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PERFORMANCE OF CASSAVA PLANT IN SANDY SOIL UNDER DIFFERENT IRRIGATION INTERVALS, WATER QUANTITIES AND PLANT SPACING

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ABSTRACT

Two field trials were carried out at South Tahrir Research Station (Ali Moubarak), during 2005/2006 and 2006/2007 to evaluate irrigation water requirements and determine an irrigation schedule for cassava crop under different plant interspacing. The study included two irrigation interval (daily and every two days interval), two quantities of applied irrigation water (100%of the ET_C and 80%of the ET_C) and three-plant interspacing (75cm apart, 100cm apart and 125cm apart). A split split plot design was used. The results indicated that yield components of cassava, i.e., was increased the total number of tubers per plant, the average length and diameter of tubers and the weight of fresh tubers/ plant when used two days interval irrigation associated with 100% Etc and increasing plant spacing up to the widest one (125cm apart.). Whereas, maximum yield of cassava tubers and water applied were associated with irrigation each two days interval and 100% ETc under the narrowest spacing of cassava plants (75cm. apart.). Whereas, maximum value of water use efficiency (WUE) was obtained every two days interval irrigation with 100% ETc and plant spacing up to the widest (125cm. apart).

Keywords: Cassava, water applied requirement, irrigation intervals, plant spacing.

INTRODUCTION

Irrigation amount, timing and uniformity of water application are the most important factors to be considered when yields have to be maximized and water losses have to be minimized. Improving irrigation system efficiency, distribution uniformity, water use efficiency in respect to the highest yield can be achieved when the water requirement are optimized. Cassava (*Manihot esculenta crantz*) belongs to family Euphorbiaceae. It is perennial shrub grown between 30^0N and30^0 S latitudes. The crop is known as tapioca, yucca or manioca. It is grown on poorer soils of tropics with rainfall greater than 750mm per year. It is considered one of the most important calories suppliers. According to data obtained from the food and agriculture organization about 65% of the total world cassava production is used for human consumption and 21% for animal feed, with lesser amounts for starch and industrial uses (FAO, 1985).

Hair and Lameberts (1995) reported that cassava has relatively low requirements for irrigation but during active growth stages, it must be irrigated when extended dry spells occur water requirements and subsequent irrigation requirements are reduced during the last few weeks of growth. Thomas *et al.* (1995) reported that an irrigation scheduling method must provide accurate

daily estimates of soil water in the root zone of irrigated crops. This requires an accounting method that records the amount of rain received on the field, the amount of irrigation water applied, and accurate estimate of daily crop water use. Joshi *et al.* (1995) reported that irrigation water requirements may be defined as the quantity of water that must be supplied by irrigation to satisfy Evapotranspiration, leaching, consumptive use by the crop and miscellaneous water requirements that are not provided by water stored in the soil and perception that enters the soil. The definition also includes the use of water for salinity control, frost protection and plant cooling and yields. El-Saeed (2000) Reported that maize yield was affected by irrigation interval. It was found that with irrigation every two days the ear yield of maize was increased by 10.80% compared with irrigation ever day. Day (1996) reported that the most significant crop factor affecting Et_c is the amount of ground area covered by the crop. Also, the added irrigation scheduling for drip irrigation involves two major things, the first is the estimation of Et_c and the second is the monitoring of soil moisture. The effect of optimizing plant spacing on yield and yield components of cassava is another important cultural practices. Khalil (1995) found that cassava grown at narrow row spacing (1.0×1.5) exceeded that planted at the wider spacing (1.5×2.5) in each of plant height, average diameter of tubers, number of tuber/plant, average length of tubers and fresh weight/plant. Atalla *et al* (2001) reported that cassava height was decreased with widening interplant spacing. Other growth traits, yield components and yield per plant, were increased with increasing row spacing, but narrow spacing resulted in more yield of tuber/fed Ibrahim *et al* (2004) Hassan *et al* (2007) came to similar results.

The aim of this study was estimating irrigation water requirements and determination of irrigation scheduling for cassava crop under different plant interspacing.

MATERIAL AND METHODS

Two field trials were carried out at South Tahrir Research Station (Ali Moubarak), during 2005/2006 and 2006/2007 seasons to estimate the actual water consumptive for cassava crop and to study the effect of irrigation intervals, quantity of applied irrigation water and plant interspacing on growth, yield and yield components of cassava crop. The irrigation system used in this study was surface drip irrigation. The treatments were two irrigation intervals (daily and Every two days), two applied irrigation water (100% of the Et_c and 80% of the Et_c) and three plant spacing (75, 100 and 125 cm).

