FACULTY OF AGRICULTURE

Minia J. of Agric. Res. & Develop.
Vol. (43), No.3, pp 211- 226 , 2023

IMPROVING WATER USE EFFICIENCY AND PRODUCTIVITY IN POTATO PLANTS WITH MELATONIN AND IRRIGATION REGIMES

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Received : 31 July 2023 Accepted: 7 August 2023

ABSTRACT

The production of potato, a major essential crop in Egypt, is declining for biotic and abiotic reasons, even though the area increases each year. Drought stress is primarily brought on by water scarcity and climatic change. Both have negative effects on the yield and quality of potatoes. In the present study, two water regime treatments (irrigation every 10 days and irrigation every 20 days) were done after complete germination (30 days from planting).

Three melatonin foliar treatments (Mel=0.0, Mel=75 ppm,Mel=150ppm) were used two times after 45 and 60 days from planting (stage of potato tuberization) on plant cv. Lady Balfour .The experiment was conducted at the experimental farm of the Horticulture Department at Minia University's Faculty of Agriculture over two consecutive fall seasons (2018/2019 and 2019/2020). the experiment was set up in split plots design using a complete randomized block with three replications.

The obtained results showed that: -

Irrigation regime had a significant effect on some growth characters such as plant height and plant fresh weight.

The first irrigation regime was the better in comparison to the second one.

With the first regime (irrigation every 10 days) showing the highest values of plant growth parameters compared to the second regime.

Melatonin treatments also had a significant effect on plant growth parameters. The highest concentration showing the best effect in improving plant growth parameters.

Also, yield and its component addition to tuber quality were affected significantly with irrigation regime and the first one (irrigation every 10 days) was the better for obtained the highest values of these characters. Spraying melatonin particularly with highest concentration had significantly increased total yield and decreased adverse effect of water deficiency. After spraying potato plant with melatonin, some of the water use efficiency i.e., water applied, water saving, and water use coefficient were improved.

In conclusion, the study found that irrigation regime and melatonin treatment had significant effects on various growth parameters of potato plants. The first irrigation regime (irrigation every 10 days) and melatonin treatment at its highest concentration showed the best results in improving plant growth, water use efficiency, productivity, and tuber quality.

***-Keywords**: Potato, Melatonin, Irrigation, Water use efficiency, Productivity

INTRODUCTION

Water is a vital component of water production. It is essential to maximize both yield and quality. Because of water scarcity, climate change and is a sensitive of potato plant to water shortage especially at the temporization stage in the life of the crop. The experiment was conducted using water regimes and foliar spray with melatonin to achieve increasing potato yield on the quality under drought stress.

Potatoes are an important crop in Egypt, where they are grown for both domestic consumption and export. The total cultivated area is approximately 450,000 feddans, which is equivalent to 189,000 hectares . In 2018, Egypt produced 5.6 million tons of potatoes, of which 723,920 tons were exported and the rest were locally consumed. Egypt is one of the top 20 producers of potatoes in the world and the largest producer and exporter of potatoes in Africa (Rabia et al. 2021).

In fruit and vegetable crops water deficits in the middle to late part of the growing period tend to reduce yield more than in the early part. However, varieties vary in their sensitivity to water deficit (Berríos et al. 2023; Asrey et al 2018; Sidhu et al. 2021).

Drought stress (as environmental stress) is severe deficiency of water which depress plant growth, development and productivity especially in arid and semi-arid regions (Bettipaglie et al.,2014).

Also, drought stress caused oxidative damage to plant cell by ROS increase which decrease photosynthesis process and enzymes activities (Chen et al.,2019).

Potato has little tolerance to water shortage specially during tuber bulking. Whereas, under irrigation leads to losses in tuber quality, market grades and price.

Over irrigation leads to disease susceptibility and tuber loss (Shock et al.,2013).

