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EFFECT OF WATER QUANTITY AND FARMYARD MANURE ON GARLIC UNDER SANDY SOIL CONDITIONS I. DRY WEIGHT AND PLANT CHEMICAL COMPOSITION

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ABSTRACT: This experiment was carried out during two successive winter seasons of 2000-2001 and 2001-2002 at EL-Khattara Experimental Farm, Fac. Agric., Zagazig Univ., to study the effect of water quantity, farmyard manure and their interactions on dry weight and plant chemical composition of garlic under sandy soil conditions.

Obtained results indicated that water quantity at the rate of 2600 m^3/*fed* recorded maximum values of dry weight of roots, bulb, leaves and total / plant, free and total water in leaves and total uptake of N, P and K by plant. Meanwhile, water quantity at 600 m^3/*fed* led to increase chlorophylls, carotenoids, prolein and bound water in leaf tissues.

Addition of 30 m^3FYM / *fed* recorded maximum values of total dry weight / plant and both free and total water in leaf tissues. Whereas, FYM at 45 m^3/*fed* recorded maximum concentration of all leaf pigments and total N, P and K uptake / plant. FYM treatments had no significant effect on bound water, in the second season only and prolein content in leaf tissues.

The interaction between 2100 or 2600m^3 /*fed* and 30 or 45 m^3 FYM/*fed* significantly increased total dry weight / plant .Garlic plants irrigated with 2100 m^3/*fed* and fertilized with FYM at 45m^3/*fed* gave the highest N and K content in bulb and leaves, respectively. Also the interaction between 2100 or 2600 m^3/*fed* and 45 m^3 FYM/*fed* significantly increased total uptake of N and K /plant.

Key words : garlic , water quantity, FYM, dry weight, leaf pigments, plant water relation and mineral uptake.

INTRODUCTION

Garlic (*Allium sativum* L.) is one of the oldest, and very important vegetable crops in Egypt, due to its wide local consumption as a spice, exportation and for medicinal properties.

It is well known that sandy soil is low fertile, low water retention, poor soil properties; i.e., physical, chemical and biological, and had high soil pH. Addition of organic fertilizers to sandy soil increases the amount of nutrients a soil can hold in a form which resists leaching. It also increases the water holding capacity of the soil. It lowers the soil pH, and hence increases the availability of nutrient elements in the soil.

Increasing soil moisture contents and / or irrigation water quantity increased total dry weight of garlic plants (Abou El-Magd, 1979; Maksoud *et al.*,1986; El-Mansi *et al.*,1999 a) , N, P and K uptake by plant (Abou El-Magd, 1979; El-Mansi *et al.*,1999 b), total and free water percentage in leaf tissues (Abou- El-Magd, 1979; Maksoud *et at.*,1986; El-Mansi *et al.*, 1999 b) and decreased chlorophylls a, b, total (a+b) and carotenoids, prolein and bound water in leaf tissues (El-Mansi *et al.*,1999 b and d on garlic and pea , respectively).

Also, fertilization of garlic plants with organic manure increased total dry weight /plant (Khalaf and Taha, 1988; Ali *et al.*, 2001 on garlic), N and P uptakes by leaves and N, P and K uptakes by bulb (Fayed, 1998 on onion), also, increased free water, but decreased bound water in leaf tissues (El-Mansi *et al.*, 1999 d on pea).

This study aimed to determine the suitable amounts of irrigation water and farmyard manure to obtain high yield of dry weight of garlic plant and high plant chemical composition, under sandy soil conditions.

MATERIALS AND METHODS

This experiment was carried out during two successive winter seasons of 2000-2001 and 2001-2002 at EL-Khattara Experimental Farm, Fac. Agric., Zagazig Univ., Sharkia Governorate, to study the effect of irrigation water quantity, farmyard manure and their interactions on dry weight, plant water relations and plant chemical composition of garlic plants under sandy soil conditions.

The physical and chemical analysis of the experimental soil, irrigation water and farmyard manure and are presented in Tables 1a, 1b and 1c.

Table 1a: The physical and chemical properties of the experimental soil in 2000-2001 and 2001-2002 seasons

Soil property	1st season	2nd season
Physical properties		
Sand (%)	92.80	96.36
Silt (%)	5.20	2.20
Clay (%)	1.94	1.40
Organic matter (%)	0.06	0.04
W.H.C (%)	16.08	14.20
F.C. (%)	8.04	7.10
W.P. (%)	4.02	3.60
Texture	Sandy	Sandy
Chemical properties		
pH	8.47	8.41
E.C. (mmhos/cm)	2.31	2.24
Available N (ppm)	4.21	3.87
Available P (ppm)	3.34	4.17
Available K (ppm)	10.39	10.73

Samples of the soil were obtained from 25 cm soil surface.
W.H.C: Water holding capacity; FC: Field capacity; WP: Wilting point; and E.C: Electric conductivity

Table 1b: Analysis of irrigation water

Properties		Values
EC	(dsm^{-1})	1.42
pH		8.02
Ca^{++}	(mol/l)	1.21
Mg^{++}	(mol/l)	1.08
Na^{+}	(mol/l)	12.20
K^{+}	(mol/l)	0.12
$SO4^{--}$	(mol/l)	1.44
$CO3^{--}$	(mol/l)	0.00
Cl^{-}	(mol/l)	5.79
$HCO3^{-}$	(mol/l)	7.38

Table 1c: Analysis of farmyard manure

Properties	1st season	2nd season
Total N %	0.53	0.50
Total N units in m^3 (340kg)	1.802	1.700

This experiment included 20 treatments, which were the combinations between five water quantities; i.e., 600, 1100, 1600, 2100 and 2600 m^3 */fed* and four amounts of farmyard manure; i.e., 0, 15,30 and 45 m^3 FYM /feddan.

