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ORIGINAL ARTICLE

Effect of Irrigation Regimes on Growth and Yield of Two Potato Cultivars

[1]Shahram Sharafzadeh, [2]Masood Deimehr, [3]Alireza Eftekharian Jahromi

[1]Islamic Azad University, Firoozabad Branch, Firoozabad, Iran
[2]Islamic Azad University, Jiroft Branch, Jiroft, Iran
[3]Islamic Azad University, Shiraz Branch, Shiraz, Iran

Shahram Sharafzadeh, Masood Deimehr, Alireza Eftekharian Jahromi: Effect of Irrigation Regimes on Growth and Yield of Two Potato Cultivars

ABSTRACT

Potato (*Solanum tuberosum* L.), a member of Solanaceae family, is a perennial herb, but in agriculture it is used as an annual crop. A field experiment was conducted to evaluate the effects of irrigation regimes, every fourth day as control (I_c), every day (I_1), every second day (I_2) and every sixth day (I_6) and two cultivars, Picasso (P) and Santea (S) on growth and yield of the potato. The experiment carried out as a factorial experiment based on randomized complete block design (RCBD) with three replications. The results indicated that the maximum shoot height (74.53 cm) was achieved on I_1P. The highest stolon number (7.17) was obtained in I_1P. Stolon length was maximum (4.78 cm) in I_1S. The maximum tuber number (6.90) was shown in I_1P. The highest total tuber weight (714.67 g/plant) was achieved on I_1P.

***Key words*:** *Solanum tuberosum*, Picasso, Santea, tuber, stolon

Introduction

The potato plant (*Solanum tuberosum* L.) is a perennial herb, but in agriculture it is used as an annual crop. It is usually propagated using seed tubers. Seed tubers produce sprouts in their eyes, which develop into shoots, and produce roots from primordia on the sprouts. On these shoots, the stems, foliage, stolons, roots, inflorescences and the next generation of tubers are formed. Worldwide 85% of fresh water is used in agriculture. The efficiency of the use of available water, i.e. the proportion of available water directed towards plant transpiration, is often less than 50%, but there is a large variety of different options to reduce water losses and enhance water productivity, including micro-management such as drip irrigation, improved varieties, growing alternative crop species and better timing of the crop cycle in the season. Potato is a crop that uses water relatively efficiently. Its high harvest index of about 0.75, compared with approximately 0.5 for cereals, contributes to this property as does its agro-ecological character, characterized by relatively low evaporative water demand. Uptake and assimilation of carbon dioxide are intimately linked with transpirational loss of water, and a linear relation between potato production and water use is commonly found in very divergent agro-ecological conditions [17].

In comparison with the other crops, potato is sensitive to water stress at some growth stages and irrigation has become an essential component of potato production in arid and semiarid regions [18]. Numerous irrigation experiments have proved that potato is sensitive to water stress, since it has a weak root system and 85% of roots is concentrated in the top soil (upper 30 cm) [11]. Water stress results in yield reduction, weaker plant growth and lower amount of biomass produced. During growth, potato evaporates 3–5 mm water per day if the soil moisture level is optimal [10]. Yuan *et al.* [19] and Kiziloglu *et al.* [7] reported that potato for suitable growth and

Corresponding Author

Shahram Sharafzadeh, Department of Agriculture, Islamic Azad University, Firoozabad Branch, Firoozabad, Iran.
E-mail: s.sharafzadeh@iauf.ac.ir or shahramsharafzadeh@hotmail.com; Tel: +98-9177158317.

optimum yield needs frequent irrigation. For potato production in Hamedan, Iran irrigation is needed, because occurred rainfall during growing season and stored soil moisture are insufficient to provide potato water requirement to acquire the optimum yield [3]. Van Loon [16] concluded that potato is quite sensitive to drought. Wright and Stark [18] reported that some stress can be tolerated during early vegetative growth and late tuber bulking under water deficit condition. Under deficit irrigation conditions, potato yield and grade responded linearly to applied water [13].

The objective of this study was to determine the effect of irrigation regime on growth and yield of two potato cultivars.

Materials and methods

Plant materials and experimental conditions:

The field study was conducted using the potato tubers at the Faryab region in the state of Kerman, Iran in order to evaluate the effects of Four irrigation regimes: every fourth day as control (I_c), every day (I_1), every second day (I_2) and every sixth day (I_6) and two cultivars: Picasso (P) and Santea (S) on growth and yield of the potato. The experiment carried out as a factorial experiment based on randomized complete block design (RCBD) with three replications. Each plot contained 5 rows with 5 m long and spacing of 15 cm between plants within row and 75 cm between rows.

The soil of field was tested before planting and soil texture was sandy-loam with PH=6.8, N=0.08%, available P=12.6 mg/kg, available K=87.9 mg/kg and EC=1.3 dS/m. Aerial parts were cutted one week before harvesting. Ten plants were randomly selected from each replication and shoot height, stolon number and length, tuber number and total tuber weight were measured.

Statistical analysis:

Data from the experiment were subjected to analysis of variance (ANOVA) using SPSS computer software at $P < 0.05$ and means compared with Duncan's new multiple range test (DNMRT).

