

4- RESULTS AND DISCUSSION

4-1- The first experiment: -

Effect of NPK fertilizers level, different sources of organic manures and their mixtures on vegetative growth, yield, chemical composition and storageability of garlic bulbs.

4-1-1- Vegetative growth.

Data illustrated in Table (3) clearly indicate that, vegetative growth characteristics expressed as plant length, number of leaves /plant, fresh and dry weight of leaves as well as plant fresh weight were significantly increased when the plants were fertilized with either half-recommended dose of chemical fertilizers (60 kg N + 32 kg P₂O₅ + 48 kg K₂O/fed.) or with the recommended dose (120 kg N + 64 kg P₂O₅ + 96 kg K₂O /fed.) compared with the control treatment during both seasons of this study. In this respect, plant length and plant fresh weight were significantly increased with completely recommended doses compared with half recommended doses in the first season only, while number of leaves /plant, leaves fresh and dry weight did not show significant differences in between. Such obtained results are in agreement with those reported by Ramirez et al. (1973), Abou El-Magd (1979), Ismail et al. (1979), Das et al. (1985), Eid et al. (1991), Naidu et al. (2000), Silva et al. (2000)

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Table (3): Effect of N, P and K fertilizers level, different sources of organic manures and their mixtures on some vegetative growth characteristics of garlic plants

Seasons		2	2000-2001	11				2001-2002	2	
-	Plant	Plant leaves	eaves	plant	Leaves	Plant	Plant	Plant leaves	plant	Leaves
I reatments	(cm)	number	F.W (g)	F. (g)	%) (%)	Length (cm)	number	F.W	F.W (g)	D.W (%)
Control	54.50	9.48	31.88	74.94	11.88	29 00	0 10	27.75		000
60 kg N + 32 kg P ₂ O ₅ + 48 K ₂ O / fed.	58.25	11.41	40.25	101.30	13.64	69.00	10.05	27.72	71.13	10.85
120 kg N + 64 kg P ₂ O ₅ + 96 K ₂ O/ fed.	61.75	11.56	43.75	106.50	13.27	60.75	11.12	40.00	97.16	13.13
FYM at 120 kg N/fed.	56.75	10.16	33.44	89.83	12.53	68.00	0.74	16.24	101.40	13.15
Compost manure at 120 kg N/fed.	58.00	7.93	35.50	93.31	13.36	69.05	02 53	00.00	18.81	11.89
Biogas manure at 120 kg N/fed.	58.75	11.06	37 79	99 96	12.14	67.00	10.75	32.38	89.75	12.52
FYM + Compost	57.00	0 80	34 53	01.00	17.07	07.30	10.73	37.40	93.22	12.77
FYM + Biogas	57.75	8 36	34.80	02.05	12.02	08.20	9.36	31.94	82.35	12.19
Biogas + Compost	57.50	10.77	35 10	02 60	12.00	00.07	9.47	33.25	84.00	12.30
NPK1 + 1/2 compost	60.00	11.00	20.10	27.00	13.24	00.79	9.50	33.54	84.54	12.45
NPK1 + V Biograph	02.00	11.88	45.75	107.40	14.24	70.50	11.39	43.08	102.20	13.77
MINIT /2 DIOGAS	63.25	12.00	46.38	111.90	15.10	72.50	11.81	46.06	108 20	14.60
NPRI + % FYM	61.75	11.63	42.50	105.10	13.57	70.00	10.94	41 29	08 80	12.00
/3 Biogas+ '/3Compost + '/3 FYM	56.75	10.09	33.53	89.29	12.95	66.75	932	30.75	82 56	12.00
L.S.D at 0.05	1.56	3.13	4.43	5.08	1.14	3 98	104	100	07:30	00.21

*NPK1 = $60 \text{ kg N} + 32 \text{ kg P}_2\text{O}_5 + 48 \text{ K}_2\text{O}$ / fed.

and *Naruka* and *Dhaka (2001)* all working on garlic where they reported that, application of mineral fertilizers as NPK at different levels resulted in increasing plant height of garlic plants.

With respect to the improving effect of increased NPK fertilization level on number of leaves / plant, obtained results are in agreement with those reported by *Fouda* and *Saleh* (1983), *Abo-Sedera et al.* (1991), *Eid et al.* (1991), *Silva et al.* (2000), *Naruka* and *Dhaka* (2001) and *Kakar et al.* (2002) all working on garlic found that, there are significant and continues increments in number of leaves of such plants with increasing fertilization levels of N, P and K up to the highest used levels i.e. $90 \text{ kg N+} 45 \text{ kg P}_2\text{O}_5 + 72 \text{ kg K}_2\text{O}/\text{fed}$

Concerning the effect of NPK fertilization on fresh and dry weight, obtained results are in conformity with those reported by Abou El-Magd (1979), Ismail et al. (1979), Ismail et al. (1980), Fouda and Saleh (1983), Maksoud and El-Oksh (1983), Ismail et al. (1988), Eid et al. (1991) and Naruka and Dhaka (2001) working on garlic. They suggested that the highest values of fresh and dry weight of garlic plants were obtained as a result of mineral fertilization level.

Regarding the effect of organic sources, i.e. biogas, compost and farmyard manures, data presented in Table (3) reveal that, application of organic manures containing 120 kg N /fed. either in a single or in combination forms gave a significant positive effect on vegetative growth characters compared with the control treatment. Moreover, biogas manure containing 120 kg N/fed. gave the highest values of different studied characters during both seasons compared with other organic sources.

With respect to the effect of organic manure on plant height, *Khalaf* and *Taha* (1988), *Seno et al* (1995), *Fayed* (1998) reported that organic manure application significantly increased plant height. On the other hand, *Ahmed* (2002) reported that garlic plants cv. Chinese received poultry manure as (180 kg N/ fed.) gave the shortest plants.

With regard to the improving effect of organic manures application on number of leaves /plant, obtained results are in agreement with those reported by *Khalaf* and *Taha* (1988) and *Fayed* (1998) all working on garlic. However, *El-Sheekh* and *Hegazy* (1998) on onion plants found that, organic fertilizer treatments in general did not exert any significant effect on number of leaves / plant. In addition, *Farrag* and *Hussein* (2000) on onion found that poultry manure at 30 t/fed.

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Significantly increased number of leaves / plant. On the other hand, *Ahmed (2002)* working on garlic stated that treatment which received only poultry manure as (180 kg N/ fed.) gave the lowest number of leaves at most studied seasons.

Concerning the effect of organic manures on plant fresh and dry weight, obtained results are in agreement with those reported by *Khalaf* and *Taha* (1988), on garlic. In addition, *Bhonde et al* (1997), *Farrag* and *Hussein* (2000), *Geetha et al*. (2000) and *Mahmoud et al*. (2000) on onion where they reported that application of each of compost manure at rates of 2, 3 or 4 t/ha, poultry manure at 30 tons / fed. or sheep manure, farmyard manure at 25 t/ ha and town refuse of 10 t /feddan resulted in the highest fresh and dry weight of bulb and foliage.

The same data presented in Table (3) reveal also that, application of NPK fertilizers level at 120 kg N + 64 kg P_2O_5 + 96 kg K_2O /fed. gave significantly increases in plant height and fresh weight of leaves in the first season only compared with different organic sources containing the same level of nitrogen (120 kg N/fed.) whereas, in the second season the effect was not significant . Moreover, fertilizing garlic plants with 60 kg N + 32 kg P_2O_5 + 48 kg K_2O /fed. plus 60 kg N as biogas manure led to significant increments in plant length, number of leaves, fresh

and dry weight of leaves as well as plant fresh weight when compared with the control treatment or with some of the other used treatments. This was true during both seasons of growth. Such promoting effect of fertilization with organic fertilizer on plant growth characteristics my be attributed to the role of the macronutrients, which are main content of organic fertilizers, in increasing cell division and cell elongation and consistently increased plant growth. In addition, the main role of such nutrients in increasing the photosynthetic pigments assimilation, in plant leaves (Table, 7) which is necessary for cell formation and division as well as consequently plant growth.

