STUDYING THE EFFECT OF SOME PARAMETERS ON QUINOA CROP

Moursy, M. A. M.[1], K. I. Wasfy [2] and M. H. Rady[1]

ABSTRACT

Agricultural irrigated area depends on the availability of irrigation water. To cope with scarcity of water supplies, deficit irrigation is an important tool to achieve the goal of reducing irrigation water use. Field experiments were carried out to study the effect of forward speed of seed drill (2.1, 3.6, 4.5 and 6.3 km/h), deficit irrigation (zero, 15 and 30%) and fertilization methods (broadcasting and fertigation) on the amount of water applied, productivity, water and fertilizer use efficiency, net return and net return/m^3 of Quinoa (Chenopodium quinoa W.) in sandy soils.

The main results of the study could be summarized as follow:-

- *Increasing the forward speed, increased field capacity and therefore, seed scattering was increased, vice versa field efficiency values were decreased.*
- *Amount of water applied and water consumptive use were (1989 and 1611), (1750 and 1407) and (1527 and 1268) m^3/fed for treatments zero, 15 and 30% deficit irrigation, respectively. The water saving was 12 and 23.2 % for treatments 15 and 30% deficit irrigation, respectively as compared with treatment zero deficit irrigation.*
- *Seed and straw productivity, water and fertilizer use efficiency, net return and net return/m^3 were increased under using fertigation method and forward speed of 3.6 km/h.*
- *Net return/m^3 under 15% deficit irrigation (2.55 LE/m^3) was higher than under zero and 30% deficit irrigation (2.31 and 2.54 LE/m^3) under fertigation method and 3.6 km/h forward speed.*
- *Fertilization by fertigation was more efficiency than broadcasting fertilizers.*

INTRODUCTION

Agriculture has been and still the backbone of Egyptian national economy. Therefore, it is vital that any program for economic development should bear on getting the highest production using

[1] Researcher - Water Management Research Institute, National Water Research Center.
[1] Lecturer of Agric. Eng., Fac. of Agric., Zagazig Univ.

the best agricultural techniques with least effort and cost. Modern irrigation methods, mechanization and fertilization techniques are becoming necessary to save water and chemicals fertilization for cultivating new reclamation soil. Quinoa (*Chenopodium quinoa* W.) which has been an important cultivated food crop in the Peruvian and Bolivian Andes for more than 5000 years and recently it attracted more attention due to its high nutritional values and strong growth potential under the extreme harsh conditions of drought and soil salinity. The nutrient composition is favorable compared with common cereals. Quinoa seeds contain essential amino acids like lysine and acceptable quantities of calcium, phosphorus, and iron. One of the shortcomings overcome by quinoa involves its protein content. Most grains are considered to be inadequate as total protein sources because they lack adequate amounts of the amino acids lysine and isoleucine. By contrast, quinoa has significantly greater amounts of both lysine and isoleucine (especially lysine) and these greater amounts of lysine and isoleucine allow the protein in quinoa to serve as a complete protein source. It is an equally impressive food in terms of its overall phytonutrient benefits. Due to that, Quinoa is newly introduced as a food crop can replenish part of food gap, but; it has more privileges because this crop can be drought, salinity tolerant and could be grown in sandy soil of arid and semiarid regions and with other most harmful abiotic adverse factors that affect crop production **(Ogungbenle, 2003 and Shams, 2010)**.

The main aims which affected on plants were irrigation, sowing methods and fertilizers. **Arnaout (1999)** reported that the applied fertilizers through the modern irrigation methods (surface drip, subsurface drip and sprinkler) are more efficient than broadcasting fertilizer. He also found that the fertigation through surface and subsurface drip and sprinkler reduced the cost of production unit (LE/Mg) by 38%, 40% and 33.75%, respectively than broadcasting fertilizer. **Erdem *et al.* (2006)** found that increasing drought stress, decreases the grain yield and weight of 1000 grains. Fertigation technique also were indicated to by **Abdel-Aziz and El-Bagoury (2008)** which proved that fertigation method increased total yield by 11.79 – 12.62% under drip and sprinkler irrigation system respectively comparing with the traditional method of fertilization and pea yield increased from (0.35 to 2.46 ton/fed) and from (0.26 to 1.98 ton/fed) with increasing fertigation rate from 30 to 60 kg N/fed under both drip and sprinkler irrigation systems, respectively. **Abou El-Azem (2009)** compared among four irrigation levels (60, 80, 100 and 120% evaporation pan coefficient) under grain sorghum and showed that the irrigation with 80% gave the best results with regard to yield components and grain yield and the maximum values of water use efficiencies was found when irrigated by 80%. Where, saving water were 46.15, 24.32 and 12.39% through irrigation using evaporation pan coefficients 60, 80 and 100% compared to 120%. **Ahmad *et al.* (2009)** indicated that with increasing water stress the plant height and plant dry matter decreased under controlled conditions**. Fghire *et al*. (2015)** investigate the effect of deficit irrigation (ETc 100%, 50%, 33% and rainfed) and manure fertilization (with (2kg/m²) and without manure fertilization) on quinoa crop and found that deficit irrigation of 50% ETc caused significant reduction in grain yield to the tune of 15.83% and 15.15 % respectively of the with and without manure compared to 100% ETc. By increasing deficit irrigation, 33% ETc and rainfed decreased significantly the grain yield. 50% ETc gave the highest water use efficiency (1.94Kg/m^3) in comparison to both controls, with and without manure treatments.