Evaporimeter was used as measuring instrument to observe evaporation. World Meteorological Organization and its generally called class (A) pan acknowledge, it as standard Evaporimeter. This Evaporimeter is composed of water tank made of zinc plate, its diameter 1200 mm, depth 250 mm, and the water gauge ranged between 0 – 100 mm scale with accuracy from 0.1 – 0.06 mm.

Irrigation water calculations:

Reference Evapotranspiration (ET_0) and Et_{crop} were calculated according to **Doorenbos and Pruitt 1977** as follows:

$$ET_0 = Kp^* E_{pan} \text{ ----------(1)}$$

Where :

ET_0 : Reference Evapotranspiration (mm/day).

Kp: pan coefficient (equals to 0.7).

E_{pan} : pan evaporation (mm).

$$Et_{crop} = ET_0 * k_c \text{ ----------(2)}$$

Where:

Et_{crop}: Crop consumptive use (mm/day).

k_c : crop coefficient.

The average daily ET_0 use to obtain Et_c for each period for cassava growth is presented in Table (1).

Table (1): Average daily ET_0 (mm/day) at Research Station.

Month	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
ET_0 mm/day	2.2	3.5	4.0	5.4	6.2	7.2	8.2	8.6	6.5	5.4	4.4	4.0

1- 2 Actual water consumptive use (ET_{actual}).

----------Actual water consumptive use was estimated from the sampling method and calculated according to Cuenca (1989).

$$ET_{actual} = D (\theta_2 - \theta_1) \text{----------(3)}$$

Where:

ET_{actual}: Actual Evapotranspiration per day, (mm/day).

D : Irrigation depth (m).

θ_2 : Soil moisture content by volume weight (mm/m) after irrigation.

θ_1 : Soil moisture content by volume weight (mm/m) before next irrigation.

Soil samples for actual crop consumptive use (ET_{actual}) were collected from the top 60 cm layer. Ten samples were taken four times through each growth stage after irrigation and taken again before the next irrigation to calculate actual consumptive use per day. Irrigation was stopped from December up to harvested date at February.

1-3 Crop coefficient (K_c).

The crop coefficient was estimated during the growing season period as follows:

$$K_c = \frac{ET_{actual}}{ET_0} \quad \text{----------(4)}$$

Where:

ET_{actual} : Actual Evapotranspiration per day, (mm/day).

ET_0: Reference Evapotranspiration (mm/day).

1-4 Water use efficiency "WUE" (kg per m^3)

WUE= yield (kg/fed)/total applied water (m^3/fed) ----------(5)

Experimental design

The twelve treatments were laid out randomly in split split plot design. Irrigation intervals occupied the main plots, the subplots were devoted for the irrigation quantities treatments, whereas, the sub subplots were devoted for the different inter spacing treatments. Each treatment was replicated three times. The plot area was $28m^2$ and included four rows, each was 7.0m in length and 1.0m in width

Soil analysis

Soil analysis was carried out according to Wiled *et al.* (1985), the obtained data are shown in Tables (2and 3).

Table (2): Physical properties of the experimental soil.

Depth (cm)	Particle size distribution%				F.C. %	W .P. %	Texture class
	sand	Fine sand	silt	clay			
0-30	52.00	40.27	4.40	3.33	9.4	4.3	Sandy
30-60	48.00	42.53	4.80	4.67	8.5	4.4	sandy

The name of the textural class was ascertained from the textural triangle given by Alexander (1977).

Table (3): Some chemical properties of the experimental soil.

Depth (cm)	pH	EC dS/m	Soluble cautions. meg/l				Soluble Anions. meg/l		
			Ca^{++}	mg^{++}	Na^{+}	K^{+}	HCo_3	So_4	Cl
0-30	7.83	1.49	5.75	4.60	3.60	0.2	4.60	2.75	6.80
30-60	7.91	1.27	5.75	4.20	3.40	0.3	4.70	2.80	6.90

Cultural practices

Sufficient cassava stakes of Brazilian variety were taken from Ismaillia Agricultural Research Station. Primary and secondary stakes were cut into 25-30cm length inserted according to the treatment of plant spacing in witty soil. The stakes were planted on April 1st in both seasons by inserting two thirds of the stakes into the soil keeping one third above ground, and irrigated immediately after planting. Nitrogen, phosphorus, and potassium were applied within the fertigation system. Tuber yield was harvested on 1st and 15th of February in both seasons, respectively.