Regarding the effect of mixtures of NPK fertilizers level with organic manures on plant height, results are in agreement with those reported by each of *Reddy (1985)* on garlic and *Jana*, and *Jahangir (1990)* on onion. Furthermore, *Blay et al. (2002)* on shallot stated that, a combination of 40 tons poultry manure/ha with 300 kg or and 600 kg, NPK /ha 15-15-15 fertilizer ratio increased plant height.

Concerning the effect of NPK fertilizers with organic manures on number of leaves/ plant, obtained results are in conformity with those reported by *Reddy (1985)* on garlic. In addition, *Jana* and *Jahangir (1990)* and *Serrano et al. (1995)*

on onion. Moreover, *Blay et al.* (2002) working on shallot they stated also that, a combination of 40 tones poultry manure/ha with 300 kg P_2O_5 /ha and or 600 kg NPK 15-15-15 fertilizer/ha or FYM at 20 t/ha combined with 100 kg N, 60 Kg P_2O_5 and 100 kg K_2O and /or FYM at 25 t/ha + 60 kg N and 60 kg P_2O_5 /ha. increased number of leaves per plant.

With regard to the effect of NPK fertilizers combined with organic manures on the fresh and dry weight of plant obtained results are in conformity with those reported by *Jana* and *Jahangir* (1990), *Singh et al.* (1997) and *Geetha et al.* (2000), all working on onion, they reported that FYM at 20 t/ha combined with chemical fertilizers at 100 kg N, 60 Kg P₂O₅ and 100 kg K₂O or with FYM at 25 t/ha in combination with 200 kg K₂O / ha resulted in the highest values of fresh and dry weight per plant

4-1-2- Bulb characters:-

Concerning the effect of N, P and K fertilizers level on some bulb characters, data presented in Table (4) show that diameter for both bulb and neck as well as bulb length and number of cloves/bulb were increased with application of NPK fertilizers compared with the control treatment during both seasons of growth In this respect, such increasing effect did not

Table (4): Effect of N, P and K fertilizers level, different sources of organic manures and their mixtures on some bulb characters of garlic plants.

Seasons		2000-2001	001			2001-2002	2002	
	Neck	Bulb	b	No of	Neck	Bulb	Q Q	No of
Treatments	diameter (cm)	diameter (cm)	length (cm)	cloves/ bulb	diameter (cm)	diameter (cm)	length (cm)	cloves/ bulb
Control	1.195	3.87	3.04	16.42	1.220	3.71	2.96	15.00
60 kg N + 32 kg P ₂ O ₅ + 48 K ₂ O / fed.	1.200	5.07	3.46	17.52	1.207	5.12	3.68	16.13
120 kg N + 64 kg P ₂ O ₅ + 96 K ₂ O/ fed.	1.295	5.17	3.61	17.77	1.263	5.17	3.80	16.25
FYM at 120 kg N/fed.	1.243	4.42	3.29	16.66	1.205	4.31	3.26	15.60
Compost manure at 120 kg N/fed.	1.200	4.68	3.31	16.89	1.212	4.36	3.31	15.25
Biogas manure at 120 kg N/fed.	1.212	4.95	3.42	17.13	1.237	4.85	3.56	16.06
FYM + Compost	1.170	4.50	3.13	16.41	1.222	4.59	3.28	15.95
FYM + Biogas	1.178	4.56	3.12	17.33	1.212	4.68	3.32	16.13
Biogas + Compost	1.158	4.59	3.24	17.41	1.112	4.28	3.24	16.49
NPK1 +1/2 compost	1.145	5.30	3.81	17.86	1.143	5.24	3.96	16.94
NPK1 + 1/2 Biogas	1.065	5.58	4.09	18.27	1.102	5.46	4.20	18.25
NPK1 + ½ FYM	1.165	5.20	3.65	17.96	1.155	5.17	3.72	16.03
1/3 Biogas+ 1/3 Compost + 1/3 FYM	1.232	4.43	3.12	16.11	1.250	4.07	3.17	16.11
L.S.D at 0.05	0.208	0.730	0.480	n.s.	0.110	0.620	0.470	1.610

*NPK1 = $60 \text{ kg N} + 32 \text{ kg P}_2\text{O}_5 + 48 \text{ K}_2\text{O}$ / fed.

reach the level of significance in case of neck diameter and number of cloves/ bulb during both seasons of study. Moreover, the maximum increments in these characters were connected with the highest used level of chemical fertilizer (120 kg N + 64 kg P₂O₅ + 96 kg K₂O /fed.). Furthermore, there were no significant differences between the application of low level of fertilizer 60 kg N + 32 kg P₂O₅ + 48 kg K₂O/feddan or high level (120 kg N + 64 kg P_2O_5 + 96 kg K_2O / feddan.). Such results are in harmony with those reported by Tseng, (1972) Serrano et al. (1995), Anez et al. (1996), Vachhani and Patel (1996) and Oukal (1999) on onion. Also, Naruka and Dhaka (2001) on garlic they found that neck thickness and bulb diameter significantly increased with application of N up to 150 kg /ha., P₂O₅ at 60kg /ha. and K at 120 kg / ha. On the other hand, Mahmoud et al. (2000) found that applying NPK levels had no effect on neck diameter of onion. Reddy (1985) and Silva et al. (2000) stated that using nitrogen fertilizer cloves per bulb (54.07 % increases over the control, while the P application did not result in any significant differences in number of cloves. In addition, Reddy (1985), Ali et al. (1998), Silva et al. (2000), Resende and Souza (2001) on garlic found also that number of cloves per bulb was significantly increased with increasing N up to 300 kg / ha.

Regarding the effect of organic manures, the same data in Table (4) show also that applying the different sources of organic manures at 120 kg N/fed. enhanced all the studied bulb characters expressed as diameter for both bulb and neck, bulb length and number of cloves per bulb compared with the check treatment during both seasons of study. However, no significant differences noticed among the different organic sources in all studied bulb parameters. In this respect. *Khalaf* and *Taha* (1988) on garlic, *Jana* and *Jahangir* (1990) and *Mahmoud et al.* (2000) on onion. They stated that neck diameter, bulb length and diameter were significantly increased with application of different levels of organic manure i.e. FYM at a rate of 10 ton/fed. alternatively, town refuses at a rate of 20 ton/fed.

As for the effect of the mixture of mineral and organic fertilizers on bulb characters, the same data in Table (4) indicated that, using mineral fertilizer (NPK) at half of the recommended dose i.e. 60 kg N + 32 kg P₂O₅ + 48 kg K₂O/fed. mixed with 60 kg N/fed. from any source of organic fertilizer gave the lowest values on neck diameter compared with the chemical fertilizers either in half or complete recommended dose treatments while the most measured bulb characters i.e. bulb diameter and length were improved with the same treatments in both seasons of study. Furthermore, application of biogas

manure containing 60 kg N/fed. combined with 60 kg N + 32 kg P₂O₅ + 48 kg K₂O/fed. gave the highest values bulb length and diameter as well as number of cloves /bulb compared with chemical treatments either alone at different used levels or in a maxed form with the other organic fertilizer sources. Similar trend was obtained by Asiegbu and Uzo (1984), Jana and Jahangir (1990), Singh et al. (1997) and Mahmoud et al. (2000), all working on onion, who reported that both and bulb, neck diameter as well as the neck /bulb ratio of onion were increased with applied organic manure as FYM at rate of 10 t/fed. alternatively, with town refuse at rate of 20 t/fed combined with 60 kg N, 45 kg P₂O₅ and 75 kg K₂O /fed. rates when compared with control, respectively. In this concern, the increment effect of biogas manure on studied bulb traits my be due to the higher content from organic matter and phosphorus content (Table, 2) that my exhibit improving effect on physical and chemical characteristics of the soil which improved plant growth (Table, 3) and consequently enhanced bulb characters expressed as bulb diameter and number of cloves/bulb.