Melatonin (N-acetyl-5-methoxytryptamine) is a pleiotropic signaling molecule with a wide range of cellular and physiological actions in living organisms (Hernández-Ruiz et al 2021; Arnao et al 2019). It has been considered a multi-regulatory molecule in higher plants due to its diverse range of cellular and physiological actions (Arnao and Hernández-Ruiz 2021). Melatonin regulates a wide range of plant processes, including seed germination, root growth, flowering, fruit ripening, and postharvest fruit quality. It is also an antioxidant that can protect plants from damage caused by reactive oxygen species (ROS) (Gao et al. 2022). Melatonin has been shown to reduce the amount of pesticide residues and heavy metals that accumulate in food. This makes melatonin a promising candidate for improving horticultural crop production and ensuring food safety (Yan et al. 2019; Nawaz et al. 2018). Melatonin helps plants resist drought by scavenging ROS, preventing oxidative damage, and improving photosynthesis. It is regulated by cell signaling and has potential for GM drought-resistant crops (Sharma and Zheng 2019).

The aim of this study is to evaluate the effect of melatonin on improving the tolerance of potato plants against drought stress and to statistically compare the use of melatonin to improve potato production with less water requirements.

MATERIALS AND METHODS

This experiment was conducted at the experimental farm of the Horticulture Department at Minia University, Faculty of Agriculture. The physical and chemical properties of the experimental farm soil are shown in Table 1.

The experiment was carried out over two consecutive fall seasons (2018/2019 and 2019/2020) to study the effect of irrigation regimes with two intervals (10 days and 20 days) after 30 days from planting and the use of melatonin with three concentrations (0, 75, and 150 ppm) as plant spraying twice at the time of tuberization (after 45 and 60 days from sowing) on plant growth, water use efficiency, productivity, and tuber quality of potato plant c.v. Lady Balfour. The characteristics of the studied cultivar are shown in Table 2.

Soil analysis was performed according to (Piper 1974). The pH of the soil was measured in a soil-water suspension using a pH meter as described by Hesse (1971). The electrical conductivity (EC) of soil was determined as described by Hesse (1971). The organic matter of the soil was determined according to Walkley and Black's rapid titration method as described by Hesse (1971). Total nitrogen was determined using Micro Kjeldahl's method according to Jackson (1973). Available phosphorus was determined according to Olson's method as described by Jackson (1973). Available potassium was measured e according to Jackson (1973).

Land preparation: -

- The soil was ploughed twice in two opposite directions and plots were planned and divided. The experimental plot consisted of five ridges, each 4 meters long and 0.7 meters wide, forming a plot area of 14 m^2 equal to (1/300 fed). Potato

c.v. Lady Balfour tubers were used in this study.

Planting: -

- When the soil dried out, it was ready for planting. For the first and second seasons, tubers were planted manually on September 5 and 7, respectively. The distance between hills inside ridges was around 25 cm, with depths of 12 cm) on the east side of the ridges. The two irrigation regimes were distributed in the main plots while melatonin concentrations were distributed in the subplots. The experiment was then set up in split plots using a complete randomized block design with four replications.

Treatments: -

1- Irrigation regimes (A): -
   1) Irrigation every 10 days. (A1)
   2) Irrigation every 20 days. (A2)

2- Melatonin and concentrations: -
   1) MEL=0.0 (B1)
   2) MEL=75 ppm (B2)
   3) MEL=150 ppm (B3)

3- Irrigation regime ×Melatonin conc. (AB)
   1) MEL 0.0 + irrigation every 10 days.
   2) MEL 0.0 + irrigation every 20 days.
   3) MEL 75 + irrigation every 10 days.
   4) MEL 75 + irrigation every 20 days.
   5) MEL 150 + irrigation every 10 days.
   6) MEL 150 + irrigation every 20 days.

- After 80 days from seeding, five plants were randomly selected and tagged from each experimental unit to test vegetative growth characters plant height, plant fresh weight of vine gm/plant, plant dry weight of vine gm/plant which was calculated from drying the whole plant vegetative portion (plant stem and leaves) at 70℃ until constant weight. The potassium components of leaves after 80 days from planting were also determined. At harvest time (112 days) five plants from each plot were selected and the number and weight of small, medium, and large tubers were collected. Total yield as ton /fed was calculated.

