

**EFFECT OF PLANTING DATES AND DRIP IRRIGATION RATES ON GROWTH, YIELD AND ITS COMPONENTS OF COWPEA (*VIGNA UNGUICULATA* L. WALP) PLANTS UNDER SANDY SOIL CONDITIONS**

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**ABSTRACT:** *Two field experiments were carried out in privet farm at Bani Mazar region, North Al-Minia Governorate, Egypt, during the two fall seasons of 2016 and 2017, respectively under drip irrigation system, in sandy soil conditions. The objectives of this experiment were to study the effect of two factors i.e. determine the proper planting date from three planting dates i.e. at middle of July (as a control), 7<sup>th</sup> and 28<sup>th</sup> of August at twenty one days interval as well as two water schedule regimes treatments i.e. 80 and 60 % from water requirements/ fed. as compared with the control treatment i.e. 100 % from the cowpea (*Vigna unguiculata* L. Walp) plants irrigation requirements/ fed. and their interactions on growth, yield, its components, water use efficiency as well as some chemical constituents of the leaves and dry seeds under the condition of the newly reclaimed soil on the cowpea Kaha 1 cv. The experimental design was split-plot, i.e. the three planting dates devoted in the main plots and the water schedule regimes randomly distributed in the sub plots with three replications per treatment.*

*The results indicated that, the best planting date under this investigation was at middle of July as compared with the two other planting dates i.e. 7<sup>th</sup> and 28<sup>th</sup> of August which occurred the highest significantly increased in vegetative growth characters, dry seeds yield (ton/ fed.), its components, water use efficiency, total chlorophyll content in the fresh leaves, proline contents in the dry leaves, protein, nitrogen, phosphorus and potassium (%) in the cowpea dry seeds.*

*Concerning to the influence of schedule water regime, it was found that, the cowpea plants received the complete irrigation treatment (100 %/ fed.) as compared with increasing water deficient from 80 % to 60 % from the cowpea plants irrigation requirements/ fed. produced no significant increases in some characters i.e. plant height, dry weight of the foliage/ plant, average weight of dry pods, number of dry seeds/ pod, weight of 100 dry seeds and total chlorophyll content in the fresh leaves.*

*Whereas, the cowpea plants irrigated with the moderate irrigation treatment (80 % from the cowpea plants irrigation requirements/ fed.) led to no significant increases in number of branches, dry seeds yield, number and weight of dry pods/ plant, proline contents in the dry leaves, protein, nitrogen and potassium (%) contents in the dry seeds.*

*The lowest results of all previous characters were obtained when the plants were irrigated with the lowest water amount i.e. 60 % from the cowpea plants irrigation requirements/ fed. as compared with the two other water schedule regimes. On the other hand, water use efficiency significantly increased with irrigation the cowpea plants with 60 %/ fed. followed with irrigation with 80 % and 100 % from water requirements / fed.*

*Regarding to the results of the interactions between the two studied factors used in this study showed that, the distinguished interactions treatment which led to the highest antecedent means values over all the other interactions was obtained with the interaction*

between the 1<sup>st</sup> planting date at the middle of July and irrigation the cowpea plants by the moderate irrigation regime (80 % from the cowpea plants irrigation requirements/ fed.) specially, its produced significant increases in dry seed yield and its components as well as water use efficiency as compared with the rest of the two interactions, these findings were true in the both fall seasons.

**Key words:** Cowpea, Planting dates, Irrigation schedule regimes, Water use efficiency and Newly reclaimed soil.

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## INTRODUCTION

Cowpea (*Vigna unguiculata* (L.) Walp) is one of the most important food grain legume crops in Egypt as well as other tropics and sub-tropics countries. The nutritional values of the cowpea grains are important because it is eaten by several millions people who otherwise have diets lacking in protein, minerals and vitamins. The nutritional of the cowpea grain is a relatively low fat content and total protein content but it is contain two to four times greater than cereal and tubers crops from these components. Its dry-seeds have high percentage which consider as a cheap source of protein for the poor protein (20 to 30 %) that characterized as a complete protein compared with those of other vegetables. The protein in cowpea grains are rich in the amino acids such as lysine and tryptophan, compared to the cereal grains. However, it is deficient in methionine and cystine when compare with the cereal crops. The green leaves are prepared as a pot herb, like spinach, in addition its immature green pods is used in the same way as snap beans (Belay *et al.*, 2017).

Planting date and appropriate water regimes are the major factors responsible for successful the cowpea production especially under the newly reclaimed desert areas in Egypt. In this respect, planting date is one of the important cultural practices results in the greatest differences in growth and yield of grain legumes, sowing cowpea seeds at the optimum time enables the crop to best use the available growth factors

such as temperature and solar radiation at different stages of growth led to ensure good plants establishment, flowering and pod filling stages for maximum seed yield. Cowpea is consider as an adaptable to harsh environments including extreme temperatures and water limiting conditions as well as other biotic stresses compared with other crops. The optimum soil temperature for rapid germination of the cowpea seed is above 18.3°C, but the minimum base temperature to initiate germination can be (7 - 14°C), chilling damage can cause slow and incomplete emergence. Cowpea is adapted to high temperatures in the range, 20 – 35 °C, it does not withstand flooded conditions. It grows under a wide extreme of moisture and once established it is fairly tolerant to drought and can give good yields under marginal rainfall but in high rainfall areas (Dugje *et al.*, 2009).

Regarding to, the water regimes, water deficit is one of the main factors limiting crop production. It decreases growth, interrupts water relations and reduces water use efficiency in crops; this may be attributed to the strong sensitivity of cowpea stomata to water stress with reduction in photosynthetic capacity, which this attributed to the effect of drought on water use efficiency to stomatal closure, decreased transpiration and decreased leaf turgidity, which have consequences on photosynthesis (Farooq *et al.*, 2012).