Data Recorded :

1- Climatic data such as pan evaporation, relative humidity %, and maximum and minimum temperature (^{0}C),
2- Soil moisture content at field capacity and wilting point (%).
3- Irrigation water application efficiency for irrigation system.
4- Percentage of irrigated area for different plant spacing was determined according to Bresler E. (1978)
5- Growth parameters.

At harvested five guarded plants were taken randomly from each sub sub plot to determine plant height and number of total branches per plant:

6- Yield and yield components.

Average number of total tubers per plant, average length of tubers per plant, average diameter of tubers per plant, Weight of fresh tubers per plant and yield of fresh tubers /fed.

Statistical Analysis

All data of the treatment imposed were subjected to the statistical analysis according to the procedures outlined by Snedecor and Coehran(1980). Using MSTAT- computer V4(1986) L.S.D. test at 0.05 level was used to compare among treatment means.

RESULTS AND DISCUSSION

Cassava crop coefficient (k_c)

Table (4) and Fig (1) showed the estimated value of cassava coefficient (k_c) by equation number 4. The results indicated that when plants were irrigated with 100%ETc the values of kc were 0.47, 0.64, 0.99, 0.52 and 0.35 at establishment, vegetative, mid season, late season and harvest, respectively. The corresponding values of k_c were 0.38, 0.51, 0.80, 0.41 and 0.28 when plants received irrigation water at 80%ETc. Generally, it is clear that value of kc started low at the beginning of the season then it increased gradually until it reached its maximum value at the end midseason stage. This might be due to the changing of growth stage and climatic conditions.

Seasonal irrigation water requirements (SIR) for cassava crop.

The seasonal irrigation water requirements for cassava estimated by using pan evaporation method were higher than those estimated using sampling method by 38%. Also it's clear that the seasonal irrigation water requirements were 4050.9 m^3/fed

Effect of irrigation interval on growth, yield and yield components of cassava.

Effect of irrigation intervals on growth, yield and yield components of cassava are presented in Table (5). Results indicated that plant height, number of total branches per plant, number of total tubers per plant, average length, diameter and weight of tubers as well as yield were significantly increased when the irrigation interval. These results hold true in both seasons. This may be due to using management allowed deficit in high moisture content existed at the root depth and then water stresses which will inhibit the root growth is eliminated. El –Saeed (2000) supported our results. Irrigation every two days interval the weight of fresh tubers per plant and yield

per fed the increase was 11.57, 29.40, 14.58 and 29.27% in both seasons, respectively. Maximum value of water use efficiency (WUE) was obtained when daily irrigated. Moreover, the results indicated significant differences between the treatments. These results are true in both seasons.

Effect of irrigation water quantity on growth, yield and yield components of cassava.

The effect of irrigation water quantity on growth, yield and yield components of cassava are presented in Table (6). It is clear that irrigation with amount corresponding to 100%ET_c of the calculated Evapotranspiration increased plant height, number of total branches per plant, number of total tubers per plant, average length and diameter of tubers compared with those received 80% of the calculated Evapotranspiration. Differences among treatments imposed statistically significant in both seasons. The weight of fresh tubers and yield were also increased by increasing water quantity. This may be due to that water is essential for plant growth and plant physiological processes and lack in available water caused water stress which affect plant growth and productivity. El –Saeed (2000) came to similar results. Yield increased when plants received 100% ETC, the increase was 29.51 and 25.78 % compared with these received 80%ETc in both seasons. respectively. Data obtained in the same table revealed also that water applied and WUE were increased by increasing irrigation quantities. The excesses estimated to 25.0% for water applied and 3.84% for water use efficiency (WUE) when 100%ETc was done compared with 80% ETC

Table (4): cassava crop coefficient as affected by varying amount of irrigation Water.

	April	May	Jun	Jul.	Aug.	Sep.	Oct.	Nov.	SIR m3/fed
Av.ET0 mm/day	5.40	6.20	7.20	8.20	8.60	6.50	5.40	4.40	6539.4
100%ETc mm/day	2.55	2.80	4.60	8.15	7.30	3.35	1.85	1.55	4050.9
Kc at 100%ETc	0.47	0.45	0.64	0.99	0.85	0.52	0.34	0.35	-------
80%ETc mm/day	2.04	2.24	3.68	6.52	5.84	2.68	1.48	1.24	3240.7
Kc at 80%ETc	0.38	0.36	0.51	0.80	0.68	0.41	0.27	0.28	----------

Table (5): Effect of irrigation interval on growth, yield and yield components of cassava in 2005/2006 and 2006/2007 seasons.