Results and discussion

The results indicated that the maximum shoot height (74.53 cm) was achieved on I_1P which was not different when compared to I_cP and I_1S and the minimum shoot height (32.60 cm) was in I_6S (Fig. 1). The maximum tuber number per plant (6.90) and total tuber weight (714.67 g/plant) was shown in I_1P which were different when compared to other treatments (Fig. 2 and Fig. 3). The highest stolon number (7.17) was obtained in I_1P which was not different when compared to other treatments. Stolon length was maximum (4.78 cm) in I_1S.

Thornton [15] and Shock [12] found that all growing stages of potato, especially tuber formation stage are very sensitive to water deficit stress. However, Doorenbos and Kassam [4] reported that initial vegetative stage is not sensitive to water stress. Hassan *et al.* [6] concluded that the stolonization and tuberization stages were more sensitive than bulking and tuber enlargement stages. Also, Shock *et al*. [14] reported that potato can tolerate water deficit before tuber set without reduction in tuber quality in some conditions. However, Shock and Feibert [13] concluded that a short period of water stress following tuber set reduces tuber yield and quality. The poor root system of potato has a low suction capacity, therefore, in dry periods, water becomes a limiting factor in plant development easily. The impact of irrigation is dependent upon the degree of deficiency in the natural water supply and on the plant development stage. Lelkes [9] showed that the average total tuber yield without irrigation ranged between 7 and 50 t/ha. The average yield was 28 t, 80% of which reached the table size. With proper irrigation, yields of 40–47 t/ha were obtained with the average yield being 43.5 t/ha. The yield increment due to irrigation was 15.5 t/ha. The favorable effect meant not only a yield increment, but also a significant reduction in the variation in yield between the years. Under non-irrigated conditions, especially in dry years, the ratio of small tubers was 40–50%, under irrigated conditions with a proper water supply, this ratio was below 25%, it was even less than 10% for some cultivars. Under good water supply or due to irrigation, the ratio of undersized tubers decreases and the ratio of marketable tubers increases. No significant differences were found in the number of tubers. Harun-ur-Rashid *et al.* [5] found when studying the relationship between the water use of irrigated potato and potato yield that if 40 mm water was given in 12 days (irrigation was started 30 days after planting), the highest number of the tubers were in the size categories of 28–45 mm and larger than 45 mm. The highest ratio of tubers below 28 mm was found in the non-irrigated treatment. Arends [2] also found that the lack of water during the period of tuber set and development had a disadvantageous effect on the distribution of tubers between the different size categories: the ratio of large tubers is reduced. According to his results, the adverse effect of water deficiency is stronger on loose and heavy soils than on mid-heavy loam soil. According to Antal *et al.* [1], the number of potato plants per unit area should be increased by 10–15% by irrigation. For yields higher than 40 t/ha and for superior quality, continuous and regular irrigation is necessary.

In developing potato production, the exact knowledge of production factors (ecological, biological and agrotechnical), their exploration and the application of cultivar-specific technologies are of special importance, in addition to the improvement of efficacy, the better utilization of opportunities of the technologies and the biological bases, irrigation can increase yields considerably: the temporary periods of water deficiency can be prevented and the amount and quality of yield are enhanced [8].

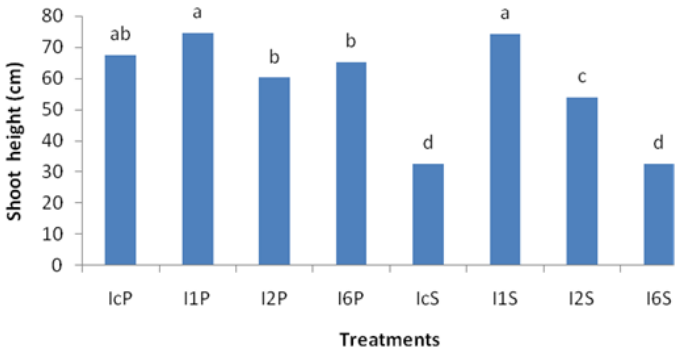

Fig. 1: Effect of irrigation regimes and cultivars on shoot height of potato. Columns with the same letters are not significantly different at 5% level of Duncan's new multiple range test (DNMRT).

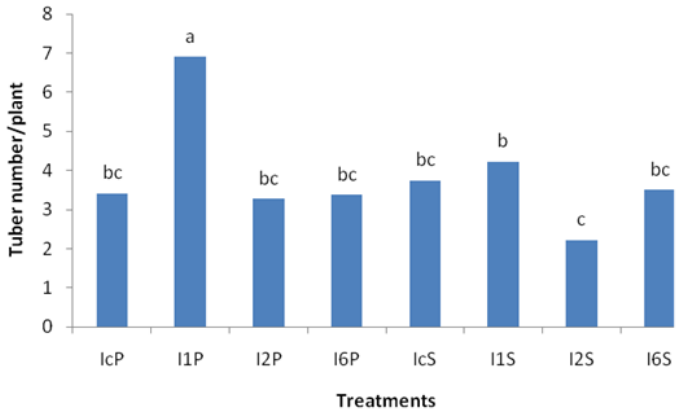

Fig. 2: Effect of irrigation regimes and cultivars on tuber number of potato. Columns with the same letters are not significantly different at 5% level of Duncan's new multiple range test (DNMRT).

