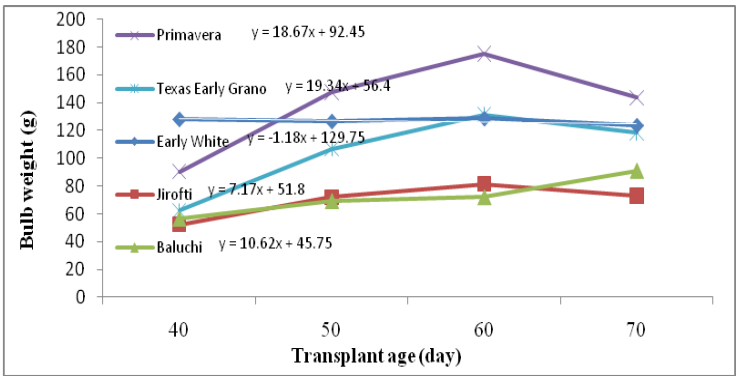

Fig. 4- Changes trend of bulb weight in the evaluated cultivars and landraces by increasing transplant age.

3.3. Average bulb diameter

In PR and TEG cultivars and Baluchi landrace, 60 and 70 days old transplants significantly were thicker than 40 and 50 days old transplants. In the all cultivars and Jirofti landrace, bulb diameter in 60 days old transplants was more than other transplant ages. Totally, increasing transplant age in the all cultivars and landraces except EW caused to increase bulb diameter (Fig. 5).

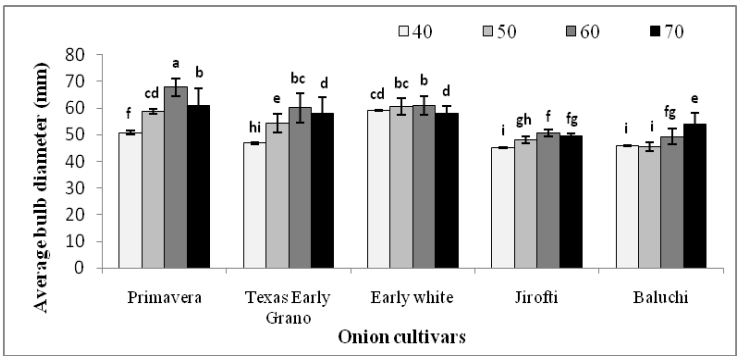

Fig. 5- Effect of transplant age and cultivar on average bulb diameter
Columns having same letter are not significantly different according to LSD ($p<0.05$)

In evaluation of regression coefficient, the highest increasing trend of bulb diameter synchronous enhancing transplant age (RC=3.9) was observed in PR and TEG cultivars. The lowest RC (1.8) was relative to Jirofti landrace. Regression coefficient in EW cultivar was -0.3 that it is represents of bulb diameter reduction by increasing transplant age in this cultivar (Fig. 6).

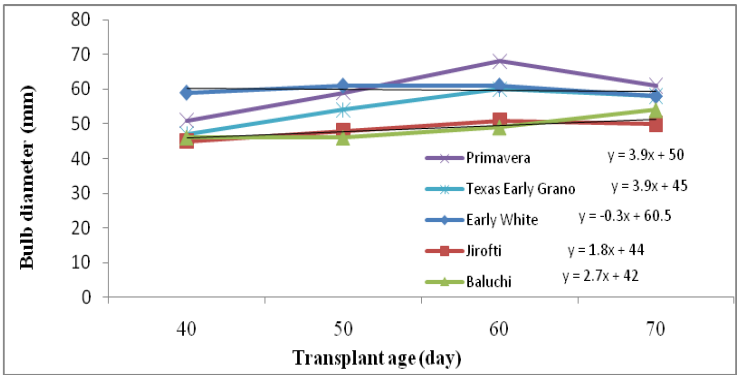

Fig. 6- Changes trend of bulb diameter in the evaluated cultivars and landraces by increasing transplant age.