After 80 days from sowing, the following characteristics were recorded.

Data recorded:

I. Plant height (cm): stem length of each plant was measured from plant base to its top.

II. Plant fresh weight of vine gm/ plant.

III. Plant dry weight of vine gm/ plant which was calculated from drying the whole plant vegetative portion (plant stem and leaves) at 65-70℃ untill the constant weight.

The chemical components of leaves after 80 days from planting. The third leaf at the top of the main stem of the plant were taken for each sample and oven dried at 65-70℃ until a constant weight, and then 0.2 gm of the dried leaves was taken for chemical analysis to determine potassium percentage in plant tissue. where Potassium was measured using the flame photometer device according to Jackson (1973).

V- Yield and its components: -

Five plants in each plot were harvest at maturity stage after 112 days from planting in both seasons and the following data were recorded:

1-Total tuber weight gm per plant. Potato tubers were collected and graded according to their diameter 1 small (>25mm). medium (5.0-6.5 mm) and large (>6.5 mm tubers) using wire-mesh-riddles differing in size as reported by Adams and Hide (1981), then number and weight (kg) of small, medium, and large tubers per plant were determined, weighted, and divided as follow:

a. Number and weight of large tubers/plant.

b. Number and weight of medium tubers/ plant

c. Number and weight of small tubers/plant.

2- Total yield as (ton/fed) was determined as a yield of each plot then calculated as ton/fed.

VI. Tubers Quality

A- Tuber dry matter % as percentage:

Dry matter percentage of tubers were determined by using 100 gm of tubers dried at ℃ until a constant weight. According to (Association of Official Analytical (A.O.A.C.)1990).

B- Specific gravity of tubers= $\frac{\text{Tuber weight in air}}{(\text{Tuber weight in air} - \text{tuber weight in water})}$

as reported by (Sinha et al. 2003).

vii. Water Measurements

The quantity of water was measured in studied area by cutthroat Flume size (20×90 cm) where applied water was added during each irrigation and at the end of each growth season the total quantity of water applied was estimated (m^3/ fed.). I. Water consumptive use (WCU) = Water applied as m^3/fed. The quantities of consumptive use were calculated for the 60 cm soil depth which was a to be the depth of the root zone as reported by many investigators as described by (Israelsen 1962).

RESULTS

Vegetative growth parameters:

Plant height/cm:

Data presented in Table 3 shows that plant height of potato plant cv. Lady Balfour was in significantly affected by irrigation regime. The first regime (irrigation every 10 days) showed the highest values of plant height (86.4 cm) in the first season and (82.44cm) in the second season when compared to the irrigation every 20 days (86.14 and 85.16) in the first and second season respectively. The differences between the two regimes were significant in both seasons.

Regarding to the effect of melatonin concentration, the highest concentration (150 ppm) showed the best effect for improving plant height (91.66 and 93.82 cm) compared to the control treatment (81.85 and 80.62 cm) in the first and second season respectively.

The interaction between irrigation regimes and melatonin treatment showed a highly significant effect.

The best treatment was irrigation every 10 days and spraying melatonin with the highest concentration (150 ppm) which showed plant height values of (93.67cm) only in the first season and irrigation every 20 days with melatonin (150 ppm) foliar treatment in the second seasons (89.56cm).

Plant fresh weight of vine (gm/plant):

Data in Table 3 shows that irrigation intervals treatment had a significant effect on this trait in both seasons. The first irrigation treatment (irrigation every 10 days) showed the highest values of fresh weight g/plant in both seasons

compared to the second irrigation regime (every 20 days) which showed (732.8 and 702.9 gm/plant) lower values in the first and second season respectively.

Melatonin concentration at 75 and 150 ppm showed significantly increasing in plant fresh weight in both seasons compared to control treatments.