4-1-3-Bulbing ratio:-

Data presented in Table (5) reveal that no significant differences were obtained in bulbing ratio due to all the studied treatments during both seasons of growth. However, using

Table (5): Effect of N, P and K fertilizers level, different sources of organic fertilizers and their mixtures on bulbing ratio of garlic plants

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es	Seasons		2000	2000-2001			2001	2001-2002	
		Bu	Ibing rat	Bulbing ratio (at DAP)	4P)	Bu	Bulbing ratio(at DAP)	tio(at DA	(P)
Treatments	7	06	120	150	180	06	120	150	180
Control		0.485	0.328	0.282	0.250	0.533	0.388	0.321	0.339
60 kg N + 32 kg P ₂ O ₅ + 48 K ₂ O / fed.	/ fed.	0.490	0.325	0.274	0.235	0.453	0.318	0.239	0.245
120 kg N + 64 kg P ₂ O ₅ + 96 K ₂ O/ fed.)/ fed.	0.508	0.345	0.321	0.281	0.460	0.330	0.312	0.244
FYM at 120 kg N/fed.		0.510	0.328	0.311	0.257	0.510	0.365	0.314	0.282
Compost manure at 120 kg N/fed.	//fed.	0.490	0.350	0.293	0.236	0.523	0.348	0.311	0.280
Biogas manure at 120 kg N/fed.	.pa	0.543	0.340	0.294	0.247	0.515	0.343	0.315	0.259
FYM + Compost		0.518	0.350	0.312	0.260	0.523	0.363	0.305	0.269
FYM + Biogas		0.508	0.345	0.314	0.245	0.500	0.363	0.324	0.261
Biogas + Compost		0.503	0.333	0.283	0.253	0.523	0.353	0.311	0.261
NPK1 + 1/2 compost		0.495	0.348	0.297	0.243	0.495	0.320	0.271	0.220
NPK1 + 1/2 Biogas		0.495	0.310	0.273	0.243	0.495	0.300	0.291	0.202
NPK1 + ½ FYM		0.508	0.318	0.261	0.250	0.508	0.335	0.321	0.224
1/3 Biogas+ 1/3 Compost + 1/3 FYM	FYM	0.520	0.338	0.332	0.247	0.518	0.370	0.348	0.309
L.S.D at 0.05		n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s

* DAP= day after planting

mineral fertilizer at 60 kg N +32 kg P₂O₅ + 48 kg K₂O/fed. during the first season or combined with biogas manure containing 60 kg N/fed. in the second season at 180 days after planting gave the best bulbing ratio. These results are in conformity with those reported by Ibrahim (1975), Fouda and Saleh (1983) and Mahmoud et al. (2000) found that applying NPK levels had no effect on bulbing ratio of onions. On the other hand, Jana and Jahangir (1990) and Mahmoud et al. (2000) on onion reported that, bulbing ratio was significantly increased with application of different levels of organic manure i.e. FYM at a rate of 10 ton/fed. alternatively with town refuses at a rate of 20 ton /fed. compared to 100 kg N + 60 kg P_2O_5 + 100 kg K₂O or with control. Furthermore, Mahmoud et al. (2000) on onion reported that bulb, necks diameter and the neck /bulb ratio of onion was increased with applied organic manure as FYM at a rate of 10 t/fed. alternatively, with town refuses at rate of 20 t/fed combined with 60 kg N, 45 kg P2O5 and 75 kg K₂O /fed. rates when compared with control, respectively.

4-1-4- Yield and its components: -

Data presented in Table (6) reveal the effect of N, P and K fertilizers level, different organic manure sources and their mixtures on bulb yield and its components for garlic plants.

Table (6): Effect of N, P and K fertilizers level, different sources of organic manures and their mixtures on some aspects of bulb yield and its components of garlic plants.

Seasons		2	2000-2001				2	2001-2002	2	
	Clove	Bı	Bulb	Yi ton/	Yield ton / fed.	Clove	Bı	Bulb	Yi ton/	Yield ton / fed.
Treatments	(gm)	F.W (gm)	D.W (gm)	F.W	cured	(mg)	F.W (gm)	D.W (gm)	F.W	cured
Control	1.838	43.06	20.49	8.120	4.280	1.548	43.63	18.96	7.436	3.968
60 kg N + 32 kg P ₂ O ₅ + 48 K ₂ O / fed.	2.355	61.08	25.37	11.52	6.803	2.142	57.44	24.09	6.799	5.743
120 kg N + 64 kg P ₂ O ₅ + 96 K ₂ O/ fed.	2.438	62.76	25.00	11.84	086.9	2.150	59.59	23.59	10.310	5.956
FYM at 120 kg N/fed.	2.362	56.40	22.63	10.63	5.929	1.763	48.50	19.75	8.528	4.684
Compost manure at 120 kg N/fed.	2.457	58.49	24.25	11.03	6.350	2.085	54.40	22.88	00006	5.359
Biogas manure at 120 kg N/fed.	2.017	58.88	24.68	11.10	6.453	2.125	56.18	23.20	209.6	5.543
FYM + Compost	2.540	57.06	23.13	10.76	6.032	1.955	50.93	21.26	8.686	4.839
FYM + Biogas	2.675	57.25	23.24	10.80	6.114	1.730	50.13	21.65	8.529	4.931
Biogas + Compost	2.412	57.06	23.65	10.86	6.189	1.997	52.97	22.03	8.743	5.135
NPK1 +1/2 compost	2.612	63.63	26.81	12.00	7.266	2.07	60.75	25.29	10.410	6.212
NPK1 + 1/2 Biogas	2.890	65.55	28.17	12.36	7.648	2.303	64.48	27.57	11.050	6.693
NPK1 + ½ FYM	2.457	62.54	25.50	11.79	7.135	2.182	59.10	24.07	10.480	6.125
1/3 Biogas+ 1/3 Compost + 1/3 FYM	2.090	56.50	22.87	10.65	5.962	1.762	48.88	20.48	8.336	4.647
L.S.D at 0.05	0.756	1.521	4.113	0.287 0.213	0.213	0.314	3.995	2.615	0.907	0.458

*NPK1 = $60 \text{ kg N} + 32 \text{ kg P}_2\text{O}_5 + 48 \text{ K}_2\text{O}$ / fed.

Such data show that application of N, P and K chemical fertilizers significantly influenced the total yield and its components compared with the control treatment. Such trend was true during both seasons of study. Moreover, the total garlic yield progressively increased with increasing NPK fertilizers level up to higher used one, i.e. 120 kg N + 64 kg P₂O₅ + 96 kg K₂O / feddan. However, in both seasons of study there were no significant differences in average clove weight and cured yield between the two treatments receiving N P K fertilizers at a rate of 60 kg N + 32 kg P_2O_5 + 48 kg K_2O or 120 kg N + 64 kg P_2O_5 + 96 kg K₂O /feddan. The superiority of the total bulb yield of garlic plants as a result of using the highest level of NPK fertilizer is mainly due to the improving effect of such treatment (Table 3), characteristics growth the vegetative on photosynthetic pigments (Table 7), macronutrients content (Table 8) and carbohydrates (Table 9). Obtained results are in agreement with those found by each of Ramirez et al. (1973), El-Mansi et al. (1985), Das et al. (1985), Eid et al. (1991), Oh et al. (1991), Casanova et al. (1994), Saravanan and Nambisan (1994), Ashak and Singh (1996), Lipinski and Gaviola (1999) working on garlic who reported that the total yield of garlic was significantly increased with the highest level of N, P and K fertilizers level.