3.4. Average bulb neck diameter

The highest bulb neck diameter was observed in 40, 50 and 70 days old transplants of Jirofti and Baluchi landraces. In 60 days transplants, the highest bulb neck diameter was relative to Jirofti landrace. On the whole, foreign short-day onion cultivars had lower neck diameter than native landraces in the all transplant ages. The lowest bulb neck diameter was observed in PR cultivar. It was no observed distinct trend in increase or reduction of bulb neck diameter by increasing transplant age. Only in PR and TEG cultivars, bulb neck diameter non-significantly decreased by increasing transplant age (Fig. 7).

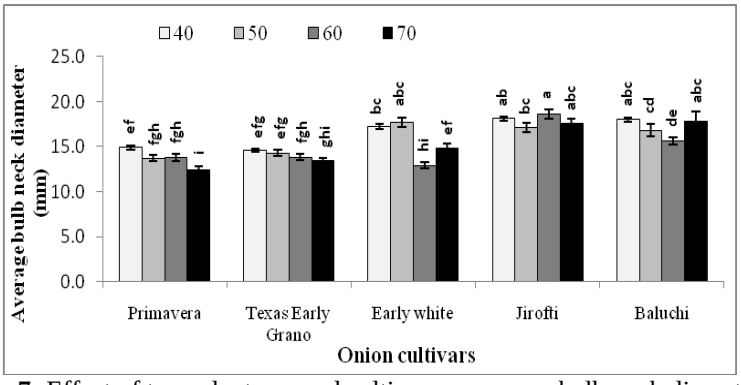

Fig. 7- Effect of transplant age and cultivar on average bulb neck diameter
Columns having same letter are not significantly different according to LSD ($p<0.05$)

Regression coefficient indicated that in the cultivars and Baluchi landrace bulb neck diameter decreased by increasing transplant age. The changes trend in Jirofti landrace was not distinct (Fig. 8).

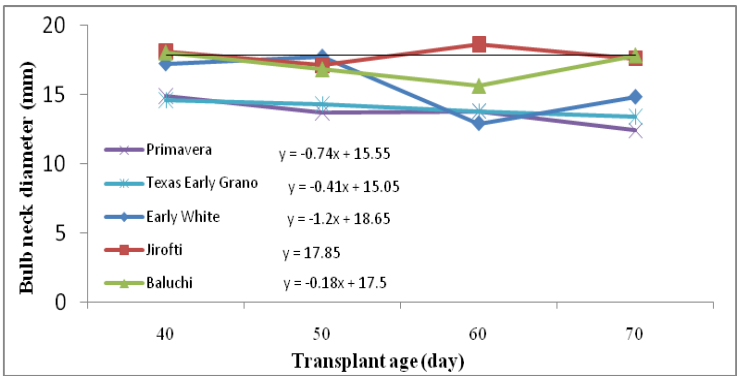

Fig. 8- Changes trend of bulb neck diameter in the evaluated cultivars and landraces by increasing transplant age**.**

3.5. Leaf number

It was no observed significant difference among various transplant ages in PR and TEG in viewpoint of leaf number. Leaf number of 40 days old transplants of EW cultivar and Baluchi landrace was significantly more than other transplant ages. Leaf number of 60 and 70 days old transplants of Jirofti landrace significantly was more than 40 and 50 days old transplants. Totally, the produced leaf number in the all transplant ages of native landraces significantly was more than foreign short-day onion cultivars (Fig. 9).

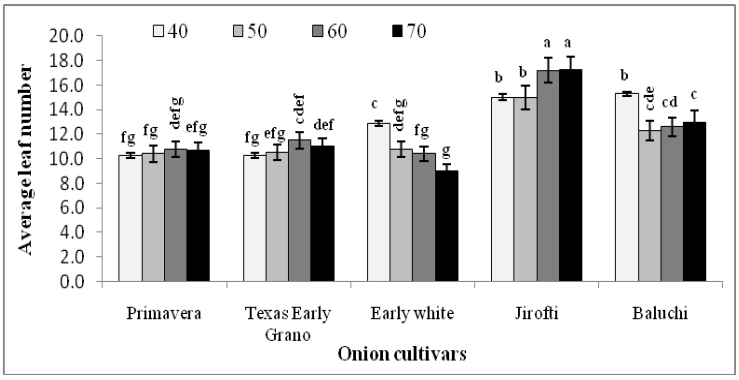

Fig. 9- Effect of transplant age and cultivar on leaf number
Columns having same letter are not significantly different according to LSD ($p<0.05$)