Irrigation intervals	Plant height (cm)	No. of total branches /p	No. of total tubers /p	Length of tubers (cm)	Diame-ter of tubers (cm)	Weight of fresh tubers (kg /p)	Yield (ton /fed)	Water applied (m^3/fed)	Water Use efficiency
2005/2006									
Every day	153.77	2.91	5.45	27.76	4.23	3.63	14.75	3001.75	4.96
Every two days	160.11	3.36	6.07	28.75	5.01	4.05	16.90	3001.69	4.66
LSD at 0.05	3.07	0.11	0.17	0.44	0.38	0.12	0.82	N. S	0.26
2006/2007									
Every day	151.18	2.69	5.09	27.56	4.10	3.18	12.35	3001.73	4.96
Every two days	156.52	3.08	5.73	28.47	4.83	3.58	16.02	3001.69	4.66
LSD at 0.05	1.19	0.28	0.26	0.81	0.12	0.16	0.55	N. S	0.26

Table (6): Effect of irrigation quantities on growth, yield and yield components of cassava in 2005/2006 and 2006/2007 seasons.

Irrigation quantitiy	Plant height (cm)	No. of total branches /p	No. of total tubers /p	Length of tubers (cm)	Diameter of tubers cm (cm)	Weight of fresh tubers (kg /p)	Yield (ton /fed)	Water applied (m^3/fed)	Water use efficiency
2005/2006									
80% ETc	148.92	2.82	5.02	27.08	4.37	3.34	13.79	2668.14	5.21
100% ETc	164.96	3.45	6.07	29.44	4.88	4.34	17.86	3335.29	5.41
LSD at 0.05	**2.07**	0.74	**0.05**	**0.26**	**0.07**	**0.03**	**0.19**	**0.18**	**0.08**
2006/2007									
80% ETc	145.12	2.61	4.67	26.83	4.22	2.91	12.57	2668.14	5.21
100% ETc	162.58	3.15	6.15	29.19	4.71	3.84	15.81	3335.29	5.41
LSD at 0.05	**1.96**	0.17	**0.15**	**0.24**	**0.18**	**0.09**	**0.58**	**0.18**	**0.08**

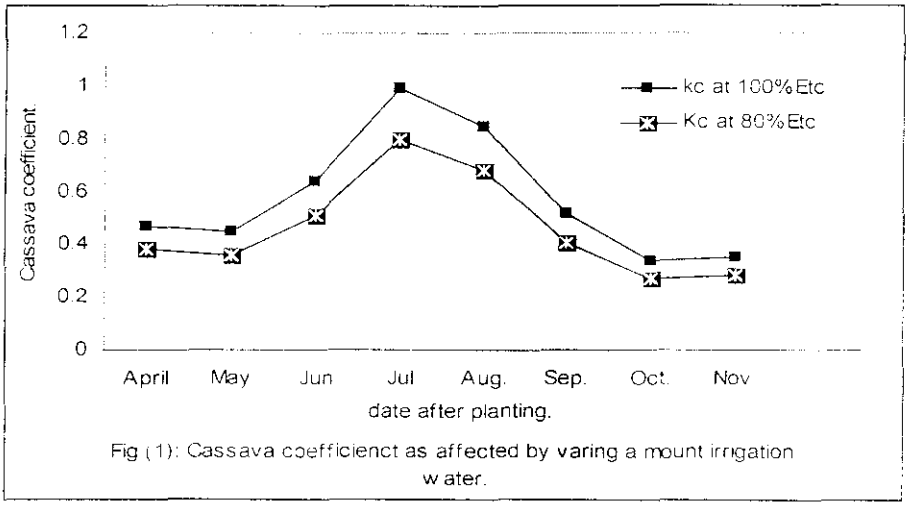

Fig (1): Cassava coefficienct as affected by varing a mount irrigation w ater.