These treatments were arranged in split plots in a randomized block design with three replications. The water quantities were randomly arranged in the main plots and the FYM were randomly distributed in the sub plots.

All the experimental units during germination stage up to 25 days from sowing received 100m^3 water, then irrigation treatments were started on 5th October in the two seasons of the study two days intervals. The irrigation treatments were stopped 15 days before harvesting time. The water was controlled using water counter and pressure counter.

The time and amounts of water in every irrigation are shown in Schedule 1.

Schedule 1: The time and amounts of applied irrigation water (m^3/*fed)* at every irrigation during the growth period of garlic via dripper lines with discharge of 2 L/h for each dripper at 0.5 bar.

Water quantity m ^{3}/*fed*	Irrigation numbers	Irrigation time (minute)/ irrigation	Water quantity (m^3/*fed)* / irrigation	Water quantity (m^3/plot) / irrigation (12.6 m^2)
500	80	8	6.25	0.01875
1000	80	16	12.50	0.03750
1500	80	24	18.75	0.05625
2000	80	32	25.00	0.07500
2500	80	40	31.25	0.09375

Plot size was 12.6 m^2 .It contained three dripper lines with 7m long and 60 cm in wide. A guard area (1.5 m wide) was left between each two experimental units to avoid the overlapping infiltration of irrigation.

Garlic cloves of Balady *cv* were selected for uniformity in shape and size. The cloves were sown on both sides of the dripper lines on September10th in both seasons at 7.5 cm apart.

All experimental units received equal amounts of commercial fertilizers/*fed*: .i.e., 600 kg ammonium sulfate (20.6%N), 200 kg calcium superphosphate (15.5%P_2O_5), 70 L orthophosphoric acid (85 %P_2O_5) and 200 kg potassium sulfate (48%-52% K_2O).

Total amounts of FYM and one third of the commercial fertilizers (200 kg ammonium sulfate, 68 kg potassium sulfate and 200 kg calcium superphosphate) were added at soil preparation. The rest of commercial fertilizers (two thirds); i.e., 400 ammonium sulphate, 132 potassium sulphate and 70 L orthophosphoric acid were added as fertigation times by 7 days intervals beginning one month after sowing.

The other normal agricultural treamtments for growing garlic plants were practiced.

Data Recorded:

1. Dry Weight

A random sample of ten plants were taken from each plot at 135 days after sowing in both seasons of study for measuring growth characters of garlic plants as follows :

The different parts of garlic plant; i. e., roots, leaves and bulb were oven dried at 70°C till constant weight and then were weighed and total dry weight / plant was calculated.

2.Leaf Pigments

Chlorophyll a, b as well as carotenoids in leaf tissues were determined at 135 days after sowing according to the method described by Wettestein (1957).

3. Plant Water Relations

Total, free and bound water in leaf tissues were determined at 135 days after sowing according to the methods described by Gosev (1960).

4.Prolein Amino Acid Content

It was determined in dry leaves at 135 days after sowing in the second season according to the method described by Bates (1973).

5.Nitrogen, Phosphorus and Potassium Contents

They were determined in rootss , bulb and leaves on the basis of dry weight according to the methods described by Bremner and Mulvaney (1982), Olsen and Sommers (1982) and Jakson (1970), respectively.

6.Statistical Analysis

All obtained data were subjected to the analysis of variance according to Snedecor and Cochran (1980). Mean separation was done according to LSD at 5 % level.

RESULTS AND DISCUSSION

1. Dry Weight

Concerning the effect of water quantity, data in Table 2 show significant differences in the dry weight of garlic roots, bulb, leaves and total / plant among the water quantity levels, in the two growing

Table 2: Effect of water quantity levels and farmyard manure on the dry weight (gm)of garlic plant in 2000-2001 and 2001-2002 season

Characters / Treatments	2000-2001 season				2001-2002 season			
	Root	Bulb	Leaves	Total	Root	Bulb	Leaves	Total
	Effect of water quantity (m^3/*fed*)							
600	0.78	2.43	3.45	6.66	0.74	1.96	2.29	4.99
1100	1.15	2.70	4.09	7.94	0.62	2.02	2.33	4.97
1600	1.26	3.13	4.22	8.61	0.91	2.40	2.89	6.20
2100	1.32	3.36	4.30	8.98	0.81	2.17	3.15	6.13
2600	1.16	3.28	5.08	9.52	0.82	2.51	3.40	6.73
LSD at 0.05 level	0.23	0.33	0.55	0.96	0.14	0.25	0.21	0.48
	Effect of farmyard manure (m^3/*fed*)							
0	1.05	2.41	3.37	6.83	0.67	1.96	2.31	4.88
15	1.02	2.72	4.10	7.84	0.83	2.18	2.65	5.67
30	1.23	3.28	4.70	9.21	0.78	2.35	2.98	6.12
45	1.23	3.49	4.77	9.49	0.84	2.36	3.30	6.51
LSD at 0.05 level	NS	0.28	0.39	0.39	NS	0.17	0.18	0.26

NS : not significant at 0.05 level

seasons. Increasing water quantity levels significantly increased the dry weight of different plant parts as well as whole plant. Higher water quantities; i.e., 2100 and 2600 m^3/*fed*, generally, attained heavier dry weights for the different plant parts without significant differences between them in most cases. It was also obvious that , the dry weights of different plant parts and total dry weight/ plant were at the lowest values under water stress; i.e. 600 or 1100 m^3/*fed*, in both seasons.