Regression coefficient demonstrated that leaf number enhanced by increasing transplant age in PR and TEG cultivars and Jirofti landrace. Changes trend of leaf number by increasing transplant age in EW cultivar and Baluchi landrace was decreasing (Fig. 10).

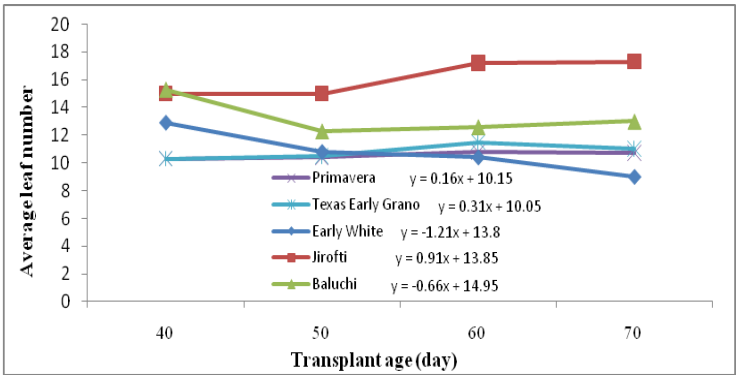

Fig. 10- Changes trend of leaf number in the evaluated cultivars and landraces by increasing transplant **age.**

3.6. Plant height

It was no observed significant difference among various transplant ages in viewpoint of plant height in PR cultivar. In TEG cultivar and Jirofti landrace, final plant height enhanced by increasing transplant age, so that, plant height of 60 and 70 days old transplants was more than 40 and 50 days old transplants. Contrary to other cultivars, in EW cultivar, plant height decreased by increasing transplant ages, so that, plant height of 40 days old transplants significantly was more than 70 days old transplants (Fig. 11).

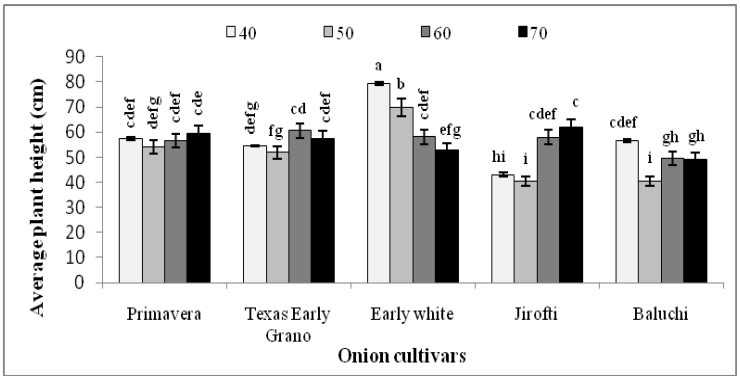

Fig. 11- Effect of transplant age and cultivar on plant height
Columns having same letter are not significantly different according to LSD ($p<0.05$)

Trend of plant height changes in EW cultivar and Baluchi landrace was descending by increasing transplant age (RC= -9.13 and -1.41, respectively). Increase trend of plant height in Jirofti landrace was very high by increasing transplant age (RC= 7.42) (Fig. 12).

