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EFFECT OF FARMYARD MANURE APPLICATION ON PRODUCTIVITY OF POTATO (*Solanum tuberosum* L.) VAR. SPUNTA UNDER DRIP IRRIGATION REGIME IN NORTH NILE DELTA, EGYPT

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ABSTRACT

Two field experiments were conducted to study the effect of drip irrigation regime and farmyard manure application on growth and tuber yield of Potato (Solanum tuberosum L.) Var. Spunta, grown on sandy loam soils at Balteem, Kafr El - Sheikh Governorate, Egypt during winter in two seasons of 2008/2009 and 2009/2010. Four treatment combinations involving two drip irrigation regimes (I_1: 60% ET_o and I_2: 80% ET_o) in main plots and two farmyard manure levels M_1: 5 ton.fed^{-1}and M_2: 10ton.fed^{-1} in sub plots were tested in a split-plot design with four replications.

Tuber yield obtained was significantly higher with the drip irrigation regime of 80% ET_0 (19.77 and 21.47 ton. fed^{-1}) as compared to 60% ET_0 (16.42 and 18.11 ton.fed^{-1}) in the 1st and 2nd seasons (2008/2009 and 2009/2010), respectively.

Application of higher level of farmyard manure i.e. 10 ton. fed^{-1} resulted in a significantly higher yield of tubers in the two Seasons (20.98 and 22.68 ton. fed^{-1}) as compared with the lower level of organic manure i.e.5 ton. fed^{-1} (17.62 and 19.32 ton. fed^{-1}) in the 1st and 2nd seasons, respectively

This increase in potato yield may be attributed to a significant improvement in the growth and yield components.

On an average of the two seasons, water use efficiency obtained was a significantly higher with the drip irrigation regime of 60% ET_0 (33.71 kg.m^{-3}) as compared with 80% ET_0(30.19 kg.m^{-3}), Whereas, the total water requirement of potato crop was higher with the drip irrigation regime of 80% ET_0 (683.34 kg.m^{-3}) as compared to 60% ET_0 (512.41 kg.m^{-3}). Therefore To maximize tuber yield recorded with average 20.62 ton. fed^{-1}, drip irrigation should be applied at 80% ET_0 under the conditions of the limited water supply in Egypt. Application of drip irrigation at 60% ET_0 gives average of a tuber yield 17.27 ton. fed^{-1}and saves 33% of irrigation fresh water which is a limited resource in Egypt.

Over the two seasons, the average protein yield increase was 60 % higher with the drip irrigation regime of 80% ET_0 as compared to 60% ET_0. Also, the average of nutrient uptake (N, P and K) was significantly higher with the drip irrigation regime of 80% ET_0 as compared to 60% ET_0 and increasing with the application of higher level of farmyard manure. Since the soils are sandy and poor in organic matter content, it is advisable to apply farmyard manure at 10ton.fed^{-1}along with the recommended dose of fertilizers which gives average of a tuber yield 21.83 ton. fed^{-1}.

Keywords: Drip irrigation, Farmyard manure, irrigation efficiency, nutrient balance.

INTRODUCTION

In Egypt agricultural expansion in addition to increasing population requires incrementally more amount of irrigation water. Agriculture in Egypt depends entirely on irrigation from the Nile. The annual Nile water supply is 55.5 milliard cubic meters of water in 2000 (Abd El –Dayem, 1994). The

possibility to increase water supply to accomplish this gap is limited and conditioned an available alternative is to increase irrigation efficiency by minimizing water losses. Farmers in Egypt normally irrigate water heavily, most of which is lost as deep percolation along with some nutrients. Efficient irrigation requires proper and suitable irrigation scheduling to meet the ET crop and to prevent salt accumulation in the soil profile. Improving the irrigation system constitutes the key element to achieve the national goal of increasing irrigation use efficiency (Kassab, 2003 and Abo Soliman *et al*., 2005) .Drip irrigation is helpful to increase productivity, reduce water needs and increase water use efficiency.

The organic matter content of the Egyptian soils is usually less than 2% in cultivated area. Frequent and high applications of organic manure are necessary for improving physical, chemical and biological properties of soil (Abd-el moez *et al*., 1999). These organic fertilizers vary greatly in their composition.

In Egypt farmyard manure is usually used as organic fertilizer to improve soil properties and increasing crop yield.

In agriculture, every attempt is necessary to achieve higher nutrient efficiency in the light of reduced availability of resources for the manufacture of fertilizers coupled with limited water resources available for crop production. Hence, a better management system like drip irrigation with fertilizer application facility i.e. fertigation ensuring uniform nutrient distribution at the zones of active roots which improves the nutrient use efficiency (NUE) and thus saves the fertilizer cost, as well the crop yields. Adoption of modern or efficient methods of irrigation is one of the avenues to increase the output and at the same time to save water and fertilizer.