The interactions between irrigation regimes and melatonin treatments significantly showed the highest conc. (150 ppm) gave the best treatment (827.7 and 801.4 gm/p) in the first and second season respectively.

The best treatments to obtain the highest values of this trait was the first irrigation of water regime (every 10 days) and spraying potato plant with the highest concentration of melatonin (150 ppm) and showed (867.9 and 808.7) of plant fresh weight g/plant in the first and second season respectively.

Plant dry weight (gm/plant):

Data in Table 3 indicates that irrigation regimes had a significant effect on dry weight of plant in the both seasons and the best values was obtained with the irrigation every 10 days, while melatonin treatment had a significant effect on dry weight gm/plant only in the first season ,whereas the first regime irrigation showed the highest significant values of plant dry weight (gm/plant) in compare with the second one. Also, the highest concentrations of Melatonin showed higher values (86.6 and 86.1 gm/plant) compered to the control treatments (78.8 and 79.5 gm/plant) of dry weight gm/plant in both seasons. The interactions between irrigation regimes and melatonin treatments showed significant effects in both seasons. The best values were recorded with irrigation regime every 10 days and melatonin foliar treatments twice at 150 ppm.

Tuber dry matter percentage:

Data presented in Table 4 shows that there was no significant difference in tuber dry matter between the two irrigation regimes, in both seasons.

The highest melatonin concentration (150 ppm) showed a significant increase in potato dry matter % (18.02 and 17.93%) compared to the control treatments (16.65 and 15.89 %) in the first and second season respectively. Concerning the interaction effect between irrigation regimes and melatonin treatments data showed that using the highest concentration of melatonin with the second irrigation regime (each 20 days) showed the highest significant value of dry matter % (18.08) and (17.071) in both seasons.

Specific gravity:

Data in Table 4 shows that the second irrigation regime (20 days) had higher significant values for specific gravity/tuber compared to the first irrigation regime with spraying potato plants by melatonin particularly with highest concentration this treatment led to increase significantly specific gravity for potato tubers in both seasons.

Also, interaction treatments showed significant effect on this trait and the best treatment was the second irrigation regime and use the second concentration of melatonin in the first season, while in the second season the best one was second regime of irrigation and third concentration of melatonin.

potassium % in plant leaves:

Data presented in Table 4 show that K% in the leaves of potato cv. Lady

Balfour significantly affected by irrigation regimes and melatonin treat after 80 days from planting.

The percentage of K in the leaves of potato plant had increased significantly with irrigation intervals (10 days) (3.23 % and 3.35) compared to 20 days intervals (2.35% and 2.70 %), in both seasons.

Foliar application of melatonin two times after 45 and 60 days showed significant effect on K% in plant leaves in both seasons.

The highest K% was recorded with the highest melatonin conc. (150 ppm) in the second season (3.32%) and the conc. 75 ppm (2.87 %) in the first season.

Regarding to the interaction between irrigation regimes and melatonin treatments data revealed significant effect add the highest concentration 150 PPM and 75 PPM of melatonin and the irrigation every 10 days and the K % in potato leave was increased and recorded 3.23% and 3.65% and 3.45 and 3.51 % compared to the control treatment (3.01 and 2.90 %) at the same irrigation regime every 10 days in the first and second season respectively.

Number and weight of large tubers/plant:

Data presented in Table 5 shows that irrigation regime had a significant effect on both number and weight of large tubers/plant in both seasons. The second irrigation regime (each 20 days) was superior in its effect to increase the number of large tubers in both seasons. Table 5 shows that the first irrigation regime was superior to the second irrigation regime in terms of the weight of large tubers in the first season, but not in the second season. In both seasons, spraying potato plants with different concentrations of melatonin had a significant effect on both the number and weight of large tubers. The highest concentration of melatonin led to the production of the highest number and weight of large tubers per plant in both seasons. The interaction between irrigation regime and melatonin concentration also showed significant effects in both seasons.