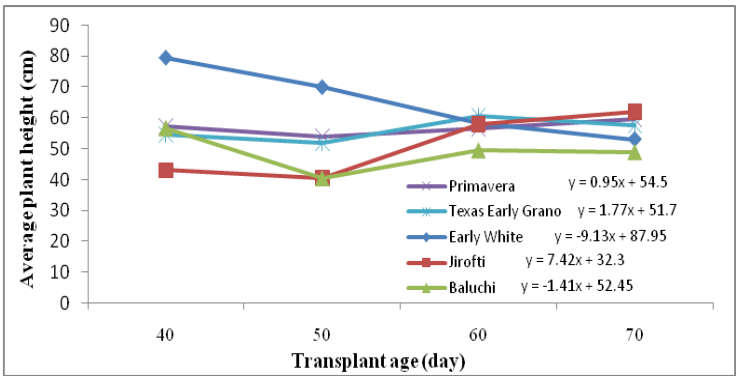

Fig. 12- Changes trend of plant height in the evaluated cultivars and landraces by increasing transplant age.

3.7. Edible layer number

The highest number of edible number in PR and TEG cultivars was observed in 70 days transplants and in Jirofti and Baluchi landraces in 60 days transplants. The highest number of edible number in EW cultivar was observed in 50 days old transplants. In the all cultivars and landraces, except EW cultivar, by increasing transplant age, the number of edible layer enhanced. In EW cultivar, increasing of transplant age caused to reduce the number of edible layer (Fig. 13).

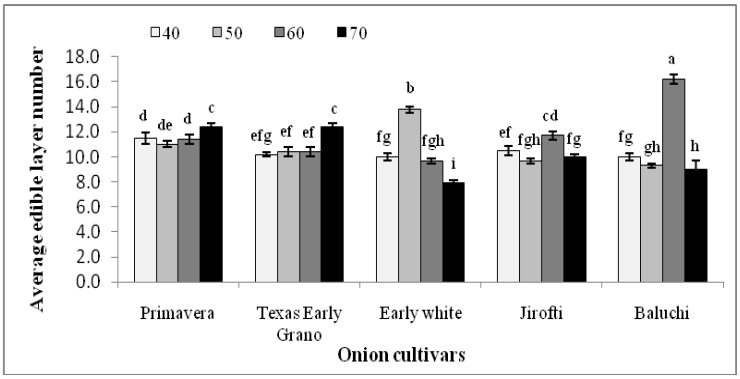

Fig. 13- Effect of transplant age and cultivar on edible layer number
Columns having same letter are not significantly different according to LSD ($p<0.05$)

Altogether, according to the regression coefficients it was distinguished that increasing of transplant age in the all cultivars and Baluchi landrace led to increase the number of edible number, so that, the highest and lowest RC (0.66 and 0.05, respectively) was observed in TEG cultivar and Jirofti landrace, respectively. Regression coefficient in EW cultivar (-1.04) indicated that edible layer number in this cultivar decreased by increasing transplant age (Fig. 14).

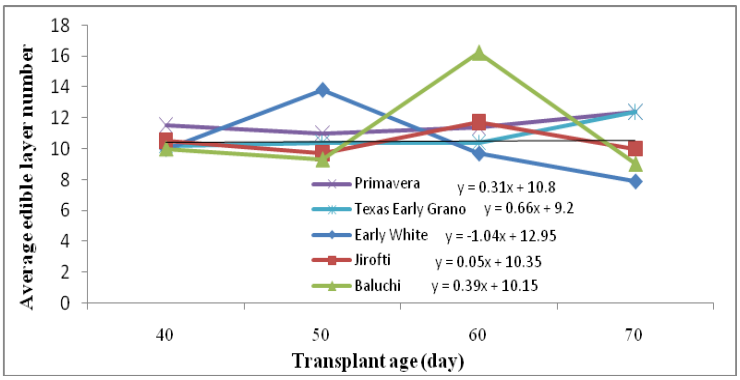

Fig. 14- Changes trend of edible layer number in the evaluated cultivars and landraces by increasing transplant age.

3.8. Bulb dry matter percent

Generally, bulb dry matter percent of the produced bulbs from Jirofti and Baluchi landraces in the all transplant ages significantly was more than foreign short-day onion cultivars. In PR, TEG and EW cultivars, bulb dry matter percent did not significantly changed by increasing transplant age. Vice versa, in Jirofti and Baluchi landraces, bulb dry matter percent of 60 days old transplants significantly was more than other transplant ages (Fig. 15).