Additionally, one of the most challenges facing the agriculture of Egypt is a serious in shortage of water

resources, with a continuously increasing population. Irrigation water is one of the most important factors for increasing agricultural production. Water is a very limited resource and most of Egypt's water uses are for the agriculture sector, which consumes about 84 % from water amounts. The increasing gap between the available renewable water resources so it is advised to evaluate new possible approaches to minimize the plant water consumption and hence to rationalize irrigation water use, Egypt, like many other countries which lie in arid and semi-arid region, is subjected to water scarcity (FAO, 2013). Climate change (rising of temperature and lowering of precipitation), misuse of water resources, pollution and inefficient agriculture irrigation techniques besides rapid rising of population are the major factors that aggravate water security problem in the country. Egypt was demanded saving water irrigation by using drip irrigation which it is the best and the most suitable method for the irrigation of the cowpea plants especially in the sand soil compared to surface irrigation for many reasons *i.e.* drip is the most efficient way to irrigate. It is usually about 90 % efficient compared to about 70 % for sprinkler and often 50 % for surface irrigation which has to be applied in the newly reclaimed desert areas as well as old Delta soils, for saving much irrigation water especially for using it under the old Delta conditions instead the traditional surface irrigation system. A drip irrigation system makes fertigation and chemigation easy and convenient, plant foliage stays dry with drip and therefore there are fewer problems with plant diseases that do better on wet leaves and in humid conditions as well as a large portion of the soil surface always stays dry (Abdel-Raouf, 2015).

The main objectives of this study were to identifying the optimal planting dates, exact irrigation regime and their interactions to enhance growth, dry pod

characters, dry seed yield productivity, water use efficiency and some chemical properties, in order to be saving 20 % from the cowpea plants irrigation requirements/ fed. grown under the newly reclaimed of sandy soil conditions without any reduction on dry seed yield and its quality.

## MATERIALS AND METHODS

Two field experiments were carried out during the two fall seasons of 2016 and 2017 in sandy soil of private farm at Bani Mazar region, North Al-Minia Governorate, Egypt. Coordinates: its located 28.50° North latitude and 30.80° East longitude and it is situated at elevation 43 meters above sea level. The objectives of this study were to determine the exact of the date planting, water schedule regimes and their interactions under the condition of the newly reclaimed soil on growth, yield, its components, water use efficiency as well as some chemical constituents of leaves and cowpea dry seeds Kaha 1 cv.

The experimental design was split-plot; the treatments were arranged in a complete randomized block design with three replicates. The main plots were devoted for three planting dates (factor A) *i.e.* 1<sup>st</sup> (planting date at the middle of July), 2<sup>nd</sup> (planting date at the seventh of August) and the 3<sup>rd</sup> (planting date at 28<sup>th</sup> of August) at twenty one days interval, of 2016 and 2017 seasons, respectively. The drip irrigation system was used (including GR dipper, with discharge rate of 4 L/ h was spaced at 25 cm intervals) to apply the three levels of water schedule regimes (factor B) as sub plots, *i.e.* 100 % (full irrigation) with 1500 m<sup>3</sup>, 80% (moderate stress) with 1200 m<sup>3</sup> and 60 % (severe stress) with 900 m<sup>3</sup> water/ fed., respectively from the cowpea plants irrigation requirements/ fed. through the season. Total water irrigation (m<sup>3</sup>/ fed.) was estimated according to the meteorological data of the Central Laboratory for Agricultural Climate,

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Agricultural Research Center, Ministry of Agriculture, Giza, Egypt under the condition at Bani Mazar region. All experimental units were received equal amounts of water until the complete germination (15 days from each seed sowing date) then irrigation treatments were started in the both fall seasons.

Seeds of the cowpea Kaha 1 cv. were purchased from Horticulture Research Institute, Agricultural Research Center; the area of the experimental plot for every treatment was 11.2 m<sup>2</sup>. Each plot consisted of 4 dripper lines at 4 m in length and 0.7 m in width, seeds were sown with three seeds/ hill at 7-10 cm apart on one side of dripper lines. After complete emergence, plants were thinned to one plant for hill.

The recommended agricultural practices of the cowpea plants in this

area such as fertigation method, weed control and pest management were applied during the two fall growing seasons according to the recommendations of Egyptian Ministry of Agriculture.

The meteorological data for the experimental area obtained from Central Laboratory for Agricultural Climate (CLAC), Agricultural Research Center (ARC), Ministry of Agricultural and Land Reclamation, values were recorded during the two fall growing seasons as shown in Table 1.

Soil samples were randomly collected each year before cultivation at a depth of 0-30 cm in order to measure the important of the physical and chemical properties which determined according to (Jackson, 1973) were shown in Table 2.

**Table 1: Meteorological data at Bani Mazar region, Al-Minia Governorate during the two fall seasons of 2016 and 2017**

Months	Air temperature ° C			
	2016		2017	
	Maximum	Minimum	Maximum	Minimum
July	40.0	20.5	39.5	20.6
August	40.0	19.3	39.0	19.4
September	38.0	17.1	37.0	15.6
October	38.5	38.5	37.0	13.0
November	33.0	11	30.3	13.2

**Table 2: Physical and chemical analysis properties of the experiment soil.**

Components	1 <sup>st</sup> season	2 <sup>nd</sup> season
Soil Type	sand loam	sand loam
Organic Matter %	0.35	0.42
Clay %	4.51	3.93
Silt %	24.66	26.01
Fine Sand %	41.93	38.65
Coarse Sand %	28.90	31.41
pH	7.79	7.96
E.C. (mmhos /cm )	0.70	0.78
CaCO <sub>3</sub> %	8.31	8.18
Total N (%)	0.032	0.028
Available P mg/100 g	37.62	38.80
Available K mg/100 g	362.6	375.9

The following parameters were recorded:

**1- Growth parameters:** Five cowpea plants from each treatment were randomly chosen at 60 days from each sowing date to measure plant height, number of branches and dry weight of the foliage/ plant (leaves and stems).