Number and weight of medium tuber/plant:

The highest values with significant difference of number and weight of medium size potato tuber were obtained from potato plants irrigated with shorter intervals (10 days) in both seasons compared to longer irrigation intervals (each 20 days).

Treated potato plants with melatonin significantly increased number and weight of potato tubers from medium size in compare with untreated plants.

In the same time the highest concentration of melatonin shows the best effect on this trait.

The interaction between irrigation and melatonin treatment were significant in both seasons.

Number and weight of small tuber /plant:

The number and the weight of small was affected significantly with irrigation interval treatment as their table resented in table (5). The higher value of both number and the weight of the small tuber was observed with the second irrigation regime (each 20 days) as data show in the same table and that is meaning that decreasing in water applied quantity caused decreasing in potato tuber size

and increasing in small tuber number /plant.

In the meantime, after spraying plants with melatonin particularly with the highest concentrate led to improve potato tuber size and decreased significantly number of small tuber /plants as data show in Table (5). Also, the interaction effects between irrigation regimes and spraying plants with melatonin were significant in both seasons.

Total yield ton/fed:

Data in Table 5 shows that total yield (ton/fed) significantly decreased in both seasons as irrigation intervals time increased from 10 to 20 days. The highest total yield (ton/ fed.) was obtained by the first irrigation regime with significant differences in both seasons in compared to the second irrigation regime.

Total yield of potato plants was increased significantly after treating plants with melatonin particularly with the highest concentration these results were observed in both seasons.

Also, total yield of potato (ton/fed) was significantly affected by the effect of interaction between two experimental treatments.

Water measurements:

Water applied as m^3/fed:

Data in Table 6 shows that when plants were irrigated every 20 days, the quantity of water applied decreased by 1515 and 1445 m^3 of water in both seasons a part. The results are compared to when irrigated every 10 days.

Water saving m^3/area:

Water saving cubic meter/area as shown in Table 6 indicates that total saving water irrigation was lower with plants irrigated every 20 days compared to those irrigated every 10 days.

Water use efficiency(kg/m^3):

Data presented in Table 6 shows that the best treatment which had the highest value for water use efficiency was observed with plants irrigated every 10 days and treated with melatonin at its highest concentration.

DISCUSSION

The study investigated the effect of irrigation regimes with two intervals (10 days and 20 days) and the use of melatonin with three concentrations (0, 75, and 150 ppm) as plant spraying on plant growth, water use efficiency, productivity, and tuber quality of potato plant c.v. Lady Balfour.

The results showed that irrigation regime had a significant effect on plant height, with the first regime (irrigation every 10 days) showing the highest values of plant height compared to the second regime. Melatonin treatment also had a significant effect on plant height, with the highest concentration showing the best effect in improving plant height.

Irrigation intervals treatment also had a significant effect on plant fresh weight of vine gm/plant in both seasons. The first irrigation treatment (irrigation every 10 days) showed the highest values of fresh weight g/plant in both seasons compared to the second irrigation regime (every 20 days) which showed lower values in both seasons.

Melatonin treatment also had a significant effect on dry weight gm/plant in both seasons. Melatonin showed

higher values of dry weight gm/plant compared to untreated plants.

The percentage of K in potato plant leaves increased with shorter irrigation intervals (10 days) compared to 20 days intervals. Total yield (ton/fed) significantly decreased in both seasons as irrigation intervals time increased from 10 to 20 days.

The study investigated the effect of irrigation regimes with two intervals (10 days and 20 days) and the use of melatonin with three concentrations (MEL=0.0, MEL=75 ppm andMEL=150 ppm as spraying on plant

Data showed that with the first irrigation regime most growth characters were improved in comparison with the second regime except percentage of plant dry weight. This decreasing in plant growth parameter with the second regime may related to decreasing in water quantity which of course caused reducing in vital process in plant such as photosynthesis, respiration, and transpiration and this related to decrease plant cell division and elongation resulted in decreasing in plant growth.