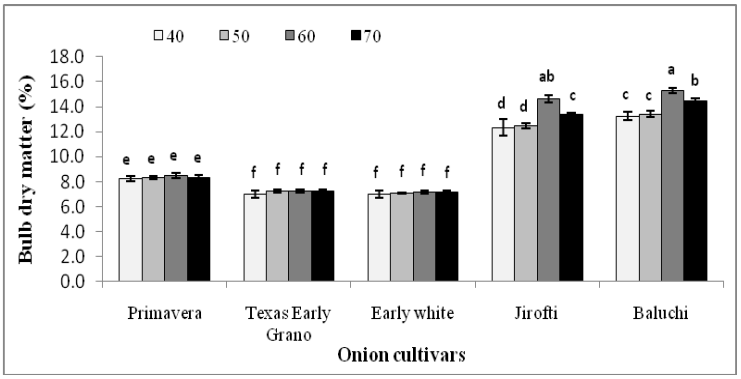

Fig. 15- Effect of transplant age and cultivar on bulb dry matter percent
Columns having same letter are not significantly different according to LSD ($p<0.05$)

Based on regression coefficient, in the all cultivars and landraces, bulb dry matter percent enhanced by increasing transplant age but this enhancement in Jirofti and Baluchi landraces (RC= 0.522 and 0.539, respectively) was more than foreign short-day cultivars (Fig. 16).

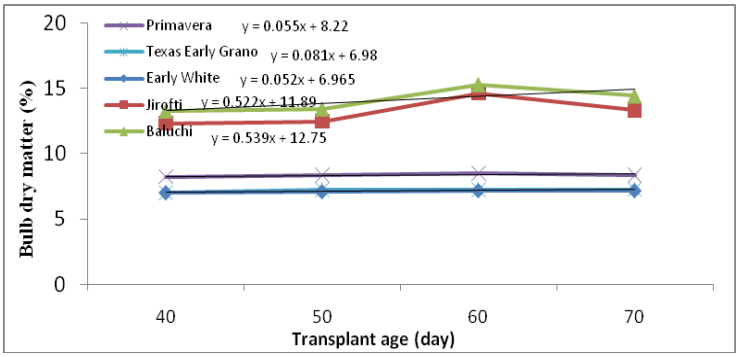

Fig. 16- Changes trend of bulb dry matter percent in the evaluated cultivars and landraces by increasing transplant age.

3.9. Bulb yield

The highest bulb yield in PR and EW cultivars and Baluchi landrace was observed in 60 days transplants and in TEG cultivar and Jirofti landrace in 70 days transplants. Forty days old transplants significantly produced the lowest bulb yield in the all cultivars and landraces except EW cultivar. The average produced bulb in EW, PR and TEG cultivars and Jirofti and Baluchi landraces were 44.69, 42.45, 31.56, 24.56 and 22.44 ton/ha, respectively. In relation to various transplant ages, the highest bulb yield was relative to 60, 70, 50 and 40 days old transplants with 37.6, 34.8, 32.8 and 27.4 ton/ha, respectively (Fig. 17).

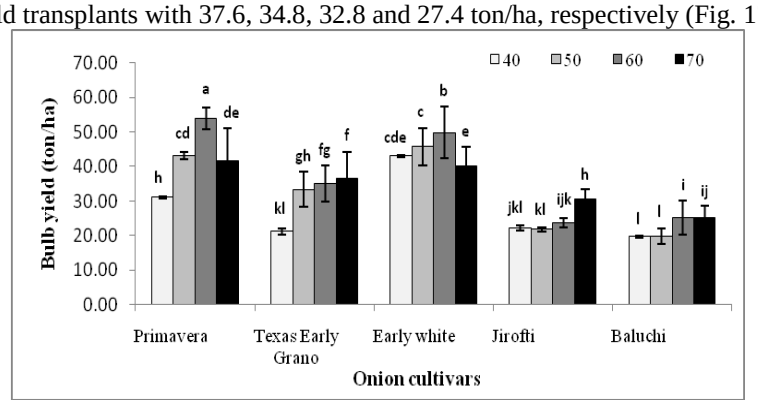

Fig. 17- Effect of transplant age and cultivar on bulb yield
Columns having same letter are not significantly different according to LSD ($p<0.05$)