**2-1- Yield and its components:** At harvest time *i.e.* dry pods stages, a random samples of 20 dry pods of cowpea which, were taken from each treatment to determine each of pod length (cm), pod diameter (cm), weight of dry pod (g), number of dry seeds/ pod and weight of 100 dry seeds (g). Number of dry pods/ plant and weight of dry pods/ plant (g) were determined by chosen a random sample of five plants. At suitable maturity dry stage, cowpea dry pods were threshed and calculated as total dry seeds yield as (ton/ fed.).

**2-2-Water Use Efficiency:** Water use efficiency (WUE) is an indicator of the efficiency of irrigation in increasing cowpea crop yield. Water use efficiency ( $\text{Kg}_{\text{yield}} / \text{m}^3_{\text{water}}$ ) was calculated from the following equation of Rahil and Qanadillo, 2015:-

WUE =

$$\frac{\text{Dry seed yield (Kg/ fed.)}}{\text{Total applied of irrigation water (m}^3\text{/ fed.)}} = \text{Kg/ m}^3$$

**3-Chemical composition in the leaves and dry seeds:**

**3-1- Minerals contents:** Fresh samples of the cowpea leaves and dry seeds were dried in an electric forced-air oven at 70°C to constant weight then fractionated and sifting. The fine powder (at 0.2 g) of each dry sample was digested in a mixture of sulphuric and perchloric acids, as wet digestion according to Piper (1947). Total nitrogen, phosphorus and potassium

contents (%) in dry seeds were determined according to Bremner and Mulvaney (1982), Olsen and Sommers (1982) and Horneck and Hanson (1998), respectively.

**3-2-Total chlorophyll content (mg/ 100 g of fresh weight):** Was determined at 60 days from each sowing date in the fresh leaves (random sample of five fresh leaves from the plants top/ plot), according to Nagata and Yamashita (1992).

**3-3-The free proline content (mg/g):** In dry leaves was determined according to the method described by Troll and Lindsley (1955).

**3-4-Protein (%):** Were determined in dry seeds through the determination of total nitrogen and a factor of 6.25 was used for conversion of total nitrogen to protein percentage according to Kelly and Bliss (1975).

**4- Statistical analysis:** All obtained data of the present study was subjected to the analysis of variance techniques according to the design used by the MSTATC computer software program variance and mean of treatments were compared according to the Least Significant Differences (L. S. D.) test at the 0.05 probability level, method described by (Bricker, 1991).

## RESULTS AND DISCUSSION

**I- Vegetative growth parameters:-**

**1-1-Effect of planting dates:**

Data pertaining in Table, 3 on plant height, number of branches/ plant and dry weight of the foliage/ plant of the cowpea plants indicate clearly that the 1<sup>st</sup> planting date seemed to be the best planting time for vegetative growth of the cowpea plants which it is produced the superior significant increases between the rest of the other two planting dates

which gave the tallest plant height, the highest number of branches and the heaviest dry weight of the foliage (g)/ plant, while the lowest previous traits were recorded at the 3<sup>rd</sup> planting date (late season). There was no significant difference in number of branches between the 2<sup>nd</sup> and the 3<sup>rd</sup> planting dates on the two fall seasons, respectively. Meteorological data of temperature means at the first month from the early sowing date (middle of July) showed that prevalent temperature during germination of the cowpea seeds, were (40:39.5 °C and 20.5:20.6 °C) as the maximum and the minimum temperature in the first and the second seasons, respectively and in this warm condition prevailing may be furnished to better germination which produce healthy plants which lead to causing higher photosynthates having greater fresh and dry weight of the foliage values than the 2<sup>nd</sup> and the 3<sup>rd</sup> planting dates. On the other hand, the abundance of growth characters of the cowpea plants, which planted in the 1<sup>st</sup> sowing date under this investigation may be attributed to the long time of the plants which was took it during the growth stage, higher solar radiation led to the increase potential photosynthesis production as well as the longer duration of the growth period, consequently produce the better growth characters as compared with the rest of the two other planting dates. Additionally, the cowpea is a heat-loving and drought-tolerant crop, the optimum temperature for growth and development is around 35 °C as mentioned before by (Dugje *et al.*, 2009). Similar trends were reported by Ezeaku *et al.* (2015) they reported that the 1<sup>st</sup> planting date at 24<sup>th</sup> of July gave significantly higher on dry weight, number of internodes, leaves and vine length as compared with the 2<sup>nd</sup> planting one at the 12<sup>th</sup> of September which gave the lowest vegetative growth traits of the cowpea plants.

## 1-2-Effect of water schedule regimes:

Data presented in the same Table, 3 show that the irrigation schedule regimes (%) had a significant effect on plant height, number of branches and dry weight of the foliage/ plant in both fall seasons. Irrigation at 100 % from the cowpea plants irrigation requirements/ fed. produced the highest mean values of plant height and dry weight of the foliage/ plant, this is explained the increase in dry matter of plants grown in the high levels of soil moisture could be attributed mainly to the effect of water on some quantitative, qualitative changes in certain metabolic processes, enhancing cell division and enlargement which need more water supplies during the vegetative stage. While, the highest values in number of branches/ plant obtained from the cowpea plants received the moderate irrigation stress regime *i.e.* 80 % from the cowpea plants irrigation requirements/ fed. No significant differences were detected in the 1<sup>st</sup> and the 2<sup>nd</sup> irrigation schedule regime (%) under the condition of this investigation in the first and the second seasons, respectively.

