Kurdistan Journal of Applied Research (KJAR)
Print-ISSN: 2411-7684 | Electronic-ISSN: 2411-7706
Volume 3 | Issue 2 | December 2018 | DOI: 10.24017/science.2018.3.5

Received: 5 November 2018 | Accepted: 28 November 2018

The Effect of Different Irrigation Interval on Tuber Yield and Quality of Potato (*Solanum tuberosum* L.)

Farhan Ahmad Abdulrahman
Horticulture and Landscape Design
Technical College of Applied Sciences
Sulaimani Polytechnic University
Halabja, Iraq
farhan173a84@gmail.com

Salah Abdulla Salih
Natural Resources and Environmental Science
Technical College of Applied Sciences
Sulaimani Polytechnic University
Halabja, Iraq
salah.salh@spu.edu.iq

Yonis Abdulla Mahmood
Halabja Agriculture High School
Directorate of Education Halabja
Halabja, Iraq
yonis_a982@yahoo.com

Abstract: ***Gaining high yield of potato is very crucial for farmer and quality also has a great impact on their production. Beside the quality and yield using the amount of irrigation also important to reduce water lose. The tuber yield and quality of potato (Solanum tuberosum L.) is impacted by irrigated water. This study was carried out in two respectively season (2017 and 2018) in Halabja province of Kurdistan regional of Iraq to evaluate the impact of irrigation interval on quality and tuber yield in potato cultivars. In this study there are four irrigation intervals (3,5,7 and 9 days) used by furrow irrigation method which subjected in complete randomized design (CRD) with three replications. The potato tuber production in 3 day interval showed highest percentage also protein and starch content was recorded highest in both year of cultivation, but the*** **abscisic** ***acid was affected by more irrigation which in 3 day interval irrigation the rate was less than other. Also in 5 day interval irrigation the rate was acceptable because there is no significant difference in terms of tuber yield, protein and starch content if compare with 3 day interval irrigation in particular for those area faced restricted in using water irrigation.***

Keywords: Irrigation interval, Potato, Water efficiency, Abscisic acid, Starch.

1. INTRODUCTION

Potato (*Solanum tuberosum* L.) is belonging to Solanaceae family is considered the most important vegetable crops in the world that came to the fourth grade after rice, wheat and corn. It is the main sources of carbohydrate and amino acids [1]. Also it is contains protein, fiber, vitamin B6 and Vitamin C [2]. According to [3] that potato production potential of approximately 327 million tons was taken from 18.6 million hectares of planted land which is considered very vital among the agriculture of the world. There are many factors influenced on potato production, including planting date, varieties, weather conditions, nutrients and irrigation [4]. Also potato plant is sensitive to the altering in the soil moisture content and the decrease of water stress that leading to a significant decrease in tubers quantity and quality. Current research study indicated that water have the role in limiting potato production also be able to increase the rate of production by taking the best scheduled irrigation programs in the growing seasons of potato [5]. The requirement for water irrigation of potato plants are diverse in different plant growth stages; tubers initiation and tubers bulking are the more sensitive stages in the plant growth life. In addition, more than 40% of world land is under arid or semi-arid climatic conditions [6]. The climate change has made the situation very difficult by dropping the rate of rainfall and therefore affected on the amount of water available for agriculture cultivation to get higher yield [7]. Decreasing sources of water available for irrigation in the worldwide in particular in Kurdistan region of Iraq due to changing climate (less precipitation, raising temperature) as well as the reducing amount of water entering Iraq through rivers from neighbor countries due to dam construction by the neighboring countries on river is a vital limiting factor in agriculture production. Therefore, the irrigation intervals are considered one of the strategies used to support irrigation water use efficiency. Generally, reduced yields are very often reported due to drought occurrences [8]. As a result of the limiting of water resources the full irrigation and using more water is not a strategic option in areas where water is the most limiting factor, more increasing in water productivity may be economically more affected for the farmer than obtaining high yields [9]. The potato plants are required water irrigation depending on growth stage, which is tuber starting to produce and tuber bulking; both stages are sensitive in the growth of plant life [10]. There are study confirm that decreasing in the rate of water irrigation leads to a significant reduction in leaf area and plant height [11]. In addition, the percentage of dry mater in potato tuber and specific gravity were significantly increased with a reduction in water irrigation amount [12]. Another aspect affected by water irrigation amount on the content of potato is abscisic acid (ABA) in tuber. The impact of water irrigation amount on potato ABA that mild soil water stress reduces nutrient uptake and increases the xylem sap pH. This allows higher amounts of ABA in the leaf to be translocations to stomata through the transpiration stream [13, 14]. Additionally, the starch content also is changing with applying the irrigation amount especially in the beginning of producing tuber it becomes strong then collapse and develops