Potato (Solanum tuberosum L.) is one of the most important vegetables in Egypt. It gained a considerable importance as an export crop to European markets and one of the national income resources. Potato being shallow and sparse rooted crop requires small quantities of water applied at frequent intervals which enhance moisture availability and nutrient uptake in sandy soils.

El-Tantawy *et al* (2009) have stated that, the addition of compost significantly increased dry shoot yield of potato and fresh tuber yield. Also, application of compost increased dry matter, crud protein and specific gravity of tubers. Also, the addition of farmyard manure into the soil increased both of total and available nitrogen, phosphorus and potassium in the soil.

Application of FYM increased dry shoot yield, fresh tuber yield, dry matter, protein and specific gravity of tubers (El-Sirafy *et al*., 2008). Application of FYM with higher fertilizer level has given maximum tuber yield (18.7 t/ha) in sandy clay loam soil (Krishnamurthy *et al*., 1999).

Generally, the beneficial effects of farmyard manure on tuber yield might be related to improved the physical conditions of the soil, provided energy for microorganisms activity, increased nutrient supply and improved the efficiency of macro elements, El-Shazly (2008).

Makaraviciute (2003) illustrated that farmyard manure (FYM) application increased dry matter and starch contents in the tuber, where potato tuber yield increased by 20 %.

In drip irrigation, 31% increase in dry chilly production was obtained with 20% saving in fertilizer, 36% saving in irrigation water, Leaching losses of nutrients was least in drip fertigation with 80% recommended dose and 42% higher WUE (Veeranna *et al*., 2001).

Therefore, this Research aimed to study the effect of organic manure application and drip irrigation regime on productivity of Potato (Solanum tuberosum L.) under limited water availability in north Nile Delta, Egypt.

MATERIALS AND METHODS

A field experiments was conducted in Balteem, Kafr El–Sheikh Governorate during the two successive growing seasons of winter 2008/2009 and 2009/2010 on potato (Solanum tuberosum, L.) Var. Spunta cultivated in sandy loam soil under drip irrigation. The experimental design was split-plot design with four replications. A two drip irrigation regimes (I_1: 60% ET_o and I_2: 80% ET_o) were in main plots and two farmyard manure levels (M_1: 5 ton.fed^{-1}and M_2: 10ton.fed^{-1}) in sub plots.

The land was ploughed 3-4 times and brought to a fine tilth. Leveled beds with furrows were made at 50 cm apart. The plot area was 45 m^2 (3 m x 15 m). The FYM was applied at rate of 5 and 10ton.fed^{-1}before the last tillage and mixed well in the soil. Cut tubers were planted on the beds all along the drip line 50 cm apart. The crop was earthed up after 4-6 weeks after planting.

The sandy loam soil at Balteem, Kafr El – Sheikh Governorate (Table 1) initially had pH 7.5, EC 1.7dS.m^{-1}, OM 0.40%, N 35 ppm, available P 13 ppm and K 140 ppm. Soil chemical and physical properties were determined according to Page (1982) and Klute (1986) Farmyard manure was applied to the soil before planting; some chemical properties of farmyard manure are stated in Table (2).

Table (1): Some chemical and physical properties of the experimental soil.

EC,dS.m^{-1}	pH 1:2.5	O.M, %	Total Carbonate,%	Available nutrients, ppm			Soil texture				Soil moisture characteristics		
				N	P	K	Clay, %	Silt, %	Sand, %	Texture class	FC, %	WP, %	AW, %
1.7	7.5	0.40	1.58	35	13	140	18.3	35.8	45.9	Sandy loam	13.5	7.5	6.0

Table (2): Some chemical properties of farmyard manure.

EC, dS.m^{-1}	pH 1: 10	Organic matter	Total N, %	C / N ratio	Total P %	Total K %
1.89	7.46	25.55	1.91	7.78	0.73	1.33

The N, P2O5 and K2O fertilizer was applied through drip fertigation in weekly intervals starting from 4-6 weeks after planting until tuber development as shown in Table (3).

Table (3): Schedule of Chemical fertilizer (18-18-18- 3% N, P2O5, K2O & MgO) applied to potato crop during the growing seasons under drip fertigation.

Sl. No.	Weeks duration	Weekly splits	Weekly %	Total %	gm. plant^{-1}. Week^{-1}	gm.m^{-2}.week^{-1}	kg/fed week
1	4 - 7th wk	4	10.0	40	2.50	10.0	42
2	8 - 11th wk	4	12.5	50	3.13	12.5	52.5
3	12-13th wk	2	5.0	10	1.25	5.0	21

Potato tuber pieces were planted on December 1, 2008 in the 1 st season and harvested on March 30, 2009, while the 2nd season planted on November 28, 2009 and harvested on March 28, 2010. The Potatoes were harvested after 120 days from planting

The main line in drip irrigation net was 63.0 mm. and the laterals were 16.0 mm in diameters. The distance between laterals was 50 cm and lateral length was 15 m. The designed factory discharge of dripper was 4 L.hour^{-1}.