The decrement in all studied growth aspects significantly gained with increasing water stress levels from 80 % to 60 % from water requirements/ fed. The largest reduction in growth characters of the cowpea plants were observed under a severe water stress (60%/ fed.) during the two fall seasons of this study, this may be duo to the shortage of irrigation water caused a reduction in nutrients uptake, metabolism translocation as well as cell division and elongation which decreased plant height, number of branches and dry weight of the foliage/ plant. The enhanced production of reactive oxygen species during water stress lead to the progressive oxidative damage and

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ultimately cell death and growth suppression in plant (Ruiz-Lozano *et al.*, 2012). Similar results were also reported by Dalia *et al.* (2017) who suggested that irrigation the cowpea plants at 70 % of available water of the available soil moisture produced the highest mean values of branches per plant while, the lowest one were obtained when irrigation was applied at 30 %.

**1-3-Effect of the interactions:**

Significant interactions effects were found between of the two studied factors on vegetative growth of the cowpea plants, data in the same Table, 3 indicate that the tallest plants and the heaviest dry weight of the cowpea foliage were obtained with the surpassing the

interactions treatments *i.e.* sowing at the middle of July with the full irrigation regime *i.e.* 100 % from the cowpea plants irrigation requirements/ fed. While, the most number of branches occurred with the interactions between sowing at the middle of July and the moderate irrigation regime *i.e.* 80 % from the cowpea plants irrigation requirements/ fed. The lowest records data on vegetative growth of the previous characters cowpea plants were obtained with the interactions treatment between the 3<sup>rd</sup> planting date at 28<sup>th</sup> of August (late season) and irrigation the cowpea plants with severe stress irrigation regime *i.e.* 60 % from the cowpea plants irrigation requirements/ fed. in the 1<sup>st</sup> and the 2<sup>nd</sup> seasons, respectively .

**Table 3: Effect of planting dates, irrigation schedule regimes and their interactions on plant height, number of branches and dry weight of the foliage/ plant of the cowpea plants during the two fall seasons of 2016 and 2017**

Effect of planting dates	Irrigation schedule regimes (%)	2016			2017		
		Plant height (cm)	Number of branches/ plant	Dry weight of foliage (g) / plant	Plant height (cm)	Number of branches/ plant	Dry weight of foliage (g) / plant
1 <sup>st</sup> date at 15/7	100 %	55.2	5.7	34.983	53.3	6.0	33.827
	80 %	50.7	6.4	32.000	51.3	6.4	32.727
	60 %	47.9	5.4	28.020	47.7	5.3	28.640
Mean		51.3	5.8	31.668	50.8	5.9	31.731
2 <sup>nd</sup> date At 7/8	100 %	45.6	4.9	26.160	46.2	4.9	26.843
	80 %	42.5	4.6	24.060	42.5	4.8	25.687
	60 %	38.6	4.4	20.953	39.1	4.7	21.510
Mean		42.2	4.6	23.724	42.6	4.8	24.680
3 <sup>rd</sup> date at 28/8	100 %	36.0	4.7	20.793	36.9	4.8	21.673
	80 %	33.6	4.5	19.713	34.2	4.7	20.380
	60 %	31.4	4.3	17.533	32.8	4.4	16.510
Mean		33.6	4.5	19.347	34.7	4.6	19.521
Average	100 %	45.6	5.1	27.312	45.5	5.2	27.448
	80 %	42.3	5.2	25.258	42.7	5.3	26.264
	60 %	39.3	4.7	22.169	39.9	4.8	22.220
L S D at 0.05 %	Planting dates	4.8	0.40	3.817	3.7	0.36	3.496
	Irrigation schedule regimes (%)	3.9	0.31	2.443	4.3	0.24	2.932
	Interactions	3.6	0.35	2.729	4.8	0.27	3.276

**2-Yield and its components:**

**2-1-Effect of planting dates:**

The results at Tables, 4 and 5 illustrate that the effect of planting dates on dry seeds yield and its components measurements as well as water use efficiency indicated that, the superior values were obtained from the 1<sup>st</sup> planting date which induced significantly increases of all traits as compared with

the 2<sup>nd</sup> and the 3<sup>rd</sup> planting dates, respectively. In this connection, the dry seeds yield of cowpea plants is the result of many interacting of yield components such as, number of dry pods/ plant, number of dry seeds/ pod, weight of dry pods/ plant and weight of 100 dry seeds, whereas this component values showed significant increases which it reflected on the total dry seed yield.

**Table 4: Effect of planting dates, irrigation schedule regimes and their interactions on dry pod length, dry pod diameter, dry pod weight and number of dry seeds/ pod of the cowpea plants during the two fall seasons of 2016 and 2017**

Effect of planting dates	Irrigation schedule regimes (%)	2016				2017			
		Dry pod length (cm)	Dry pod diameter (cm)	Dry pod weight (g)	No. of dry seeds/ pod	Dry pod length (cm)	Dry pod diameter (cm)	Dry pod weight (g)	No. of dry seeds/ pod
1 <sup>st</sup> date at 15/7	100 %	13.1	0.54	2.137	9.5	13.0	0.52	2.063	9.5
	80 %	13.3	0.58	2.410	9.7	13.5	0.54	2.240	9.7
	60 %	12.6	0.51	2.047	9.0	12.7	0.46	1.917	9.1
Mean		13.0	0.54	2.198	9.4	13.1	0.51	2.073	9.4
2 <sup>nd</sup> date at 7/8	100 %	12.7	0.47	1.850	8.2	12.7	0.46	1.767	7.8
	80 %	12.6	0.46	1.620	7.9	12.4	0.44	1.657	7.5
	60 %	12.2	0.42	1.420	7.6	12.2	0.43	1.343	7.5
Mean		12.5	0.45	1.630	7.9	12.4	0.44	1.589	7.6
3 <sup>rd</sup> date at 28/8	100 %	11.5	0.42	1.627	7.8	11.5	0.39	1.557	7.4
	80 %	11.3	0.41	1.457	7.4	11.3	0.39	1.447	7.2
	60 %	11.2	0.39	1.317	7.2	11.1	0.37	1.423	7.1
Mean		11.3	0.41	1.467	7.5	11.3	0.38	1.476	7.2
Average	100 %	12.4	0.48	1.871	8.5	12.4	0.46	1.796	8.2
	80 %	12.4	0.48	1.829	8.4	12.4	0.46	1.781	8.1
	60 %	12.0	0.44	1.594	8.0	12.0	0.42	1.561	7.9
L S D at 0.05 %	Planting dates	0.41	0.05	0.39	0.59	0.45	0.07	0.34	0.42
	Irrigation schedule regimes (%)	0.17	N S	0.16	0.39	0.21	N S	0.11	N S
	Interactions	0.24	0.07	0.34	0.44	0.32	0.10	0.37	0.49



