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EFFECT OF DRIP IRRIGATION SCHEDULES AND SOIL MULCHING ON TUBER YIELD OF POTATO (*Solanum tuberosum* L.) VAR. SPUNTA

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ABSTRACT

Two field experiments were carried out to find out the "Effect of drip irrigation schedules and mulching 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 seasons of 2005-2006 and 2006-2007. Six treatments combinations involving two drip irrigation regimes (I_1: 60% ETo and I_2: 80% ETo) in main plots and three kinds of mulch (M_0: No mulch, M_1: Organic mulch and M_2: Plastic mulch) 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 (52.0 t/ha in 2005-06 and 48.2 t/ha in 2006-07) as compared to 60% ET_0 (47.2 t/ha in 2005-06 and 43.4 t/ha in 2006-07).

Use of black polyethylene mulch resulted in significantly higher yield of tubers (53.7 t/ha in 2005-06 and 49.8 t/ha in 2006-07) as compared to rice straw mulch (50.6 t/ha in 2005-06 and 46.6 t/ha in 2006-07) and no mulch (44.5 t/ha in 2005-06 and 41.0 t/ha in 2006-07).

The seasonal water consumptive use of potato crop was higher with the drip irrigation regime of 80% ET0 (1708.55 and 1654.2 m3/ha) as compared to 60% ET0 (1281.41 and 1240.7m3/ha) in the 1st and 2nd seasons, respectively.

The total water applied to potato crop was higher with the drip irrigation regime of 80% ET_0 (3417.11 and 3308.42 m3/ha) as compared to 60% ET_0 (2562.83 and 2481.31 m^3/ha) in the 1st and 2nd seasons, respectively.

The crop water use efficiency (C.W.U.E.) was significantly higher with the drip irrigation regime of 60% ET_0 (18.42 and17.49 kg/m^3) as compared to 80% ET_0 (15.22 and14.47 kg/m^3) in the 1st and 2nd seasons, respectively.

The field water use efficiency (F.W.U.E.) was significantly higher with the drip irrigation regime of 60% ET_0 (36.83 and 34.98 kg/m^3) as compared to 80% ET_0 (30.44 and 29.14 kg/m^3) in the 1st and 2nd seasons, respectively.

Using plastic mulching resulted in the highest (C.W.U.E.) which the values were (17.98 and 17.20 kg/m^3) in the 1st and 2nd seasons, respectively and (F.W.U.E.) values (35.92 and 34.41 kg/m^3) in the 1st and 2nd seasons, respectively.

Therefore to maximize tuber yield (52.0 t/ha), drip irrigation should be scheduled at 80% ET_0 under the conditions of limited water availability. In order to optimize irrigation water, drip irrigation should be scheduled at 60% ET_0. This gives a tuber yield of 47.2 t/ha and saves 40% of irrigation water under conditions of limited water availability.

It is economically beneficial to use organic mulch. Apply organic manure at rate of 12.5t/ha along with the recommended dose of fertilizers. Incorporate organic mulch and potato plants after harvest to enrich soil fertility and sustains potato production for long time in sandy loam soil.

Keywords : Drip irrigation , Potato, Mulching, Water use, Irrigation efficiency.

INTRODUCTION

Drought is a severe environmental stress that limits agricultural production. Vegetable crops, including potato, have high water requirements and in most countries full or supplemental irrigation is necessary for successful vegetable production. However, water availability for agriculture is being reduced as a consequence of global climate change, environmental pollution and growing demand for other uses. Therefore, great emphasis is placed on crop management for dry conditions with the aim of increasing water use efficiency. Irrigation systems affect water use efficiency and yield of potato.

This sensitivity to water stress makes potato a water-demanding crop, requiring from 400 to 600 liters of water to produce 1 kilogram of tuber dry matter (Beukema & Van der Zaag, 1979). Under field conditions, the water requirements vary between 350 to 500 mm over the growing season, depending on the crop period, environmental conditions, soil type and cultivar (Sood & Singh., 2003). Potato plants can respond with increments of up to 2 t/ha for each 2 cm of water lamina (Harris, 1978). The optimal yield is highly dependent on well-planned watering with low volume and high frequency (Vayda, 1994 and Wright and Stark, 1990).