Quinoa is a new crop in Egypt and was sowing manually for that the effect of different forward speeds for seed drill was studied to sown quinoa. The fertilizer method effect in fertilizer efficiency, the fertilizer by broadcasting machine leads to losses large amounts of fertilizer for that the fertilizer is evaluated by fertigation.

The objectives of this study are:

1- To evaluate some different parameters of seed drill forward speed, deficit irrigation and fertilization methods that affecting on the quinoa crop production.

2- To determine the highest water and fertilizer use efficiency and net return of different seed drill forwards speed and deficit irrigation under fertilization method.

MATERIALS AND METHODS

Field experiments were carried out on sandy soil through agricultural season of 2013/2014 at private farm in El-Khattara, Sharkia Governorate, Egypt. El-Khattara is situated at 30° 38' 24″ N latitude, 31°50'54"E longitude. Total area of the farm was 10 feddans.

1. Materials

1.1. Soil analysis: Soil samples from each plot were taken from 0-20 cm and 20-40 cm depth before planting quinoa crop and then, the mechanical properties were analyzed according to standard methods of **Peterson and Calvin (1965) and APHA (1989)** as shown in Table (1).

Table (1): Soil mechanical analysis

Soil layer, cm	Particle size distribution, %			Texture class	Bulk density, g/cm^3	Moisture content, %		
	Sand	Silt	Clay			F. C.	W.P.	A.W.
0 –20	88.0	9.7	2.3	Sandy	1.35	11.0	5.0	6.0
20-40	89.1	9	1.9		1.24	10.7	5.1	5.6

1.2. Crop: Quinoa crop was used under this study in order to select the optimum conditions for its planting, fertilizing and water requirements under Egyptian conditions. Quinoa was sown at the rate of 4 kg/fed and planted at dates of 5th Nov. and harvesting date 10th May. The physical and mechanical properties of quinoa seeds were determined as shown in Table (2).

Table (2): Physical and mechanical properties of Quinoa seeds

Physical properties		Mechanical properties	
Length, mm	1.91	Repose angle, degree	33
Width, mm	1.86		
Thickness, mm	1.26	Friction angle, degree	27
Mass of 1000 seeds, g	30	Coefficient of friction	0.51
Bulk density, g/cm^3	0.67		

1.3. Water analysis: water samples were taken from water pump and the chemical analysis was determined as shown in Table (3).

Table (3): Chemical analysis of water.

pH	EC (dS/m)	Soluble Cations (meq/L)				Soluble Anions (meq/L)			
		K^+	Na^+	Mg^{++}	Ca^{++}	So_4^{--}	Cl^-	HCO_3^-	CO_3^{--}
7.5	1.76	10.2	6.4	4.6	0.8	9.7	6.4	-	6.3

1.4. Fertilizer: The fertilizer of calcium super phosphate (15% P_2O_5) was applied during soil preparation at the rate of 30 kg/fed. Nitrogen in the form of ammonium sulfate (20.5%) was added at the rate of 150 kg/fed at four equal doses under broadcasting method but under fertigation method at 8 doses, according to **Shams (2012).**

1.5. Machinery and equipment:

1.5.1. Tractor Kubota V 1702 – DI – A: Tractor L 2850 (4WD), made in Japan, engine power 25.4 kW (34 hp), direct injection, water cooled, 4 cycles diesel, 4 cylinders, engine rated speed 2600 rpm and mass 1230 kg.

1.5.2. Seed drill: Mounted seed drill, model Colorado, made in Italy, 21 tubes, spacing between tubes 10 cm and mass 350 kg.

1.5.3. Broadcasting machine: Mounted broadcaster, model Rond INI SR 250, made in Italy, 6 blades and 250 kg capacity.

1.6. Irrigation system: The sprinkler irrigation system was used under study. Control head consist of centrifugal pump, pressure regulator, pressure gauges, flow meter and filters. The main, sub-main, secondary and lateral lines were made from PVC pipes that having diameters of 125, 110, 90 and 63 mm, respectively. The distance between lateral lines and between the sprinklers as shown in Fig. (1) was 12 m, sprinkler riser 0.75 inch diameter and 75 cm height above soil. Rotating sprinklers 0.75 inch out diameter, 1.25 m^3/h discharge 2.2 bar operating pressure.

2. Methods

The experimental area was about 1.65 fed cultivated with quinoa. They divided into two main plots for broadcasting machine and fertigation method, the main plots have dimensions of 12 x 96 m. The experiments were carried out in a split-split plot design Fig. (1)

2.1. Experimental condition

Field experiments were conducted under the following variables:-

- The main treatment (two fertilization methods (broadcasting machine and fertigation).
- The sub main (four seed drill forward speeds (2.1, 3.6, 4.5 and 6.3 km/h)).
- The sub sub main (three deficit irrigation (zero, 15 and 30%)).

Planting quinoa was carried out by using seed drill at an average depth of 2.5 cm under previous mentioned forward speeds. The average forward speed of broadcasting machine was 6 km/h.