**Table 5: Effect of planting dates, irrigation schedule regimes and their interactions on weight of 100 dry seeds, number of dry pods/ plant, weight of dry pods/ plant, total dry seed yield and water use efficiency of the cowpea plants during the two fall seasons of 2016 and 2017**

Effect of planting dates	Irrigation schedule regimes (%)	2016					2017				
		weight of 100 dry seeds (g)	No. of dry pods/plant	weight of dry pods/plant (g)	Total dry seed yield (Ton/fed.)	Water use efficiency	weight of 100 dry seeds (g)	No. of dry pods/plant	Weight of dry pods/plant (g)	Total dry seed yield (Ton/fed.)	Water use efficiency
1 <sup>st</sup> date at 15/7	100 %	16.750	31.7	63.333	0.950	0.633	17.123	29.1	60.173	0.908	0.605
	80 %	17.390	35.3	70.620	1.109	0.924	17.167	33.8	65.593	1.087	0.906
	60 %	16.527	27.4	54.693	0.825	0.917	16.457	27.0	53.980	0.800	0.889
Mean		16.889	31.5	62.882	0.961	0.825	16.916	29.6	59.916	0.932	0.800
2 <sup>nd</sup> date at 7/8	100 %	15.193	27.7	49.843	0.707	0.471	15.110	25.5	47.137	0.737	0.491
	80 %	14.580	26.5	47.603	0.661	0.551	14.317	24.9	45.367	0.680	0.567
	60 %	13.913	25.0	44.713	0.613	0.681	13.397	24.4	43.830	0.622	0.691
Mean		14.562	26.4	47.387	0.660	0.568	14.274	25.0	45.444	0.680	0.583
3 <sup>rd</sup> date at 28/8	100 %	13.690	24.5	37.943	0.660	0.440	13.220	23.3	34.937	0.670	0.447
	80 %	13.117	22.9	35.400	0.625	0.521	12.883	21.8	32.633	0.607	0.506
	60 %	12.453	21.3	32.403	0.600	0.667	12.473	19.8	29.727	0.586	0.651
Mean		13.087	22.9	35.249	0.628	0.543	12.859	21.6	32.432	0.621	0.535
Average	100 %	15.211	27.9	50.373	0.772	0.515	15.151	26.0	47.416	0.771	0.514
	80 %	15.029	28.2	51.208	0.798	0.665	14.789	26.5	47.864	0.791	0.660
	60 %	14.298	24.6	43.937	0.680	0.755	14.109	23.7	42.512	0.669	0.743
L S D at 0.05 %	Planting dates	0.454	2.63	7.573	0.091	0.080	0.363	3.3	7.373	0.111	0.097
	Irrigation schedule regimes (%)	0.454	1.92	3.610	0.074	0.068	0.638	2.7	2.653	0.091	0.081
	Interactions	0.507	2.15	4.043	0.132	0.125	0.713	3.0	2.964	0.160	0.151

On other wise, the highest reduction of dry seeds yield were obtained from the treatment of the late planting date and this may be attribute to the low soil temperatures which its affected the seed germination poor and consequently resulted in lowered plant population and also cause abscission of the flowers and small pod abortion led to reduce in the dry seeds yield that may be caused by early low temperature at night or lack of enough time for pods filling stage and

production, this could lead to loss in grain yield (Akande *et al.*, 2012). These results reinforced with Ezeaku *et al.* (2015) they pointed out that the 1<sup>st</sup> planting date at 24<sup>th</sup> of July gave significantly increased the weight of 100 dry seeds, number of pods per plant, number of dry seeds per pod, pod length and yield/ hectare as compared with that the 2<sup>nd</sup> planting date at the 12<sup>th</sup> of September which gave the lowest of all the previous traits of the cowpea plants.

## 2-2-Effect of water schedule regimes:

Data recorded in the same Tables, 4 and 5 indicate that the effect of water schedule regimes *i.e.* 100 %, 80 % and 60% from the cowpea plants irrigation requirements/ fed. on dry seeds yield, its components and water use efficiency measurements the obtained data showed that, the full irrigation treatment (100 %/ fed.) lead to the maximum increases in dry pod weight, number of dry seeds/ pod and weight of 100 dry seeds. While, the cowpea plants irrigated with the moderate irrigation treatment (80 %/ fed.) lead to the maximum increases on the dry seeds yield, number of dry pods/ plant and weight of dry pods/ plant in the 1<sup>st</sup> and the 2<sup>nd</sup> season, respectively as well as no significant different was obtained between the 100 and 80 %/ from the cowpea plants irrigation requirements/ fed. Water use efficiency significantly increased with irrigation plants with 60 % from water requirements/ fed. followed with plant irrigated with 80 % and 100 %/ fed.

