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Effect of under Irrigation Management on Potato Performance Components

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Abstract

To evaluate the effect of water, tape drip and furrow irrigation methods on the performance components and features of Agria cultivar potato, an experiment was carried out in the agriculture faculty of Kermanshah. Repeated three times, this study was carried out in the form of full random blocks with the main factor of different amounts of irrigation water in three levels (50, 75, and100 percent of cumulative evaporation from an A- class evaporation pan) and the secondary factor of irrigation method (including drip and furrow irrigations). At 3 repetitions, results showed that the minimum performance (19.168 tons per hectare) was related to the drip irrigation method with 50 percent evaporation from the A-class pan and the maximum one (34.455 tons per hectare) was related to the drip irrigation method with 100 percent evaporation from the A-class pan. The rate of irrigation and effectiveness of method on the number of the main stem per square meter and number of the main stem in the bush were not significant. The minimum percent (number of tubers) of tubers smaller than 35mm (26.47percent) and the maximum tuber production (37.17 percent) in the size of food and market-friendly (tuber bigger than 55mm) were attained by drip irrigation method with 100 percent evaporation from the A-class pan. The impact of Irrigation method on and the specific gravity of tubers and starch (dry matter) was and was not significant, respectively.

Keywords:
Tape drip irrigation, Furrow irrigation, Potato, Dry matter

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INTRODUCTION

Potato is one of the glandular products having an important role in human and animal nutrition. It is cultured in different climates and is the fourth product after wheat, rice, and popcorn; in the subject of producing countries number, it is the second product after popcorn (Dokhani and Rabiee Motmaen, 2001).

Studies showed that potato is very sensitive to the aridity stress .moisture stress has a bad effect on the potato`s growth and performance. Moisture stress, at the chlorophyll growth stage and before the tubers formation stage, reduces the leaf area, number of root system`s secondary branches, bush height, and the overall growth of the plant`s green cover. The second stage of potato growth is the tuber formation stage in which aridity reduces one of the performance components which is the number tuber per each bush; the tubers` mean size and specific gravity is highly reduced, too. The third stage of the potato growth is the tubergrowth stage. At this stage, the product`s quality and performance is highly affected by the aridity stress. The last stage is the ripening stage. At this stage, the green cover of the plant senesces and the tuber skin becomes thick, the water need is reduced, and even the moisture stress, after harvesting, increases the tuber resistance to the pests (Mosavi Fazl and Faeznia, 2003).

Produced tubers` size and weight distribution depends on each gland`s growth and the competitive relation between the tubers. All tubers of a bush do not, simultaneously, start the dry matter aggregation. This differences are resulted from the tuber formation time and the location of the tuber on the bush causing the distribution of the gland`s size and weight (Elizabeth, 1992). It seems that despite the reduction of a bush`s mean weight of each tuber caused by the increase of the produced tubers number, a larger number of tubers gratifies the weight reduction and the weight of all tubers is more in such bushes; but the market-friendly of tubers with a lesser mean weight would be reduced (Wurr and Allen, 1994).

Yuan *et al.,* evaluated the effects of different irrigation regimes on the potato growth at the drip irrigation. Irrigation water quantity was considered as 125, 100, 75, 50, and 25 percent of evaporation from the water level in a ceramic evaporation pan (0.2 m diameter). Plant height, biomass amount, total fresh glandular products, and market-friendly tubers (more than 85 g) were increased by increasing the irrigation water. Plant height and the total glandular product at the treatment of 125 percent evaporation from the evaporation pan were close to the 100 percent one. Increasing the irrigation water not only have the number of tubers increased, but increased the mean weight of the tubers, too. Irrigation water increased the quantity of the tubers but reduced their quality (Yuan *et al.,* 2003).

Nadler and Heour (1995) believed that the specific gravity of the tubers is reduced and the reducing sugars rates are increased by reducing the irrigation water. This reduction in the gland`s specific gravity is caused by a reaction to the under irrigation during the long term of growth season.

This study is aimed at evaluating the effect of different irrigation water quantities and tape drip and furrow irrigation methods on the performance, performance components, and features of potato (dry matter and specific gravity).

MATERIALS AND METHODES

The experiment, to compare the performance of potato (agria cultivar) under tape drip and furrow irrigation methods, was carried out in the agriculture faculty`s research farm of Kermanshah in the spring of 1386. Farm`s soil texture was salty clay. Repeated three times, this study was carried out in the form of full random blocks plan.

The main factor was different amounts of irrigation water in three levels of 50, 75, and100 percent of cumulative evaporation from an A-class evaporation pan and the secondary factor was two irrigation methods including drip and furrow irrigations. Each check was 13 m length and 3m width in which 4 lines were cultivated. The distance of culture lines was 75cm and the bushes distance on the row was 30cm. volume contours were used to measure and control the amount of influent irrigation water of each plot in each treatment. In measuring the gross irrigation requirement performance efficiency for the furrow method was 40 percent because the water was running off from the end of check.