Light irrigation was provided immediately after planting. Subsequent irrigations were scheduled by drip irrigation adjusted based on ET_0 (Class A Pan Evaporation) with crop coefficient values at different stages of crop growth for efficient utilization under scarce water conditions as shown in Table (4). The plots were kept free from weeds. Tubers exposed to sun at the surface were covered with soil to prevent greenness.

Table (4): Irrigation intervals as affected by potential evapotranspiration (ET_0).

ET_0,mm/day	Type of frequency	Interval, days
< 3.0	Low	3
3.0 - 5.0	Moderate	2
> 5.0	High	1

Note:

Water relations:

1. The quantity of water applied was estimated using the class A pan evaporation equation: ET_0= Epan x KP

Where :

ET0 = Class A Pan Evaporation

Epan = pan evaporation, mm.d-1,

KP = pan coefficient (0.8 – 1.0),

2. Water consumptive use(ETcrop) by equation: ET_c=ET_0 x Kc

Where:

Kc = Crop coefficient factor

Kc for potato crop for different growth stages was taken from FAO Irrigation and Drainage Technical Paper No. 24 according to Doorenbos, J and W.O.Pruitt (1977) where Kc= 0.45(Initial), 0.45(Devt.), 0.75(Mid-season), 1.13(Late season) and 0.90(At harvest).

3. Field water use efficiency (]F.W.U.E): was calculated as follows:

FWUE (kg/m3$^{)}$ = Yield (kg/fed.)/Amount of water applied (m^3/fed).

4. Crop Water use efficiency (C.W.U.E) was calculated by using formula:
C.W.U.E (kg/m3) = Yield (kg/fed.)/Seasonal water consumptive use (m^3/fed), (Doorenbos and Pruitt, 1977).

Table (5): The metrological data of Sakha Climatologically Station during the growing seasons.

Month	Air Temp.C°		Relative humidity,%		wind speed , km /24 hr.at 2 m height	Solar radiation, MJ .m-2	Soil Temp. C°	Ep, mm.day-1	Total rain, mm
	T , MAX	T, MIN	RH, AX	RH, IN					
Nov. 08	26.00	8.00	82.00	53.00	68.00	9.40	17.40	3.17	0.00
Dec. 08	22.00	7.00	75.50	55.00	50.00	6.60	13.97	2.16	0.60
Jan. 09	20.00	6.80	74.50	55.50	49.00	8.10	10.58	1.98	3.50
Feb. 09	22.60	7.80	80.00	60.00	79.00	13.7	14.60	2.97	4.50
Mar. 09	22.00	7.00	72.00	52.20	84.00	15.4	19.32	3.43	0.00
Nov. 09	26.00	10.5	77.70	50.00	58.00	13.0	18.30	2.69	0.00
Dec. 09	22.20	8.80	76.50	52.00	64.00	9.20	13.30	2.08	0.00
Jan. 10	21.50	7.50	83.50	55.00	53.00	8.10	13.40	1.82	0.00
Feb. 10	24.50	9.40	84.20	55.70	76.80	12.4	16.20	2.94	1.20
Mar. 10	24.30	10.0	76.30	44.00	110.0	16.7	18.50	4.26	0.00

Harvesting and yield

When the aerial stems and foliage turned yellowish brown and started drying up, the crop was harvested. Irrigation was stopped 8-10 days before harvesting the crop. The plants were dug out carefully without damaging the tubers when the soil moisture was optimum. The tubers were cured for 10-15 days in a well ventilated place

Data and the following parameters were recorded:-

A) Growth parameters and tuber yield of potato:-
Plant height, no. of leaves, branches, yield Tuber yield, No. of tubers, tuber girth, and specific gravity of tubers.

B) Water requirement and water use efficiency of potato.

C) Quality of potato tubers and nutrient uptake: - Protein content and nutrient uptake of NPK. Statistical analysis of all data according to Cochran (1960)

RESULTS AND DISCUSSION

A) Growth parameters and tuber yield of potato:-

Data of potato growth, tuber yield and its attributes is provided in Tables (6 & 7).

The average over the two years of tuber yield recorded was 19.55 ton. fed^{-1}. However, the obtained tuber yield was higher during 2009-2010 (20.40 ton. fed^{-1}) which is 9 % higher when compared to 2008-009(18.70 ton. fed^{-1}).

The obtained tuber yield significantly higher with the drip irrigation regime of 80% ET_0 (19.77 ton. fed^{-1} in 2008-2009 and 21.47 ton. fed^{-1} in 2009-2010) as compared to 60% ET_0(16.42 ton. fed^{-1} in 2008-2009 and 18.11 ton. fed^{-1} in 2009-2010). The average increase in tuber yield was 19.4% higher with the drip irrigation regime of 80% ET_0 (I_2) when compared to 60% ET_0 (I_1).