It could be suggested that increasing water quantity applied to garlic plants led to keep higher moisture content in the soil, and this in turn might favoured the plant metabolism that leads to the production of higher dry matter.

Water stress decreased the dry matter production due to the reduction in the uptake of nutritional elements causing disturbance in the physiological process need for plant growth (Salter and Goode, 1967), and /or to reduction in leaf area and photosynthetic rate (Fisher and Hagan, 1965).

Water stress affects carbohydrates metabolism, protein synthesis and the activities of many enzymes that may reflect a change in the balance between rates of synthesis and degradation leading to decrease in dry matter accumulation (Hamlyn 1986) .

Water stress causes an increase in ABA/CYT ratio, which in turn decreased plant growth (Marchner1995). He added that under sufficient water conditions there were decrease in ABA and increase in CYT, GA and IAA reflecting good growth and dry matter content. Moreover, under water stress the synthesis of ABA from carotenoids in roots occurs and then transport to different parts of plant especially leaves and this in turn affect the dry matter accumulation in leaves and different organs (Lancher, 1993).

These results are agreeable with those reported by Abou El-Magd (1979), Maksoud *et al.*, (1986) and El-Mansi *et al.*, (1999a) who reported that total dry weight of garlic plant significantly increased with increasing soil moisture or increasing water quantity up to 2600 m^3/feddan.

Regarding the effect of FYM, data in Table 2 reveal that FYM had significant effect on the dry weight of bulb, leaves and total / plant, while roots dry weight / plant was not significantly affected by FYM treatments. Higher FYM

levels; i.e., 30 and 45 m^3 / *fed* led to produce maximum dry weight of both bulb and leaves as well as total /plant without significant differences between them except leaves and total dry weight / plant, in second season plants without FYM produced the lowest dry weight of different plant parts and total plant. This means that 30 m^3/*fed* was economically much enough for enhancing dry matter production of garlic plant grown in sand soil.

Khalaf and Taha (1988) and Ali *et al.*(2001) found that total dry weight of garlic significantly increased with increasing organic manure up to 20 m^3/feddan.

Since sandy soil had low organic matter and also low mineral nutrition, organic manure can improve its content of organic matter and this in turn led to improve soil conditions. For maximum exploitation of organic matter, mineralization of the manure by its flora, needs N-supply for multiplication of such flora to utilize the organic manure. Therefore, application of organic and mineral nitrogen fertilizers together may increase the exchangeable water soluble of NPK , and the uptake of these elements (Cooke, 1972), consequently increasing cell division and cell enlargement .as a result , this might be reflected on the plant growth of garlic .

Farmyard manure contains many species of living organisms which release phytohormones as GA_3, IAA and CYT which stimulates plant growth, absorption of nutrients and photosynthesis processes (Reyndres and Vlassake,1982) and this in turn increases dry matter accumulation.

Regarding the interaction between water quantity and FYM, it is clear from the data in Table 3 that the interaction between irrigation water quantity and FYM had significant effect on dry weight of roots and leaves in the second season and total dry weight in both seasons. The interaction between 2100 or 2600 m^3 water/*fed* and 30 or 45 m^3 FYM / *fed* gave the highest total dry weight /plant .

However, the interaction between water quantity at the rate of 1600 m^3/*fed* and higher values of FYM; i.e., 30 or 45 m^3/*fed* produced total dry weight similar to those obtained by the interaction between higher levels of both water quantity and FYM. This may be due to organic fertilizers which can increase the water holding capacity of the soil.

Table 3: Effect of the interaction between water quantity levels and farmyard manure on the dry weight (gm) of garlic plant in 2000-2001 and 2001-2002 season

Treatments / Characters		2000-2001 season				2001-2002 season			
Water quantity (m^3/*fed*)	FYM (m^3/*fed*)	Root	Bulb	Leaves	Total	Root	Bulb	Leaves	Total
600	0	0.63	2.02	2.98	5.63	0.52	1.54	1.90	3.96
	15	0.74	2.46	3.58	6.78	0.69	1.83	2.00	4.52
	30	0.89	2.77	3.74	7.40	0.68	2.17	2.66	5.51
	45	0.87	2.46	3.49	6.82	1.05	2.35	2.60	6.00
1100	0	1.23	2.26	3.29	6.78	0.48	1.66	1.92	4.06
	15	0.67	2.32	3.74	6.73	0.65	2.13	2.38	5.16
	30	1.32	2.88	4.54	8.74	0.72	2.14	2.35	5.21
	45	1.40	3.36	4.81	9.57	0.61	2.18	2.67	5.46
1600	0	0.79	2.32	3.33	6.44	0.67	2.41	2.22	5.30
	15	1.52	2.89	4.06	8.47	1.04	2.32	2.49	5.85
	30	1.28	3.52	4.53	9.33	0.78	2.58	3.19	6.55
	45	1.48	3.78	4.96	10.22	1.16	2.32	3.66	7.14
2100	0	1.36	2.75	3.48	7.59	0.85	2.00	2.61	5.46
	15	1.16	2.90	4.08	8.14	0.97	2.14	2.76	5.87
	30	1.42	3.91	4.99	10.32	0.60	2.23	3.12	5.95
	45	1.36	3.86	4.65	9.87	0.82	2.36	3.78	6.96
2600	0	1.26	2.72	3.77	7.75	0.80	2.29	2.57	5.66
	15	1.08	3.04	4.96	9.08	0.79	2.51	3.63	6.93
	30	1.26	3.35	5.65	10.26	1.11	2.66	3.60	7.37
	45	1.07	4.01	5.96	11.04	0.56	2.62	3.79	6.97
L.S.D at 0.05 level		NS	NS	NS	0.87	0.31	NS	0.40	0.59

FYM : Farmyard manure ; NS : not significant at 0.05 level

On decomposition of the organic matter carbon dioxide is set free and this may be of indirect value in making available of some of the mineral elements in the soil and that may contributes in building metabolites leading to increas in dry matter accumulation.