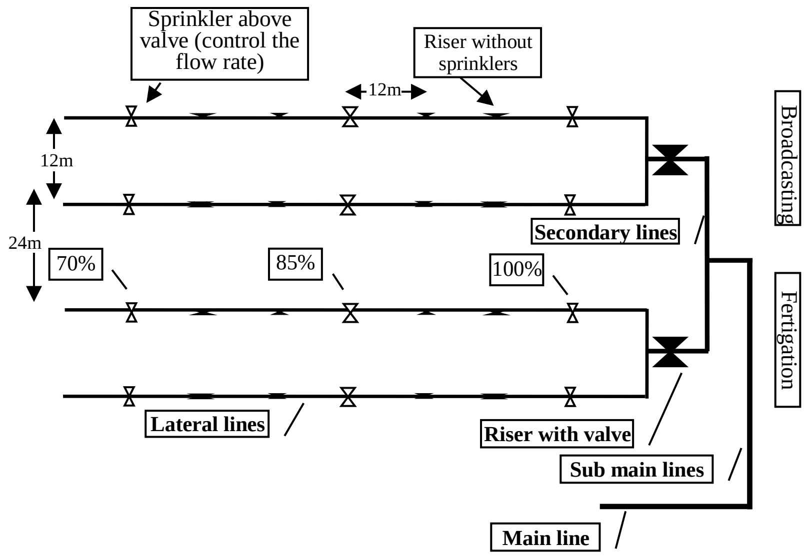

Fig. (1), Schematic of the used sprinkler irrigation system

2.2. Measurement and determinations

2.2.1. Seed scattering

Seed scattering is very important parameter to determine the performance of planting machines. It was determined according to the following formula (**Snedecor and Cochran, 1967**) as,

$$C.V. = \frac{\sigma n-1}{\bar{x}} \times 100 \qquad \sigma n-1 = \sqrt{\frac{\sum (x-\bar{x})^2}{n-1}}$$

Where:

C.V.: Coefficient of variation between row from average distance, %

$\sigma n-1$: Standard deviation $\bar{x}$: The average distance

x: Distance between rows n: Number of readings

Field capacity and efficiency

The theoretical field capacity is the rate of the field coverage that will be obtained if the machine is performed its function 100% of the time at the rated forward speed and always cover 100% of its rated width (**Kepner *et al.* 1978**). Thus, it was calculated as:

$$T_{f.c.} = (W_m \text{ x } F_s) / 4.2$$

Where: $T_{f.c:}$ Theoretical field capacity, fed/h

W_m: Width of the machine, m $F_{s:}$ Forward speed, km/h

However, actual field capacity ($A_{f.c.}$) is based upon the total effective operating time (**Kepner *et al.* 1978**). Thus, it was calculated as:

$$A_{f.c.} = 1 / T_t$$

Where: T_t: Actual total time in hours required per feddan, h/fed

While, the field efficiency (η_f) was calculated by using the following formula:

$$\eta_f = (A_{f.c.} / T_{f.c.}) \times 100$$

Power and energy requirements.

The required power (*EP*) was calculated using the following formula according to **(Embaby, 1985*).***

$$EP = \left(F_c \times \frac{1}{3600}\right) \times p_f \times L.C.V. \times 427 \times \mu_{th} \times \mu_m \times \frac{1}{75} \times \frac{1}{1.36}, kW$$

Where:

F_c = Fuel consumption, *l/h*

ρ_f = Density of diesel fuel (0.85 *kg/l*)

L.C.V. = Lower calorific value of diesel fuel (10000 *kcal/kg*)

427= Thermo-mechanical equivalent, *kg.m/kcal*

η_{th} = Thermal efficiency of diesel engine, (40%)

η_m = Mechanical efficiency of diesel engine, (80%).

The Energy Requirements (ER) was estimated using the following equation:-

$$ER = \frac{\text{Required power (kW)}}{\text{A fielctual field capicity (fed./h)}}, kW.h/fed$$

2.2.2. Amount of water applied

The irrigation requirements was calculated according to the equation given by **Israelsen and Hansen (1962)** as follows:

$$D_{aiw} = \frac{F.C. - \theta_1}{100} \times B_d \times d$$

Where:

D_{aiw}	: Depth of irrigation water applied	(mm)
F. C.	: Soil moisture content at field capacity	(%)
Θ_1	: Soil moisture content before irrigation	(%)
B_d	: Bulk density	(g/cm^3)
d	: Soil depth	(mm)

2.2.3. Water Consumptive Use

The actual water consumptive use was calculated using the following equation described by **Israelsen and Hansen (1962)** as the follow:

$$W_{cu} = \frac{\theta_2 - \theta_1}{100} \times B_d \times d$$

Where:

W_{cu} : Water consumptive use (mm)

Θ_2 : Soil moisture content after irrigation (%)

2.2.4. Yield components at harvest, samples of plants were taken from each treatment to estimate the following:

- Plant height (cm).
- Seed yield (kg/fed.).
- Straw yield (kg/fed.).