Interaction effect of irrigation interval and irrigation quantities on growth, yield and yield components of cassava

Data in Table (7) showed that the effect of both irrigation interval and irrigation quantities on cassava yield and yield components was governed by the trend of irrigation interval and irrigation quantities either when they behaved as the main factors. The statistical analysis revealed significant differences in all studied traits except in case of number of total branches per plant and average length of tubers in both seasons and average diameter of tubers in the second season, only. The data obtained that the tuber yield per plant and per feddan were increased by increasing the irrigation interval within each irrigation quantities. In order words, the most effective treatment for increasing the yield either per plant or per feddan was the irrigation every two days combined with 100% Etc. These results were true in both seasons. Also, water applied and water use efficiency (WUE) selected the same trend of other traits. The highest value of WUE (5.82) was obtained when irrigation was applied every two days interval associated with 100% ETc.

Effect of plant interspacing on growth, yield and yield components of cassava.

Data in Table (8) indicated clearly that increasing distances between cassava plants resulted in gradual decreases in cassava height, these results hold true in both seasons. Several investigators support these results. Khalil (1995), Atalla *et al* (2001) and Hassan *et al* (2007) pointed out that plant height of cassava grown at narrow spacing exceeded these grown at the wide one. Increases in plant height with decreasing plant spacing might be due to competition between plants for light which in turn resulted in elongating the internodes. On the other hand, number of total branches per plant followed a reversal trend; data indicated a gradual increase with increasing plant spacing from 75cm up to 125cm between plants. Leihner (1983) reported that the deleterious effect of growing cassava at higher plant density produced greater number of primary stems per unit area which lead to increased competition at later growth stage. Khalil (1995) and Atalla *et al* (2001) came to similar results and support our results. Yield components, i.e., total number of tubers per plant, average length and diameter of tubers and weight of fresh tubers per plant behaved the same as the number of total branches per plant. There were increases in the average values with increasing plant spacing up to the widest one. These results were also true in both seasons. Differences among treatments imposed were statistically significant in both seasons. The increase in yield components by weiding distances between plants might much owe to less competition between plants for nutrients.

Table (7): Interaction effect of irrigation interval and irrigation quantities on growth, yield and yield components of cassava in 2005/2006 and 2006/2007 seasons

Irrigation intervals	Irrigation quantities	Plant height (cm)	No. of total branches /p	No. of total tubers /p	Length of tubers (cm)	Diameter of tubers (cm)	Weight of fresh tubers (kg /p)	Yield (ton /fed)	Water applied (m^3/fed)	Water use efficiency
2005/2006										
Every day	80%	144.32	2.58	4.83	26.48	3.93	3.21	13.06	2668.18	4.93
	100%	163.21	3.25	6.07	29.04	4.54	4.05	16.44	3335.29	4.99
Every two days	80%	153.52	3.07	5.21	27.67	4.81	3.47	14.52	2668.10	5.49
	100%	166.70	3.65	6.93	29.83	5.22	4.63	19.27	3335.29	5.82
LSD at 0.05		2.93	N. S	0.07	N. S	0.09	0.04	0.28	N. S	0.12
2006/2007										
Every day	80%	141.36	2.34	4.49	26.31	3.81	2.80	11.57	2668.18	4.93
	100%	161.01	3.03	5.69	28.81	4.39	3.55	13.13	3335.29	4.99
Every two days	80%	148.88	2.88	4.84	27.36	4.64	3.02	13.57	2668.10	5.49
	100%	164.16	3.27	6.61	29.58	5.03	4.14	18.48	3335.29	5.82
LSD at 0.05		2.77	N. S	0.21	N. S	N. S	0.13	0.81	N. S	0.12

Table (8): Effect plant spacing on growth, yield and yield components of cassava in 2005/2006 and 2006/2007 seasons.

Plant spacing cm	Plant height (cm)	No. of total branc-hes /p	No. of total tubers /p	Length of tubers (cm)	Diameter of tubers (cm)	Weight of fresh (tubers (kg /p)	Yield (ton /fed)	Water applied (m^3/fed)	Water use effici-ency
2005/2006									
75 cm	167.23	2.77	4.34	26.52	4.01	3.22	18.04	3645.52	4.94
100 cm	160.00	3.22	6.07	28.55	4.59	3.64	15.69	2916.74	5.37
125 cm	143.59	3.42	6.86	29.70	5.27	4.66	13.74	2442.88	5.61
LSD at 0.05	1.49	0.06	0.11	0.38	0.23	0.08	0.37	0.28	0.12
2006/2007									
75 cm	162.60	2.51	4.00	26.33	3.85	2.82	16.62	3645.52	4.94
100 cm	157.19	2.98	5.73	28.27	4.42	3.20	13.93	2916.74	5.37
125 cm	141.76	3.15	6.50	29.44	5.13	4.11	12.02	2442.88	5.61
LSD at 0.05	1.50	0.08	0.11	0.32	0.29	0.07	0.24	0.28	0.12