2. Leaf Pigments

It is evident from the data in Table 4 that irrigation water quantity had significant effect on chlorophyll a, b, total (a+b) and carotenoides in leaf tissues of garlic plant. The concentration of chlorophyll a, b, total (a+b) as well as carotenoides significantly decreased with increasing irrigation water quantity up to 2600 m^3 / *fed*, in both seasons.

That means more intensive leaves were observed under water stress.

Addition of low quantity of water to garlic plants resulted in lowering the water content in leaf tissues and increase the thickness of blade of leaves and this in turn increased the intensity of the chlorophyll and carotenoides of garlic leaves.

Regarding the effect of FYM on leaf pigments content, data in Table 4 clearly indicate that FYM had significant effect on all leaf pigments. Increasing FYM rate up to the highest level (45m^3/*fed*) recorded maximum concentration of all leaf pigments. These results could be attributed to the property of organic manure, which improves soil water holding capacity and minerals need for pigments synthesis. In this respect, Hsieh and Hsu (1993) reported that the use of FYM increased soil acidity, organic matter, available P, exchangeable Mn, and Zn and this in turn may affect leaf pigments.

The enhancing effect due to the increase in nitrogen dose on photosynthetic pigments might be owe much to that N is a constituent o chlorophyll molecule. Moreover, nitrogen is the main constituent of all the amino acids. Correspondingly an enhancement of protein synthesis and chloroplasts formation leads to an increase in chlorophyll and carotene (Marschner, 1995).

Concerning the interaction between irrigation water quantity and FYM , it is clear from the data in Table 5 that the interaction treatments had no significant effect on chlorophyll a , b and total (a+b) as well as carotenoids in leaf tissues of garlic, except carotenoids in the first season.

Table 4: Effect of water quantity levels and farmyard manure on the leaf pigments content (mg/ gm DW) in garlic leaf tissues in 2000-2001 and 2001-2002 season

Characters / Treatments	2000-2001 season				2001-2002 season			
	Chlorophyll			Carotenoids	Chlorophyll			Carotenoids
	a	b	(a+b)		a	b	(a+b)	
Effect of water quantity (m^3/*fed*)								
600	3.41	1.96	5.37	2.79	3.48	1.33	4.81	3.50
1100	3.09	1.78	4.87	2.46	3.03	1.31	4.34	2.76
1600	2.91	1.86	4.77	2.39	2.95	1.29	4.24	2.75
2100	2.89	1.74	4.63	2.18	2.80	1.24	4.04	2.61
2600	2.73	1.74	4.47	2.16	2.62	1.16	3.78	2.57
LSD at 0.05 level	0.21	0.15	0.32	0.25	0.22	0.10	0.27	0.38
Effect of farmyard manure (m^3/*fed*)								
0	2.54	1.68	4.22	2.15	2.70	1.14	3.84	2.50
15	2.80	1.77	4.57	2.26	2.89	1.19	4.08	2.72
30	3.16	1.84	5.00	2.46	3.05	1.32	4.37	3.00
45	3.52	1.97	5.49	2.72	3.26	1.41	4.67	3.13
LSD at 0.05 level	0.19	0.12	0.25	0.16	0.11	0.05	0.12	0.18

Table 5: Effect of the interaction between water quantity levels and farmyard manure on the leaf pigments content (mg/gm DW) in garlic leaf tissues in 2000-2001 and 2001-2002 season

Treatments / Characters		2000-2001 season				2001-2002 season			
Water quantity (m^3/*fed*)	FYM (m^3/*fed*)	Chlorophyll a	Chlorophyll b	Chlorophyll a+b	Carotenoids	Chlorophyll a	Chlorophyll b	Chlorophyll a+b	Carotenoids
600	0	2.80	1.77	4.57	2.32	3.09	1.24	4.33	2.92
	15	2.95	1.73	4.68	2.35	3.30	1.23	4.53	3.30
	30	3.57	1.98	5.55	2.92	3.64	1.35	4.99	3.82
	45	4.32	2.38	6.70	3.57	3.90	1.48	5.38	3.94
1100	0	2.66	1.67	4.33	2.17	2.77	1.25	4.02	2.63
	15	2.86	1.81	4.67	2.44	2.87	1.19	4.06	2.60
	30	3.14	1.79	4.93	2.51	3.12	1.32	4.44	2.83
	45	3.70	1.84	5.54	2.73	3.35	1.48	4.83	2.97
1600	0	2.40	1.72	4.12	2.15	2.65	1.09	3.74	2.32
	15	2.81	1.83	4.64	2.24	2.96	1.27	4.23	2.78
	30	3.09	1.92	5.01	2.47	3.04	1.39	4.43	2.89
	45	3.34	1.97	5.31	2.68	3.13	1.43	4.56	2.99
2100	0	2.48	1.68	4.16	2.05	2.54	1.10	3.64	2.27
	15	2.80	1.69	4.49	2.07	2.79	1.16	3.95	2.47
	30	3.04	1.76	4.80	2.26	2.79	1.30	4.09	2.80
	45	3.22	1.82	5.04	2.36	3.06	1.39	4.45	2.92
2600	0	2.34	1.57	3.91	2.03	2.43	1.04	3.47	2.34
	15	2.57	1.80	4.37	2.19	2.53	1.10	3.63	2.47
	30	2.96	1.76	4.72	2.15	2.68	1.23	3.91	2.64
	45	3.04	1.83	4.87	2.26	2.85	1.27	4.12	2.81
L.S.D at 0.05	level	NS	NS	NS	0.36	NS	NS	NS	NS

FYM : Farmyard manure ; NS : not significant at 0.05 level

That means both of the two factors are working independently; since the effect of FYM alone on leaf pigments was in the opposite direction of that of water quantity.

