

## Impact of Cultivar and Growing Season on Potato (*Solanum tuberosum* L.) Under Center Pivot Irrigation System

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**Abstract:** This study was conducted to evaluate potato (*Solanum tuberosum* L.) yield and tuber quality under center pivot irrigation system at Desi area in the southern part of Jordan desert. This experiment conducted on the seven potato varieties ('Spunta', 'Arrow', 'Bernadette', 'Debora', 'Matador', 'Serafina' and 'Zafira') by using randomized complete block design with three replicates over two growing seasons (spring and fall of 2008). The spring growing season showed better yield by 16% over that of the fall season. Although, average tuber weight was higher in the fall season than the spring, the specific gravity was greater in spring than in the fall season, however, all cultivars responded similarly with respect to specific gravity in the fall season. Total yield, yield parameters (number and weight of tubers per plant and average tuber weight) and fruit quality including specific gravity and starch content showed large variations among potato cultivars during the two seasons. 'Spunta' and 'Matador' were superior in their yield; and produced 39.6t/ha and 42.1t/ha respectively in the spring season and 39.0 t/ha and 41.9 t/ha respectively in the fall season. The starch content of 'Matador' was the highest (18.01%) in spring season compared to the other cultivars. Generally, In addition to be affected by cultivars, starch concentration also was significantly affected by growing season showed higher starch content in the spring season over what recorded in the fall season.

**Key words:** *Solanum tuberosum* L • Starch • Specific growth • Tuber counts

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### INTRODUCTION

Worldwide, potato (*Solanum tuberosum* L.) is among the most important vegetable crops of Solanaceae family in the world [1,2]. It is ranked in fourth volume in annual production after the cereal species rice, wheat and barley [3]. Potatoes produce more food energy and protein production per acre than wheat and rice. Moreover, at least, 12 different essential vitamins and minerals are also found in potatoes [4]. The potato is a cool season crop [5]. Under normal conditions the eyes of potato seed tuber will not sprout during the first 1-2 months after harvest unless it exposed to special treatments to break down dormant period. Results of [6,7] showed that a short storage period of potato seed tubers at 2-4 °C for three weeks alternating with storage at high temperature resulted in a further shortening of tuber dormancy. Fall potato production usually started with planting tubers in late July and early August and harvesting tubers

yield in mid to late fall. Different potato varieties differ markedly in yielding ability [6, 8]. Results of [9] indicated that the increase in number of stems per plant didn't increase total yield. The appearance of foliage growth is characteristics for distinguishing cultivar from the other. In the southern part of Jordan (desert area), potato is among other vegetables grown under center pivot irrigation system [10] through two main growing seasons: the spring potato seeded in late January and late February and harvested in early summer. Potato varietal experiments are important since potatoes are very sensitive to their growing environment and not all cultivars are adapted to Jordan desert zone. Farmers are more interested in the cultivars that produce consistent high yields under their growing conditions. The objective of this study, therefore, was to determine the yield performance and to assess the growth quality of seven cultivars of potato in spring and fall cultivation consecutive seasons.

## MATERIALS AND METHODS

Seed tubers of seven potato cultivars ('Spunta', 'Arrow', 'Bernadette', 'Debora', 'Matador', 'Serafina' and 'Zafira') were tested over two growing seasons in 2008 in Jordan desert (Desi area) under center pivot irrigation system using a randomized complete block design with 3 replications. Each treatment was consisted of two rows, three meters long and 0.9 m apart with plants spaced at 0.3m within the row. Potato mother tubers (class: Elite) were hand planted at 0.1 m depth on February 10, 2008 (spring season) and the obtained tubers of class- A were planted on July 30, 2008 for the fall growing season. The seed tubers of class- A that harvested in the spring season were stored on June 1, 2008 in a controlled store at 12 °C for 1 week (curing period) followed by three weeks storage period at 3-4°C and then concluded by two weeks at 23°C at 86% relative humidity conditions to break down the dormancy period of the tubers for the purpose of planting of the fall season portion of study. One alley meter was left between every two treatments to prevent cross movement of minerals. Plots were irrigated uniformly and whenever needed through central pivot system. One month after planting, 240 kg/ha of each N and K and 200kg/ha of P as mono soluble fertilizers were applied through center pivot irrigation system in ten applications during the growing season at 3-4 days intervals. Similar fertilization program was applied in the fall season. Weeds were kept under control using glyphosonate (sincor) as a selective herbicide. Protection against blights was accomplished by the applications of some chemical fungicides such as Dithane and Ridomil [11] during the vegetative growing period. Treatments were hand harvested on May 30, 2008 and on November 10, 2008 for the spring and fall seasons, respectively. Tubers were sampled from every experimental unit. Data on potato tubers including: yield, tuber number and tuber average weight was recorded at the harvest time. Representative samples of the tubers were taken for laboratory analysis. Tuber shape and size were determinate by measuring the ratio of minor to major axis and by the water displacement method respectively. Specific gravity was then determined by weighing each tuber in air and then in water [12]. The starch content was quantified in tubers dried in a forced air circulation oven at a temperature near 70°C until constant weight was achieved and later ground in willey type, stainless mill; determinations were made according to the methodology proposed by [13]. Obtained data were statistically analyzed by SAS program version 7 [14],