Yield and its components of garlic expressed as total fresh and cured yield (t /fed.), fresh and dry weight of bulb as well as average clove weight as affected by FYM, Biogas and Compost manures are presented in Table (6). Such data show also that application of organic manures either single or combined with each other improved total yield and its components in both seasons compared with the control. In this regard, there were no significant differences between the treatments, which received organic manures containing 120 kg N /fed. in single or in combination form. Furthermore, obtained results dealing with the positive effects of different sources of organic manures application on yield and its components are also going in line with those reported by Pereira et al. (1987), Guadi-N et al. (1988), Khalaf and Taha (1988), Ranganna et al. (1991), Seno et al. (1995) and (1996) and Faved (1998) all working on garlic where they found that, organic manures i.e. FYM, chicken manure and biogas manure at different levels were very effective on yield of garlic bulbs and its components.

Data presented in Table (6) confirms that total yield and its components differed significantly with different sources of organic manures during both seasons of this study. In this respect, application of different organic sources in combination with chemical fertilizers containing 60 kg N/fed. as organic

sources plus 60 kg N + 32 kg P_2O_5 + 48 kg K_2O / fed. as chemical source reflected the maximum increments in total yield and its components compared with other treatments. Moreover, application of biogas manure plus 60 kg N + 32 kg P₂O₅ + 48 kg K₂O/fed. gave the greatest values of total yield and its studied components i.e. average clove weight, bulb fresh and dry weight as well as total fresh and cured yield (t/fed.). Obtained results are true during both seasons of this study. In this connections the highest total fresh and cured yield obtained in case of using biogas manure at 60 kg N/fed. plus mineral fertilizer at 60 kg N + 32 kg P₂O₅ + 48 kg K₂O /fed. was connected with the highest average number and weight of cloves/bulb and the dry matter accumulation in bulbs. These results are in accordance with those reported by Koltunov (1984), Wange (1995) and Zhang et al. (1998) all working on garlic. They reported that application of FYM at 40 t /ha + N: P: K at 1: 1: 2 [N, P2O5 and K2O at 60: 60: 120 kg/ha] gave the best yield of garlic bulbs. In addition, Mahmoud et al. (2000), Singh et al. (2001) and Alkaff et al. (2002) working on onion recorded also that, the highest values and best quality of yields of onion was obtained in plants, which received 20 tons / feddan of town refuse in addition to 60 kg N, 45 kg P₂O₅ and 75 kg K₂O /feddan.

4-1-5- Chemical composition:

4-1-5-1- photosynthetic pigments:-

Data in table (7) show the effect of N, P and K fertilizers level and sources of organic fertilizers as well as their combination on chlorophyll a, chlorophyll b, total chlorophyll and total carotinoides content of garlic leaves. In this regard, such data reveal that application of mineral fertilizers to garlic plants resulted in increasing such pigments in the tissues of garlic leaves. The highest value in this respect was obtained from the higher used level of NPK fertilizers (120 kg N + 64 kg P₂O₅ + 96 kg K₂O /feddan.). The previously mentioned results are in agreement with those obtained by Abou El-Magd (1979), El-Beheidi et al. (1985), El-Mansi et al. (1985), Eid et al. (1991) and Naruka and Dhaka (2001) all working on garlic. They reported that there was a progressive and consistent increase in chlorophyll a, chlorophyll b, total chlorophyll and total carotinoides tissues of garlic with increasing N and K fertilizers level up to 300 kg N, 100 kg K₂O /fed.

It is obvious also from data in Table (7) that chemical analysis for photosynthetic pigments in leaves of garlic, i.e. chlorophyll a, chlorophyll b, total chlorophyll and total carotinoides were significantly increased with different organic manure sources, i.e. biogas, compost and farmyard manure

RESULTS AND DISCUSSION

Table (7): Effect of N, P and K fertilizers level, different sources of organic manures and their mixtures on photosynthetic pigments of garlic plants (mg/100 g. F.W.).

		200	2000-2001			200	2001-2002	
Seasons	ප්	Chlorophyll	_		ت ت	Chlorophyll	_	Carotinoides
Treatments	(a)	(p)	Total (A+	Сагоппонея	(a)	(p)	Total (A+b)	
	101.20	59.65	160.85	107.68	98.75	57.42	156.17	103.82
Control	175.68		261.07	160.58	167.74	80.78	248.52	151.90
130 La N + 64 La P.O. + 96 K.O. fed.	186.44		276.93	168.28	191.59	93.58	285.17	174.13
120 kg in + 04 kg i 105 + 70 kg in 100 kg in 1	132.07	64.39	196.46	120.12	137.94	71.79	205.71	126.62
FIM at 120 kg 191cu.	152.13	75.91	228.04	143.51	151.66	75.11	226.77	141.81
Diagram manura at 120 kg N/fed.	156.99	77.88	234.87	145.51	154.29	76.45	230.74	142.41
EVM + Compost	147.34	72.95	220.29	135.98	155.98	77.27	233.25	143.95
FIM + Biogas	115.16	55.62	170.78	104.33	128.88	96.29	191.84	117.98
Riogas + Compost	148.67	71.74	220.41	134.06	154.32	75.40	229.72	140.99
NDK1 + 1% compost	189.63	92.45	282.08	172.59	191.49	93.47	284.96	174.36
NPV1 + 1/2 Riogas	196.75	96.16	292.91	181.28	193.81	93.92	287.73	177.14
NPC1 + 71 Diogas	194.44	95.72	290.16	177.92	188.20	91.93	280.13	170.41
1/ Biogas+ 1/. Compost + 1/, FYM	133.63	91.99	199.79	123.34	144.29	71.67	215.96	133.60
1.S.D at 0.05	19.82	10.34	30.16	19.54	45.61	21.37	86.99	11.16

compared with the control. On the other hand, such increments in photosynthetic pigments content was less in case of using organic sources compared with treatments which received chemical fertilizers only up to 120 kg N + 64 kg P_2O_5 + 120 kg K₂O /fed. or with those received the mixture of chemical fertilizers and organic manures. However, application of biogas manure + 60 kg N + 32 kg P₂O₅ + 48 kg K₂O gave the greatest values for photosynthetic pigments content in plant leaves during both seasons of this study. Such increase in photosynthetic pigments of garlic leaves as a result of mineral and organic fertilizer application my be due to the main role of such fertilizers increasing the concentration of macro and microelements at rooting zone which consequently increased the uptake of such nutrients by plant which contributed in the synthesis of chlorophyll a, b and carotinoides pigments. These results are in harmony with those obtained by Shaniyazov and Dailev (1978) on onion who reported that total Chlorophyll content was increased due to fertilization with addition of FYM at 40 t/ha to onion plants grown in the sandy soil. Meanwhile, Kostyuk (1995) found that potatoes cv. Klibinsbii early when given no fertilizers or combinations of 0, 60 or 120 cattle manure and 0, 140 or 280 kg each of N, P2O5 or K2O /ha. respectively, contra results were obtained on leaf chlorophyll a + b content.

4-1-4-2- Macronutrients content:-

Data presented in Table (8) shows the effect of NPK mineral fertilizer and organic fertilizer sources as well as their mixture on NPK content of different plant parts. Such data indicate that total nitrogen, phosphorus and potassium content of different plant parts, i.e. foliage and bulbs were significantly affected with application of NPK fertilizers. The highest values of macro-elements content was obtained from the treatment, which received the highest NPK fertilizers, level i.e. 120 kg N + 64 kg P₂O₅ + 96 kg K₂O /fed. These results were true in both seasons of study. Such increments in the content of nitrogen, phosphorus and potassium in different plant parts my be attributed to the increase in soil concentration of such macronutrients as a result of fertilization in the root zoon which led to increasing the amounts absorbed by plant roots. These results are in conformity with those obtained by, Abo-Sedera et al. (1991), Eid et al. (1991), Lipinski et al. (1994), Fayed (1998) all working on garlic. They found that, there were significant increments in the percentages of total. N, P and K due to increasing the level of fertilization.