On the other hand, yield of tubers per feddan followed another trend. The data revealed that the most cassava population density produced the highest yield per feddan. These results were true in both seasons. The differences were statistically significant in both seasons. The increase in yield when cassava was spaced at 75cm. apart over those spaced at 100cm. apart amounted to 14.98 and 19.31% in both seasons respectively, while it attained 31.30 and 38.27 % when cassava was spaced at 75cm. apart over those spaced at 125cm. apart in both seasons, respectively. These results are in agreement with Khalil (1995) , Atalla *et al* (2001), Ibrahim *et al* (2004) and Hassan *et al* (2007). The increase in yield of tubers per feddan by narrowing distances between plants might due to increase population per unit area. Data also revealed that water applied was decreased by increasing plant spacing of cassava up to the widest one. This reduced estimated to 19.99 and 32.99%. Whereas, water use efficiency (WUE) select a reversal trend. The data showed that WUE increased by increasing plant spacing up to the widest one. The increases reached 13.56 and 4.47% in both seasons, respectively.

Interaction effect of irrigation interval and plant spacing on growth, yield and yield components of cassava

Data in Table (9) revealed that the effect of both irrigation interval and plant spacing on cassava plant growth, yield and its components showed insignificant differences in all studied traits except in case of yield per feddan in both seasons. Tuber yield decreased with increasing cassava spacing up to the widest one within each irrigation intervals treatment. These results were true in both seasons. The highest values of cassava yield were obtained by irrigation every two days interval associated with the narrowest spacing (75cm. apart) as compared with other treatments. Plant population of cassava plants per fed might be the main contributors to gave the more yield of fresh tubers. These results were also true in both seasons. These results are in agreement with those obtained by Khalil (1995), Atalla *et al* (2001) and Ibrahim *et al* (2004). Data also revealed that water applied decreased with increasing cassava spacing up to the widest one within each irrigation

intervals treatment. Water use efficiency (WUE) selected another trend. The highest value of WUE was obtained when irrigation was applied every two days interval associated with increasing plant spacing up to the widest one (125cm. apart).

Interaction effect of irrigation quantities and plant spacing on growth, yield and yield components of cassava

Data in Table (10) indicated that growth, yield and yield components of cassava plants were significantly affected by the interaction of the two main variables in most traits in both seasons. Regular trends predominated the interaction in both seasons. Yield components of cassava, i.e., total number of tubers per plant, the average length and diameter of tubers and the weight of fresh tubers per plant were increased with increasing the applied water up to100% ET_C and increasing plant spacing up to the widest one (125cm apart.). On the other hand, data revealed that the yield of fresh tubers was increased with increasing the irrigation quantities up to 100%ETc associated with the narrowest spacing between cassava (75cm. apart). These results were also true in both seasons. Although, water applied decreased with increasing plant spacing within each irrigation quantity treatment, the maximum value was obtained with 100% ETc associated with the narrowest spacing (75cm. apart). Whereas, maximum value of water use efficiency (WUE) was obtained with 100% ETc and increasing plant spacing up to the widest one (125cm. apart).

Table (9): Interaction effect of irrigation interval , and plant spacing on growth, yield and yield components of cassava in 2005/2006 and 2006 /2007 season