2.2.5. Water use efficiency (WUE):

It was determined according to (**Pene and Edi, 1996*)*** using the following equation:

$$\text{WUE} = \frac{\text{Yield (kg/fed.)}}{\text{Amount of water applied (m}^3\text{/fed)}}\ \text{, kg/m}^3$$

2.2.6. Fertilizer use efficiency (FUE):

It was determined using the following equation as sited from **Abdel-Aziz and El-Bagoury (2008)**:

$$\text{FUE} = \frac{\text{Yield (kg/fed)}}{\text{Total applied nitrogen (kg/fed)}}\text{, kg yield/kg nitrogen}$$

2.2.7. Economic analysis

- Total return (LE/fed.) was calculated with the following equation:

  Total return = price (LE/kg)× productivity (kg/fed)
- Total costs (LE/fed.) was calculated with the following equation:

  Total cost = fixed cost + variable cost
- Net return (LE/fed.) was calculated with the following equation:

  Net return = Total return - Total costs
- Net return/ m^3 (LE/m^3) was calculated by using the following formula:

$$\text{Net return/m}^3 = \frac{\text{Net return (LE/fed.)}}{\text{Amount of water applied (m}^3\text{/fed)}}\ \text{, LE/m}^3$$

2.2.8. Statistical analysis:

Data were subjected to statistical analysis according to **Snedecor and Cochran (1990).** This statistical was done by SPSS program.

RESULTS AND DISCUSSION

The obtained results will be discussed under the following heads:-

Seed scattering

Results of the effect of seed drill forward speed on quinoa seed scattering as shown in Fig. (2) clarified that increasing forward speed from 2.1 to 6.3 km/h, increased seed scattering from 4.02 to 7.05 %. Increasing the forward speed, increased the machine vibration, more slip occurred and therefore, seed scattering was increased.

Field capacity and field efficiency

The effect of forward speed on field capacity and field efficiency in Fig. (3) showed that increasing forward speed from 2.1 to 6.3 km/h, increased field capacity from 0.89 to 1.83 fed/h. While, field efficiency values were decreased by increasing the forward speed. Increasing forward speed from 2.1 to 6.3 km/h, decreased field efficiency values from 84.76 to 58.10 %. The major reason for this reduction in field efficiency by increasing forward speed was due to the less theoretical time consumed in comparison with the other items of time losses.

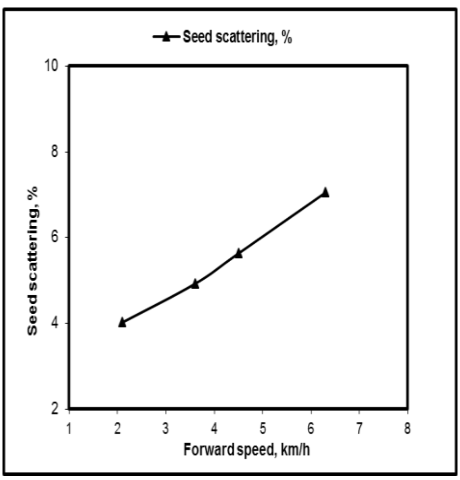

Fig. (2): Effect of seed drill forward speed on seed scattering.

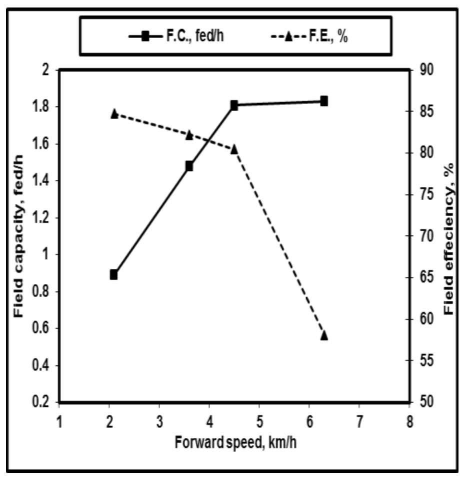

Fig. (3): Effect of seed drill forward speed on field capacity and field efficiency.

Amount of water applied, water consumptive use and water saving

The presented data indicated clearly that the amount of water applied and water consumptive use varied greatly according to the variation in the treatments. It can be noticed that amount of water applied and water consumptive use were (1989 and 1611), (1750 and 1407) and (1527 and 1268) m^3/fed, for treatments zero, 15 and 30% deficit irrigation, respectively. It can be concluded that amount of water applied was lower with treatment of 30% deficit irrigation than these applied with other treatments while, the highest volume of applied water was found to be under the zero deficit irrigation treatment, where full irrigation 100% of amount of water applied was practiced during the whole cropping period. On the other hand, 30% deficit irrigation where lower irrigation was the one with the lowest irrigation volume corresponding to only 23.2% of that of the zero deficit irrigation.

The water saving was 12 and 23.2 % for treatments 15 and 30% deficit irrigation, respectively compared with treatment of zero deficit irrigation.

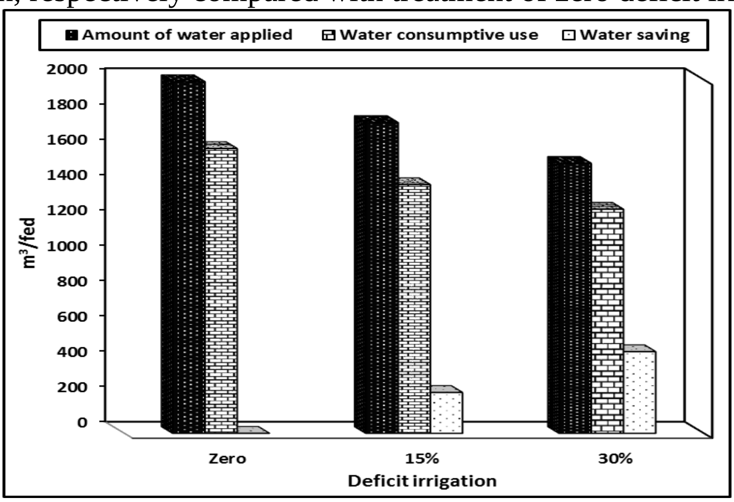

Fig. (4): Amount of water applied, water consumptive use and water saving under investigated irrigation treatments.