The same data presented in Table (8) shows the effect of organic manure either in single or combined form on total nitrogen, phosphorus and potassium content in both foliage and

Table (8): Effect of N, P and K fertilizers level, different sources of organic manures and their mixtures on macroelements contents of different parts of garlic plant (mg/100 g D.W).

Seasons			2000	2000-2001					2001	2001-2002		
Transmonto	Z			Ь	_	X		z	Ь		1	X
T catments	Leaves	Bulbs	Leaves	Bulbs	Leaves	Bulbs	Leaves	Bulbs	Leaves	Bulbs	Leaves	Bulbs
Control	4249	2428	339	237	3128	2193	4266	2416	344	242	3138	2212
60 kg N + 32 kg P ₂ O ₅ + 48 K ₂ O / fed.	4417	3366	502	364	3842	3216	4412	3368	506	376	3856	3227
120 kg N + 64 kg P ₂ O ₅ + 96 K ₂ O/ fed.	4475	3557	518	389	4010	3322	4492	3566	423	400	4024	3333
FYM at 120 kg N/fed.	4206	3178	421	327	3488	3094	4208	3168	429	337	3496	3105
Compost manure at 120 kg N/fed.	4234	3203	431	334	3516	3104	4226	3209	437	339	3526	3116
Biogas manure at 120 kg N/fed.	4279	3223	453	338	3525	3111	4268	3222	459	341	3538	3177
FYM + Compost	4186	3148	413	318	3316	3004	4184	3142	422	227	2000	2716
FYM + Biogas	4200	3180	420	324	3391	3007	4203	2170	777	175	3320	3013
Biogas + Compost	4233	3192	428	332	3430	3019	4202	2186	120	255	3405	3017
NPK1 + ½ compost	4468	3511	522	387	4107	3321	4460	3512	536	385	3431	3231
NPK1 + ½ Biogas	4507	3570	529	413	4155	3387	4508	3583	538	423	4161	3390
NPKI + ½ FYM	4409	3422	513	380	4080	3313	4397	3433	527	376	4099	3373
1/3 Biogas+ 1/3 Compost + 1/3 FYM	4228	3152	425	316	3334	3004	4238	3148	436	330	3345	3015
L.S.D at 0.05	69.12	170.1	15.90	19.29	87.30	51.20	47.39	78.78	13.29	19.21	40.96	21.63

bulbs of garlic. In this respect, there was a significant increase in macronutrients content in both foliage and bulbs of garlic with application of organic manures containing 120 kg N/fed. as compared with the control. The maximum values in this connection were obtained with the application of biogas manure at 120 kg N per fed. In this concern, *Khalaf* and *Taha* (1988) and *Ranganna et al.* (1991) working on garlic found that biogas spent sludge (BGSS, manure used for biogas generation) and untreated farmyard manure (FYM) were applied at 10 t/ha a few weeks before sowing of garlic crop and incorporated into the soil. BGSS treatment showed a higher percentage of total N, P₂O₅, and K₂O in the plant tissues. In addition, *Abdel-Ati* (1998) working on potato and *Geetha et al.* (2000) on onion, also found that farmyard or chicken manures at 25 t/ ha or 15 m³/ ha. respectively, gave the highest uptake of NPK.

Data in Table (8) illustrate also that, NPK content of plant leaves and bulbs was significantly affected with the application of the mixture of different sources of organic manures and NPK fertilizers during both seasons of this work. In this concern, application of biogas + 60 kg N + 32 kg P₂O₅ + 48 kg K₂O reflected the maximum increments of mineral content in plant leaves and bulbs. These results were true during both seasons of this study. In this regard, *Kropisz* (1992), *Sharma et al.* (1994),

Geetha et al. (2000) and Muthuramalingam et al. (2002) on onion found that farmyard manure at 25 t/ ha in combination with 200 kg K₂O / ha, gave the highest K content and K uptake. Moreover, Mallanagouda et al. (1995) on garlic and onion found also that application of NPK and farmyard manure (FYM 50 t/ha) resulted in the highest uptake of N, P and K which was 111.00, 14.21 and 70.20 for garlic and 186.32, 24.69 and 102.09 kg/ha for onion.

4-1-5-3-Nitrate content:-

Data illustrated in Table (9) show the effect of NPK fertilizers level and different sources of organic manures as well as their mixtures on nitrate content of garlic bulbs. Such data indicate clearly that NO₃ content of garlic bulbs was significantly increased with increasing N, P and K fertilizers level compared with other treatments. In this connect application of 120 kg N + 60 kg P₂O₅ + 96 kg K₂O / fed. gave the highest values of nitrate content during both seasons of this trial. These results are in accordance with those reported by *Benkenstein et al.* (1989), *Radwan* (1998) and *Belanger et al.* (2002). They reported that application of 250 kg N/ ha. significantly increased NO₃-N content in potato tubers.

Table (9): Effect of N, P and K fertilizers level, different sources of organic manures and their mixtures on nitrate content and carbohydrates percentage of garlic plants.

		2000-2001	100			2001	2001-2002	
Seasons		Car	Carbohydrates	tes	Nitrate	Ca	Carbohydrates %	tes
Treatments	Nitrate (ppm)	Leaves	Bulb	Mean	(mdd)	Leaves	Bulb	Mean
	165	143	17.4	15.9	174	14.3	25.6	20.0
Control	350	18.4	35.9	27.2	359	19.1	31.4	25.3
60 kg N + 32 kg P ₂ O ₅ + 48 K ₂ O/ reu.	394	18.8	38.3	28.6	383	19.5	30.4	25.0
120 kg N + 64 kg P ₂ O ₅ + 90 K ₂ O/ 1eu.	300	16.9	29.3	23.1	293	17.6	27.6	22.6
FYM at 120 kg N/fed.	283	16.2	27.8	22.0	278	16.9	26.9	21.9
Compost manure at 120 kg Wied.	090	17.4	26.3	21.9	263	18.1	28.2	23.2
Biogas manure at 120 kg N/ted.	250	16.3	25.8	21.1	258	17.0	26.1	21.6
FYM + Compost	246	16.2	25.0	20.6	250	16.9	28.4	22.7
FYM + Biogas	047	15.0	23.6	19.8	236	16.6	27.4	22.0
Biogas + Compost	313	185	31.7	25.1	317	19.1	30.3	24.7
NPK1 + ½ compost	303	18.9	29.7	24.3	297	19.6	32.0	25.8
NPK1 + 1/2 Biogas	200	180	32.4	25.2	324	18.7	30.1	24.4
NPK1 + ½ FYM	076	16.2	24.1	20.2	241	16.8	27.3	22.1
'/3 Biogas+'/3Compost + '/3 F I'M	15.9	0.80	9.2	5.0	9.2	9.0	1.5	1.0
L.S.D at 0.05	7.0.7							