These results are in harmony with those reported by El–Mansi *et al.* (1999b) on garlic. They found that chlorophyll a, b, total (a+b) as well as carotenoides in leaf tissues of garlic increased with decreasing irrigation water quantity up to 600 m^3 /feddan.

3.Plant Water Relations and Prolein Contents

Regarding main effect of irrigation water quantity, it is obvious from the data in Table 6 that irrigation water quantity had significant effect on total, free and bound water (%) and prolein content in leaves tissues.

Total and free water (%) in garlic leaves significantly increased with increasing irrigation water quantity up to 2100 or 2600 m^3 */fed* while bound water (%) significantly decreased with increasing irrigation water quantity up to 2100 m^3 /feddan. Meanwhile, prolein content in leaf tissues was at the highest value under water stress (600 m^3/feddan).

As for the effect of FYM, it can be concluded from the data in Table 5 that increasing FYM up to 30 or 45 m^3*/fed* significantly enhanced both free and total water in garlic leaf tissues without any significant differences between the two treatments and when compared to the plants received no FYM, whereas the effect of FYM on bound water was vice versa to that of its effect on free and total water. The effect of FYM on bound water was insignificant, in the second season. Moreover, FYM treatments had no significant effect on prolein content in leaf tissues.

Stewart (1977) reported that the conversion of prolein to glutamic acid and hence to other soluble compounds (prolein oxidation) proceeds readily in turgid leaves and it is stimulated by higher concentrations of prolein. This suggests that prolein oxidation could function as a control mechanism for maintaining low cellular levels of prolein in turgid tissues. In water stressed, however, prolein oxidation is reduced to negligible rates. It seems likely that inhibition of prolein oxidation is necessary in maintaining high levels of prolein found in stressed levels.

The decrement in the amount of prolein with FYM may be

Table 6: Effect of water quantity levels and farmyard manure on the plant water relations (%) of garlic leaves in 2000-2001 and 2001-2002 and prolein amino acid in 2001-2002 season

Characters / Treatments	2000-2001 season			2001-2002 season			
	Free water	Bound water	Total water	Free water	Bound water	Total water	Prolein mg/100 gm/DW
	Effect of water quantity (m^3/*fed*)						
600	55.49	29.71	85.20	48.80	38.77	86.71	149.83
1100	61.46	23.73	85.19	52.10	35.84	87.94	141.82
1600	63.96	21.93	85.89	55.46	32.70	88.16	88.04
2100	65.40	21.36	86.76	62.03	26.80	88.83	104.98
2600	67.48	20.17	87.65	61.44	27.73	89.17	79.52
LSD at 0.05 level	2.36	2.99	0.42	3.82	3.45	0.65	16.66
	Effect of farmyard manure (m^3/*fed*)						
0	58.77	26.87	85.65	52.74	34.48	87.22	120.55
15	62.62	23.45	86.07	54.21	33.89	88.10	109.40
30	64.67	21.72	86.39	57.26	31.02	88.28	116.32
45	64.96	21.44	86.40	58.99	29.38	89.03	105.08
LSD at 0.05 level	3.65	2.98	0.41	3.81	NS	0.73	NS

NS : not significant at 0.05 level

attributed to that FYM decrease water loss through evaporation and leaching in soil and this in turn increases the availability of water for longer time than unfertilized with FYM, resulting in decrease in prolein content of garlic leaves.

Under water stress the starch converted in to soluble carbohydrates, and decrease cell volume which led to increases in concentration of cell sap and osmotic pressure of the cell sap and these in turn increase the bound water % and decrease the free water (Lancher , 1993)

These results are agreeable with those reported by Abou El-Magd (1979), Maksoud *et al.* (1986) and El-Mansi *et al.* (1999b) on garlic. They reported increase in the total water and free water percentage and decrease of bound water percentage in leaf tissues of garlic by increasing soil moisture content (irrigation after 15 or 20% depletion of available soil moisture) or increasing water quantity up to 2100 or 3100 m^3/ feddan.

Water stress or low water quantity up to 600 m^3/*fed* or decreasing FYM up to 20 m^3/*fed* increased prolein in leaf tissues (El-Mansi *et al.*, 1999b and d on garlic and pea, respectively).

With respect to the interaction between irrigation water quantity and FYM, it is evident from the data in Table 7 that the interaction treatments did not show any significant effect on total, free and bound water (%) in leaves of garlic, but had significant effect on prolien content in leaf tissues of plants received lower water quantity; i.e., 600 m^3/*fed* (under stress) without adding FYM recorded maximum prolein content in their leaf tissues. Since then, prolein content in leaves can be taken as an indicator for water stress.

4.Nitrogen, Phosphorus and Potassium Contents and Uptake

Illustrated data in Table 8 show the effect of both water quantity and FYM on N, P and K contents in roots, bulb and leaves of garlic plant.

It is evident that water quantity reflected significant effect on N, P and K contents in different plant parts except P and K in root and bulb, respectively. In general, moderate and / or high levels of water quantity applied to garlic plants (1600-2600m^3/*fed*) showed enhancing effect on minerals concentration in different plant parts, while they were minimum under water stress.