According to decreases plant growth parameters both yields, and its component were affected adversely with shortage water quantity.

The results showed that irrigation regime had a significant effect on plant height, with the first regime (irrigation every 10 days) showing the highest values of plant height compared to the second regime. melatonin treatment also had a significant effect on plant height, with the highest concentration showing the best effect in improving plant height.

Irrigation intervals treatment also had a significant effect on plant fresh weight of vine gm/plant in both seasons. The first irrigation treatment (irrigation every 10 days) showed the highest values of fresh weight g/plant in both seasons compared to the second irrigation regime (every 20 days) which showed lower values in both seasons.

Melatonin treatment also had a significant effect on dry weight gm/plant in both seasons. The percentage of K in potato plant leaves increased with shorter irrigation intervals (10 days) compared to 20 days intervals. Total yield (ton/fed) significantly decreased in both seasons as irrigation intervals time increased from 10 to 20 days.

CONCLUSION

In conclusion, the study found that irrigation regime and melatonin treatment had significant effects on various growth parameters of potato plants. The first irrigation regime (irrigation every 10 days) and melatonin treatment at its highest concentration showed the best results in improving plant growth, water use efficiency, productivity, and tuber quality.

Azotobacter histidineless record the highest biological yield (6.96 and 7.14 ton/fed) and harvest index (38.68 and 40.65%) for seasons 2020/2021 and 2021/2022, respectively, these results are agreement with **Hassanein et al., 2018**

Table 1: The physical and chemical properties of the soil used for growing potato before of any fertilizers in both seasons of (2018/2019-2019/2020).

Soil properties	Sand %	Silt %	clay	Texture grade	CaCo3 % PH	Organic Matter%	PH	EC M. mhos/cm	N%	Available P (ppm)	Available K (ppm)
1st season	25.66	32.61	41.73	Clay loam	2.91	1.64	7.31	1.61	0.28	24	261.0
2nd season	23.58	34.81	41.61	Clay loam	2.69	1.46	7.28	1.58	0.24	26	234

Table 2: Some economical characters and description of Lady Balfour cultivar. British potato variety handbook (2011).

Cultivar	Lady Balfour	
Parentage	8204 A4 ×15119 AC5	
Tuber characteristics	Smoothness of skin	Medium
	Shape of tuber	Oval
	Depth of eyes	Medium
	Color of skin	Red parti-colored
	Color of flesh	White
Botanical description	Height of plant	Very tall
	Frequency of berries	Absent
	Color of base of light sprout	Pink
Characters	Lady Balfour is an extremely high yielding under Egyptian conditions in new reclaimed and old lands (Delta and middle Egypt) in both cultivation seasons (summer and winter). Productivity is around 12-15 tons / fed for old land, ranging from 12-14 for reclaimed lands.	
Maturity	Main crop	115 days

Table 3: The effect of irrigation regime and spraying plant with melatonin on some growth characters of potato plant.

Irrigation regime / Melatonin concentration		Plant height		Plant fresh weight (g /plant)		Plant dry weight (g /plant)	
		First season	Second season	First season	Second season	First season	Second season
Al	B1	83.40	78.9	617.9	593.7	81.4	83.6
	B2	82.10	89.7	712.6	706.3	87.9	85.9
	B3	93.67	78.73	867.9	808.7	91.0	89.2
Mean of A		**86.4**	**82.44**	**732.8**	**702.9**	**86.7**	**86.23**
A2	**B1**	78.97	82.33	543.3	550.8	76.2	75.3
	B2	89.94	83.58	614.3	648.9	82.2	82.3
	B3	89.53	89.56	787.5	794.0	82.2	83.0
Mean of A		**86.14**	**85.16**	**648.36**	**664.56**	**80.2**	**80.2**
Mean of B		81.85 86.02 91.60	80.62 86.62 93.82	580.6 663.5 827.7	572.3 677.6 801.4	78.8 85.5 86.6	79.5 84.1 86.1
L.S. D		A=N.S B=2.89 AB=4.07	A=N.S B=3.15 AB=4.13	A=12.32 B=11.16 AB=15.16	A=11.02 B=11.27 AB=14.76	A=N.S B=7.56 AB=10.4	A=N.S B=7.72 AB=10.54

Table 4: The effect of irrigation regime and spraying plant with melatonin on some tuber quality characters of potato plant.