The potato's limited tolerance to drought is due to its comparatively shallow root system (50-60 cm) and the stomatal tendency to close (Harris, 1992 and Kleinkopf and Westermann, 1981), which reduce leaf extension rates (Haverkort & MacKerron, 2000). Stomatal closure also reduces CO2 uptake and photosynthetic activity, increases leaf temperature and photorespiration, and is therefore negative for crop production (Egúsquiza, 2000). The longer the reduction of stomatal opening lasts, the higher the reduction in yield (Martínez and Huamán 1993). The critical period to water deficit in potato is during tuber development; achieving high yields requires an adequate water supply from tuber initiation to maturity (Salter and Goode, 1967; Jensen et al., 2000 and Egúsquiza, 2000) and even short episodes of water stress during this period can cause significant reductions in yield and quality (Miller and Martin, 1987; Kumar et al., 2003) causing chained, hollow and small tubers (Jensen et al., 2000).In drip irrigation, 31% increase in yield over furrow irrigation was obtained with 20% saving in fertilizer, 36% saving of irrigation water, 42% higher WUE besides reduced acidification problem below the emitters(Veeranna *et al.*, 2001).

Agronomic practices that reduce soil evaporation should tend to increase water productivity. In a study of the benefits of surface mulches on yield, Midmore et al. (1986b) showed that mulch increased tuber yield during the summer by 20%. Although it was not directly determined how much water productivity might have been affected, Midmore *et al.* (1986a) did conclude that mulch always increased soil-moisture retention. Thus enhanced yields obviously mean increased water productivity for the same amount of applied water, at least for the summer season in Lima. These same studies also showed that mulch resulted in earlier tuber initiation and greater tuber bulking rates.Manrique and Meyer (1984) also studied the impact of mulches on

potato yield during winter and summer seasons. They showed no effect on yields during the winter, but summer yields were increased by 58% with surface mulch, which improved soil moisture retention. High frequency irrigation given in smaller quantities and polyethylene or rice-straw mulch was superior in dry matter accumulation, tuber yield, uptake of nutrients and water use efficiency when compared to no mulching(Abd Al - Gaffar and Kumaraswamy, 1992a, b and c). Mulching with straw or polythene resulted in reduction of weed bio-mass and higher economic benefit (Abd Al - Gaffar and Kumaraswamy, 1993).

Therefore, an investigation has been planned to find out the performance of growing potato under limited water availability under drip fertigation with water conservation techniques such as soil mulching.

MATERIALS AND METHODS

The Spunta variety of potato crop which comes up in 120-130 days was grown under irrigated conditions from November to March. Disease free, F_1 class A seed tubers of grade 35/55 mm with bold buds ready to sprout were used for planting. Large sized tubers were cut into pieces in such a way that each piece containing at least two eye buds and weighing approximately 35-40 grams each. Small tubers weighing about 65 grams or less were not cut. After cutting every tuber, the knife was dipped in formalin (10% v/v) to check the spread of bacterial diseases carried through the tubers. Seed tubers were dipped in a solution of Rhizolex (1 g) dissolved in 1 liter of water for 5 minutes and dried in shade before planting, which prevents the decay of seed tubers.

The soil was ploughed 3-4 times and brought to a fine tilth. Leveled beds with furrows were made at 50cm apart. The plot area was 45 m^2 (3 m x 15 m). The entire quantity of poultry manure was applied (12.5 ton/ha.) and mixed well in the soil before planting. 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. Later mulching was done using rice straw at 5t/ha and black polyethylene sheets of 400g thickness.

The sandy loam soil at Balteem, Kafr El – Sheikh Governorate(Table 1) initially had pH 7.3, EC 1.65 dSm^{-1} , OM 0.42%, N 38 ppm, available P 15 ppm and K 150ppm.Soil chemical and physical properties were determined according to Page (1982) and Klute (1986).

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

EC,dS/m	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, %
1.65	7.3	0.42	1.54	38	15	150	18.3	35.8	45.9	Sandy loam	13.7	7.7	6.0

The N, P_2O_5 and K_2O fertilizer was applied through drip irrigation in weekly intervals starting from 4-6 weeks after planting until tuber development as shown in Table (2).

Table (2): Schedule of Chemical fertilizer (Kristalon: 18-18-18-3% N, P_2O_5, K_2O & Mg O) applied to potato crop during winter seasons of 2005-06 and 2006-07 under drip fertigation.