as for the randomized complete block design outlined by Steel and Torrie [15]. Means separation was conducted by the least significant differences (LSD) test at 0.05 level of probability.

## RESULTS AND DISCUSSION

Potato yield (Table 1) showed 16% increase in the spring growing season (29.0 t/ ha) over what produced in the fall season (25.0 t/ ha). Moreover, similar trend was manifested by the yield per plant which was significantly higher (79.0 kg/ plant) in the spring compared to (66.0 kg/ plant) obtained in the fall growing season. This could be related to longer period of growth of spring season compared to fall season, as well as to cool temperature domination [5] during the first two growing months of the spring season. On the other hand, different potato cultivars showed significant differences in their seasonal yield and production per plant. Matador (42.0 t/ ha) and Spunta (39.3 t/ ha) produced statistically more yields over all other cultivars, while Debora cultivar produced (15.8 t/ ha) which was significantly of the lowest yield among all the cultivars used in this study. This could be attributed to direct effect of genetically variation among different varieties used [16]. Number of tubers per plant and average tuber weight are shown in Table 1. Spring season yielded significant higher number of tubers per plant with lower tuber average weight, while the fall season provided higher tuber average weight accompanied with significant lower fruit counts per plant. Moreover, Matador and Spunta cultivars were superior in their fruit number per plant with 9.34 and 9.30tubers/plant, respectively. Regarding tuber weight, Matador (121.64g), Zafira (115.26g) and Spunta (114.64g) produced the heaviest tuber weight compared to all other tested cultivars. Number of stems per plant effects on total yield and number of tubers per plant was evident over both growing seasons. Nevertheless, Matador cultivar showed the highest number of stems per plant and consequently the highest total yield. This could be due to the fact of more vegetative growth parts including more leaves that produced more photosynthates, as a consequence. This goes along with the conclusions of [9]. Matador as well as Spunta cultivars provided better yieldsand fruit average weight, which may provide better performance and better fit local market opportunities. Tuber long/short axis ratio, specific gravity and starch contents (Table 2) were increased significantly by 15%, 1% and 19% respectively, in spring season compared to results of fall season.

Table 1: Tuber set, yield and stem number per plant of seven potato cultivars under center pivot irrigation system

Treatments	Variables	Yield		Tuber		Stems /plant
		Kg/plant	Total (T/Ha)	Per plant	Average weight (g)	
G. Season	Spring =1	0.79 a	29.00 a	8.6 a	91.7 b	3.05 a
	Fall =2	0.66 b	25.00 b	6.6 b	97.3 a	2.00 b
	LSD	0.049	1.82	0.457	3.829	0.317
Variety	Spunta =1	1.06 a	39.30 a	9.30 a	114.64 a	3.17 b
	Arrow =2	0.65 bc	24.20 bc	8.4 b	78.40 b	2.33 cd
	Bernadette=3	0.55 d	20.27 d	7.13 c	76.80 b	1.83 de
	Debora =4	0.43 e	15.80 e	5.47 d	79.61 b	1.33 e
	Matador =5	1.13 a	42.00 a	9.34 a	121.64 a	3.83 a
	Serafina =6	0.57 cd	21.10 cd	7.48 c	75.25 b	2.83 bc
	Zafira =7	0.70 b	26.00 b	6.15 d	115.26 a	2.33 cd
	LSD	0.092	3.40	0.855	7.164	0.5923
Interactions	1*1	1.069 a	39.59 a	10.017 a	106.67 b	3.67 a b
	1*2	0.687 c	25.44 c	8.967 a b	76.56 c	2.67 bc
	1*3	0.634 c	23.49 c	8.267 bc	76.91c	2.33 c
	1*4	0.488 de	18.07 de	6.317 d	78.52 c	1.67 cd
	1*5	1.137 a	42.10 a	9.967 a	113.82 b	4.33 a
	1*6	0.72 bc	26.47 bc	9.033 a b	78.59 c	3.67 a b
	1*7	0.821 b	30.40 b	7.417 cd	110.81 b	3.00 bc
	2*1	1.052 a	38.95 a	8.583 bc	122.63 a b	2.67 bc
	2*2	0.621 c	22.99 c	7.733 bc	80.23 c	2.00 cd
	2*3	0.460 de	17.04 de	5.983 de	76.70 c	1.33 d
	2*4	0.367 e	13.58 e	4.617 e	80.70 c	1.00 d
	2*5	1.130 a	41.85 a	8.717 b	129.47 a	3.33 b
	2*6	0.423 e	15.68 e	5.933 de	71.90 c	2.00 cd
	2*7	0.59 cd	21.67 cd	4.883 e	119.7 ab	1.67 cd