In the tape drip irrigation method volume contours 30 m length T tapes were used and regulating valves were used to measure and control the amount of irrigation water in each treatment. Application efficiency for the tape drip method

Table 1: Total quantity of irrigated water during the plant growth period in each method

treatment	100 percent of water requirement	75 percent of water requirement	50 percent of water requirement	Furrow irrigation
Total quantity of the irrigated water (m^3) in each hectare	9749.62	7312.215	4874.81	21357.207

was 90 percent. Data of evaporation from the A-class evaporation pan located in the weather station near the agriculture faculty was used to calculate the plant water requirement. The potential rate of evaporation and transpiration was calculated by the following equation:

$$ET = K_p . E_{pan} \quad (1)$$

In which

ET: evaporation and transpiration (in millimeter) between two irrigations

K_p: evaporation pan coefficient

E_{pan}: rate of evaporation (in millimeter) from the pan between two continuous irrigations

The amount of water for each treatment was then attained by multape driplying the coefficients related to the water level of treatment (50, 75, and 100 percent) by the evaporation and transpiration calculated by equation1.

Agricultural operations such as weeding, fertilizing, and spraying were equally carried out based on the customs and requirements of the farms in each experimental unit. At the end of the growth season, two centric 6 m adjacent lines were selected from each check and their potato tubers were harvested. Based on the size, tubers were divided in three groups of smaller than 35, 35 to 55, and bigger than 55 mm. samples of each treatment were prepared and sent to the laboratory to carry out the qualitative tests of product such as measuring the specific gravity and the percent of dry matter.

Measurement of the specific gravity

Specific gravity was attained from division of samples - weight and volume. Tubers were randomly selected, peeled, chopped to very little pieces, and mixed to determine the dry matter. About 5 g of this mixture was poured in the ceramic bushes which have reached the fixed weight at 105° C in the oven; after 6 hours in the oven with air flow, it reached the fixed weight. Then, the ceramic bushes were cooled down in the desiccators, weighted again, and the percentage of the dry matter was calculated (Dokhani and Rabiee Motmaen, 2001). Consumptive water volume in different irrigation water treatments is illustrated in table 1. SAS software was used for statistical analysis and was compared to Duncan. Measure and control the amount of irrigation water input to each plot in each treatment was done by volumetric meters.

RESULTS AND DISCUSSION

Tubers` performance

Table 2 below shows the effect of the irrigation water rate on the tuber performance was significant at a 1 percent level. The minimum performance related to the 50 percent treatment was 19.168 tons per hectare and the maximum one related to the 100 percent treatment was 34.455 tons/ha as demonstrated on table 3. The 75 percent treatment and the furrow irrigation

Table 2: Analysis of variance of potato tuber`s performance

Source changes	degree of freedom	Bush performance(kg)	performance ton per hectare
repetition	2	0.0156	6.1351
treatment	3	0.4251**	354.0292**
error	6	0.0368	27.6018
sum	11	0.4777	378.7662
CV(%)		8.85	8.16

ns, no significant; ** p≤0/01, * p≤0/05

Table 3: Mean Comparison of potato tuber`s performance

experimental treatment	Bush performance (kg)	performance ton per hectare
50 percent cumulative evaporation from the pan	0.62167 c	19.168 c
75percent cumulative evaporation from the pan	0.95967 b	25.938 b
100 percent cumulative evaporation from the pan	1.13667 a	34.455 a
Furrow irrigation	0.82600 b	25.582 b

Means followed by same letter (s) in each column are not significantly different ($p < 0.05$)

treatment, based on Duncan groups, classified in one group. This experiment showed that the more water is provided for the plant, the more performance of tubers is resulted.

Size of the tubers

Percent of tubers smaller than 35m

The effect of irrigation water on the percent of the smaller than 35mm tubers was not significant as illustrated on table 4. Minimum losses (small tubers, 26.47 percent) were resulted from drip 100 percent treatment and the maximum ones (37.39 percent) were resulted from the furrow irrigation treatment.

Percent of 35-55 mm tubers

The effect of irrigation water on the percent of 35-55mm tubers was not significant as showed on table 4. The size of 35-55 mm is considered as seed size in classifying the tubers size. If the objective is to produce the potato seed size, the maximum seed tuber (47.87 percent) can be produced by the 50 percent drip method.

Percent of bigger than 55 mm tubers

Table 4 shows the effect of irrigation water on the percent of bigger than 55 mm tubers was not significant. More than 55 mm tubers are considered as the food size and market-friendly ones.

Table 4. Analysis of variance of tuber percent in the groups of smaller than 35mm, 35-55mm, and bigger than 55mm (Mean Squares)

Number of the main stem

Table 4 illustrates the effect of irrigation water on the number of the main stem per meter square was not significant. The number main stem depends on the size, physiologic age of the seed gland, and the genetic characteristics of the cultivar - number of eyes in the seed tuber (Allen, 1992). Maximum number of the main stem per square meter in the 100 percent treatment was 25.08 as shown on table 6.