quickly due to huge influx of sucrose then convert to starch rapidly [15]. The tuber continued to storage more energy in the form of starch [16]. In addition, the irrigation also has the impact of the growing stage of forming tuber such [17] cited the water irrigation during the growing period may reduce the quality of tuber by increasing the amount of starch and decreeing the rate of sugar. Also [18,19] state that water irrigation by sprinkling of potato cultivar in the growing period may cause the amount of starch with dry matter is reduced. Moreover, the protein content also is impacted by the irrigation interval which conducted in this research paper as [20] cites that the rate of protein is changed depending on verities, location and fertilizer. Also some of the other factor affected on the tuber quality harvesting, cultivation methods, such as irrigation [21] and the methods of cultivation as well [22]. The aim of this study is to determine the impact of different irrigation interval under furrow irrigation methods on potato tuber yield and tuber contents which are the total of starch and protein contents.

2. METHODS AND MATERIALS

This research was conducted at the fields of Halabja, locating on 35°02'N latitude, 45°58'E longitude and the altitude of 670 m above sea level. The experimental design was used complete randomized design (CRD) with four treatments and 3 replicates. The Experimental plots were planted by potato during 15 April (2017and 2018) consecutive year by using four treatments (irrigation intervals) ;T1= 3 days, T2= 5 days,T3= 7 days and T4= 9 days). Experimental plot sizes are (5m X 10m) with a distance of 0.75 m and 0.30 m between rows and plants respectively. Hence, there
were a total of 7 rows with in a plot and 30 potato tubers within a single row. The spacing between treatments and replications were kept at 0.75 m and 1.5 m respectively in order to minimize edge effect of irrigation. The three-water irrigation was applied in 2017 and 2018 early potato growing seasons. Some physical and chemical properties of the soil at a depth of (30-50cm) of this location which were taken according to [23] are presented in (Table 1) below. Experimental plots were fertilized with di-ammonium phosphate (DAP) and potassium sulfate. All experimental plots were irrigated with a uniform amount of water until 15 day after planting. After that Irrigation treatment was started from 1/5 until physiological plant maturity. The crop was harvested at full maturity after 100 days of planting. Depth of irrigation water was calculated by [23] equation after modifying according to treatments as follow:

$$d = (\theta vf.c - \theta vw.p)Rz \quad (1)$$

Where
d: depth of water applied (mm)
θvf.c : Volumetric water content at field capacity ($m^3\ m^{-3}$)
θvw.p: Volumetric water content wilting point ($m^3\ m^{-3}$)
Rz : root zone depth (mm)

At the end of physiological maturity, central 4 rows of each plot, (3 m by 6 m) was harvested manually and weighed to determine total tuber yield. The amount of the total starch, protein in potato tuber yield and abscisic acid in leaves was done by [24]. The average nitrogen-to-protein conversion factor was 6.25 for potato [25, 26] respectively. The weighed samples of tubers from each plot of the four treatments were converted into kilogram per hectare and irrigation water use efficiency (IWUE) was calculated as follow [27, 28].

$$IWUE = \frac{Yield}{Total\ water\ applied} \quad (2)$$

Where, **IWUE:** is irrigation water use efficiency in ($kg.ha^{-1}.mm^{-1}$)
Y: potato tuber yield in ($kg.ha^{-1}$)
AW: total water applied (mm).

The variance analysis (ANOVA) was studied to evaluate the influenced of the treatments on the potato tuber yield, total starch, protein, abscisic acid and water use efficiency. Least significant differences method (LSD) is used to differentiate means at the 0.05 level (SAS, 2002).

Table 1: Soil physical and chemical properties analyzed by Agricultural Research Centre in Halabja.