Table 7 : Effect of the interaction between water quantity levels and farmyard manure on the plant water relations (%) in 2000-2001 and 2001- 2002 seasons and prolein amino acid of garlic leaf tissues in 2001 – 2002 season

Treatments / Characters		2000-2001 season			2001-2002 season			
Water quantity (m^3/*fed*)	FYM (m^3/*fed*)	Free water	Bound water	Total water	Free water	Bound water	Total water	Prolein (mg/ 100 gm/DW)
600	0	51.58	33.31	84.89	44.49	40.62	85.11	158.78
	15	54.64	31.03	85.67	46.02	39.70	85.72	149.90
	30	58.60	26.32	84.92	51.34	35.70	87.04	169.25
	45	57.14	28.14	85.28	53.38	35.57	88.95	121.41
1100	0	58.94	25.38	84.32	49.87	37.04	86.91	151.63
	15	62.31	22.70	85.01	50.77	37.46	88.23	119.15
	30	62.20	23.51	85.71	52.77	35.45	88.22	154.25
	45	62.39	23.32	85.71	55.03	33.36	88.39	142.26
1600	0	59.22	26.37	85.29	52.31	35.44	87.75	89.46
	15	62.88	23.00	85.88	54.89	32.83	87.72	95.65
	30	66.46	19.50	85.96	56.70	31.34	88.04	66.66
	45	67.28	18.82	86.10	57.94	31.20	89.14	100.38
2100	0	60.27	25.98	86.25	57.18	30.95	88.13	106.30
	15	62.91	23.19	86.10	60.45	29.29	89.74	101.96
	30	67.89	19.63	87.52	63.89	24.77	88.66	109.58
	45	70.52	16.63	87.15	66.60	22.19	88.79	102.48
2600	0	63.87	23.33	87.20	59.88	28.29	88.17	96.56
	15	70.34	17.34	87.68	58.91	30.16	89.07	80.76
	30	68.21	19.62	87.83	61.63	27.85	89.48	81.88
	45	67.50	20.39	87.89	65.36	24.58	89.94	58.86
L.S.D at 0.05	level	NS	NS	NS	NS	NS	NS	30.18

FYM : Farmyard manure ; NS : not significant at 0.05 level

Table 8: Effect of water quantity levels and farmyard manure on the minerals content of garlic plant at 135 days after sowing in 2001-2002 season

Characters / Treatments	Minerals content (%)								
	Root			Bulb			Leaves		
	N	P	K	N	P	K	N	P	K
	Effect of water quantity (m^3/fed)								
600	1.48	0.298	0.85	1.92	0.344	0.92	3.32	0.300	2.79
1100.	1.66	0.308	1.04	1.91	0.390	0.98	3.79	0.316	2.77
1600	1.72	0.290	0.97	2.02	0.372	1.00	4.16	0.343	2.83
2100	1.81	0.278	1.02	2.27	0.411	1.01	4.55	0.368	2.91
2600	1.78	0.289	1.03	2.10	0.398	1.02	4.48	0.386	3.08
L.S.D at 0.05 level	0.13	NS	0.07	0.13	0.036	NS	0.48	0.040	0.10
	Effect of farmyard manure (m^3/fed)								
0	1.46	0.283	0.87	1.85	0.360	0.90	3.54	0.294	2.72
15	1.65	0.285	1.00	1.92	0.376	0.98	3.66	0.340	2.87
30	1.88	0.292	1.02	2.17	0.399	1.01	4.16	0.349	2.89
45	1.77	0.310	1.03	2.22	0.398	1.05	4.88	0.388	3.03
L.S.D at 0.05 level	0.12	NS	0.10	0.15	0.023	0.05	0.29	0.023	0.09

NS : not significant at 0.05 level

Increasing the quantity of water applied to the soil increased the moisture content that make minerals more available to the plant .

As for the effect of FYM, the results in the same table indicate that FYM had significant effect on N, P and K content in root, bulb and leaves except P in root. Increasing FYM level up to the highest levels 30 or 45 m^3*/fed* recorded the highest concentrations of these elements in different plant parts without any significant differences between them in root and bulb, while 45 m^3*/fed* gave the highest N, P and K content in leaves. Moreover, maximum K in leaves was obtained by adding 2600 m^3*/fed* water quantity and 45m3FYM / feddan .

The interaction between water quantity levels and FYM did not show any significant effect on the concentrations of N, P and K in different plant parts except N in bulb and K in leaves (Table 9). Comparison among the four FYM levels within each of the studied water quantities, generally indicated that increasing FYM level, irrespective of the water quantity level used, increased N, P and K contents (%) in different plant parts.

The three minerals uptake and total uptake / plant, generally, increased with increasing either water quantity or FYM levels (Table 10).

The interaction between water quantity and FYM had favourable significant effect on the uptake of N, P and K by root and leaves of garlic plant. Whereas, it had no significant effect on the uptake of these minerals by bulb (Table 11). Meantime, the total uptake of both N and K / plant were significantly affected by the same interaction treatments, but the total uptake of P/ plant was not. Such effect was more pronounced under moderate and high levels of water quantities (1600 – 2600 m^3*/fed*). This trend seemed to be similar to those obtained regarding the dry matter content and minerals content of different plant parts.

Farmyard manure contains microorganisms as *Azotobacter* ,*Azospirillum*, etc. which fix N and release phytohormones as GA, IAA,CYT, etc. necessary for stimulating plant growth and dry matter content, and absorption of nutrients (Reynders and Vlassak, 1982).