The number of tubers

Number of tubers per meter square

The effect of irrigation water on the number of tubers was not significant (table 6). The maximum tuber number per meter square in the 50 percent water treatment was 35086 and the minimum one in the 75 percent treatment was 34.06. Shock *et al.,* (1993) showed that there a great correlation between stolen and the number of tubers.

Percent of the dry matter

The effect of irrigation water on the dry matter was not significant shown on table 9 but the percent of the dry matter reduced by increasing the

Table 4: Analysis of variance of tuber percent in the groups of smaller than 35mm, 35-55mm, and bigger than 55mm (Mean Squares)

Source changes	degree of freedom	smaller than 35mm	35-55mm	bigger than 55mm
Repetition	2	356.94	7.875	326.44
treatment	3	270.86ns	211.13ns	370.14*
error	6	388.61	505.60	274.83
sum	11	1016.42	724.60	971.42
CV(%)		26.26	22.31	23.98

ns, no significant; ** p≤0/01, * p≤0/05 .ger than 55mm (Mean Squares)

Table 5: Mean comparison of in the groups of smaller than 35mm, 35-55mm, and bigger than 55mm

Source changes	smaller than 35mm	35-55 mm	bigger than 55mm
50 percent cumulative evaporation from the pan	26.427 a	47.877 a	25.700 ab
75percent cumulative evaporation from the pan	31.677 a	40.457 a	27.867 ab
100 percent cumulative evaporation from the pan	26.470 a	36.357 a	37.170 a
Furrow irrigation	37.933 a	39.857 a	22.153 b

Means followed by same letter (s) in each column are not significantly different ($p < 0.05$)

Table 6: Analysis of the variance of the number of main stem and tubers (Mean Squares)

Source of variation	degree of freedom	Number of stem in the bush	Number of stem per meter square	Number of tuber in the bush	Number of tuber per meter square
Repetition	2	2.50	54.62	2.2386	45.93
Treatment	3	2.56*	63.04^{ns}	1.86^{ns}	44.93^{ns}
Error	6	1.63	51.50	10.32	260.35
Sum	11	6.707	169.17	14.42	351.22
CV(%)		12.25	13.73	19.29	19.29

ns, no significant; ** p≤0/01, * p≤0/05

Table 7: Mean comparison of the main stem and tubers numbers

Experimental treatment	Number of stem in the bush	Number of stem per meter square	Number of tuber in the bush	Number of tuber per meter square
50 percent cumulative evaporation from the pan	4.0300 ab	19.753 a	7.097 a	35.863 a
75percent cumulative evaporation from the pan	4.1933 ab	21.297 a	6.193 a	31.060 a
100 percent cumulative evaporation from the pan	5.0267 a	25.080 a	6.713 a	33.903 a
Furrow irrigation	3.8033 b	19.217 a	7.197 a	35.710 a

Means followed by same letter (s) in each column are not significantly different ($p < 0.05$).

irrigation water quantity. It is believed that by increasing the quantity of irrigation, percent of the dry matter is increased (Mohammadi and Faeznia, 2001). If the rate of dry matter is very low oil absorption would be high and soft chips can be produced (Dokhani and Rabieae Motmaen, 2001).

Gland`s specific gravity

The effect of irrigation water on the Gland's specific gravity was significant at a 1 percent probability level. The maximum specific gravity (1.11 g/cm^3) was related to the tape drip 100 percent treatment. Increasing the irrigation water, the specific gravity of the tubers was also increased, which is ion accordance with the findings of Yuan *et al.,* (Yuan *et al.,* 2003).

RECOMMENDATION

1- Reciprocal effect of both chemical and organic fertilizers on the potato in different weathers of the province and at different soils should be evaluated.

2- Water stress should be evaluated at the three stages of germination, growth, and gland formation.

3- Effects of placing the tape at different depths on the water use efficiency and the potato product performance should be evaluated.

4- Drip tape drip irrigation for different varieties of potato should be analyzed.

5- Effect of different irrigation methods and regimes on the qualitative characteristics of potato should be evaluated.

6- Regimes (1.25 and 0.25) of 1 time cumula-

Table 8: Analysis of variance of specific gravity and arid matter (Mean Squares)

Source of the variations	degree of freedom	Specific gravity (g/cm^3)	dry matter (percent)
Repetition	2	0.00002	8.05
Treatment	3	0.00112*	13.78^{ns}
Error	6	0.00006	12.58
Sum	11	0.00130	34.43
CV(%)		0.29	6.974

ns, no significant; ** p≤0/01, * p≤0/05

Table 9: Mean comparison of specific gravity and dry matter

Experimental treatment	Specific gravity (g/cm^3)	Dry matter (percent)
50 percent cumulative evaporation from the pan	1.085433 d	19.168 c
75percent cumulative evaporation from the pan	1.102067 b	25.938 b
100 percent cumulative evaporation from the pan	1.1134 a	34.455 a
Furrow irrigation	1.093333 c	25.582 b

Means followed by same letter (s) in each column are not significantly different (p < 0.05)

tive evaporation from the evaporation pan should be evaluated.

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