Soil test	Sand	Silt	Clay	Bulk density	Field capacity, (33 kPa)	Wilting point, (1500 kPa)	pH of soil	EC of soil	pH of water	EC of water	Total Nitrogen	Phosphors	Potassium (soluble)
Soil sample	133.6	244.3	622.1	1200	320	188	7.57	1.4	7.7	1.05	27	21	12
Unit	g kg^{-1}	g kg^{-1}	g kg^{-1}	Kg m^{-3}	g kg^{-1}	g kg^{-1}		dS m^{-1}		dS m^{-1}	mg kg^{-1}	mg kg^{-1}	Meq kg^{-1}

3. RESULTS AND DISCUSSION

3.1. Percentage of water saving: The result of analysis as appeared in (Table 2) the maximum percent of water is saved between T1: 3 days interval with T4:9 days interval was (110%) and the minimum percent of water saved between T3 and T4 which was (19%). It is showed that reducing irrigation interval leads to decrease water saving, but in other hands the yield of tuber in (Table 3) under T4 was recorded (31.70 $t.ha^{-1}$) less than other treatments in particular significant differences if compared with T1 in year 2017 also for year 2018 was the same result because of the exposure of plants to the water stress negatively affected the growth of stolons, which decrease tubers number of the plant. However, the rate of abscisic acid in T4 was (13.16 $mg.L^{-1}$) higher than other especially compared with T1 was (5.8 $mg.L^{-1}$) in 2017. There are a big change between these amounts this may affected by water use irrigation, but for protein and starch content in both year (2017 and 2018) under the T4 recorded less than other amount that (9.71%, 8.03%) and (58.81 %, 60.4%) respectively in (Table 4).

Table 2: Irrigation characters and percentage of water saving comparison between treatments for 2017 and 2018.

Treatments	Total No of Irrigation	Average Irrigation depth (mm)	Seasonal Irrigation water (mm)	Percentage save of water compared between treatments			
				T1	T2	T3	T4
T1 (3 days interval)	24	27.5	660	0.00			
T2 (5 days interval)	17	28.8	490	35%	0.00		
T3 (7 days interval)	13	28.7	374	76%	31%	0.00	
T4 (9 days interval)	11	28.7	316	110%	56%	19%	0.00

3.2.Yield and its components

Tuber yield: The analysis result of variance indicated that irrigation interval treatments significantly impacted the tuber production of potato as showed in (Table 3). Generally, tuber yield significantly increased with increasing the rate of irrigation water. The amount of Irrigation has strongly impacted on potato production [29, 30].The application of 660 mm of irrigation water in T1 brought the highest tuber yield which recorded 38.4 and 40.73 t.ha-1 of potato for consecutive 2 years of 2017 and 2018. As [31] reported that the total tuber production of potato has been increased with raising amount of irrigation water. However, the lowest tuber yield was recorded from the application of 316 mm of irrigation water in T4 which was 31.70t.ha-1 and 31.2 respectively in year 2017 and 2018. The reason for the yield reduction is refer to the stolon will not formation more tubers in the soil. Also there were not substantial difference between 3 day interval (38.4 $t.ha^{-1}$) and 5 day interval irrigation (37.16 $t.ha^{-1}$) Irrigation increased the yield significantly, but the difference between the yield in 3day interval with 6 days interval was on the edge of significance.

The highest yield followed after the most intense irrigation and was statistically significantly higher than the yield of the delay water irrigation. The fresh tuber of potato production was higher under high frequency of water irrigation than low frequency irrigation. With delayed irrigation the yield reduced significantly due to reduction in the availability of water. The stage of stolon produce and tuber formation is sensitive step to low water irrigation [32].

Water use efficiency: The variance Analysis also indicated that water use efficiencies of potato were significantly influenced by irrigation interval at all treatments as illustrated in (Table 3). The result generally showed highest value in the T4 (100.3 $kg.ha^{-1}.mm^{-1}$, 98.94 $kg.ha^{-1}.mm^{-1}$) because of lowest water irrigated during plant seasons growth for both years despite of that the yield is decreased to (31.70, 31.2 $t.ha^{-1}$) due to exposed plant to water stress, and lower value of water use efficiency in the T1(58.24 $kg.ha^{-1}.mm^{-1}$, 61.71 $kg.ha^{-1}.mm^{-1}$) due to using high water irrigated for both years in spite of that the yield is increased to (38.4 ,40.73 $t.ha^{-1}$) as [31] cited the lower utilizing rate of irrigation water received the higher the water efficiency use Similar results were also confirmed by many researchers that conducted previously such [29, 33, 31] cited in their research paper. However, there were statistically significant water use efficiency differences among all treatments. The increasing irrigation water amounts that resulted in relatively decrease water utilize efficiency. This might be refer to accumulation of excess moisture in the root zone and consequently resulted in decreasing the yield of potato [34].