Concerning the effect of organic manure sources, the same data in Table (9) show clearly that application of the used different organic sources either in a single form or in combination containing 120 kg N/ fed. decreased the nitrate content in bulbs of garlic compared with mineral fertilizer treatments or those of the mixture of organic fertilizers and NPK (mineral fertilization). The increment effect of organic fertilizer application on nitrate content was connected with the increasing in vegetative growth (Table, 3) due to the assimilation and use of nitrogen absorbed in protein and cells formation. These results were true during both seasons of this study. Obtained results are in agreement with those found by Ahmed (2002) on garlic who reported that nitrate content in bulbs of garlic significantly decreased with different organic manures compared with NPK mineral fertilizers. Moreover, data in Table (9) also show that the mixture between organic manures and mineral fertilization level had a significant effect on nitrate content compared with application of 60 kg N + 32 kg P_2O_5 + 48 kg K_2O / fed. or 120 kg N +64 kg P₂O₅+ 96 kg/feddan. Such data reveal also that the treatment, which received FYM containing 60 kg N plus 60 kg N + 32 kg P_2O_5 + 48 kg K_2O / fed. as mineral fertilizers gave the highest values compared with other treatments. In general, the highest nitrate content in bulbs was obtained from the plants, which were fertilized with mineral fertilizer at 120 kg N + 64 kg

P₂O₅+ 96 kg/fed. followed by 60 kg N +32 kg P₂O₅+ 48 kg/fed, FYM + 60 kg N +32 kg P₂O₅+ 48 kg/fed, compost + 60 kg N +32 kg P₂O₅+ 48 kg/fed. and biogas + 60 kg N +32 kg P₂O₅+ 48 kg/fed, respectively. Obtained results are in agreement with those found by *Kawthar et al. (2002)* working on potato (*Solanum tuberosum* cv. Diamond) who found that, the most promising treatment is bio-fertilizer combined with 50% recommended dose of nitrogen fertilizer which satisfy the objective of producing high yield with low nitrate and nitrite levels and save about 50% of the cost of nitrogen fertilizer.

4-1-5-4-Total hydrolysable carbohydrates:

Data presented in Table (9) show that the total carbohydrates percentage of different plant parts are improved with the application of mineral fertilizers compared with the control treatment during both seasons of this study. In this regard, the higher mineral fertilizer rate reflected the most increments in carbohydrates content of plant bulbs and leaves during both seasons of study. These results are in conformity with those obtained by *Arafa* (1972) and *Shobahalan* and *Arumugam* (1991) on garlic who reported that garlic bulbs contained higher percentages of reducing and non-reducing sugars than the control when the crop received N at 50, P₂O₅ at 75 and K₂O at 50 kg/ha as the basal dose plus N at 50 kg/ha...

Moreover, *El-Zohery (1999)* on taro found that application of $120 \text{ kg N} + 64 \text{ kg } P_2O_5 + 120 \text{ kg } K_2O$ /fed. reflected the maximum increments in carbohydrates content of plant foliage and corms.

Concerning the effect of organic manures, the same data in Table (9) illustrate that the carbohydrates percentage in both leaves and bulbs significantly increased as a result of applied biogas, compost or farmyard manures each containing 120 kg N/fed. in a single or combined form over the control. At the same time, such treatments significantly decreased the total carbohydrates percentage in both plant foliage and bulbs when compared with NPK fertilizers level as a mineral source. Obtained results are in agreement with those found by *Usik* and *Batsei* (1973) on onion where the total sugars were 0.3 to 1.1 % in bulbs when 20 t/ha, farmyard manure was added. However, *Hassandokht* and *Kashi* (2000) on potato found that Starch and reducing sugars of tubers did not change with application of 20 or 30 m³ FYM /ha.

With regard to the effect of fertilizers mixture, data in Table (9) show obviously that the carbohydrates percentage in both leaves and bulbs were significantly increased with application of nitrogen fertilizer at 60 kg N/fed. from each of biogas, compost or farmyard manures plus mineral NPK

fertilizers level at 60 kg N + 32 kg P₂O₅ + 48 kg K₂O / feddan. In this regard, the highest values were obtained with application of biogas manure containing 60 kg N/fed plus mineral fertilizers at 60 kg N + 32 kg P₂O₅ + 48 kg K₂O / feddan. In this respect, such increment in total hydrolysable carbohydrate as a result of mineral or organic fertilizers application my be due to the role of such macro-nutrients in mineral fertilizer and macro-and micro – elements in organic fertilizer on increasing the photosynthetic pigments (Table, 7) which contributed in carbohydrate accumulation in plants. Analogous findings have been found by *Hogstad et al.* (1997) who found that carrots grown with 40-80 kg N /ha as mineral fertilizer or 20-72 t /ha. of organic fertilizer contained more total sugars more than those grown with no fertilizer.

4-1-5-Storageability of garlic bulbs:-

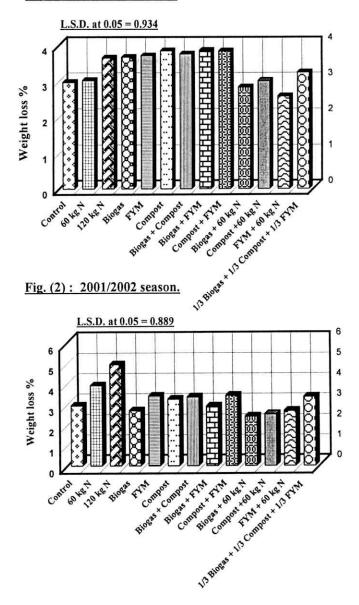
a- Weight loss:

Data presented in Table (10) & Figs. (From 1 to 12) show clearly that all treatments under this trial tended to increase the weight loss from the first to the last month during storage period (6 months). In this respect, mineral fertilizer show treatments proved significant differences in weight loss through the fifth months of storage period except in the sixth month, which had no significant effect compared with control during both seasons.

Table (10): Effect of N, P and K fertilizers level, different sources of organic manures and their mixtures on dry matter and total weight loss percentage after storage period of garlic bulbs during 200/2001 and 2001/2202 seasons.

seasons	2000-2001	2001	2001-2002	2002
Treatments	Total weight loss (%)	D.M (g/100g)	Total weight loss (%)	D.M (g/100g)
Control	57.83	40.43	62.21	41.10
60 kg N + 32 kg P ₂ O ₅ + 48 K ₂ O / fed.	62.64	35.32	63.52	35.02
120 kg N + 64 kg P ₂ O ₅ + 96 K ₂ O/ fed.	68.81	34.81	99'29	34.60
FYM at 120 kg N/fed.	60.52	37.89	60.41	38.04
Compost manure at 120 kg N/fed.	60.18	37.93	64.99	38.12
Biogas manure at 120 kg N/fed.	56.94	40.86	56.79	41.12
FYM + Compost	62.98	35.50	68.14	35.20
FYM + Biogas	60.67	36.81	64.70	37.03
Biogas + Compost	61.43	35.65	64.63	36.47
NPK1 + ½ compost	55.89	42.39	57.24	42.93
NPK1 + ½ Biogas	53.41	43.86	54.5	43.48
NPK1 + ½ FYM	56.47	41.77	58.14	42.10
1/3 Biogas+ 1/3 Compost + 1/3 FYM	59.68	38.98	65.63	39.18
L.S.D at 0.05	3.88	2.69	5.50	1.64

Fig. (1): 2000/2001 season.



Figs. (1 and 2): Effect of N, P and K fertilizers level, different sources of organic manures and their mixtures on weight loss percentage after one month of storage during 2000/2001

Fig. (3): 2000/2001 season.

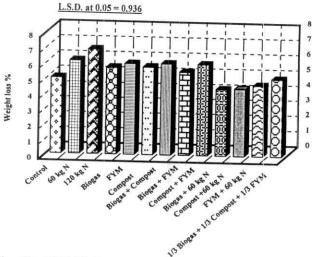
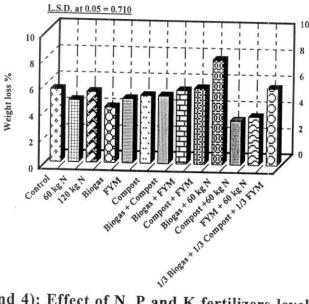
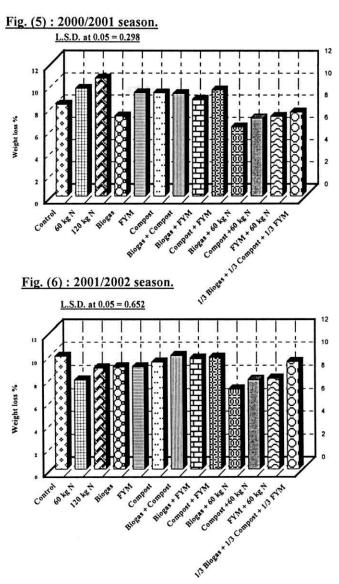


Fig. (4): 2001/2002 season.