Sl. No.	Weeks duration	Weekly splits	Weekly %	Total %	gm/plant /week	gm/m^2 /week	kg/ha week
1	4 - 7th wk	4	10.0	40	2.50	10.0	100
2	8 – 11thwk	4	12.5	50	3.13	12.5	125
3	12 -13^{t} wk	2	5.0	10	1.25	5.0	50

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 discharge of dripper was 4 L/hour.

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 (3). The plots were kept free from weeds. Tubers exposed to sun at the surface were covered with soil to prevent greenness.

Table (3): 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. Total available moisture (TAW),mm = FC – CEW

Where:

FC is field capacity , mm.

CEW is crop extractable water , mm.

2. Frequency of irrigation (I_{fr}) = AM_{40} / Et_{mgs}

Where: Et_{mgs} is the evapotranspiration at the midpoint of the growing season.

The quantity of water applied was estimated using the class A pan evaporation equation:

$$ET_P = K_P E_{pan}$$

Where:

ET_P = Evapo-transpiration of grass reference crop, mm/d

K_P = pan coefficient (0.8 – 1.0).

E_{pan} = pan evaporation, mm/d.

3. Water consumptive use (ET_c):

ETcrop=ET_0xKc

*Q = AD

a. I_1-60%ET0 I_2-80%ETo b.Crop spacing:50cmx50cm (0.25m^2/plant)

Crop coefficient 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).
Kc= Crop factor: 0.45(Initial), 0.45(Devt.), 0.75(Mid-season), 1.13(Late season) and 0.90(At harvest).

4. Field water use efficiency: was calculated as follows:
FWUE (kg/$m^{3)}$ = Yield (kg/fed.)/Amount of water applied (m^3/fed).

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

Table (4): The metrological data of Sakha Climatologically Station during the growing seasons.

Month	Air Temp.C°		Relative humidity,%		wind peed , km /24 hr.at 2 m height	Solar radiation, MJ /m^2	Soil Temp. C°	Ep, mm/ day	Total rain, mm
	T , MAX	T, MIN	RH, MAX	RH, MIN					
Nov. 05	20.697	11.766	94.483	54.552	73	9.4	17.40	3.02	7.0
Dec. 05	18.440	9.480	94.600	52.800	59	6.6	13.97	2.06	8.0
Jan. 06	20.967	11.177	94.933	56.233	48.43	8.1	10.580	1.93	84.0
Feb. 06	23.067	11.515	92.185	48.741	69.72	13.7	14.600	2.64	16.0
Mar-06	26.547	16.647	93.967	47.433	103.87	15.4	19.320	4.19	17.0
Nov. 06	23.5	8.9	77.0	58.6	63.0	13.0	18.3	2.89	0.0
Dec. 06	19.7	4.5	82.0	62.2	58.2	9.2	13.3	2.03	0.32
Jan. 07	18.7	4.1	87.0	58.5	57.2	8.1	13.4	1.94	0
Feb. 07	21.6	5.6	95.4	67.6	60.0	12.4	16.2	2.33	1.6
Mar-07	22.0	5.8	79.5	51.7	75.0	16.7	18.5	3.5	0

Harvesting and yield

When the aerial stems and foliage turned yellowish brown and started drying up, the crop was harvested during March. 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.

RESULTS AND DISCUSSION

A. Tuber yield of potato

Data of tuber yield of potato per plant and per unit area is provided in Table (5). On an average over two years, tuber yield recorded was 47.7 t/ha. However, the tuber yield obtained was higher during 2005-06(49.6 t/ha) which is 8.3% higher when compared to 2006-07 season(45.8 t/ha).

Tuber yield obtained was significantly higher with the drip irrigation regime of 80% ET_c (52.0 t/ha in 2005-06 and 48.2 t/ha in 2006-07) as compared to 60% ET_c(47.2 t/ha in 2005-06 and 43.4 t/ha in 2006-07). The

average tuber yield increase was 10.6% higher with the drip irrigation regime of 80% $ET_c(I_2)$ when compared to 60% ET_c (I_1).Higher level of drip irrigation regime of 80% $ET_c(I_2)$ is 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_c.

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

Use of black polyethylene mulch resulted in significantly higher yield of tubers (53.7 t/ha in 2005-06 and 49.8 t/ha in 2006-07) as compared to rice straw mulch (50.6 t/ha in 2005-06 and 46.6 t/ha in 2006-07) and no mulch (44.5 t/ha in 2005-06 and 41.0 t/ha in 2006-07). Such an increase in the yield of potato tubers may be attributed to significant improvement in the growth and yield components during both years. Similar results were reported by Abd Al - Gaffar and Kumaraswamy (1992a, b and c) and Abd Al - Gaffar and Kumaraswamy (1993).