Table 3: Mean value for effect irrigation interval on potato tuber yield and water efficiency of potato in 2017 and 2018.

Treatments	Year 2017				Year 2018			
	Potato tuber yield ($t.ha^{-1}$)		Water use efficiency ($kg.ha^{-1}.mm^{-1}$)		Potato tuber yield ($t.ha^{-1}$)		Water use efficiency ($kg.h^{-1}.mm^{-1}$)	
T1	38.4	a	58.24	d	40.73	a	61.71	d
T2	37.16	b	75.84	c	38.5	b	78.6	c
T3	33.68	c	90	b	34.1	c	91.17	b
T4	31.70	d	100.3	a	31.2	d	98.94	a
LSD	1.11		2.89		1.74		3.47	

Different letters indicate significant differences at $\alpha = 0.05$ by the LSD test (least significant differences

Abscisic acid, Starch and Protein: The (Table 4) showed the concentration of abscisic acid (ABA) during the growth stage for all treatments in potato leaves, it can be noticed that T1 (3 day irrigation interval) showed the lowest value of ABA which was (5.8 $mg.L^{-1}$) in year 2016 and in 2017 was (5.3 $mg.L^{-1}$). The less concentration of ABA in T1 refers to less exposed plant to water stress and less exudates of this acid from plant roots. This is consistent with [35, 36]. While the T4 showed the highest values of ABA (13.16 and 11.9 $mg.L^{-1}$) for consecutive 2 year. The starch content was (66.46 %) under T1 and (58.81 %) under T4. The starch content was recorded the highest in both under T1 (66.46 %) and T2 (64.93 %). The water supply is favorable in a respect of the starch content of potato. The highest starch percentage was measures in 2018 in T1 was (68.5 %). This means the irrigation increase the starch content which proves that the even water supply during the formation and development of tuber is very important and necessary. The starch which recorded lower rate in T4 for both year which is 58.81% and 60.4% respectively this affected by drought as [37] conducted the starch in the beginning of producing tuber it become a stronger then collapse and develops quickly due to huge influx of sucrose then convert to starch rapidly.

The protein content also impacted by irrigation which in T1 was recorded highest (12.2 %) in 2017 also in 2018 was showed highest percentage in T1 was (11 %). But the lowest rate of protein was (9.71 %) under T1 in the year 2017 as well in 2018 the rate less than other treatments which were (8.03 %) this means there are significant differences between T1 and T2, but there are no significant differences between T1 and T3 as well as between T2 and T3 according to statistically analysis showed in (Table 4). There were positive relations between protein and starch content. Similarly to the starch content the protein content was high in both years during experiment. Generally protein and starch content in tuber yield was affected by exposed plant to water stress as confirmed by [38] statically decreased percent of protein and starch content in potatoes tuber yield when increasing the stress on plant during growth.

Table 4: Mean value for effect irrigation interval on components of potato in 2017 and 2018.

Treatments	Year 2017						Year 2018					
	Abscisic acid ($mg.L^{-1}$)		Protein (%)		Starch (%)		Abscisic acid ($mg.L^{-1}$)		Protein (%)		Starch (%)	
T1	5.8	d	12.2	a	66.46	a	5.3	d	11	a	68.5	a
T2	7.03	c	11.6	ab	64.93	b	6.36	c	10.3	ab	67.1	b
T3	9.5	b	10	bc	61.99	c	8.9	b	8.46	bc	63.3	c
T4	13.16	a	9.71	c	58.81	d	11.9	a	8.03	c	60.4	d
LSD	0.93		1.13		0.46		0.86		1.98		0.57	

Different letters indicate significant differences at $\alpha = 0.05$ by the LSD test (least significant differences)

4. CONCLUSION

Finding the appropriate irrigation intervals for potato has a huge impact on the areas with poor irrigation water management and no soil water measuring devises. It eases the application of the improved agricultural water control practices, which conserve water and increase water productivity. The results of this study illustrated that increasing irrigation interval, increased the WUE and abscisic acid exudates in the plant but decreased the starch and protein content in tuber yield for two consecutive years. This research showed that increasing irrigation interval be able to save water and raising area under

cultivation about 35% compared (T1 with T2) (660 mm divided to 490 mm).