Figs. (3 and 4): Effect of N, P and K fertilizers level, different sources of organic manures and their mixtures on weight loss percentage after two months of storage during 2000/2001 and 2001/2002 seasons of garlic bulbs.



Figs. (5 and 6): Effect of N, P and K fertilizers level, different sources of organic manures and their mixtures on weight loss percentage after three months of storage during 2000/2001 and 2001/2002 seasons of garlic bulbs.

Fig. (7): 2000/2001 season.

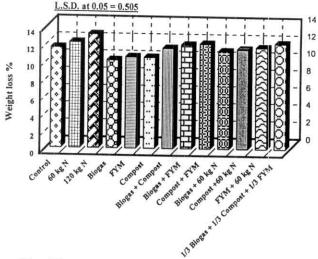
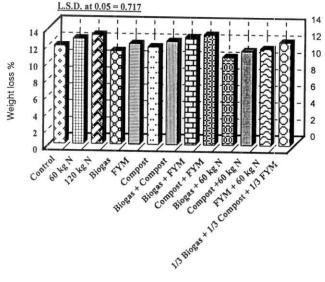


Fig. (8): 2001/2002 season.



Figs. (7 and 8): Effect of N, P and K fertilizers level, different sources of organic manures and their mixtures on weight loss percentage after four months of storage during 2000/2001 and 2001/2002 seasons of garlic bulbs.

Fig. (9):2000/2001 season.

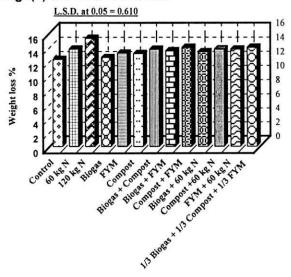
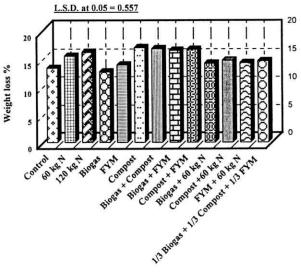


Fig. (10): 2001/2002 season.



Figs. (9 and 10): Effect of N, P and K fertilizers level, different sources of organic manures and their mixtures on weight loss percentage after fifth months of storage during 2000/2001 and 2001/2002 seasons of garlic bulbs.

Fig. (11): 2000/2001 season.

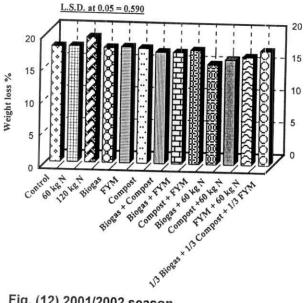
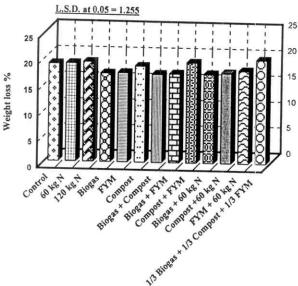


Fig. (12) 2001/2002 season.



Figs. (11 and 12): Effect of N, P and K fertilizers level, different sources of organic manures and their mixtures on weight loss percentage after sixth month of storage during 2000/2001 and 2001/2002 seasons of garlic bulbs.

However, in the third month of storage, the mineral treatments gave significant decreases in weight losses during the second season only. In the same time, treatment of 120 kg N + 60 kg $P_2O_5 + 96 \text{ kg } K_2O / \text{ fed.}$ gave the highest value of weight loss compared with 60 kg N + 32 kg P_2O_5 + 48 kg K_2O / feddan. In general, the present results are in conformity with those found by Abou El-Magd (1979), Fouda and Saleh (1983) and Ahmed (2002) all working on garlic where they found that the lowest storageability was obtained from those received only mineral fertilizers of NPK at 180 kg N + 60 kg P₂O₅ + 72 kg K₂O/feddan. In addition, Pandey et al. (1994), El-Sheekh and Hegazy (1998) and Abbey (2000) all working on onion reported that application of NPK at 340 kg NPK /ha. increased the bulb weight loss through storage period (6 months). Moreover, no significant effect in this respect was reported by Gupta and Sharma (2000) where bulb storage behavior was not affected by increasing N-fertilizer level from 75 to 100 kg N/ fed.

Concerning the effect of organic manure sources as shown in Figs (1 to 12) obtained results reveal that all treatments had a fewer significant effect on weight loss through the storage period (6 months) comparing with the control except during the second month of storage where the treatments of FYM, FYM + compost and Biogas + compost are the only treatments which

showed significant improving effect comparing with the control. Moreover, through the storage period the organic treatments (biogas and compost) in a single form had a significant good effect comparing with the control treatment. This data also indicate that through the fifth storage month only the treatment of the biogas manure showed significantly good effect compared with the control. Generally, it is obvious that there were no significant differences between the organic treatments through all the storage period (6 months) of study. Similar findings have been found by Pereira et al. (1987) and Cho et al. (1994) working on garlic who reported that bulbs of garlic showed low weight loss, moderate pest and damage with 20 t/ ha of compost manure. In addition, Bhonde et al. (1997), El-Sheekh and Hegazy (1998), Abbey (2000) and Singh et al. (2001) on onion also found that the lowest decay and total weight loss were recorded with basal application of 25 t FYM/ha which was at equivalence with 40 tons of FYM /ha.

Regarding the effect of organic manures combined with NPK fertilizers, data in Figs. (1 to 12) show that the treatments which received organic sources i.e. biogas, compost or farmyard manures containing 60 kg N/fed. plus 60 kg N + 32 kg P_2O_5 + 48 kg K_2O / fed. reflected the lowest values in case of weight loss through the storage period (6 months). In this connection, there

were no significant differences between each of organic sources in different storage months except, biogas manure that gave significant effect at the end of the storage period (6months). In general, applications of biogas manure containing 60 kg N plus 60 kg N + 32 kg P₂O₅ + 48 kg K₂O / fed. was the most effective treatment in reducing the weight loss during storage period (6months) in both seasons. These results are in accordance with those reported by *Koltunov* (1984) who reported that the application of FYM at 40 t / ha. + N: P: K at 1:1:2 (N, P₂O₅ and K₂O at 60: 60:120 kg / ha.) gave the best yield of garlic bulbs suitable for long-term storage. *Aliudin et al* (2000) on onion stated that weight loss of two months storage were 31.82 and 32.21 percent for fine compost and bokhasi respectively, while for chemical fertilizer was 25 percent.

b. Dry matter percentage:-

Data presented in Table (10) demonstrate the effect of N, P and K mineral fertilizers level, organic manures sources as well as their mixtures on dry matter percentage subsequent to storage period (6 months). Obtained data reveal that, dry matter percentage subsequent to storage period was significantly decreased with using mineral fertilizers at both the low level (60 kg N +32 kg P₂O₅ + 48 kg K₂O /fed.) and high level (120 kg N + 64 kg P₂O₅ + 96 kg K₂O /fed.) compared with control

treatment during both seasons of this trial. Such decreasing dry matter during the storage my be due to using of dry matter in respiration. In this regard, *Sharfuddin* and *voican* (1985) on sweet potato found that application of 50-100 kg N/ha. and 62-186 kg K₂O/ha led to increase of plant dry matter content after 4 months of storage. However, *El-Shimi* (1996) on sweet potato found that, application of nitrogen at different levels i.e. 20.5, 41 and 61.5 kg N/fed. had no significant effect on dry matter percentage after storage periods (3 months).