Table (5): Effect of irrigation schedules and mulching on tuber yield per plant and per unit area of potato crop grown in open field under drip irrigation during 2005/2006 and 2006/2007seasons.

Treatments	Tuber yield, kg/plant	Tuber yield, kg/m^2	Tuber yield, ton/ha	Tuber yield, kg/plant	Tuber yield, kg/m^2	Tuber yield, ton/ha
	First season			Second season		
Main plots						
I1 (60 % ETc)	1.18	4.72	47.2	1.09	4.34	43.4
I2 (80 % ETc)	1.3	5.2	52	1.21	4.82	48.2
S.Em. +	0.033	0.132	1.32	0.03	0.118	1.18
C.D. at 5%	0.119	0.474	4.74	0.109	0.434	4.34
Sub - plots						
M0 (No mulch)	1.11	4.45	44.5	1.83	4.1	41
M1 (Rice straw)	1.27	5.06	50.6	1.17	4.66	46.6
M2 (Plastic mulch)	1.34	5.37	53.7	1.25	4.98	49.8
S.Em. +	0.014	0.055	0.055	0.017	0.068	0.681
C.D. at 5%	0.041	0.164	0.164	0.054	0.217	2.17
C mean	1.24	4.96	49.6	1.15	4.58	45.8

S.Em.+ = Standard error of means C.D. = Critical difference

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 (6).On an average over two years, the total water applied was 2942.42 m^3/ha.The obtained results showed that, water applied to potato crop was higher with the drip irrigation regime of 80% ETc (3417.11 and 3308.42 m^3/ha) as compared to 60% ET0 (2562.83and 2481.31 m3/ha) 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_c (1708.55 and 1654.2 m^3/ha) as compared to 60% ET_c(1281.41and 1240.7 m^3/ha) in the first and second seasons, respectively. The increase in the average water consumptive use was 33.3% higher with the drip irrigation regime of 80% ET_c (I_2) when compared to 60% ET_c (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_c. Hence, there will be a water saving in this lower irrigation regime I_1.

The water use efficiency value was higher during 2005-06 when compared to 2006-07. 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.

Crop water use efficiency (C.W.U.E.) obtained was significantly higher with the drip irrigation regime of 60% ET_c (18.42 and 17.49 kg/m^3) as compared to 80% ET_c(15.22 and 14.57 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_c (36.83 and 34.98 kg/m^3 as compared to 80% ET_c(30.44 and 29.14 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_c (I_1) when compared to 80% ET_c(I_2). Such an increment in the water use efficiency of potato crop may further be attributed to the lower requirement of irrigation water with I_1.

Whereas, the water use efficiency obtained was significantly higher with the drip irrigation regime of 60% ET_c as compared to 80% ET_c. Therefore to maximize tuber yield (50.1 t/ha), drip irrigation should be scheduled at 80% ET_c under the conditions of limited water availability. In order to optimize irrigation water, drip irrigation should be scheduled at 60% ET_c. This gives a tuber yield of 45.3 t/ha and saves 40% of irrigation water which is a scarce and costly resource.

The highest average values of (C.W.U.E.) as affected by mulching (17.46 and 17.2 kg/m^3) in the 1st and 2nd seasons respectively were obtained under (M2) treatment. While, the highest average values of (F.W.U.E.) as affected by mulching (35.92 and 34.41 kg/m^3) in the 1st and 2nd seasons, respectively were obtained under (M2) treatment. The obtained results are in agreement with those of Sood and Singh, 2003; Vayda, 1994 and Wright and Stark, 1990).

Use of plastic or rice straw as mulch maintains higher content of actual soil moisture before every irrigation which may in turn be attributed to its better water holding capacity. Therefore, it is economically beneficial to use organic mulch by applying rice straw at rate of 12.5t/ha along with the recommended dose of fertilizers. Incorporation of organic mulch and potato plants after harvest enriches soil fertility and sustains potato production for long time in north Delta. Veeranna *et al.* (2001) have also revealed similar results and quoted that potato production can be sustained over a long time by maintaining the soil moisture and nutrient status. The obtained results are

in agreement with those of Midmore *et al.* (1986a) ; Midmore et al. (1986b) and Manrique and Meyer (1984)

Table (6): Effect of irrigation schedules and soil mulching on applied water, water consumptive use, and water use efficiency (WUE) of potato crop during 2005-2006 and 2006 - 2007.