Plant height

The statistical analysis of the data showed significant effect for plant height under study as influenced by fertilizer method. The values are presented in **Table 4**. Data clarified that by using fertigation method the plant height was increased compared with broadcasting. Fertigation method increased the plant height by 7.9% compared with broadcasting.

Regarding to seed drill forward speed, the results reveal that there was no significant in plant height. Increasing forward speed from 2.1 to 6.3 km/h, decreased plant height under different treatments. By increasing forward speed from 2.1 to 6.3 km/h decreased the plant height from

141.37 to 134.33 cm and from 153.67 to 143.67 cm under broadcasting and fertigation methods, respectively. The increase in plant height at lower forward speed was attributed to the increase in plant population because under high plant population, the competition among adjacent plants pushed them in the vertical direction to obtain enough light.

With regard to the effect of deficit irrigation, statistical analysis revealed that deficit irrigation had a significant effect on plant height. Decreasing deficit irrigation from 30 to zero% the plant height increased from 119.03 to 151 cm and from 132.5 to 163.96 cm under broadcasting and fertigation methods.

Interaction between fertilizer method, forward speed and deficit irrigation was insignificant.

Table 4: The plant height (cm) of quinoa under the effect of deficit irrigation, forward speed and fertilizer methods.

Fertilizer methods	Forward speed	Deficit irrigation			Mean
		Zero	15%	30%	
Broadcasting	2.1	155	147	122	141.37
	3.6	152	145	121	139.33
	4.5	150	144	118	137.33
	6.3	147	141	115	134.33
Mean		151	144.25	119.03	138.09
Fertigation	2.1	167	156	138	153.67
	3.6	166	152	135	150.94
	4.5	162	150	132	148
	6.3	161	145	125	143.67
Mean		163.96	150.75	132.5	149.07

LSD at 5%

Fertilizer methods (F)	**S**
Forward speed (S)	N.S
Deficit irrigation (D)	**S**
F*S	N.S
F*D	N.S
S*D	N.S
F*S*D	N.S

Seed and Straw productivity

Data in **Table 5** showed that deficit irrigation and fertilization methods significantly affect in seed productivity while forward speed had insignificant effect.

Relating to fertilizer method, data indicated that seed productivity increased significantly by using fertigation method compared with broadcasting. The highest value of seed productivity was 664.93 kg/fed under fertigation method. The increase in productivity may be due to the fertigation as attractive concept, as it permits application of nutrients directly at the site of a high concentration of active roots and as needed by the quinoa plants, while applying the fertilizers using broadcasting method causes non-uniformity distribution of fertilizer through the soil profile and consequently, decreasing fertilizer utilization efficiency and crops productivity **(El-Gindy, 1988).**

With regard to the effect of deficit irrigation, it is obvious that the decreasing of irrigation by 15 and 30% decreased the seed productivity by (3.5 and 17.3%) and (3.9 and 15.9%) under broadcasting and fertigation method, respectively than treatment with no decreasing of irrigation (zero).

As to effect of seed drill forward speed, the seed productivity was increased by increasing forward speed up to 3.6 km/h and then, decreased. Seed productivity was increased from 595 to 627 kg/fed and from 664 to 709.67 kg/fed with increasing forward speed from 2.1 to 3.6 km/h, while it decreased from 627 to 568.31 kg/fed and from 709.67 to 639.18 kg/fed by increasing forward speed from 3.6 to 6.3 km/h under broadcasting and fertigation methods, respectively.

With regard to the effect of different treatments on straw productivity, statistical analysis revealed that different forward speed, deficit irrigation and fertilization methods had a significant effect on straw productivity. **Table 5** showed that fertigation methods produced higher straw productivity compared to broadcasting methods. With increasing the deficit irrigation the straw productivity decreased. By increasing forward speed from 2.1 to 3.6 km/h the straw productivity was increased, while increasing forward speed to 4.5 and 6.3 km/h the straw productivity decreased.

Interaction between fertilizer method, forward speed and deficit irrigation was insignificant.

Table 5: seed and straw productivity of quinoa under the effect of deficit irrigation, forward speed and fertilizer methods.

		Seed				Straw			
Fertilizer methods	Forward speed	Deficit irrigation			Mean	Deficit irrigation			Mean
		Zero	15%	30%		Zero	15%	30%	
Broadcasting	2.1	633	614	538	595	1077	1002	829	969.33
	3.6	667	640	574	627	1156	1087	925	1056
	4.5	614.01	599.26	525.63	579.63	1055.5	984.97	816.57	952.33
	6.3	608.3	583.08	513.54	568.31	1029.3	974.13	804.32	935.92
Mean		630.58	609.09	537.79	592.49	1079.4	1012	843.72	978.4
Fertigation	2.1	701	681	610	664	1198	1102	982	1094
	3.6	755	725	649	709.67	1310	1231	1074	1205
	4.5	679.97	664.66	595.97	646.87	1174	1083.3	967.27	1074.9
	6.3	688.56	646.71	582.26	639.18	1166.4	1071.4	952.76	1063.5
Mean		706.13	679.34	609.31	664.93	1212.1	1121.9	994.01	1109.3

LSD at 5%	Seed	Straw
Fertilizer methods (F)	**S**	**S**
Forward speed (S)	N.S	S
Deficit irrigation (D)	**S**	**S**
F*S	N.S	N.S
F*D	N.S	N.S
S*D	N.S	N.S
F*S*D	N.S	N.S

Water use efficiency

The water use efficiency of seed and straw as affected by fertilizer method, seed drill forward speed and deficit irrigation and combined of them are presented in **Table 6.**

The results indicated that water use efficiency of seed was significant affected by fertilizer method and deficit irrigation, while insignificant affected by forward speed.