On the contrary, the lowest results recorded in dry pod characters and the dry seeds yield were obtained when the plants were irrigated with the lowest water amount *i.e.* 60 % from the cowpea plants irrigation requirements/ fed. as compared with the plants which irrigated with the two other water schedule regimes during the two fall seasons, respectively. The reduction in the dry seeds yield and its components as a result of increment the water stress levels may be due to the negative effect of water stress on plant height, number of branches, dry weight per plant, pod weight and number of pods as discussed before (Tables 3, 4 and 5). In this orientation, Abdul-Jaleel *et al.* (2009) indicated that water deficit is one of the major a biotic stress, which adversely affects the plant growth and yield. These changes are mainly related to the alteration of metabolic functions,

conditions due to increasing the rate of flowers abscission %, pod abortion such as the reduction in the synthesis of photosynthesis pigments, thereby these changes in the amount of photosynthetic pigments are closely associated to plant biomass yield.

In addition, it can explain the superiority effects of applied water regime *i.e.* 80 % from the cowpea plants irrigation requirements/ fed. which induced significantly increased of the dry seed yield and its components, may be due to increase volume applied water irrigation at 100 % from the cowpea plants irrigation requirements/ fed. means, decreasing in the concentration of nutrients in the root zone and also, applied 80 %/ fed. is the best case or suitable conditions, these conditions decreased from water stress or drought stress and also, achieved excellent distribution for nutrients inside root zone. While at 100 % it can get the lowest water stress but not achieve excellent distribution for nutrients inside root zone because of increasing leaching rate with increasing volume of applied water (Bakry *et al.*, 2013). The results also are in conformity with the findings with Dalia *et al.* (2017) which mentioned that irrigation the cowpea plants at 70 % of available water of the available soil moisture produced the highest mean values of the 100 seed weight, seed yield per plant and seed yield (kg/ hectare) while, the lowest previous characters as well as the highest water use efficiency recorded when irrigation was applied at 30 %.

## 2-3-Effect of the interactions:

Regarding to the effect of the interactions between planting dates and water schedule regimes of the cowpea plants on dry seeds yield, its components and water use efficiency, the results at the same Tables, 4 and 5 indicate that the 1<sup>st</sup> planting date at the

middle of July as well as irrigated the cowpea plants with the moderate irrigation regime *i.e.* 80 %. gave the highest means values of dry pod characters, the dry seeds yield (1.109 and 1.087 ton/ fed.) comparing with the other interactions *i.e.* the full irrigation regime *i.e.* 100 % (0.950 and 0.908 ton/ fed.) and the severe stress irrigation regime *i.e.* 60% (0.825 and 0.800 ton/ fed.) from the cowpea plants irrigation requirements/ fed. On the other hand, the best water use efficiency obtained with the moderate irrigation regime *i.e.* 80 % (0.924 and 0.906 Kg<sub>yield</sub>/ m<sup>3</sup><sub>water</sub>) followed with severe stress irrigation regime *i.e.* 60 % (0.917 and 0.889 Kg<sub>yield</sub>/ m<sup>3</sup><sub>water</sub>) as well as full irrigation regime *i.e.* 100 % (0.633 and 0.605 Kg<sub>yield</sub>/ m<sup>3</sup><sub>water</sub>) in the 1<sup>st</sup> and the 2<sup>nd</sup> seasons, respectively. On the contrast, the lowest records on the dry seeds yield and its components were obtained with the interactions between the 3<sup>rd</sup> planting date at 28<sup>th</sup> of August (late season) and irrigation the cowpea plants with severe stress irrigation regime *i.e.* 60 % from the cowpea plants irrigation requirements/ fed. in the 1<sup>st</sup> and the 2<sup>nd</sup> season, respectively. Moreover, the increases in the cowpea dry seed yield and its components can be explained by the significant increases due to the greatest values of the vegetative growth characters as mentioned before in Table, 3 during the two growing fall seasons.

### **3-Chemical composition of the cowpea leaves and dry seeds:**

#### **3-1-Effect of planting dates:**

Data presented at Tables, 6 and 7 on the total chlorophyll contents in the fresh leaves, the proline contents in the dry leaves, the protein, nitrogen, phosphorus and potassium in the dry seeds indicate that, the 1<sup>st</sup> planting date significantly increased all the previous traits as compared with the 2<sup>nd</sup> and the 3<sup>rd</sup> planting dates, respectively. These

results coincided with those reported by Heba *et al.* (2015) who found that sowing snap bean in the first sowing date at 1<sup>st</sup> of October gave the highest significant values of nitrogen, phosphorus and potassium contents in snap bean leaves as well as portion in its pods as compared with the 2<sup>nd</sup> sowing one at 16<sup>th</sup> of the same month.

#### **3-2-Effect of water schedule regimes:**

Regarding to the results of the previous chemical composition, data in the same Tables, 6 and 7 as affected by different water schedule regimes show that the superiority values of the total chlorophyll contents in the fresh leaves occurred when the cowpea plants received the complete irrigation treatment (100 %/ fed.). whereas, proline contents in the dry foliage as well as protein, nitrogen and potassium in the dry seeds were increased as compared with an increasing water deficient from 100 % to 80 % from the cowpea plants irrigation requirements/ fed. without any significant differences between the previous two schedule regimes. The highest percent of proline of cowpea dry leaves which achieved when the plants were irrigated with the middle water regime treatment *i.e.* 80 % followed with 100 %/ fed. but under the highest severe of water stress (60 %/ fed.) proline tended to decrease. These results are further supported by Amira (2014) who reported that the most decrease in the concentration of photosynthetic pigments *i.e.* total chlorophyll, as a result of drought stress which reduced the uptake of nitrogen, phosphorus and potassium contents %, it's occurred under the condition of 40 % (field capacity) of soybean plants. Geeth and Abdel-Aziz (2017) generalized that subjected the snap bean plants to three water levels (100, 80 and 60 % of from the snap bean plants irrigation requirements/

fed.) which led to significant increase in total chlorophyll content in the fresh leaves, protein contents in the pods, nitrogen, phosphorus and potassium % in the dry leaves. It was found also that the highest reduction in the previous characters of pods quality pronounces in the level of 60 % from water requirements/ fed.