Irrigation regime / Melatonin concentration		Dry matter %		Specific gravity		Potassium %	
		First season	Second season	First season	Second season	First season	Second season
Al	B1	15.79	16.08	1.03	1.26	3.01	2.90
	B2	17.75	17.06	1.42	1.45	3.45	3.51
	B3	17.96	17.08	1.50	1.55	3.23	3.65
Mean of A		**17.16**	**16.74**	**1.31**	**1.42**	**3.23**	**3.35**
A2	**B1**	16.34	15.69	1.50	1.37	2.19	2.30
	B2	17.72	16.08	1.73	1.52	2.23	2.82
	B3	18.08	17.71	1.57	1.62	2.63	2.99
Mean of A		**17.38**	**16.49**	**1.6**	**1.50**	**2.35**	**2.70**
Mean of B		16.65 17.73 18.02	15.89 16.57 17.93	1.25 1.57 1.53	1.31 1.48 1.58	2.60 2.87 2.79	2.60 3.17 3.32
L.S. D		A=N.S B=0.35	A=N.S B=0.30	A=0.01 B=0.02	A=0.01 B=0.01	A=0.22 B=0.19	A=0.21 B=0.16

	AB=0.51	AB=0.48	AB=0.03	AB=0.02	AB=0.26	AB=0.31

Table 5: The effect of irrigation regime and spraying plant with melatonin on yield and its components of potato plant.

Irrigation regime / Melatonin concentration		Number of large tubers		Weight of large tuber		Number of medium tubers		Weight of medium tuber		Number of small tubers		Weight of small tuber		Total yield	
		First season	Second season	First season	Second season	First season	Second season	First season	Second season	First season	Second season	First season	Second season	First season	Second season
Al	B1	3.82	3.38	322.46	348.4	3.61	3.66	161.6	168.2	3.97	5.91	202.5	283.7	14.06	10.89
	B2	4.11	3.72	408.22	431.8	4.07	4.31	173.4	180.73	4.51	4.69	207.5	215.8	13.72	12.23
	B3	4.23	5.21	427.63	423.7	4.76	4.69	175.4	191.3	3.79	4.91	170.6	198.6	14.78	14.48
Mean		4.05	4.10	386.10	401.3	4.14	4.22	170.13	180.07	4.09	5.17	193.53	232.7	14.18	12.53
A2	B1	4.43	3.23	311.13	302.33	3.39	3.29	149.03	150.7	5.21	5.99	255.3	293.5	12.00	11.12
	B2	4.21	4.22	342.22	344.50	3.69	3.57	167.2	161.5	4.92	5.77	236.3	265.4	12.42	12.18
	B3	5.27	4.93	355.41	387.06	3.73	3.42	181.96	175.5	4.14	5.14	188.5	231.3	14.02	12.19
Mean		4.63	4.12	336.25	344.63	3.60	3.42	166.06	162.5	4.75	5.63	226.7	263.4	12.81	12.61
Mean		4.13	3.31	316.8	325.37	3.5	3.48	155.32	159.45	4.59	5.95	228.9	288.6	13.03	11.01
		4.16	3.97	375.2	388.15	3.88	3.94	170.3	166.15	4.715	5.23	221.9	240.6	13.07	12.21
		4.75	5.07	391.5	405.38	4.52	4.06	178.7	183.4	3.965	5.025	179.55	214.95	14.4	13.34
L.S. D		A=0.52	A=N.S	A=10.12	A=11.23	A=0.48	A=0.51	A=3.11	A=4.17	A=0.27	A=0.22	A=8.08	A=9.7	A=0.36	0.
		B=0.49	B=0.36	B=12.01	B=12.11	B=0.41	B=0.49	B=4.8	B=4.66	B=0.38	B=0.27	B=9.71	B=9.91	B=0.44	0.41
		AB=0.7	AB=0.39	AB=15.18	AB=16.71	AB=0.52	AB=0.57	AB=5.12	AB=5.92	AB=0.41	AB=0.32	AB=10.07	AB=10.06	AB=0.53	0.49

Table 6: The effect of irrigation regime and spraying potato plant with melatonin on some soil water measurements.