In evaluation of bulb yield changes trend by increasing transplant age, regression coefficient indicated that in EW cultivar with RC= -0.45, transplant age increasing caused to reduce bulb yield. In other cultivars and landraces, increasing of transplant age led to increase bulb yield, so that, amount of this enhancement in PR and TEG cultivars (RC= 4.237 and 4.790, respectively) was more than Jirofti and Baluchi landraces (RC= 2.737 and 2.136, respectively) (Fig. 18).

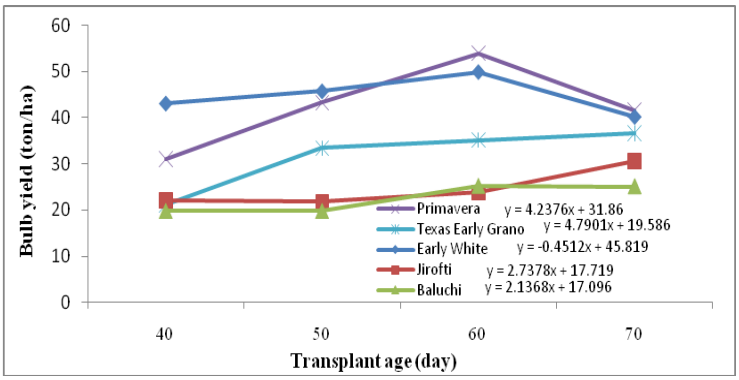

Fig. 18- Changes trend of bulb yield in the evaluated cultivars and landraces by increasing transplant age.

IV. Discussion

Bolting percent is an undesirable trait in onion production. Bolting usually doesn't occur in importer cultivars than landraces. It have been reported that bolting percent significantly decreased in Baluchi landrace by increasing transplant age from 60 to 75 days (Aboutalebi and Amirizadeh, 2015), which it had no conformity with our findings. Moreover, in their results, transplant age had no influence on bolting percent of Primavera cultivar. In viewpoint of bulb weight, among short-day onion cultivars, PR cultivar had the highest bulb weight in the all transplant ages. The highest bulb weigh have been reported from 60 days old transplants (Aboutalebi and Amirizadeh, 2015). In their study, transplant age had no influence on bulb weight of Baluchi landrace. In a report, the highest and lowest bulb weight was obtained from 40 and 70 days old transplant, respectively (Kanton *et al*., 2008) that it is contrary with our findings. Certainly, the highest and lowest bulb weights in their investigation were 57.2 and 26.1 g, respectively, which it was very different with the obtained amounts in our report (157 and 52 g, respectively). In long-day onion cultivars also bulb weight significantly enhanced by increasing transplant age (Mohammadi *et al*., 2010) that it is conformable with the findings of the present study.