Irrigation intervals	Plant spacing (cm)	Plant height (cm)	No. of total branches /p	No. of total tubers /p	Length of tubers (cm)	Diameter of tubers (cm)	Weight of fresh tubers (kg /p)	Yield (ton/ fed)	Water applied (m^3/fed)	Water use efficiency
2005/2006										
Every day	75	164.25	2.56	4.00	26.04	3.56	2.97	16.63	3645.52	4.56
	100	156.18	2.98	5.73	28.02	4.27	3.43	14.81	2916.80	5.08
	125	140.87	3.20	6.62	29.23	4.88	4.50	12.82	2442.88	5.23
Every two days	75	170.00	2.98	4.68	27.00	4.46	3.48	19.46	3645.52	5.32
	100	163.82	3.46	6.44	29.08	4.92	3.85	16.57	2916.80	5.67
	125	146.32	3.65	7.10	30.17	5.67	4.83	14.67	2442.88	5.99
LSD at 0.05		N. S	N. S	N. S	N. S	N. S	N. S	0.52	N. S	N. S
2006/2007										
Every day	75	160.55	2.31	3.67	25.88	3.42	2.59	14.50	3645.52	4.56
	100	153.90	2.78	5.38	27.71	4.08	3.01	12.06	2916.80	5.08
	125	139.10	2.97	6.22	29.08	4.79	3.94	10.51	2442.88	5.23
Every two days	75	164.35	2.72	4.33	26.79	4.29	3.06	18.75	3645.52	5.32
	100	160.48	3.18	6.08	28.83	4.75	3.39	15.80	2916.80	5.67
	125	144.42	3.33	6.78	29.79	5.46	4.29	13.52	2442.88	5.99
LSD at 0.05		N. S	N. S	N. S	N. S	N. S	N. S	0.34	N. S	N. S

Table (10): Interaction effect irrigation quantities and plant spacing on growth, yield and yield components of cassava in 2005/2006 and 2006/2007 seasons

Irrigation quantities	Plant spacing (cm)	Plant height (cm)	No. of total branches /p	No. of total tubers /p	Length of mark. tubers (cm)	Diameter of mark. tubers (cm)	Weight of fresh tubers (kg /p)	Yield (ton/ fed)	Water applied (m^3/fed)	Water use efficiency
2005/2006										
80% Etc	75	156.98	2.48	3.78	25.25	3.79	2.81	15.75	3240.23	4.86
	100	151.55	2.89	5.48	27.23	4.23	3.28	13.79	2592.75	5.32
	125	138.23	3.10	5.80	28.75	5.08	3.95	11.85	2171.43	5.46
100% Etc	75	177.47	3.06	4.89	27.79	4.23	3.63	20.34	4050.80	5.02
	100	168.45	3.55	6.70	29.88	4.96	4.01	17.59	3240.73	5.43
	125	148.95	3.74	7.92	30.65	5.46	5.38	15.64	2714.33	5.76
LSD at 0.05		2.11	N. S	0.16	N. S	N. S	0.11	N. S	0.40	N. S
2006/2007										
80% Etc	75	151.43	2.21	3.45	24.96	3.63	2.44	14.52	3240.23	4.86
	100	147.52	2.72	5.07	27.04	4.08	2.83	12.45	2592.75	5.32
	125	136.40	2.91	5.48	28.50	4.96	3.47	10.74	2171.43	5.46
100% Etc	75	173.77	2.82	4.55	27.71	4.08	3.21	18.72	4050.80	5.02
	100	166.87	3.25	6.39	29.50	4.75	3.57	15.41	3240.73	5.43
	125	147.12	3.39	7.51	30.38	5.29	4.75	13.29	2714.33	5.76
LSD at 0.05		2.12	N. S	0.16	0.45	N. S	0.10	0.34	0.40	N. S

Interaction effect of irrigation interval, irrigation quantities and plant spacing on growth, yield and yield components of cassava

Although, yield and yield components of cassava were insignificantly affected by the interaction of the three main variables in most traits in both seasons. The interaction data in Table (11) revealed that irrigation every two days associated with irrigation quantities up to 100% and 75cm.plant spacing produced the highest tuber yield. These results were also true in both seasons. In the same table data revealed that highest value of water applied was obtained when irrigation was applied every two days associated with 100% ETc at the narrowest spaced (75cm. apart). Whereas, maximum value of water use efficiency (WUE) was obtained when irrigation was applied every two days irrigation with 100% ETc and increasing plant spacing up to the widest one (125cm. apart).

Table (11): Interaction effect of irrigation intervals, irrigation quantities and plant spacing on growth, yield and yield components of cassava in 2005/2006 and 2006/2007 seasons