Irrigation regime concentration		Water applied		Water saving		Water use efficiency	
		First season	**Second season**	**First season**	**Second season**	**First season**	**Second season**
Al	B1	3185	3165	0	0	4.41	3.44
	B2	3105	3070	80	95	4.41	3.98
	B3	2965	2970	220	195	4.98	4.88
Mean of A		**3085**	**3068.3**	**150**	**145**	**4.6**	**4.1**
A2	B1	1690	1690	0	0	7.10	6.58
	B2	1585	1625	105	65	7.84	7.50
	B3	1435	1555	255	185	9.77	8.48
Mean of A		**1570**	**162333**	**180**	**125**	**8.23**	**7.52**
Mean of B		2437.5	2428	0	0	5.76	5.01
		2345	2348	92.5	80	6.13	5.73
		2200	2262	237.5	190	7.38	6.68

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الملخص العربي

" تحسين كفاءة إستخدام المياه والإنتاجية في نباتات البطاطس بالميلاتونين و معدلات الري"

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بحثت هذه الدراسة تأثير أنظمة الري بفترتين (10 أيام و20 يوم) واستخدام ثلاث تركيزات من الميلاتونين (0، 75، 150 جزء في المليون) كرش نباتي مرتين على نمو النبات، وكفاءة استخدام المياه، والإنتاجية، وجودة درنات نبات البطاطس صنف (ليدي بلفور). أجريت التجربة بالمزرعة التجريبية التابعة لقسم البساتين بكلية الزراعة بجامعة المنيا على مدى موسمين متتاليين نيلين (2019/2018 و2020/2019). تم إجراء تحليل التربة باستخدام طرق مختلفة وأجريت التجربة على قطع منقسمة باستخدام تصميم القطاعات كاملة العشوائية بأربعة مكررات.

أظهرت النتائج أن نظام الري كان له تأثير معنوي في بعض صفات النمو مثل طول ونمو النبات مقارنة بالتركيزات الأخرى. مع النظام الأول (الري كل 10 أيام) أظهر أعلى قيم معاملات نمو النبات مقارنة بالنظام الثاني. كما كان لمعاملة الميلاتونين تأثير معنوي على معاملات نمو النبات، حيث أظهر أعلى تركيز أفضل تأثير في تحسين طول النبات. كما كان للمعالجة بفترات الري تأثير معنوي على وزن النبات في كلا الموسمين.

كما تأثر المحصول ومكوناته بالإضافة إلى جودة الدرنات معنويا مع نظام الري وكان الأول (الري كل 10 أيام) هو الأفضل للحصول على أعلى قيم لهذه الصفات. أثر رش الميلاتونين خاصة مع أعلى تركيز معنويا على زيادة المحصول الكلي وتقليل التأثير المعاكس لنقص الماء. بعد رش نبات البطاطس بالميلاتونين، تم تحسين بعض كفاءة استخدام المياه، مثل استخدام المياه، وتوفير المياه ومعامل استخدام المياه.

خلصت الدراسة الي أن نظام الري ومعالجة الميلاتونين لهما تأثيرات معنوية على معايير النمو المختلفة لنبات البطاطس. أظهر نظام الري الأول (الري كل 10 أيام) ومعالجة الميلاتونين بأعلى تركيز له أفضل النتائج في تحسين نمو النبات وكفاءة استخدام المياه والإنتاجية وجودة الدرنات.