### 3-3-Effect of the interactions:

It noticed significant interactions effects between of the two studied factors *i.e.* planting dates and water schedule regimes of the cowpea plants

on total chlorophyll contents in fresh leaves, proline contents in dry leaves as well as protein, nitrogen, phosphorus and potassium contents in cowpea dry seeds as shown in the same Tables, 6 and 7. The pronounced interactions on the previous characters were obtained with the interaction between the 1<sup>st</sup> planting date at the middle of July as well as irrigation cowpea plants with the moderate irrigation regime *i.e.* 80 % from the cowpea plants irrigation requirements/ fed. as compared with the rest of the two interactions.

Table 6: Effect of planting dates, irrigation schedule regimes and their interactions on the total chlorophyll contents in the fresh leaves, proline contents of the dry leaves and protein contents of the cowpea dry seeds during the two fall seasons of 2016 and 2017

Effect of planting dates	Irrigation schedule regimes (%)	2016			2017		
		Total chlorophyll mg/ 100 g (F. W.)	Proline (mg/g)	Protein (%)	Total chlorophyll mg/ 100 g (F. W.)	Proline (mg/g)	Protein (%)
1 <sup>st</sup> date at 15/7	100 %	139.6	0.33	21.7	140.2	0.34	21.4
	80 %	149.4	0.39	22.9	150.2	0.40	22.6
	60 %	131.1	0.31	20.6	138.4	0.32	20.8
Mean		140.0	0.34	21.8	142.9	0.35	21.6
2 <sup>nd</sup> date at 7/8	100 %	141.3	0.29	20.6	138.9	0.31	20.4
	80 %	131.1	0.28	20.3	130.2	0.29	20.2
	60 %	119.3	0.24	20.0	116.8	0.26	20.0
Mean		130.6	0.27	20.6	128.6	0.29	20.2
3 <sup>rd</sup> date at 28/8	100 %	132.4	0.25	20.4	126.7	0.26	20.2
	80 %	120.8	0.23	20.3	116.2	0.24	20.1
	60 %	109.0	0.20	20.0	108.5	0.20	20.0
Mean		120.8	0.23	20.2	117.2	0.23	20.1
Average	100 %	137.8	0.29	20.9	135.3	0.30	20.7
	80 %	133.8	0.30	21.2	132.2	0.31	21.0
	60 %	119.8	0.25	20.2	121.2	0.26	20.3
L S D at 0.05 %	Planting dates	11.02	0.06	0.54	13.92	0.07	0.41
	Irrigation regimes (%)	4.77	0.09	0.24	4.44	0.08	0.20
	Interactions	5.32	0.10	0.27	4.96	0.09	0.23

Table 7: Effect of planting dates, irrigation schedule regimes and their interactions on nitrogen, phosphorus and potassium contents of the cowpea dry seeds during the two fall seasons of 2016 and 2017

Effect of planting dates	Irrigation schedule regimes (%)	2016			2017		
		Nitrogen (%)	Phosphorus (%)	Potassium (%)	Nitrogen (%)	Phosphorus (%)	Potassium (%)
1 <sup>st</sup> date at 15/7	100 %	3.47	0.240	1.923	3.43	0.243	1.963
	80 %	3.67	0.247	2.327	3.61	0.263	2.273
	60 %	3.29	0.227	1.847	3.33	0.240	1.830
Mean		3.48	0.238	2.032	3.47	0.249	2.022
2 <sup>nd</sup> date at 7/8	100 %	3.29	0.223	1.743	3.26	0.227	1.770
	80 %	3.25	0.207	1.640	3.23	0.217	1.667
	60 %	3.20	0.207	1.533	3.20	0.207	1.553
Mean		3.25	0.212	1.639	3.23	0.217	1.663
3 <sup>rd</sup> date at 28/8	100 %	3.26	0.203	1.413	3.23	0.200	1.450
	80 %	3.24	0.193	1.453	3.21	0.183	1.427
	60 %	3.20	0.170	1.367	3.15	0.170	1.383
Mean		3.23	0.189	1.411	3.20	0.184	1.420
Average	100 %	3.34	0.222	1.693	3.30	0.224	1.728
	80 %	3.39	0.216	1.807	3.35	0.221	1.789
	60 %	3.23	0.201	1.582	3.23	0.206	1.589
L S D at 0.05 %	Planting dates	0.09	0.04	0.09	0.06	0.06	0.11
	Irrigation schedule regimes (%)	0.05	N S	0.12	0.08	N S	0.09
	Interactions	0.05	0.06	0.13	0.07	0.09	0.10

### Conclusions

It could be concluded that, under the conditions of this investigation, it can recommended by cultivate, the cowpea plants Kaha 1 cv. in the first sowing date *i.e.* the middle of July as well as irrigation the plants by 80 % from plants irrigation requirements/ fed. to obtain superior effects of the vegetative growth character, dry seed yield (ton/ fed.) and its components, water use efficiency, the best dry seed quality as well as it is very important for saving a part of the

irrigation water, which calculated by about 20 % especially under the condition of the limited water resources nowadays for the newly reclaimed areas in Egypt.