Irrigation regime	Applied water,m^3/ha	Water consumptive use,m^3/ha	C.W.U.E, Kg/m^3	F.W.U.E, Kg/m^3	Tuber yield, kg/ha	Applied water,m^3/ha	Water consumptive use,m^3/ha	C.W.U.E, Kg/m^3	F.W.U.E, Kg/m^3
	First season					Second season			
I1	2562.83	1281.41	18.42	36.83	43400	2481.31	1240.7	17.491	34.98138
I2	3417.11	1708.55	15.22	30.44	48200	3308.42	1654.2	14.569	29.13778
Mulching									
M0	2989.97	1494.98	14.88	29.766	41000	2894.87	1447.4	14.163	28.32665
M1	2989.97	1494.98	16.92	33.847	46600	2894.87	1447.4	16.097	32.19566
M2	2989.97	1494.98	17.96	35.92	49800	2894.87	1447.4	17.203	34.40652

Summary and Conclusion

The total water applied to potato crop was higher with the drip irrigation regime of 80% ET_c (1219.2 m^3/ha) as compared to 60% ET_c (915.5 m^3/ha). Whereas, the water use efficiency obtained was significantly higher with the drip irrigation regime of 60% ET_c (49.6 kg/m^3) as compared to 80% ET_c (41.1 kg/m^3).

In order to maximize the tuber yield of potato (50.1 t/ha) under the conditions of limited water, drip irrigation should be scheduled at 80% ET_c.

In order to optimize the irrigation water, drip irrigation should be scheduled at 60% ET_c under the conditions of limited water availability. This gives a tuber yield of 45.3 t/ha and saves 40% of irrigation water.

It is economically beneficial to use organic mulch (rice straw) in potato crop. However to maximize yields, plastic mulch (black polyethylene) is advantageous.

Since the soils are sandy and poor in organic matter content, it is advisable to apply organic manure at rate 12.5t/ha along with the recommended dose of fertilizers. Incorporate organic mulch and potato plants after harvest to enrich soil fertility and sustain potato production.

REFERENCES

Abd Al - Gaffar, A. and A.S. Kumaraswamy (1992b).Effect of irrigation schedule and mulch on growth attributes and dry matter accumulation in potato (Solanum tuberosum L.). J. Indian Potato Assoc., 37(3):510-513.

Abd Al - Gaffar, A. and A.S. Kumaraswamy (1992a). Nutrient uptake and tuber yield of potato as influenced by irrigation and mulching under scarce water condition in alfisols. J. Indian Potato Assoc., 19(1-2):35-39.

Abd Al - Gaffar, A. and A.S. Kumaraswamy (1992c). Effect of irrigation schedule and mulching on tuber yield and water use efficiency of potato (Solanum tuberosum L.). Mysore J. Agric. Sci., 26(3):341-345.

Abd Al- Gaffar, A. and A.S. Kumaraswamy (1993).Weed bio-mass in relation to irrigation and mulching, and economics of mulching potato crop under conditions of acute water scarcity. J. Indian Potato Assoc., 20(3-4):185-189.

Beukema, H.P. and, D. E. Van der Zaag (1979). Potato improvement. Some factors and facts. International Agricultural Center. Wageningen, the Netherlands, 224 p.

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

Egúsquiza, B. R. (2000).La Papa: Producción, Transformación y Comercialización. Primera edición.Lima, Perú, 192 p.

Harris, P.M. (Ed.) 1978. The potato crop production. The Scientific Basis for Improvement. Ed. Chapman and Hall, London, 730 p.

Harris, P.M. 1992. The influence of genotype and water stress on the nitrogen requirement of the potato crop. Conference: Meeting of the Section Physiology of the EAPR. Le Conquet (France). 24-28 Jun 1991. Potato Research (Netherlands), 35(1):72.

Jensen, C.R.; S. E. Jacobsen; M.N. Andersen; N. Nuñez; S.D. Andersen; L. Rasmussen and V.O. Mogensen (2000). Leaf gas exchange and water relation characteristics of field quinoa (Chenopodium quinoa Willd.) during soil drying. European Journal of Agronomy, 13(1):11-25.