Means having same letter(s) in a column are not significantly different according to LSD) at P = 0.05.

Table 2: Tuber axis, specific gravity and starch content of seven potato cultivars under center pivot irrigation system

Treatments	Variables	Tuber Axis			Specific gravity Kg L <sup>-1</sup>	Starch %
		Long	Short	Ratio		
G. Season	Spring =1	87.51 a	53.39 b	1.64 a	1.074 a	12.79 a
	Fall =2	88.02 a	61.75 a	1.43 b	1.063 b	10.75 b
	LSD	4.836	2.216	0.06	0.0098	1.9489
Variety	Spunta =1	111.79 a	56.56 b	1.98 a	1.067 ab	11.11 ab
	Arrow =2	86.09 b	56.28 b	1.53 c	1.069 ab	11.57 ab
	Bernadette=3	76.58 d	54.55 bc	1.43 cd	1.068 ab	11.79 ab
	Debora =4	66.77 e	51.74 c	1.29 e	1.066 ab	11.95 ab
	Matador =5	97.81 b	65.43 a	1.50 c	1.081 a	14.09 a
	Serafina =6	89.35 bc	54.45 bc	1.66 b	1.069 ab	11.68 ab
	Zafira =7	85.98 c	63.97 a	1.36 de	1.061 b	9.84 b
	LSD	9.0475	4.145	0.112	0.0184	3.646
Interactions	1*1	106.10ab	52.52 de	2.03 a	1.072 b	12.08 b
	1*2	89.13cd	54.44 de	1.64 bc	1.070 b	11.76 b
	1*3	75.14de	47.30 e	1.60 c	1.076ab	13.28 Ab
	1*4	65.36e	49.61 e	1.32 de	1.060 b	10.52 b
	1*5	101.47bc	61.21 bc	1.64 bc	1.101 a	18.01 a
	1*6	84.02cd	47.54 e	1.77 b	1.070 b	11.87 b
	1*7	91.38c	61.09 bc	1.50 cd	1.069 b	11.31 b
	2*1	117.49 a	60.60 bc	1.93 a	1.062 b	10.14 b
	2*2	83.04cd	58.11 cd	1.42 d	1.068 b	11.39 b
	2*3	78.02de	61.80 bc	1.26 de	1.060 b	10.30 b
	2*4	68.18de	53.88 de	1.27 de	1.072 b	13.38 ab
	2*5	94.14bc	69.64 a	1.35 de	1.061 b	10.18 b
	2*6	94.68bc	61.36 bc	1.54 cd	1.068 b	11.50 b
	2*7	80.58cd	66.84 ab	1.22 e	1.053 b	8.38 b

Means having same letter(s) in a column are not significantly different according to LSD) at P = 0.05.

Increments in tuber size, specific gravity and starch contents could be related to the longer tuber bulking period as a result of longer growing period in spring [17] concluded similar results on potato cultivar response to drip irrigation.

Regarding interactive effects; it was obviously clear that seasons x cultivar had a highly significant effect on every potato measured parameter (Tables 1, 2). All parameters except tuber specific gravity were of better results for spring growing season x Matador and Spunta cultivars over fall one. The significant effect of season highlighted the importance of planting period and environment in potato yield and tuber quality.

### CONCLUSIONS

It could be concluded that, Matador and Spunta were significantly of the highest yielding capacity during spring over fall growing seasons. Moreover, tubers of the same two cultivars were among the highest in specific gravity, starch contents as well as, large sized ones which better fit market opportunities and local consumers need.

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