By using fertigation method the water use efficiency increased compared with broadcasting method. Fertigation method increased seed water use efficiency by 11.8% compared with broadcasting method.

As to effect of deficit irrigation, illustrated data in **Table 6** indicated that the seed water use efficiency increased with increasing deficit irrigation. Deficit irrigation 30% increased seed water use efficiency by 2.5 and 11.11% compared with 15 and zero deficit irrigation under fertigation method.

Results showed that the average seed water use efficiency under forward speed of 3.6 km/h (0.41kg/m^3) was higher than that under 2.1, 4.5 and 6.3 km/h (0.38, 0.37 and 0.37 kg/m^3) by 7.9, 10.8 and 10.8% under fertigation method.

The results indicated that water use efficiency of straw was significant affected by fertilizer method, while insignificant affected by forward speed and deficit irrigation.

Straw water use efficiency under fertigation method was higher than that under broadcasting method. Also, the straw water use efficiency increased with increasing deficit irrigation under different forward speed.

Interaction between fertilizer method, forward speed and deficit irrigation was insignificant.

Table 6: seed and straw water use efficiency of quinoa under the effect of deficit irrigation, forward speed and fertilizer methods.

		Seed				Straw			
Fertilizer methods	**Forward speed**	**Deficit irrigation**			**Mean**	**Deficit irrigation**			**Mean**
		Zero	**15%**	**30%**		**Zero**	**15%**	**30%**	
Broadcasting	**2.1**	0.32	0.35	0.35	0.34	0.54	0.57	0.54	0.55
	3.6	0.34	0.36	0.38	0.36	0.58	0.62	0.61	0.60
	4.5	0.31	0.34	0.34	0.33	0.53	0.56	0.53	0.54
	6.3	0.31	0.33	0.34	0.32	0.52	0.55	0.53	0.53
Mean		0.32	0.35	0.35	0.34	0.54	0.58	0.55	0.56
Fertigation	**2.1**	0.35	0.39	0.40	0.38	0.60	0.63	0.64	0.62
	3.6	0.38	0.41	0.42	0.41	0.66	0.70	0.70	0.69
	4.5	0.34	0.38	0.39	0.37	0.59	0.62	0.63	0.61
	6.3	0.35	0.37	0.38	0.37	0.59	0.61	0.62	0.61
Mean		0.36	0.39	0.40	0.38	0.61	0.64	0.65	0.63

LSD at 5%		
Fertilizer methods (F)	**S**	**S**
Forward speed (S)	N.S	N.S
Deficit irrigation (D)	**S**	N.S
F*S	N.S	N.S
F*D	N.S	N.S
S*D	N.S	N.S
F*S*D	N.S	N.S

Fertilizer use efficiency

From statistical analysis data indicated that forward speed, deficit irrigation and fertilizer methods had a significant influence on fertilizer use efficiency. Results showed that the highest value of seed and straw fertilizer use efficiency were 5.03 and 8.73 kg/kg-N under conditions of using fertigation method, 3.6 km/h forward speed and zero deficit irrigation.

Data as illustrated in **Table 7** indicated that fertilizer use efficiency under fertigation method was higher than that under the broadcasting method. This may be due to the fertilizer elements in solution become available to the plant root faster than when placed dry in the soil by broadcaster.

Table 7: seed and straw fertilizer use efficiency of quinoa under the effect of deficit irrigation, forward speed under fertilizer methods.

		Seed				Straw			
Fertilizer methods	Forward speed	Deficit irrigation			Mean	Deficit irrigation			Mean
		Zero	15%	30%		Zero	15%	30%	
Broadcasting	2.1	4.22	4.09	3.59	3.97	7.18	6.68	5.53	6.46
	3.6	4.45	4.27	3.83	4.18	7.71	7.25	6.17	7.04
	4.5	4.09	4.00	3.50	3.86	7.04	6.57	5.44	6.35
	6.3	4.06	3.89	3.42	3.79	6.86	6.49	5.36	6.24
Mean		4.20	4.06	3.59	3.95	7.20	6.75	5.62	6.52
Fertigation	2.1	4.67	4.54	4.07	4.43	7.99	7.35	6.55	7.29
	3.6	5.03	4.83	4.33	4.73	8.73	8.21	7.16	8.03
	4.5	4.53	4.43	3.97	4.31	7.83	7.22	6.45	7.17
	6.3	4.59	4.31	3.88	4.26	7.78	7.14	6.35	7.09
Mean		4.71	4.53	4.06	4.43	8.08	7.48	6.63	7.40

LSD at 5%		
Fertilizer methods (F)	**S**	**S**
Forward speed (S)	**S**	**S**
Deficit irrigation (D)	N.S	**S**
F*S	N.S	**N.S**
F*D	N.S	**N.S**
S*D	N.S	**N.S**
F*S*D	N.S	**N.S**

By decreasing deficit irrigation, fertilizer use efficiency increased.
Regarding the effect of different forward speed on fertilizer use efficiency. It is found that the fertilizer use efficiency was increased by increasing forward speed from 2.1 to 3.6 km/h and then, decreased.