Kleinkopf, G.E. and D.T.Westermann (1981).Predicting nitrogen requirements for optimum potato growth. Proc. Univ. Idaho Winter Commodity School, pp. 81-84. C I P • Production Systems and the Environment Working Paper 2008 – 2

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.

Kumar, D.; J.S. Minhas and B. Singh (2003). A biotic stress and potato production. In: Khurana, S.M.P.; Minhas; J.S., Pandey, S.K. (Eds.). The Potato: Production and utilization in sub-tropics.Mehta Publishers, New Delhi (India), pp. 314-322.

Manrique, L.A. and R. Meyer (1984). Effects of soil mulches on soil temperature, plant growth and potato yields in an aridic isothermic environment in Peru. Turrialba 34, 413–420.

Martinez, y. and C.A. Huamán (1993). Expresiones Metabólicas de Resistencia a la sequía en dos clones de papa sometidos a estrés hídrico. Tesis para optar el Grado de Magister Scientiae. Universidad Nacional Agraria La Molina (UNALM), Lima, Perú.

Midmore, D.J.; D. Berrios and J. Roca (1986a) Potato (Solanum spp.) in the hot tropics. II. Soil temperature and moisture modification by mulch in contrasting environments. Field Crops Research 15, 97–108.

Midmore, D.J.; J. Roca and D. Berrios (1986b) Potato (Solanum spp.) in the hot tropics III. Influence of mulch on weed growth, crop development, and yield in contrasting environments. Field Crops Research 15, 109–124.

Miller, D.E. and M.W. Martin (1987). The effect of irrigation regime and sub soiling on yield and quality of three potato cultivars. American Potato Journal, 64(3):109-117.C I P • Production Systems and the Environment Working Paper 2008 – 2 .Partial Root - Zone Drying : An Alternative 14.

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.

Salter, P.J. and J.E. Goode (1967). Crop responses to water at different stages of growth. Commonwealth Agricultural Bureau, Farnham Royal, Bucks, England, 246 p.

Sood, M.C. and N. Singh (2003). Water Management. In: Khurana, S.M.P., Minhas; J.S., Pandey, S.K. (Eds.). The Potato: Production and utilization in sub-tropics. Mehta Publishers. New Delhi, India, pp. 111-120.

Vayda, M.E. 1994. Environmental stress and its impact on potato yield. Wallingford (UK). Centre for Agriculture and Biosciences International (CABI), pp. 239-261.

Veeranna, H.K.; A. Abd AL Gaffar and G.M. Sujith (2001). Effect of irrigation and fertigation methods on sustainable chilli production. In. Proc Interntl. Res. Symp. On Sustainable Agric. Devt., March 27, 2001 at Bangalore, Part 3: 14.

Wright, J.L. and J.C. Stark 1990. Potato. American Society of Agronomy (ASA). Crop Science Society of America (ASA). Soil Science Society of America (SSSA). Wisconsin (USA), pp. 859-888.

تأثير جدولة الري بالتنقيط و تغطية سطح التربة على إنتاجية درنات البطاطس

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أقيمت تجربتان حقليتان لدراسة تأثير جدولة الري و تغطية سطح التربة على إنتاج درنات البطاطس صنف سبونتا وبعض كفاءات الري الحقلي تحت ظروف الري بالتنقيط في ارض رملية لوميه ببلطيم محافظة كفر الشيخ خلال الموسم الشتوي ٢٠٠٥/ ٢٠٠٦ و ٢٠٠٦/ ٢٠٠٧.استخدم تصميم القطع المنشقة مرة واحدة في أربعة مكررات .وزعت معاملات الري على القطع الرئيسية و هي (I_1) الاحتياجات المائية على أساس ٦٠ % من النتح و البخر الفعلي ET_0 و(I_2) ٨٠ % من النتح و البخر الفعلي ET_0 . ووزعت معاملات تغطية سطح التربة على القطع الشقية وهي (M_0) بدون تغطية (M_1) تغطية باستخدام قش الارز و (M_2) تغطية باستخدام أغشية البلاستيك.

و كانت أهم النتائج المتحصل عليها كالاتى:

- حققت معاملة جدولة الري على أساس إضافة ٨٠ % من الاحتياجات المائية المحسوبة بطريقة وعاء البخر أعلى إنتاج لدرنات البطاطس (٥٢,٠ طن/هكتار في الموسم الأول و ٤٨,٢ طن /هكتار في الموسم الثاني) مقارنة بإنتاج درنات البطاطس على أساس ٦٠ % من الاحتياجات المائية بطريقة وعاء البخر (٤٧,٢ طن/هكتار في الموسم الأول و ٤٣,٤ طن /هكتار فى الموسم الثاني).