Table 9: Effect of the interaction between water quantity levels and farmyard manure on the minerals content of garlic plant at 135 days after sowing in 2001-2002 season

Characters / Treatments		Minerals content (%)								
		Root			Bulb			Leaves		
Water quantity (m^3/*fed*)	FYM(m^3/*fed*)	N	P	K	N	P	K	N	P	K
600	0	1.26	0.255	0.66	1.69	0.311	0.80	2.91	0.227	2.52
	15	1.39	0.300	0.95	1.87	0.350	0.96	2.78	0.278	2.66
	30	1.77	0.328	0.85	2.14	0.372	0.91	3.36	0.350	2.98
	45	150	0.311	0.96	1.98	0.344	1.00	4.21	0.344	3.00
1100	0	1.18	0.278	0.98	1.83	0.355	0.91	3.45	0.283	2.66
	15	1.68	0.316	1.11	1.84	0.389	0.99	3.36	0.372	2.73
	30	1.96	0.311	1.04	1.91	0.400	0.99	3.86	0.289	2.72
	45	1.82	0.328	1.03	2.05	0.417	1.01	4.49	0.372	2.96
1600	0	1.51	0.300	0.89	2.06	0.372	0.88	3.61	0.305	2.66
	15	1.84	0.255	0.93	1.88	0.366	0.99	3.91	0.333	2.90
	30	1.80	0.278	1.00	1.98	0.389	1.03	4.21	0.344	2.89
	45	1.74	0.328	1.05	2.14	0.361	1.10	4.90	0.389	2.89
2100	0	1.76	0.311	0.90	1.80	0.394	0.93	3.89	0.300	2.79
	15	1.63	0.261	1.04	1.99	0.400	1.01	3.85	0.378	2.85
	30	1.91	0.255	1.08	2.74	0.422	1.07	4.74	0.383	2.96
	45	1.95	0.283	1.08	2.53	0.428	1.01	5.74	0.411	3.06
2600	0	1.60	0.272	0.93	1.87	0.366	0.99	3.85	0.355	2.96
	15	1.72	0.294	1.00	2.02	0.378	0.96	4.38	0.389	3.19
	30	1.95	0.289	1.14	2.10	0.411	1.04	4.63	0.378	2.90
	45	1.84	0.300	1.04	2.41	0.439	1.11	5.07	.422	3.25
L.S.D. at 0.05 level		NS	NS	NS	0.34	NS	NS	NS	NS	0.21

FYM : Farmyard manure ; NS : not significant at 0.05 level

Table 10. Effect of water quantity levels and farmyard manure on uptake of N,P and K by garlic plant in 2001-2002 season

Characters / Treatments	Minerals uptake (mg/gm DW)									Total uptake (mg/plant)		
	Root			Bulb			Leaves					
	N	P	K	N	P	K	N	P	K	N	P	K
	Effect of water quantity (m^3/*fed*)											
600	11.07	2.13	6.44	38.47	6.84	17.61	77.44	7.04	64.73	126.98	16.01	88.78
1100	10.61	1.94	6.53	38.82	7.95	20.15	89.47	7.48	65.09	138.90	17.37	91.77
1600	15.99	2.67	9.06	48.52	8.97	24.88	123.06	10.04	82.45	187.52	21.68	116.39
2100	14.71	2.27	8.37	49.81	8.93	21.96	142.93	11.42	89.98	207.45	22.62	120.31
2600	14.55	2.36	8.60	53.04	10.05	25.47	154.70	13.47	105.22	222.29	25.88	139.29
L.S.D at 0.05 level	2.20	NS	1.62	7.37	1.25	2.56	16.89	1.26	6.64	22.98	1.13	8.93
	Effect of FYM (m^3/*fed*)											
0	10.11	1.91	6.01	36.83	7.13	18.41	80.48	6.70	61.54	127.42	15.74	85.96
15	13.79	2.34	8.35	42.00	8.21	21.49	99.76	9.19	77.32	155.55	19.74	107.16
30	14.73	2.28	8.16	51.33	9.43	24.03	125.64	10.51	86.56	191.70	22.22	118.75
45	14.90	2.56	8.68	52.78	9.43	24.14	163.97	13.16	100.57	231.65	25.15	133.39
L.S.D at 0.05 level	2.57	0.45	1.82	4.77	0.84	2.03	10.35	0.89	6.10	11.88	1.22	6.44

NS : not significant at 0.05 level

Table 11. Effect of the interaction between water quantity levels and farmyard manure on uptake and total uptake of N,P and K by garlic plant in 2001-2002 season