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This significant increase in the yield of tubers per Fadden is due to drip irrigation regimes may be attributed to significant improvement in the yield components of potato during both seasons. There was significantly higher yield and number of tubers/plant when irrigation is scheduled with the drip irrigation regime of 80% ET_0. The higher girth of tubers resulted in the increased yield of tubers/plant. Specific gravity of tubers and the harvest index recorded were also higher in the irrigation regime I_2. Such an improvement in the attributes of tuber yield of potato may further be related to the significant improvement in the growth components. The plant height and the number of leaves/plant were a significantly more in the higher irrigation regime I_2. There was also an increase in the number of branches recorded/plant. Moreover, higher level of drip irrigation regime of 80% $ET_0(I_2)$ is also responsible for maintaining higher content of actual soil moisture before every irrigation and better uptake of nutrients. Hence, growth and tuber yield of potato will be better when irrigation is scheduled with the drip irrigation regime of 80% ET_0.

These results are in agreement with the findings of Veeranna *et al*. (2001) who have reported that there will be large savings in irrigation water with increased yields and water use efficiency due to higher regime of drip irrigation.

Application of higher level of farmyard manure i.e. 10ton.fed^{-1} resulted in significantly higher yield of tubers (20.98 ton.fed^{-1} in 2008-2009 and 22.68 ton.fed^{-1} in 2009-2010) as compared to the lower level of farmyard manure of 5 ton.fed^{-1} (17.62 ton.fed^{-1} in 2008-2009 and 19.32 ton.fed^{-1} in 2009-2010). The average increase in tuber yield was 18.2 % higher with the application of higher level of farmyard manure i.e. 10ton.fed^{-1} (M2) as compared to the lower level of farmyard manure i.e. 5ton.fed^{-1} (M_1). This significant increase in the yield of tubers per hectare due to levels of farmyard manure may be attributed to significant improvement in the yield components of potato during both seasons. There was significantly higher yield and number of tubers.plant^{-1}; girth of tubers and harvest index when organic manure was applied at a higher level of 10ton.fed^{-1}. Such an improvement in the attributes of tuber yield of potato may further be related to the significant improvement in the growth components. The plant height, the number of leaves and haulms/plant were significantly more in the higher organic manure level of 10ton.fed^{-1}

Several earlier workers (El-Sirafy Z. M. *et al*., 2008 and Krishnamurthy *et al*., 1999) also reported that the application of higher quantities of farmyard manure is responsible for the improvement for in the growth and yield of crops.

B) Water requirement and water use efficiency of potato

Data of water applied, water consumptive use and water use efficiency of potato are provided in Table (8). The average over the two years of total water applied was 452 during the growing seasons.55 m^3.fed^{-1}.Application of higher level of organic manure i.e. 10 ton.fed^{-}1 resulted in significantly higher crop water use efficiency (C.W.U.E.) (37.02 kg.m^{-3} in 2008-2009 and 36.00 kg.m^{-3} in 2009-2010) as compared to the lower level of organic manure i.e. 5 ton.fed^{-1} (31.10kg.m^{-3} in 2008-09 and 30.67kg.m^{-3} in

2009-2010). The average increase in water use efficiency was 18.2 % higher with the application of higher level of organic manure i.e. 10 ton.fed^{-1} (M_2) as compared to the lower level of organic manure i.e. 5 ton.fed^{-1} (M_1). Such an increase may further be related to the significant improvement in the yield of tubers. Moreover, higher level of organic manure also maintained higher content of actual soil moisture befor10 ton.fed^{-1}every irrigation which may in turn be attributed to its better water holding capacity.

Also, the obtained results showed that, water applied to potato crop was higher with the drip irrigation regime of 80% ET_o (463.8 and 742.9 m^3. fed^{-1}) as compared to 60% ET_o (347.9 and 557.2 m^3. fed^{-1}) in the first and second seasons, respectively.

The seasonal water consumptive use of potato crop was higher with the drip irrigation regime of 80% ET_o (646.8 and 719.88 m3. fed^{-1}) as compared to 60% ET_o(484.7 and 540.12 m3. fed^{-1}) in the first and second seasons, respectively. The increase in the average water consumptive use was 33.36% higher with the drip irrigation regime of 80% ET_o (I_2) when compared to 60% ET_o (I_1). It is obvious that the water consumptive use of the crop generally decreases when irrigation is scheduled with the lower drip irrigation regime of 60% ET_o. Hence, there will be water saving in this lower irrigation regime I_1.

The water use efficiency value was higher during 2008-2009 when compared to 2009-2010. Such an increment in the water use efficiency of potato crop may further be related to the higher yield of tubers and lower requirement of irrigation water due to the higher of rain precipitation.

Crop water use efficiency (C.W.U.E.) obtained was significantly higher with the drip irrigation regime of 60% ET_o (33.87and 33.54kg.m^{-3}) as compared to 80% Et_o (30.56 and 29.82 kg.m^{-3} in the 1st and 2nd seasons, respectively). Field water use efficiency (F.W.U.E.) obtained was significantly higher with the drip irrigation regime of 60% ET_o (47.19and 32.51kg.m^{-3} as compared to 80% Et_o (42.62 and 28.90 kg.m^{-3} in the 1st and 2nd seasons, respectively).