As to effect of fertilizer method, the seed and straw fertilizer use efficiency values were 4.45 and 7.71 kg/kg-N under zero deficit irrigation, forward speed of 3.6 km/h under broadcasting machine.
Interaction between fertilizer method, forward speed and deficit irrigation was insignificant.

Economic evaluation

Economic evaluation asked for estimating different cost items achieve related to different treatments as well as total returns. According, net returns and net returns/m^3 were estimated. **Table (8)** shows that the lowest total cost of quinoa production was 2333 LE/fed under 30% deficit irrigation at forward speed of 3.6 km/h and fertigation method, while the highest total cost of quinoa production was 2714 LE/fed under zero deficit irrigation at forward speed of 2.1 km/h and broadcasting method.

Table (8): Effect of different treatments on total cost, total return, net return (LE/fed) and net return/m^3.

Forward speed (km/h)	Deficit irrigation	Amount of water applied (m^3/fed)	Broadcasting				Fertigation			
			Total cost (LE/fed)	Total return (LE/fed)	Net return (LE/fed)	Net return/m^3 (LE/m^3)	Total cost (LE/fed)	Total return (LE/fed)	Net return (LE/fed)	Net return/m^3 (LE/m^3)
2.1	Zero	1989	2714.0	6057.8	3343.8	1.68	2664.0	6708.6	4044.6	2.03
	15%	1750	2564.0	5876.0	3312.0	1.89	2514.0	6517.2	4003.2	2.29
	30%	1527	2414.0	5148.7	2734.7	1.79	2364.0	5837.7	3473.7	2.27
3.6	Zero	1989	2683.0	6383.2	3700.2	1.86	2633.0	7225.4	4592.4	2.31
	15%	1750	2533.0	6124.8	3591.8	2.05	2483.0	6938.3	4455.3	2.55
	30%	1527	2383.0	5493.2	3110.2	2.04	2333.0	6210.9	3877.9	2.54
4.5	Zero	1989	2685.0	5876.1	3191.1	1.60	2635.0	6507.3	3872.3	1.95
	15%	1750	2535.0	5735.0	3200.0	1.83	2485.0	6360.8	3875.8	2.21
	30%	1527	2385.0	5030.2	2645.2	1.73	2335.0	5703.4	3368.4	2.21
6.3	Zero	1989	2688.0	5821.5	3133.5	1.58	2638.0	6589.5	3951.5	1.99
	15%	1750	2538.0	5580.1	3042.1	1.74	2488.0	6189.0	3701.0	2.11
	30%	1527	2388.0	4914.5	2526.5	1.65	2338.0	5572.3	3234.3	2.12
Price of quinoa grains (US $ 1320 /ton), source FAO Stat data, 2012 & US $ = 7.25 EG pound										

Source: calculated from table (9).

The maximum net return/m^3 was 2.55 LE/m^3 under 15% deficit irrigation, forward speed 3.6 km/h and fertigation method, while the minimum value was 1.65 LE/kg under 30% deficit irrigation, forward speed 6.3 km/h and broadcasting method.
The data indicated that the maximum values of total return and net return were 7225.4 and 4592.4 L.E/fed, respectively, under fertigation method, 3.6 km/h forward speed and zero deficit irrigation.
By using 15% deficit irrigation had higher value of net return/m^3 (2.55 LE/m^3) and the net return decreased by 3% compared with zero deficit irrigation, vice versa was saved water about 12% and increased the cultivated area about 12% under the optimum condition through this studies using 3.6 km/h forward speed and fertigation method.

CONCLUSION

Results could be summarized as follows:

- There are an effect of different forward speed on the field capacity, scattering and field efficiency.
- Highest amount of water applied (1989 m^3/fed) was obtained under zero deficit irrigation compared with 30% deficit irrigation (1527 m^3/fed), by about 23% enhancement.
- There are significant effect of different treatments at 5% on seed and straw productivity, the highest seed and straw productivity (755 and 1310 kg/fed) was obtained under zero deficit irrigation, forward speed 3.6 km/h and fertigation method compared with 30% deficit irrigation, forward speed 6.3 km/h and broadcasting method (513.54 and 804.32 kg/fed).
- There are significant effect at 5% of different treatments on water and fertilizer use efficiency, fertigation method was higher than that under broadcasting method.
- Total cost of quinoa production under fertigation was lower than that when using broadcasting.
- Net return/m^3 under 15% deficit irrigation (2.55 LE/m^3) was higher than under zero and 30% deficit irrigation (2.31 and 2.54 LE/m^3) under fertigation method and 3.6 km/h forward speed.

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Table (9): Total cost under different treatments.