REFERENCES

[1] A.A. Hassan, Potato, Dar-AL-Arabiya, Publication, Cairo, 2003

[2] M. S. Islam, M. M. Hossain and MD. Shariful, "Effect of irrigation on the yield and scab infection of potato," Bangladesh J. Agril. Res. 34(4) : 683-692, 2009

[3] FAO,"FAOSTAT Agriculture Rome," 2006. Available in: http:// faostat.fao.org/faostat/collection ?subset=agriculture. Accessed at November, 8, 2018.

[4] A. M. S. Khalel, "Effect of drip irrigation intervals and some antitranspirants on the water status, growth and yield of potato (Solanum tuberosum L.)," J. Agric. Sci. Technol, (5), 15-23, 2015.

[5] V. Assessment, E. Station, F. Cultivar, L. Sciences, and C. Testing, "Effect of irrigation on the content and yield of starch in early potato cultivar in different region of Poland Variety Assessment Experimental Station of the Research Centre For Cultivar Testing in Uhnin University of Life Sciences in Lublin Research Centre for Cultivar Testing in Słupia Wielka," vol. 8504, no. 4, pp. 61–71, 2016.

[6] M. H. Ali, and M. S. U. Talukder, "Increasing water productivity in crop production—a synthesis," Agricultural water managemen,t (95.11), p. 1201-1213, 2008.

[7] A. Iglesias, L. Garrote, F. Flores, and M. Moneo, "Challenges to manage the risk of water scarcity and climate change in the Mediterranean," Water resources management, 21(5), 775-788, 2007.

[8] M. Farooq, A. Wahid, N. Kobayashi, D. Fujita, and S. M. A. Basra, "Plant drought stress: effects, mechanisms and management," In Sustainable agriculture, pp. 153-188. Springer, Dordrecht, 2009.

[9] M. English, J.T. Musick, V.V.N. Murty, "Deficit irrigation. In: G.J. Hoffman, T.A. Howell. And K.H. Solomon (eds.) Management of Farm Irrigation Systems. ASAE," St. Joseph, MI, pp. 631-663, 1990.

[10] S. A. M. Abdallah,. "Studies on the Application of Antitranspirant and Water Regimes on Potatoes Grown in Calcareous Soils." M.Sc. thesis, Faculty of Agriculture," Alexandria University, Egypt. 1996

[11] H. H., Hegazi, and A. M. Awad, "Irrigation, Trickle, Mineral N and Bio-Fertigation Effects on Potato Yield, Tuber Quality and Water Efficiency," Alex. J. Agric. Res. 47 (1): 89-105, 2002.

[12] M. M. Samey, "The response of potato (Solanum tuberosum, L) to water regimes and irrigation systems," Ph.D. (Agric.) Thesis, Faculty of Agriculture, University of Minoufiya, Egypt,2006.

[13] W J. Davies, S Wilkinson, BR. Loveys, "Stomatal control by chemical signalling and the exploitation of this mechanism to hydraulic conductivity in the control of water relations in wheat plants exposed to increased evaporation demand," Planta 233:87–94,2002.

[14] L Taiz, E. Zeiger, "Plant physiology," 4th edn. Sinauer Associates Inc. Publishers, Massachusetts, 2006.

[15] A. R. Fernie, and L. Willmitzer, "Molecular and biochemical triggers of potato tuber development. Plant Physiology, 127(4), 1459-1465, 2001.

[16] J. I. Watkinson, L.Hendricks, A. A. Sioson, L. S. Heath, H. J. Bohnert, and R. Grene, "Tuber development phenotypes in adapted and acclimated, drought-stressed Solanum tuberosum ssp. andigena have distinct expression profiles of genes associated with carbon metabolism," Plant Physiology and Biochemistry, 46(1), 34-45, 2008.

[17] G. Lisinska, and W. Leszczynski, "Potato science and technology," Springer Science & Business Media. (1989).

[18] A. Pęksa, "Wpływ nawożenia azotem i nawadniania na skład chemiczny bulw i jakość otrzymanych znich chipsó w. Zesz. Nauk. AR Wrocław," Technol. Żyw., 7(244), 9-28,1991.