The average increase in water use efficiency of potato crop higher with the drip irrigation regime of 60% ET_o (I_1) when compared to 80% ET_o (I_2). Such an increment in the water use efficiency of potato crop may further be attributed to the lower applied irrigation water with I_1.

Whereas, the water use efficiency obtained was significantly higher with the drip irrigation regime of 60% ET_o as compared to 80% ET_o. Therefore to maximize tuber yield recorded with average 20.62 ton. fed^{-1}, drip irrigation should be applied at 80% ET_o under the conditions of limited water availability. In order to optimize irrigation water, drip irrigation should be applied at 60% ET_o. This gives average of a tuber `yield 17.27 ton. fed^{-1}and saves 33% of irrigation water which is a scarce and costly resource.

Table (8): Effect of drip irrigation regimes and farmyard manure levels on applied water, water consumptive use, and water use efficiency of potato crop during the growing seasons.

Treatments	Tuber yield, kg.fed^{-1}	Applied water, m3. fed^{-1}	Water consumptive use, m3. fed^{-1}	F.W.U.E, Kg.m^{-3}	C.W.U.E, Kg.m^{-3}	Tuber yield, kg.fed^{-1}	Applied water, m3. fed^{-1}	Water consumptive use, m3 fed^{-1}	F.W.U.E, Kg.m^{-3}	C.W.U.E, Kg.m^{-3}
Irrigation regime	**First season (2008-2009)**					**Second season (2009-2010)**				
I_1 – 60% ET_o	16417	347.9	484.7	47.19	33.87	18114	557.2	540.12	32.51	33.54
I_2 – 80% ET_o	19769	463.8	646.8	42.62	30.56	21470	42.9	719.88	28.90	29.82
Farmyard manure levels										
M_1– 5 ton.fed^{-1}	17623	405.85	566.75	43.42	31.10	19324	650.5	630.0	29.71	30.67
M_2–10 ton.fed^{-1}	20979	405.85	566.75	51.69	37.02	22680	650.5	630.0	34.89	36.00

C) Quality of potato tubers and nutrient uptake.

The data on quality of potato tubers, nutrient uptake provided in Tables (9, 10).

On an average over the two seasons, protein yield recorded was 0.89 ton. fed^{-1}. However, the protein yield obtained was higher during 2009-010 (0.94 ton. fed^{-1}) which is 13.25% higher when compared to 2008-09 (0.83 ton. fed^{-1}). On an average over two seasons, potato crop removed higher K (182.52 kg. fed^{-1}) followed by N(138.38 kg. fed^{-1}) and P(21.38 kg. fed^{-1}).

Protein yield obtained was significantly higher with the drip irrigation regime of 80% ET_0 (1.01 ton. fed^{-1}1 in 2008-2009 and 1. 14 ton. fed^{-1} in 2009-2010) as compared to 60% ET_0 (0.63 ton. fed^{-1} in 2008-2009 and 0.72 ton. fed^{-1}in 2009-2010). The average protein yield increase was 60 % higher with the drip irrigation regime of 80% ET_0 (I2).

On an average over the two seasons, nutrient uptake was higher with the drip irrigation regime of 80% ET_0(169.40, 24.60 and 214.17 kg. fed^{-1} N, P and K, respectively) as compared to 60% ET_0(106.97, 18.22 and 150.90 kg. fed^{-1} N, P and K, respectively). This may be attributed to more availability of soil moisture in I_2 than in I_1.

Application of higher level of farmyard manure i.e. 10 ton. Fed^{-1}resulted in a significantly higher yield of protein (1.14 kg. fed^{-1}) in 2008-2009 and (1.30 kg. fed^{-1}) in 2009-2010) as compared to lower level of farmyard manure i.e. 5 ton. fed^{-1}, (0.53 kg. fed^{-1}) in 2008-2009 and (0.62 kg. fed^{-1}) in 2009-2010. The average increase in protein yield was 37 % higher with the application of higher level of farmyard manure i.e. 10 ton. fed^{-1}, (M_2) as compared to the lower level of farmyard manure i.e. 5 ton. fed^{-1} (M_1). On an average over two seasons, nutrient uptake was higher with the application of higher level of farmyard manure i.e. 10 ton. fed^{-1}, (186.06, 28.31 and 239.02 kg. fed^{-1}, of N,

P and K, respectively) as compared to lower level of farmyard manure i.e. 5 ton. fed^{-1}, (91.14, 14.45 and 125.96 kg. fed^{-1}, of N, P and K, respectively). This may ultimately be related to the higher availability of soil moisture in M_2 than in M_1. El-Sirafy Z. M. *et al* (2008) and Veeranna *et al*. (2001) revealed similar results and stated that potato production can be sustained over a long time by maintaining the soil nutrient status.

Table (9): Effect of drip irrigation regimes and farmyard manure levels on tuber quality and nutrient uptake of potato crop grown during First season (2008-2009).