Characters / Treatments		Minerals uptake (mg/gm DW)									Total uptake (mg/plant)		
		Root			Bulb			Leaves					
WQ (m^3/*fed*)	FYM (m^3/*fed*)	N	P	K	N	P	K	N	P	K	N	P	K
600	0	6.82	1.34	3.45	25.85	4.75	11.87	55.08	4.26	48.27	87.75	10.35	63.59
	15	9.66	2.07	6.35	34.17	6.40	16.98	55.61	5.53	53.12	99.44	14.01	76.45
	30	11.94	2.20	5.87	47.42	8.12	20.31	89.38	9.36	79.26	148.74	19.68	105.26
	45	15.87	2.92	10.08	46.54	8.10	21.28	109.69	8.99	78.26	172.10	20.01	109.62
1100	0	5.90	1.38	4.85	30.24	5.86	15.15	66.37	5.46	51.31	102.51	12.70	71.31
	15	10.97	2.09	7.33	39.07	8.27	21.68	80.28	7.71	65.55	130.32	15.06	94.56
	30	14.35	2.29	7.62	40.96	8.56	21.85	90.78	6.79	64.06	146.09	17.64	93.53
	45	11.21	2.01	6.31	45.02	9.10	21.92	120.44	9.98	79.44	176.67	21.09	107.67
1600	0	10.05	2.06	6.25	49.38	8.95	23.49	80.58	6.80	59.16	140.01	17.81	88.90
	15	19.11	2.66	9.79	43.93	8.42	23.20	97.59	8.20	72.73	160.63	19.28	105.72
	30	13.99	2.18	7.89	51.16	10.11	27.69	134.32	10.90	92.18	199.47	23.19	127.76
	45	20.81	3.79	12.32	49.64	8.40	25.13	179.74	14.24	105.73	250.19	26.43	143.18
2100	0	15.07	2.64	7.84	36.20	7.72	18.57	100.95	7.81	72.57	152.22	18.17	98.98
	15	15.86	2.56	10.23	42.23	8.50	21.48	105.61	10.37	78.91	163.70	21.43	110.62
	30	11.67	1.53	6.58	60.99	9.41	23.74	147.91	11.95	92.58	220.57	22.89	122.90
	45	16.23	2.36	8.83	59.82	10.08	24.06	217.27	15.56	115.87	293.32	28.00	148.76
2600	0	12.27	2.13	7.65	42.50	8.38	22.95	99.41	9.15	76.36	154.18	19.66	106.96
	15	13.36	2.34	8.05	50.63	9.46	24.13	159.70	14.16	116.27	223.69	25.96	148.45
	30	21.73	3.23	12.83	56.19	10.93	26.52	165.80	13.55	104.70	243.72	27.71	144.05
	45	10.38	1.74	5.87	62.83	11.45	28.29	192.70	17.02	123.57	265.91	30.21	157.73
LS D at0.05	level	5.75	1.02	4.08	NS	NS	NS	23.15	2.00	13.65	26.55	NS	14.42

WQ : Water quantity ; FYM : Farmyard manure ; NS : not significant at 0.05 level

These results are in harmony with those reported by Abou El-Magd, (1979) and El-Mansi *et al.*, (1999b) on garlic. They reported that the concentration of N, P and K uptake by garlic plant and N and K uptake by leaves and N, P and K uptake by onion bulb increased with increasing soil moisture content (irrigation after 20% depletion of available soil moisture) or increasing water quantity up to 3100 m^3/feddan.) Also, Fayed (1998) on onion found that N , P and K uptake by onion bulb increased with increasing farmyard manure up to 20 m^3 */fed* or increasing chicken manure up to7.5 ton/feddan.

In conclusion, water quantity at the rate of 2600 m^3/*fed* seemed to be superior regarding dry weight of different plant parts and whole plant, total uptake /plant of N, P and K and both total and free water in leaf tissues. Prolein was maximum under water stress. FYM at 30 m^3/*fed* was the superior treatment for producing maximum total dry weight and for enhancing the plant chemical composition; i.e., leaf pigments, and free and total water in leaf tissues. Moreover, FYM at 45 m^3/*fed* recorded maximum N,P and K concentration and uptake in different plant and total uptake / plant.

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تأثير كمية مياه الرى والسماد البلدى على الثوم تحت ظروف الأراضى الرملية

١ - الوزن الجاف والمحتوى الكيماوي للنبات

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أجريت هذه التجربة خلال موسمى شتاء ٢٠٠٠- ٢٠٠١ و ٢٠٠١- ٢٠٠٢ فى مزرعة التجارب الزراعية بالخطارة التابعة لكلية الزراعة – جامعة الزقازيق، بهدف دراسة تأثير كمية مياه الري ، والسماد البلدى ، والتفاعل بينهما على المادة الجافة، والمحتوى الكيماوى لنبات الثوم تحت ظروف الأراضى الرملية ويمكن تلخيص أهم النتائج فيمايلى:

أوضحت النتائج المتحصل عليها أن الرى بمعدل ٢٦٠٠ م٣ / فدان سجلت أعلى وزن جاف للجذور ، والبصلة، والأوراق، والوزن الجاف الكلى للنبات ، الماء الحر والكلى فى الأوراق والممتص الكلى من النيتروجين والفوسفور والبوتاسيوم بواسطة نباتات الثوم ، بينما سجلت كمية مياة الرى بمعدل ٦٠٠ م٣ /فدان أعلى زيادة لمحتوى الأوراق من الكلوروفيلات والكاروتينويدات والبرولين والماء المرتبط فى أنسجة الورقة .

أعطى إضافة السماد البلدى بمعدل ٣٠ م٣ /فدان أعلى القيم لكل من الوزن الجاف الكلى للنبات وكلا من الماء الحر والكلى فى أنسجة الورقة ، بينما سجلت كمية السماد البلدى بمعدل ٤٥م٣/فدان أعلى تركيز لصبغات الورقة والممتص الكلى من النيتروجين ، الفوسفور والبوتاسيوم بواسطة النبات . بينما لم يؤثر السماد البلدى على محتوى الأوراق لكل من الماء المرتبط والبرولين خلال الموسم الثانى فقط.

سجلت معاملة التفاعل بين مستوى الرى ٢١٠٠م^3 أو ٢٦٠٠م^3 /للفدان والتسميد البلدى بمعدل ٣٠ أو ٤٥ م^3 للفدان إلى زيادة الوزن الجاف الكلى للنبات.

كان أعلى محتوى للنيتروجين و البوتاسيوم فى البصلة والأوراق على التوالى عند رى نباتات الثوم بمعدل ٢١٠٠ م٣/فدان، والتسميد بالسماد البلدى بمعدل ٤٥م^3 للفدان ، أيضا ازداد الممتص الكلى من النيتروجين، والبوتاسيوم زيادة معنوية بواسطة النبات بمعاملة التفاعل بين ٢١٠٠م^3 أو٢٦٠٠م^3 ماء للفدان و التسميد بالسماد البلدي بمعدل ٤٥م^3 للفدان.