Irrigation intervals	Irrigation quantities	Plant spacing (cm)	Plant height (cm)	No. of total branches /p	No. of total tubers /p	Length of mark. tubers (cm)	Diameter of mark. tubers (cm)	Weight of fresh tubers (kg /p)	Yield (ton /fed)	Water applied (m^3/ fed)	Water use efficiency
2005/2006											
Every day	80% ETc	75	152.93	2.30	3.57	24.75	3.33	2.65	14.84	3240.23	4.58
		100	146.20	2.62	5.27	26.45	3.78	3.15	13.29	2592.87	5.13
		125	133.83	2.82	5.65	28.25	4.67	3.84	11.06	2171.43	5.09
	100% ETc	75	175.567	2.82	4.43	27.33	3.78	3.29	18.42	4050.80	4.55
		100	166.17	3.35	6.20	29.58	4.75	3.71	16.33	3240.73	5.04
		125	147.90	3.58	7.58	30.21	5.08	5.16	14.58	2714.33	5.37
Every two days	80% ETc	75	161.03	2.66	4.00	25.75	4.25	2.97	16.65	3240.23	5.14
		100	156.90	3.17	5.68	28.00	4.67	3.40	14.28	2592.63	5.51
		125	142.63	3.39	5.96	29.25	5.50	4.05	12.63	2171.43	5.82
	100% ETc	75	179.37	3.30	5.35	28.25	4.67	3.98	22.27	4050.80	5.50
		100	170.33	3.75	7.19	30.17	5.17	4.30	18.85	3240.73	5.82
		125	150.00	3.90	8.25	31.08	5.83	5.61	16.70	2714.33	6.15
LSD at 0.05			N. S	0.12	N. S	N. S	N. S	N. S	N. S	N. S	N. S
2006/2007											
Every day	80% ETc	75	148.10	1.97	3.30	24.50	3.17	2.33	13.05	3240.23	4.58
		100	143.63	2.40	4.87	26.25	3.67	2.72	11.50	2592.87	5.13
		125	132.33	2.65	5.30	28.17	4.58	3.36	10.17	2171.43	5.09
	100% ETc	75	173.00	2.65	4.03	27.25	3.67	2.84	15.94	4050.80	4.55
		100	164.17	3.17	5.89	29.17	4.50	3.29	12.61	3240.73	5.04
		125	145.87	3.28	7.13	30.00	5.00	4.52	10.85	2714.33	5.37
Every two days	80% ETc	75	154.77	2.45	3.60	25.42	4.08	2.54	15.99	3240.23	5.14
		100	151.40	3.03	5.27	27.83	4.50	2.94	13.40	2592.63	5.51
		125	140.47	3.17	5.67	28.83	5.33	3.59	11.31	2171.43	5.82
	100% ETc	75	174.53	2.98	5.07	28.17	4.50	3.58	21.50	4050.80	5.50
		100	169.57	3.33	6.88	29.83	5.00	3.84	18.20	3240.73	5.82
		125	148.37	3.50	7.88	30.75	5.58	4.99	15.74	2714.33	6.15
LSD at 0.05			N. S	N. S	N. S	N. S	N. S	N. S	0.47	N. S	N. S

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أداء نبات الكسافا فى التربة الرملية تحت فترات رى وكميات رى ومسافات زراعة مختلفة

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أجريت تجربتان حقليتان بمحطة بحوث جنوب التحرير (على مبارك) خلال موسمى ٢٠٠٥/٢٠٠٦و ٢٠٠٦/٢٠٠٧ لدراسة تأثير فترات وكمات الرى كذلك مسافات الزراعة علىكمية المحصول ومكوناته لنبات الكسافا. اشتملت الدراسة على فترتين للرى هما الرى كل يوم والرى كل يومين كذلك كميتين للرى هما ١٠٠% و ٨٠%من الاحتياجات الكلية للنبات كذلك ثلاثة مسافات للزراعة (٧٥سم ، ١٠٠سم ، ١٢٥سم). وصممت التجربة بنظام القطع المنشقة مرتين. وأظهرت نتائج زيادة مكونات المحصول (العدد الكلى للدرنات/ نبات ، متوسط طول وقطر الدرنات ، الوزن الطازج للدرنات/نبات) زيادة ملحوظة عند الرى كل يومين مع اضافة ١٠٠% من الاحتياجات المائية للنبات والزراعة على مسافة ١٢٥سم بين النباتات.

بينما نتج أعلى محصول من الدرنات /فدان أعلى معدل لكميات الرى المستخدمة عند الرى كل يومين مع اضافة ١٠٠% من الاحتياجات المائية للنبات والزراعة على مسافة ٧٥سم بين النباتات. بينما كانت أعلى قيمة لكفاءة استخدام مياه الرى عند الرى كل يومين مع اضافة ١٠٠% من الاحتياجات المائية للنبات والزراعة على مسافة ١٢٥سم