Treatments	Protein content (%)	Protein yield Ton. fed^{-1}	Nutrient content (%)			Nutrient uptake Kg. fed^{-1}		
			N	P	K	N	P	K
A. Main plot (Drip Irrigation regimes: 2)								
I_1 – 60% ET_o	3.20	0.53	0.51	0.07	0.70	83.72	11.49	114. 91
I_2 – 80% ET_o	5.12	1.01	0.80	0.11	1.01	158.16	21.75	199.68
S.Em. +	0.381	0.020	0.053	0.013	0.041	32.15	2.97	5.45
C.D. at 5%	1.387	0.716	0.192	NS	0.148	116.91	10.72	19.82
B. Sub plot (farmyard manure levels: 2)								
M_1– 5 ton.fed^{-1}	3.54	0.63	0.56	0.09	0.79	98.70	15.86	139.23
M_2–10 ton.fed^{-1}	5.46	1.15	0.83	0.12	1.07	174.12	25.17	224.28
S.Em. +	0.568	0.322	0.070	0.009	0.059	45.45	5.94	56.85
C.D. at 5%	1.791	1.016	0.219	0.027	0.186	143.22	18.70	17 9.12
C. Mean	4.33	0.83	0.68	0.10	0.89	128.68	18.57	169.58

Table (10): Effect of drip irrigation regimes and farmyard manure levels on tuber quality and nutrient uptake of potato crop grown during Second season (2009-2010) .

Treatments	Protein content (%)	Protein yield t. fed-1	Nutrient content (%)			Nutrient Kg. fed-1 uptake		
			N	P	K	N	P	K
A. Main plot (Drip Irrigation regimes: 2)								
I_1 – 60% ET_o	3.40	0.62	0.54	0.10	0.76	98.39	17.35	136.98
I_2 – 80% ET_o	5.33	1.14	0.84	0.13	1.07	180.64	27.44	228.66
S.Em. +	0.362	0.175	0.054	0.013	0.042	33.62	3.47	34.66
C.D. at 5%	1.316	0.638	0.198	NS	0.151	122.24	12.61	126.00
B. Sub plot (farmyard manure levels: 2)								
M_1– 5 ton.fed^{-1}	3.73	0.72	0.60	0.11	0.84	115.24	20.58	162.56
M_2–10 ton.fed^{-1}	5.66	1.28	0.87	0.14	1.12	198.05	31.40	253.60
S.Em. +	0.512	0.348	0.069	0.009	0.060	55.67	6.92	59.29
C.D. at 5%	1.614	1.096	0.217	0.028	0.188	175.41	21.82	186.8 2
C. Mean	4.53	0.94	0.71	0.12	0.95	148.08	24.20	195.46

Summary and Conclusion

- It is possible to grow a successful crop of potato in 120 days on sandy soils of Nile Delta, Egypt during winter season in the open field under drip fertigation by adopting proper management practices. The influence of addition of farmyard manure to this crop is more pronounced as it is largely responsible for the improvement in the physicochemical and biological properties of the soil.
- To maximize the tuber yield of potato (20.62 ton. fed^{-1}) under the limited fresh water in Egypt, drip irrigation should be applied at 80% ET_0,but the application of drip irrigation at 60% ET_0 gives a tuber yield of 17.27 ton. $fed^{-1}$and saves 33% of irrigation water. under the conditions of limited water in Egypt.
- Since the soils are sandy and poor in organic matter content, it is advisable to apply farmyard manure at a rate of 10 ton. fed^{-1} along with the recommended dose of fertilizers which gives a tuber yield of 21.83 ton. fed^{-1}.
- The total water requirement and water consumptive use of potato crop was higher with the drip irrigation regime of 80% ET_0 as compared to 60% ET_0. Whereas, the average of crop water use efficiency obtained was significantly higher with the drip irrigation regime of 60% ET_0 (33.71 $kg.m^{-3}$) as compared with 80% ET_0 (30.19 $kg.m^{-3}$).
- Also, the average of nutrient uptake (N, P and K) was significantly higher with the drip irrigation regime of 80% ET_0 as compared to 60% ET_0 and increasing with the application of higher level of farmyard manure.

REFERENCES

Abd El-Dayem, M. S., (1994). “Future strategy for facing the incremental water requirements, ideas, precautions and determinants”. Water Science, 15th issue, April (in Arabic).

Abdel-Moez, M. R.; A. L.; Saleh and Sh. A H.; Wanas (1999): Influence of some organic composts on yield; nutrients uptake and consumptive use of fennel and coriander plants and some soil physical properties. J. Agric. Sci. Mansoura univ., 24(10): 6237-6253.

Abo Soliman, M.S.M.; H.A. Shams El-Din; M.M. Said; S. M. El-Barbary; M.A.Ghazy; M.E. El-Shahawy; E.A.Gazia and M.A. Abo El-Soud (2005). Maximizing conveyance efficiency through lining marwas at on-farm level in old lands of Egypt. J. Agric. Sci. Mansoura Univ., 30(10):6371-6383.