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## تأثير مواعيد الزراعة ومعدلات الري بالتنقيط على النمو والمحصول ومكوناته فى نباتات اللوبيا تحت ظروف الأرض الرملية

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### الملخص العربى

أجريت تجربتان حقليتان بمزرعه خاصة بمنطقة بنى مزار شمال محافظة المنيا فى الموسم النيلى لعامى 2016 - 2017 وذلك تحت نظام الري بالتنقيط فى الأراضى الرملية المستصلحة حديثاً بهدف تحديد أفضل ميعاد لزراعة بذور اللوبيا من خلال ثلاث مواعيد هى الخامس عشر من يوليو (كنترول) - السابع من أغسطس - الثامن والعشرون من أغسطس وكذلك أفضل مقنن مائى لرى نباتات اللوبيا من معدلين رى هما (80 % - 60 %) بالإضافة الى الكنترول (100 %) من الأحتياجات المائية لنباتات اللوبيا م<sup>3</sup>/فدان والتفاعل بينهما وتأثير ذلك على النمو الخضرى لنباتات اللوبيا صنف قها 1 ومحصول البذور الجاف ومكوناته وكفاءة استخدام المياه وبعض الصفات الكيماوية فى الأوراق و البذور الجافة وقد صممت التجربة بنظام القطع المنشقة مرة واحدة فى ثلاث مكررات حيث وضعت مواعيد الزراعة الثلاث فى القطع الرئيسية و وزعت المقننات مياه الري فى القطع المنشقة مرة واحدة. وقد أظهرت النتائج المتحصل عليها مايلى:-

ان أفضل ميعاد لزراعة اللوبيا تحت ظروف هذه التجربة هو منتصف شهر يوليو مقارنة بالمواعيد الأخرى حيث تم الحصول على أعلى زيادة معنوية فى صفات النمو الخضرى وزيادة محصول البذور الجافة / فدان ومكوناته وأعلى كفاءة فى استخدام مياه الري كذلك زاد محتوى الأوراق الخضراء من الكلورفيل الكلى كما زاد محتوى الأوراق الجافة من البرولين وأيضاً زادت جودة البذور الجافة نتيجة زيادة محتواها من البروتين وعناصر النتروجين والفوسفور والبوتاسيوم (%).

كما ادى رى نباتات اللوبيا بالمعدل المثالى (100 % من الأحتياجات الفعلية للرى /فدان) مقارنة بزيادة الأجهاد المائى من 80 % الى 60 % / فدان الى زيادة غير معنوية فى بعض الصفات مثل طول النباتات والمادة الجافة /نبات و متوسط وزن القرن الجاف وعدد البذور الجافة/ قرن ووزن ال100 بذرة جافة و زيادة محتوى الأوراق الخضراء من الكلورفيل الكلى.

كما ادى رى نباتات اللوبيا تحت ظروف الأجهاد المائى بمعدل 80 % /فدان من الأحتياجات الفعلية للرى /فدان) الى زيادة غير معنوية فى بعض الصفات مثل عدد الأفرع الجانبية و محصول البذور الجافه (طن /فدان) وعدد ووزن القرون الجافة/ نبات كذلك محتوى الأوراق الجافة من البرولين و محتوى البذور الجافة من البروتين وعناصر النتروجين و البوتاسيوم (%).

كما أنخفضت كل قيم الصفات السابقة نتيجة تعرض نباتات اللوبيا لظروف الأجهاد المائى عند الري بمعدل 60 % من الأحتياجات الفعلية للرى /فدان مقارنة المقننات المائية الأخرى. ومن ناحية اخرى أظهرت صفة كفاءة استخدام المياه أعلى زيادة معنوية نتيجة تعرض اللوبيا لظروف الأجهاد المائى و هو اللرى بمعدل 60 % من الأحتياجات الفعلية للرى /فدان يليها رى النباتات بمعدل 80 % ثم 100 %.

أما بالنسبة الى نتائج التفاعل بين عاملى الدراسة (مواعيد الزراعة والمقننات المائية) تحت ظروف هذا البحث فقد وجد أن أفضل تفاعل تم الحصول عليه كنتيجة لزراعة اللوبيا فى منتصف شهر يوليو مع الري بمعدل 80 % من الأحتياجات



## Effect of planting dates and drip irrigation rates on growth, yield and .....

الفعلية لرى نباتات اللوبيا /فدان حيث أدت هذ المعاملة الى زيادة مغنوية و بخاصة زيادة محصول البذور الجافة وارتفاع جودتها وكذلك زيادة كفاءة استخدام مياه الري /فدان مقارنة بالتفاعلات الأخرى. حيث تعتبر هذه المعاملة أفضل المعاملات لأنتاج أعلى محصول بجودة مرتفعة مع توفير جزء من مياه الري.

ويمكن التوصية بزراعة بذور اللوبيا لأنتاج المحصول البذرى الجاف فى منتصف شهر يوليو والرى بمعدل 80 % من الأحتياجات الفعلية لرى نباتات اللوبيا /فدان حيث يعتبر نتاج هذه المعاملة من أفضل النتاج المتحصل عليها تحت ظروف تلك التجربة وذلك من حيث قدرته على خفض التأثير الضار للأجهاد المائى لنباتات اللوبيا والحصول على أعلى محصول من البذور الجافة وزيادة جودتها وكذلك زيادة كفاءة استخدام مياه الري /فدان حيث أمكن توفير حوالى 20 % من المياه المستخدمة لرى نباتات اللوبيا /فدان تحت ظروف الأراضى الرملية مقارنة بالمعاملات الأخرى وخاصة معاملة التفاعل بين زراعة بذور اللوبيا فى الثامن والعشرون من شهر أغسطس والرى بمعدل 60 % من الأحتياجات الفعلية لرى نباتات اللوبيا /فدان حيث أدت هذه المعاملة الى الحصول على أقل القيم تحت الدراسة وذلك فى كلا الموسمين على التوالى.

الكلمات الداله: اللوبيا ، مواعيد زراعته، المقتنات مائية، كفاءة استخدام مياه الري، الأراضى المستصلحة حديثاً .

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