Fertilizer methods	Forward speed (km/h)	Deficit irrigation	Soil preparation	Chemical fertilizer	Labor	Irrigation (fixed + running)	Weed and best control	Total cost
Broadcasting machine	2.1	Zero	214	350	800	1100	250	2714
		15%	214	350	800	950	250	2564
		30%	214	350	800	800	250	2414
	3.6	Zero	183	350	800	1100	250	2683
		15%	183	350	800	950	250	2533
		30%	183	350	800	800	250	2383
	4.5	Zero	185	350	800	1100	250	2685
		15%	185	350	800	950	250	2535
		30%	185	350	800	800	250	2385
	6.3	Zero	188	350	800	1100	250	2688
		15%	188	350	800	950	250	2538
		30%	188	350	800	800	250	2388
Fertigation	2.1	Zero	214	350	750	1100	250	2664
		15%	214	350	750	950	250	2514
		30%	214	350	750	800	250	2364
	3.6	Zero	183	350	750	1100	250	2633
		15%	183	350	750	950	250	2483
		30%	183	350	750	800	250	2333
	4.5	Zero	185	350	750	1100	250	2635
		15%	185	350	750	950	250	2485
		30%	185	350	750	800	250	2335
	6.3	Zero	188	350	750	1100	250	2638
		15%	188	350	750	950	250	2488
		30%	188	350	750	800	250	2338

Source: Calculated under different treatments.

الملخص العربى

دراسة تأثير بعض العوامل على محصول الكينوا

د/ محمد عنتر محمد مرسى[1] د/ كمال ابراهيم وصفى أحمد[2] د/محمد حلمى راضى[1]

تعتبر الكينوا من المحاصيل التى يتم التغذيه عليها سواء كحبوب او خضروات ، حيث تحتوى على جميع الأحماض الأمينيه الضروريه وبالتالي فإنها تعد بروتينا كاملاً ، ولكنها أسهل كثيراً في هضمها من بروتينات اللحوم وبها محتوى أقل كثيراً من الدهون وغنية بالمغذيات الطبيعية التي تزود الجسم بالطاقه. تحتوى الحبوب على نسبه عالية من البروتين ١٦- ١٨% فى بينما حبوب القمح ١٣% بالإضافة الى تواجد الحامض الامينى الليسين فى بروتين الحبوب بنسبة تعادل ضعف المتواجد منه فى بروتين القمح وتحتوى على نسبه عاليه من كافة المعادن الضرورية للغذاء تفوق المتواجده فى باقى الحبوب ونسبه عاليه من فيتامين B و E ونظرا للقيمة الغذائيه العالية استخدمته وكالة الفضاء ناسا كغذاء متوازن وكامل لرواد سفن الفضاء.

أجريت هذه الدراسه بمزرعة بالخطاره – بمحافظة الشرقيه واستهدفت دراسة تأثير كلا من السرعه الأماميه للسطارة و الرى المنقوص و طريقة إضافة الأسمده الكيماويه على كلا من الإنتاجية وكفاءة إستخدام المياه والسماد وأيضا على العائد الاقتصادى لمحصول الكينوا.

ومن أهم النتائج التى توصلت اليها الدراسة:

١. بزيادة سرعة لسطارة زادت السعه الحقليه و زيادة التشتت، بينما قلت الكفاءة الحقليه.

٢. كمية مياه الرى المضافه والمستهلكه كانت (١٩٨٩ و١٦١١) و (١٧٥٠ و ١٤٠٧) و (١٥٢٧ و ١٢٦٨) م^{3}/ف تحت معاملات الرى المنقوص صفر و ١٥ و ٣٠% ، بينما كانت مياه الرى المتوفره حوالى ١٢ و ٢٣,٢% باستخدام الرى المنقوص ١٥ و ٣٠% بالمقارنة بالرى المنقوص صفر.

٣. وجد تاثير معنوى للمعاملات المختلفة و أعلى انتاجية بذور وقش وكفاءة استخدام المياه والتسميد وصافى الربح لمحصول الكينوا عند سرعة أمامية للآلة ٣,٦ كم/س والتسميد مع ماء الرى.

٤. أعلى عائد اقتصادى (٤٥٩٢,٤جنيه/فدان) تحت الرى المنقوص صفر والسرعة الامامية ٣,٦ كم/س واستخدام التسميد مع ماء الرى بينما أقل عائد إقتصادى (٢٥٢٦,٥ جنيه/فدان) باستخدام الرى المنقوص ٣٠% والسرعة الامامية ٦,٣ كم/س واستخدام التسميد بآلة النثر.

٥. أعلى عائد اقتصادى لوحدة المياه (٢,٥٥ جنيه/م^{3}) باستخدام الرى المنقوص ١٥% والسرعة الاماميه ٣,٦ كم/س و التسميد مع ماء الرى بينما كان اقل عائد (١,٥٨ جنيه/م٣) باستخدام الرى المنقوص صفر والسرعة الاماميه للآله ٦,٣ كم/س والتسميد بآلة النثر.

<u>عموما</u> تحت ظروف هذه الدراسة يمكن استخدام سرعة الآله الاماميه ٣,٦كم/س بالإضافة الى إستخدام الرى المنقوص ١٥% وإستخدام التسميد مع مياه الرى للحصول على أعلى عائد إقتصادى لوحده المياه (٢,٥٥ جنيه/م^{3}) وعائد إقتصادى (جنيه/فدان) يقل بحوالى ٣% مع وفر فى مياه الرى تعادل ١٢% وبالتالى زيادة الانتاجية لنفس كمية المياه المضافه.

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[1]باحث – معهد بحوث ادارة المياه – المركز القومى لبحوث المياه
[2] مدرس – قسم الهندسة الزراعية – كلية الزراعة – جامعة الزقازيق