Cochran, W. G. and G. M. Cox (1960) . Experimental design. 2nd John Welly , New York , pp:293-316

Doorenbos, J and W.O.Pruitt (1977). Guideline of predicting crop water requirements. Irrigation and Drainage Paper (24). FAO, Rome.

El-Shazly, M.M. (2008). Potassic, organic and bio-fertilization of potatoes under alluvial soil conditions. Ph. D. Thesis. Fac. of Agric., Mansoura, Univ., Egypt.

El-Sirafy Z. M. , Khadra A. Abbady; A. M. El-Ghamry and R. A. El-Dissoky (2008). Potato Yield Quality, Quantity and Profitabilty as Affected by Soil and Foliar Potassium Application. Journal of Agriculture and Biological Sciences, 4 (6) : 912-922.

El-Tantawy, I.M.; A. M. El-Ghamry and A. H. Habib (2009). Impact of farmyard manure and manure compost tea on potato yield and soil fertility. J. Agric. Sci. Mansoura Univ., 34(1): 669 – 678.

Kassab, (2003). Towards effective water management for some field crops in North Nile Delta Region. Ph. D. Thesis, Fac. Agric. Moshtohor, Zagazig Univ., Egypt.

Klute, A. (1986). Water retention: laboratory methods. In: A. Klute (ed.), Methods of soil analysis, Part 1. 2nd ed. Agron. Monogr. 9, ASA, Madison, WI. USA, pp. 635-660.

Krishnamurthy, N., Abdul Khalak, G.Hunsigi, H.K.Basavaraj, K.P.R. Prasanna and B.Shivaraj (1999). Ware potato production through integrated nutrient supply and management (INSM) in alfisols. In. Proc. of Global Conf. on Potato p. 118, New Delhi, Dec. 6-11.

Makaraviciute, A. (2003). Effect of organic and mineral fertilizers on the yield and quality of different potato varieties. Agro. Res.,1(2):197-209.

Page, A.L. (Ed) (1982). Methods of Soil Analysis, Part 2: Chemical and Microbiological Properties, (2nd Ed.). Am. Soc. At Agron. Inc. Soil Sci. Soc. Of Am Inc., Madison, Wisconsin, USA.

Veeranna, H.K., Abdul Khalak And Sujith, G.M. (2001). Effect of irrigation and fertigation methods on sustainable chili production. In. Proc. Interntl. Res. Symp. On Sustainable Agric. Devt., March 27 at Bangalore, Part 3: 14.

تأثير إضافة السماد العضوي على إنتاجية البطاطس صنف اسبونتا تحت ظروف الري بالتنقيط في شمال دلتا النيل بمصر.

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أقيمت تجربتان حقليتان لدراسة تأثير إضافة سماد المزرعة العضوي تحت ظروف الري بالتنقيط على إنتاج درنات البطاطس (صنف سبونتا) وبعض كفاءات الري في ارض رملية لوميه بمنطقة بلطيم محافظة كفر الشيخ خلال الموسمين الشتويين 2008-2009 و 2009 -2010م .استخدم تصميم القطع المنشقة مرة واحدة في أربعة مكررات. وزعت معاملات الري على القطع الرئيسية وهي (I_1) الاحتياجات المائية على أساس 60 % من النتح و البخر القياسيET_o و(I_2) 80 % من النتح و البخر القياسى ET_o . ووزعت معاملات إضافة سماد المزرعة العضوي بمعدلات 5 طن / للفدان (M1) و 10 طن / للفدان (M2).

و كانت أهم النتائج المتحصل عليها كالاتى:

- أن إضافة الاحتياجات المائية على أساس 80 % من البخر نتح القياسي المحسوب من وعاء البخر حقق أعلى متوسط لإنتاج درنات البطاطس والذي بلغ 20.62 طن / للفدان (19.77 طن/للفدان في الموسم الأول و 21.47 طن /للفدان في الموسم الثاني) مقارنة بمتوسط الإنتاج عند معاملة الري على أساس 60 % من البخر نتح القياسي والذي انخفض فيه الإنتاج ليصبح

17.27 طن/للفدان (16.42 طن/للفدان في الموسم الأول و 18.11 طن / للفدان في الموسم الثاني).