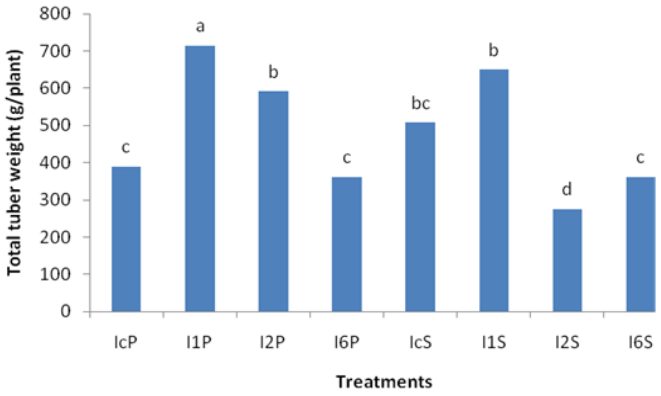

Fig. 3: Effect of irrigation regimes and cultivars on total tuber weight of potato. Columns with the same letters are not significantly different at 5% level of Duncan's new multiple range test (DNMRT).

References

1. Antal, J., J. Kruppa, K. Pocsai and M. Sarvari, 2005. Burgonya. In szerk. Antal, J.: N.ovenytermesztestan 2. Mezogazda Kiado., 51-88.

2. Arends, P., 1999. Az .onto.zes jelentosege es szempontjai Hollandiaban. In szerk. Kruppa, J.: A burgonya es termesztese III. Agroinform Kiado, Budapest., 114-118.
3. Bahramloo, R. and A. Nasseri, 2009. Optimum irrigation events for potato cultivar. Agri. Int. J. Agric. Biol., 11: 712-716.
4. Doorenbos, J. and A.H. Kassam, 1979. Yield Response to Water, Irrigation and Drainage Paper 33. Food and Agricultural Organization of the United Nations, Rome, Italy.
5. Harun-Ur-Rasid, I.T., H. Sarker and J. Alam, 1990. Water use and yield relationships of irrigated potato. Agric. Water Mgt., 18: 173-179.
6. Hassan, A.A., A.A. Sarkar, M.H. Ali and N.N. Karim, 2002. Effect of deficit irrigation at different growth stage on the yield of potato. Pakistan J. Biol. Sci., 5: 128-134
7. Kiziloglu, F.M., U. Sahin, T. Tune and S. Diler, 2006. The effect of deficit irrigation on potato evepotranspiration and tuber yield under cool season and semiarid climatic conditions. J. Agron., 5: 284-288.
8. Kruppa, J., 1998. A vizstressz (vizhiany vagy vizboseg hatasa a burgonya minosegere es egeszsegi allapotara). In: A burgonya es termesztese. (Szerk.: Kruppa J.) Holland-Magyar Burgonyaprogram, Kisvarda, pp: 128.
9. Lelkes, J., 1988. A mai korszeru szantfldi .nt.zestechnika jellemzese. Az .nt.zeses gazdalkodas ˚jabb kutatosi eredmenyei. Onto.zesi Kutatoo Intezet, Szarvas., pp: 157-16.
10. Marutani, M. and F. Cruz, 1989. Influence of supplemental irrigation on development of potatoes in the tropics. HortScience., 24: 920-923.
11. Opena, G.B. and G.A. Porter, 1999. Soil management and supplemental irrigation effects on potato. II. Root growth. Agron. J., 91: 426-431.
12. Shock, C.C., 2004. Efficient Irrigation Scheduling. Malheur Experiment Station, Oregon State University, Oregon, USA.
13. Shock, C.C. and E.B.G. Feibert, 2002. Deficit Irrigation on Potato, pp: 47– 56. In Deficit irrigation practices, FAO, Rome.
14. Shock, C.C., J.C. Zalewski, T.D. Stieber and D.S. Burnett, 1992. Impact of early- season water deficits on Russet Burbank plant development, tuber yield and quality. American Potato J., 69: 793-803.
15. Thornton, M.K., 2002. Effects of Heat and Water Stress on the Physiology of Potatoes. Idaho Potato Conference, Idaho.
16. Van Loon, C.D., 1981. The effect of water stress on potato growth, development and yield. American Potato J., 58: 51-69.
17. Vreugdenhil, D., J. Bradshaw, C. Gebhardt, F. Govers, D.K.L. Mackerron, M.A. Taylor and H.A. Ross, 2007. Potato Biology and Biotechnology Advances and Perspectives. Elsevier.
18. Wright, J.L. and J.C. Stark, 1990. Potato. In: Stewart, B.A. and D.R. Nielson (eds.), Irrigation of Agricultural Crops. American Society of Agronomy, Crop Science Society of America, Soil Science Society of America, Madison, USA.
19. Yuan, B.Z., S. Nishiyama and Y. Kang, 2003. Effects of different irrigation regimes on the growth and yield of drip irrigated potato. Agric. Water Mgt., 63: 153-167.