Increasing transplant age in the all cultivars and landraces except EW caused to increase bulb diameter. In an investigation, 45 and 75 days old transplants of Primavera cultivar had the highest and lowest bulb diameter, respectively, so that, bulb diameter decreased by increasing transplant age from 45 to 75 days (Aboutalebi and Amirizadeh, 2015). But, in the present study, increasing transplant age up to 70 days led to increase bulb diameter. In the investigation of the above-mentioned peoples, the obtained results about Baluchi landrace were similar to the results of our study, which bulb diameter enhanced by increasing transplant age. On the whole, foreign short-day onion cultivars had lower neck diameter than native landraces in the all transplant ages. Mohammadi *et al*. (2010) reported that in long-day onion cultivars, bulb neck diameter significantly decreased by increasing transplant age. In an experiment, the highest plant height was obtained from 40 days old transplants (Kanton *et al*., 2008) in which it is according to the our findings about EW cultivar and it is contrary to our results about other cultivars. It seems plant height parameter in addition to affinity with transplant age, be affiliate with cultivar type. Generally, bulb dry matter percent of the produced bulbs from Jirofti and Baluchi landraces in the all transplant ages significantly was more than foreign short-day onion cultivars. Khodadadi (2016) reported that transplant age had no influence of bulb dry matter percent. In studies of other researchers, the highest yield of Primavera cultivar and Baluchi landrace have been obtained from 60 days old transplants (Aboutalebi and Amirizadeh, 2015) in which it is according with our results. It have been reported that in long-day onion cultivars, bulb yield significantly increased by enhancing of transplant age (Mohammadi *et al*., 2010). In the other investigation, the highest bulb yield was obtained from 20-40 days old transplants (Kanton *et al*., 2008), in which it is completely contrary to the results of present study. It may nursery conditions as well as cultivar type (in viewpoint of short-day or long-day) in the mentioned study had been different, although, they have not been pointed to these subjects. In evaluation of 4 to 10 weeks old onion transplants, it has been distinguished that the bulb yield increased by increasing of transplant age up to 7 weeks, but the yield had descending trend by aging transplants (Vachhani and Patel, 1998). It has been reported that the produced crop from larger transplants have been more than the lower transplants (Lujan-Favela, 1992; Harison *et al*., 1993). Certainly, these two researchers found that the effect of transplant size on bulb yield was more than transplant age. However, it has been reported the influence of nitrogen during nursery time on final bulb yield (Harison *et*

al., 1993). In the other study, it has been recommended larger transplants with 20 cm long to produce bulb compared with smaller transplants (Izadkhah *et al*., 2011). In Primavera cultivar, 65 days old transplants have been recommended for Jiroft region of Kerman province, Iran (Khodadadi, 2016).

V. Conclusion

In the southern regions of Iran, according to favorable environmental conditions during autumn and winter, cultivation of short-day onion cultivars is important. In some of these regions such as Minab, according to hot weather in late summer and early of autumn, it is not possible earlier planting of onion and the required transplant is mainly produced in cool regions of south Kerman province and it is transported to Minab region. Costs of transplant preparation in this production system are high and it cause to increase current expenses. On the other hand, the used transplants in this region mainly have 10 weeks old and this time is long time, therefore, reduction of nursery duration and faster transplanting to main filed could be cause to complete vegetative growth before shortening of day length and forming bulb and utilizing actual crop potential to increase quantitative and qualitative of the yield. Based on the existence references, in different regions of the world is used various transplant ages from 6 to 10 weeks (Galmarini and Della- Gaspera, 1995; Leskovar and Vavrina, 1999). For this purpose, in the present study the minimum and maximum transplant age (about 40 to 70 days) was evaluated.

Yield of each plant influences by different factors such as planting method, density, planting time and genetic characteristics of each cultivar. Therefore, selection of proper planting time significantly helps to increase the plant yield, because plant cultivation in suitable time avails necessary opportunity for sufficient growth and establishment before beginning of low temperatures. Besides, other factors also affect planting time including climate factors and non-climate factors like pests, diseases, weed, birds, production economy, etc. With accurate knowledge of environmental factors, ecological requirements of desirable cultivar and interaction between cultivar and environment could be determine approximate planting time and/or it could be change planting time in order to run away from unfavorable environmental conditions or better enjoyment of favorable environmental conditions (Khajehpour, 1997). It has been reported that planting time of onion is dependent to plating location, onion type and planting method. It has been reported 8-10 weeks transplants in Pakistan climate (Jilani, 2004). Performance of various cultivars under different agro-climate conditions is different and even in similar environmental conditions often has different performance. Competence of a cultivar mainly is dependent to interaction between genetic structure and environment, therefore, both factors are determinative the selected cultivars in a region (Jilani, 2004). In the present study, planting 40 days transplants was very difficult in due to small size of these transplants and also its mortalities percent and its replanting necessity was very high. Generally, in the conditions of our study, 60 and 70 days transplants had suitable potential to produce bulb and they had no significant difference together. Therefore, regard to the 60 days transplants are planted to main field 10 days earlier than 70 days transplant and it establishes faster, it is recommended as superior transplant age for the all evaluated onion cultivars.

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