- أن إضافة سماد المزرعة العضوي بالمعدل الأكبر(10 طن/ للفدان) أعطى أعلى متوسط إنتاجية لدرنات البطاطس للموسمين والذي بلغ 21.83 طن للفدان (20.98 طن /للفدان في الموسم الأول و 22.68 طن / للفدان في الموسم الثاني) مقارنة بمتوسط الإنتاج للموسمين عند إضافة المعدل الأقل من السماد العضوي (5 طن / للفدان) والذي انخفض فيه الإنتاج ليصبح 18.47 طن/ للفدان(19.32 طن/للفدان في الموسم الأول و 17.62 طن /للفدان في الموسم الثاني).
- زادت قيم الاستهلاك المائي لنباتات البطاطس كمتوسط لموسمي النمو لتصل لأعلى القيم عند الري على أساس 80 % من البخر نتح القياسي فكانت683.34 م3 / للفدان بينما انخفضت لتصل إلى 512.41 م3 /للفدان عند الري على أساس 60 % من البخر نتح القياسي ولذا سجلت كفاءات الاستخدام المائي لمحصول البطاطس أعلى القيم المعنوية عند الري بمستوى 60% من البخر نتح القياسي لتصل إلى 33.71 كجم/ م3 مقارنة عند الري بمستوى 80 % من البخر نتح القياسي والتي انخفضت إلى 30.19كجم/ م3 كمتوسط لموسمي النمو.
- زادت قيم نسبة البروتين زيادة معنوية عند الري بمستوى 80 % من البخر نتح القياسي عنها عند الري بمستوى 60% من البخر نتح القياسي بزيادة تصل مقدارها الى60% وكذلك زادت قيم الامتصاص من عناصر النيتروجين والفوسفور والبوتاسيوم زيادة معنوية وازدادت القيم بزيادة مستوى الإضافة من المادة العضوية.

اعتمادا على النتائج السابقة يمكن التوصية بما يلي:-

- إضافة الاحتياجات المائية للبطاطس على أساس 80 % من البخر نتح القياسى المحسوبة من وعاء البخر عند الرغبة في الحصول على أعلى إنتاجية.بينما عند نقص مياه الري وعدم توافرها تضاف الاحتياجات المائية للبطاطس على أساس 60 % من البخر نتح القياسى المحسوبة من وعاء البخر للحصول على إنتاجية اقل مع توفير 33 % من مياه الري.وحيث أن الأرض رملية فقيرة في المادة العضوية فان إضافة سماد المزرعة العضوي بمعدل 10 طن / فدان مع إضافة الجرعات الموصى بها من التسميد المعدني يؤدى إلى تحسين خواص التربة الطبيعية والكيماوية وزيادة الإنتاجية.

قام بتحكيم البحث

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Table (6): Effect of drip irrigation regimes and farmyard manure levels on tuber yield and yield attributes of potato crop during the growing seasons.

Treatments	Tuber yield Ton. Fed^{-1}		Tubers .plant $^{-1}$		Tuber girth (cm)		Specific gravity Mgm^{-3}		Harvest index	
	08/09	09/10	08/09	09/10	08/09	09/10	08/09	09/10	08/09	09/10
A. Main plot (Drip Irrigation regimes: 2)										
I_1 – 60% ET_o	16.42	18.11	8.45	11.98	11.45	12.09	1.13	1.19	0.67	0.72
I_2 – 80% ET_o	19.77	21.47	10.27	16.48	13.16	13.70	1.26	1.32	0.75	0.79
S.Em. +	1.160	1.23	0.199	0.555	0.275	0.335	0.025	0.076	0.010	0.009
C.D. at 5%	4.220	4.47	0.72	2.017	NS	NS	NS	NS	0.038	0.031
B. Sub plot (farmyard manure levels: 2)										
M_1– 5 ton.fed^{-1}	17.62	19.32	9.42	13.70	12.31	12.84	1.18	1.23	0.71	0.75
M_2–10 ton.fed^{-1}	20.98	22.68	11.24	18.19	14.02	14.45	1.31	1.36	0.78	0.82
S.Em. +	0.630	0.550	0.576	0.954	0.700	0.573	0.036	0.031	0.023	0.023
C.D. at 5%	1.990	1.74	1.816	3.007	2.206	1.806	0.112	0.098	0.072	0.076
C. Mean	18.70	20.40	9.85	15.09	12.74	13.27	1.22	1.28	0.73	0.77

ET_o = Reference evapo-transpiration
S.Em. + = Standard error of means
C.D. = Critical difference
NS = Not Significant

Table (7): Effect of drip irrigation regimes and farmyard manure levels on growth attributes of potato crop during the growing seasons.

Treatments	Plant height (cm)		No. of leaves .plant^{-1}		No. of branches .plant^{-1}	
	2008-2009	2009-2010	2008-2009	2009-2010	2008-2009	2009-2010
A. Main plot (Drip Irrigation regimes: 2)						
I_1 – 60% ET_o	19.3	24.2	58.8	65.6	3.4	3.6
I_2 – 80% ET_o	25.0	29.5	72.0	77.8	4.7	4.9
S.Em. +	0.520	0.802	1.615	1.543	0.389	0.310
C.D. at 5%	1.876	2.917	5.873	5.612	NS	NS
B. Sub plot (farmyard manure levels: 2)						
M_1– 5 ton.fed^{-1}	22.1	26.1	64.1	70.8	3.8	4.0
M_2–10 ton.fed^{-1}	27.4	31.4	77.3	83.0	5.1	5.3
S.Em. +	1.996	1.456	4.333	4.480	0.385	0.454
C.D. at 5%	6.289	4.588	13.654	14.116	1.213	1.429
C. Mean	23.5	27.8	68.0	74.3	4.25	4.5