[19] A. Nadler, B. Heuer, "Effect of saline irrigation and water deficit on tuber quality" Potato Res., 38(2), 393-400, 1995

[20] J. Lachman, K. Hamouz, P. Dvorák, and M. Orsák, "The effect of selected factors on the content of protein and nitrates in potato tubers," Plant Soil and Environment, 51(10), 431,2005.

[21] G. Belanger, J.R Walsh, J.E Richards, P.H. Milburn, N. Ziadi, Nitrogen fertilization and irrigation affects tuber characteristics of two potato cultivars," 2002.

[22] M.G. Lindhauer, and L. Weber, "Critical comments on nitrate in potatoes" In: Proceedings of 12th Trien- nial Conference of European Association of Potato Research (EAPR): 363–364, 1993.

[23] A. Klute, "Method of Soil Analysis," Part I., 2nd ed., Agron, Monogr.9, ASA, 1986.

[24] AOAC. Williams, "Association of Analytical Chemists, Standard Official Methods of Analysis of the Association of Analytical Chemists,"14th Edition, S.W Williams, Washington DC, p 121, 1984

[25] W.M.J. Van Gelder, "Conversion Factor from Nitrogen to Protein for Potato Tuber Protein," Potato Research,24(4), 423–425,1981.

[26] M. Kelen, E.C. Demiralay, S. Sen, and G. Ozkan, "Separation of Abscisic Acid, Indole-3-Acetic Acid, Gibberellic Acid in 99 R (Vitisberlandieri x Vitisrupestris) and Rose Oil (Rosa damascena Mill.) by Reversed Phase Liquid Chromatography," Tuk. J. Chem, 28, 603-610, 2004.

[27] H. Zhang, T. Oweis, S. Garabet, M. Pala, "Water-use efficiency and transpiration efficiency of wheat underrainfed conditions and supplemental irrigation in a Mediterranean-type environment," Plant Soil 201, 295-305, 1998.

[28] A.S. Ati, D.I Ammar, M.N. Salah, "Water use efficiency of potato (Solanumtuberosum L.) under different irrigation methods and potassium fertilizer rates," Annals of Agricultural Sciences, 57.2 99-103,2012.

[29] V. Cantore, F. Wassar, S.S. Yamaçb, M.H. Sellami, R. Albrizio, A.M. Stellacci, M.Todorovic, "Yield and water use efficiency of early potato grown under different irrigation regimes," Int. J. Plant Product, (8)409-428, 2014.

[30] N. Demelash, "Deficit irrigation scheduling for potato production in North Gondar, Ethiopia," African J. Agric. Res., 8(11), 1144-1154, 2013.

[31] B.Z. Yuan, S. Nishiyama, Y. Kang, "Effects of different irrigation regimes on the growth and yield of drip-irrigated potato," Agric. Water Manage., 63, 153-167, 2003.

[32] D. K. L. MacKerron, and R. A Jefferies, "The influence of early soil moisture stress on tuber numbers in potato," Potato Research, 29(3), 299-312, 1986.

[33] M.A. Badr, W.A. El-Tohamy, A.M. Zaghloul, "Yield and water use efficiency of potato grown under different irrigation and nitrogen levels in an arid region," Agric. Water Manage., 110, 9-15, 2012.

[34] T. E.,Adisu, S. Teshome, "The Impact of Alternate Furrow Irrigation on Water Productivity and Yield of Potato at Small Scale Irrigation, Ejere District, West Shoa, Ethiopia," Applied Engineering, 2(1), 1-18, 2018.

[35] S.Z. Kang, X. Hu, I. Goodwin, P. Jerie, "Soil water distribution, water use, and yield response to partial root zone drying under a shallow groundwater table condition in a pear orchard," ScientiaHorticulturae, (92), 277-291, 2002.

[36] Y.S Wang, F.L. Liu, M.N. Andersen, C.R. Jensen, "improved plant nitrogen nutrition contributes to higher water use efficiency in tomatoes under alternate partial root zone irrigation," functional plant biology, 37, 175-182, 2010.

[37] A. R. Fernie, and L. Willmitzer, Molecular and biochemical triggers of potato tuber development. Plant Physiology, 127(4), 1459-1465, 2001.

[38] S. Mohammad, M. Ali, "Effect of Every-Other Furrow Irrigation on Water Use Efficiency, Starch and Protein Contents of Potato," vol. 1,no2. 2009.