- حققت تغطية سطح التربة بأغشية البلاستيك أعلى إنتاجية لدرنات البطاطس (٥٣,٧ طن/هكتار في الموسم الأول و ٤٩,٨ طن /هكتار في الموسم الثاني) مقارنة بإنتاج درنات البطاطس تحت نظام التغطية باستخدام قش الارز(٥٠,٦ طن/هكتار في الموسم الأول و ٤٦,٦ طن /هكتار في الموسم الثاني) بينما ادى ترك سطح التربة بدون تغطية إلى أقل إنتاج لدرنات البطاطس فى الموسم الأول و الثاني.
- كانت اعلي قيم الاستهلاك المائي لنباتات البطاطس عند إضافة ٨٠ % من الاحتياجات المائية المحسوبة بطريقة وعاء البخر (١٧٠٨,٥٥ م٣ /هكتار في الموسم الأول و ١٦٥٤,٢ م٣ / هكتار في الموسم الثاني) مقارنة ب ١٢٨١,٤١ م٣/هكتار و ١٢٤٠,٧ م٣/هكتار عند إضافة ٦٠ % من الاحتياجات المائية المحسوبة بطريقة وعاء البخر في الموسم الأول و الثاني على التوالي.
- أدت جدولة الرى عند ٨٠ % من وعاء البخرالى تسجيل اعلي كميات مياه مضافة (٣٤١٧,١١ م٣ /هكتار فى الموسم الأول و ٣٣٠٨,٤٢ م٣ / هكتار في الموسم الثاني) مقارنة بجدولة الرى عند ٦٠ % من وعاء البخر (٢٥٦٢,٨٣ م٣ /هكتار في الموسم الأول و ٢٤٨١,٣١ م٣ / هكتار فى الموسم الثاني).
- سجلت كفاءات الاستخدام المائي لمحصول البطاطس أعلى القيم بجدولة الرى عند ٦٠% من وعاء البخر (١٨,٤٢كجم/ م٣ فى الموسم الأول و١٧,٤٩ كجم/ م٣ في الموسم الثاني) مقارنة بجدولة الرى عند ٨٠ % من وعاء البخر (١٥,٢٢كجم/ م٣ في الموسم الأول و ١٤,٤٧كجم/ م٣ فى الموسم الثاني).
- سجلت كفاءات الاستخدام المائي الحقلي اعلي القيم بجدولة الرى عند ٦٠% من وعاء البخر (٣٦,٨٣كجم/ م٣ في الموسم الأول و٣٤,٩٨ كجم/ م٣ في الموسم الثاني) مقارنة بجدولة الرى عند ٨٠ % من وعاء البخر (٣٠,٤٤كجم/ م٣ في الموسم الأول و ٢٩,١٤كجم/ م٣ فى الموسم الثاني).
- استخدام تقنية تغطية سطح التربة بأغشية البلاستيك حقق اعلي القيم لكفاءة استخدام المياه المحصولية (١٧,٩٨كجم/ م٣ في الموسم الأول و ٢٩,١٤كجم/ م٣ في الموسم الثاني) و كذلك أعلى القيم لكفاءة استخدام المياه الحقلية (٣٥,٩٢كجم/ م٣ فى الموسم الأول و ٣٤,٤١كجم/ م٣ في الموسم الثاني).

اعتمادا على النتائج السابقة يمكن التوصية بما يلي:

- إضافة الاحتياجات المائية للبطاطس على أساس ٨٠ % من وعاء البخر عند الرغبة في الحصول على أعلى إنتاجية (٥٢,٠ طن / هكتار كمتوسط للموسمين).
- عند نقص مياه الرى تضاف الاحتياجات المائية للبطاطس على أساس ٦٠ % من وعاء البخر للحصول على إنتاجية (٤٧,٢ طن / هكتار كمتوسط للموسمين) و توفير ٤٠ % من مياه الرى.
- من الناحية الاقتصادية يوصى بتغطية سطح التربة بمخلفات قش الارز لتقليل الفواقد المائية بالبخر من سطح التربة و تحسين خواص التربة خفيفة القوام عند خلطها بالتربة بعد الحصاد.