Concerning the effect of organic sources and their mixtures on dry matter percentage in bulbs, such data presented in Table (10) reveal also that, irrespective of biogas treatment in a single form application of different organic manures either in single or combined form resulted in decreasing dry matter percentage in bulbs subsequent to storage periods compared with control treatment in both seasons of study.

With regard to the effect of N, P and K mineral fertilizers plus organic manures on dry matter percentage in bulbs, the same data presented in Table (10) show that, the fertilization with lower level of mineral fertilizers (60 kg N + 32 kg P_2O_5 + 48 kg K_2O /fed.) plus organic manure containing 60 kg N/fed. reflected the highest values on dry matter percentage

in bulbs compared with the control treatments or with most of the other ones during storage period (6 months). In this respect, biogas manure containing 60 kg N plus 60 kg N + 32 kg P_2O_5 + 48 kg K_2O /fed. gave the best results during both season of study.

5-1-4-2-Chemical composition of storage bulb:-

5-1-4-2-a. Macronutrients contents:-

Data presented in Table (11) show the effect of NPK fertilizers level, organic manures and their mixture on macroelement content (NPK) after 6 months of storage. Such data show clearly that, increasing the NPK fertilizers level up to 120 kg N + 64 kg P₂O₅ + 96 kg K₂O /fed. significantly increased NPK contents in bulbs of garlic subsequent to storage period (6 months). In this respect, bulbs contents of NPK were at their highest values with higher used level (120 kg N + 64 kg P₂O₅ + 96 kg K₂O /fed.) compared with the control or with the other used level (60 kg N + 32 kg P₂O₅ + 48 kg K₂O/fed.). Such increasing in NPK contents after storage were connected with the increase in macronutrient uptake during the plant growth and the decrease in moisture content during the storage.

Concerning the effect of organic manures on macronutrients, the same data presented in Table (11) reveal that

Table (11): Effect of N, P and K fertilizers level, different sources of organic manures and their mixtures on minerals contents (mg/100 g D.W) and carbohydrates percentage of garlic bulbs after storage period.

Seasons		2	2000-2001			2	2001-2002	
Treatments	z	Ь	Ж	Carbohydrates	z	Ы	×	Carbohydrates
Control	2253	264	2347	16.5	2251	287	2360	16.5
$60 \text{ kg N} + 32 \text{ kg P}_2\text{O}_5 + 48 \text{ K}_2\text{O}$ / fed.	3269	476	3363	23.6	3266	505	3377	24.3
120 kg N + 64 kg P ₂ O ₅ + 96 K ₂ O/ fed.	3426	490	3464	23.3	3434	521	3483	24.0
FYM at 120 kg N/fed.	3044	427	3258	22.0	3047	476	3269	22.7
Compost manure at 120 kg N/fed.	3092	420	3196	21.1	3102	452	3210	21.8
Biogas manure at 120 kg N/fed.	3109	436	3234	22.9	3111	458	3242	23.6
FYM + Compost	3013	397	3150	20.4	3016	451	3165	21.1
FYM + Biogas	3018	413	3134	20.6	3022	446	3142	21.3
Biogas + Compost	3040	417	3108	21.2	3022	430	3118	22.0
NPK1 + ½ compost	3368	508	3473	23.7	3376	537	3487	24.3
NPK1 + ½ Biogas	3396	530	3458	23.8	3402	527	3470	24.5
NPK1 + ½ FYM	3180	493	3361	23.3	3191	519	3366	24.0
1/3 Biogas+ 1/3Compost + 1/3 FYM	3011	431	2887	20.3	3037	434	2878	21.0
L.S.D at 0.05	63.58	21.37	28.71	1.614	29.99	12.89	27.83	0.991

different organic manures each equivalent to 120 kg N/fed. either in single or in combined form gave a significant increase in NPK contents of bulbs compared with the control treatments during storage period (6 months). Moreover, application of biogas manure equivalent to 120 kg N/fed. showed the highest values of NPK contents during both seasons of study. With reference to the effect of organic manures combined with NPK fertilizers, data in Figs. (1 to 12) show that the treatments which received organic sources i.e. biogas, compost or farmyard manures containing 60 kg N/fed. plus 60 kg N + 32 kg P_2O_5 + 48 kg K_2O / fed. as mineral fertilizers reflected the highest values of NPK contents in bulbs subsequent to the storage period (6 months). Obtained results were connected with the increase in vegetative growth, which contributed in increase of macronutrients uptake and accumulation in storage parts of plant that consequently reflected on the concentration of such nutrient in bulbs during storage.

5-1-4-2-b. Total carbohydrates:-

Data presented in Table (11) show the effect of NPK fertilizers level and organic manure sources as well as their mixture on carbohydrates percentage in bulbs subsequence to storage period. Such data reveal that, all treatments, which received mineral fertilizers level, significantly increased

carbohydrates percentage compared with control treatments in both seasons of study. However, each of *Fivkov (1976)* and *Rabie (1996)* on potato. and *El- Shimi (1996)* on sweet potato found that increasing nitrogen fertilizer level resulted in reduction of starch content in tubers root of potato that stored for 3 months while sugar percentage was increased with the lowest level of nitrogen (20.5 kg N/fed.).

Concerning the effect of organic manures on carbohydrates percentage in bulbs subsequence to storage period, the same data presented in Table (11) show that, carbohydrates percentage in bulbs were significantly increased due to the application of organic manure either in a single or combined form at 20 kg N/fed. compared with the control treatment. Moreover, such increments are less than those recorded to the addition of mineral fertilizers. These results are true during both seasons of study.

With regard to the effect of mineral fertilizers combined with organic manures on carbohydrates percentage in bulbs subsequence to storage period (6 months), the same data presented in Table (11) disclose that, all organic manure treatments combined with the low level of mineral treatment i.e. $60 \text{ kg N} + 32 \text{ kg P}_2\text{O}_5 + 48 \text{ kg K}_2\text{O}$ / fed. gave the highest values

of carbohydrates percentage compared with other treatments in both seasons of study. In this regard, the treatment that received biogas manure containing 60 kg N/fed. Plus 60 kg N + 32 kg $P_2O_5 + 48$ kg K_2O / fed. was the most effective on carbohydrates percentage in bulbs subsequence to storage period. Generally, carbohydrates percentage in bulbs, which were stored for 6 months, was increased under conditions of this trail. In this respect the increasing in total carbohydrates percentage at the end of storage period my be due to the water loss during the storage which consequently show temporarily increased in carbohydrates percentage.

4-2- Second experiment:-Effect of some micronutrients on vegetative growth and yield of plants as well as chemical composition and Storageability of garlic bulbs.

4-2-1- Vegetative growth characteristics:-

Data presented in Table (12) show the effect of preplanting soaking cloves and foliar spray of garlic plants with some of tested micronutrients at different concentrations on vegetative growth characteristics of plants expressed as plant length, number of leaves per, plant fresh and dry weight of leaves as well as fresh weight of whole plant. Such data reveal that all of the previously mentioned growth characters were

RESULTS AND DISCUSSION

Table (13): Effect of some micronutrients on some bulb characters of garlic plants.

	Seasons		2000-2001	001			2001-2002	2002	
1 100 100 100 100 100 100 100 100 100 1		Neck	Bulb	Bulb	No. of	Neck	Bulb	Bulb	No. of
Application	Micronutrients (ppm)	diameter	diameter	length	cloves/	diameter	diameter	length	cloves/
methods		(cm)	(cm)	(cm)	qlnq	(cm)	(cm)	(cm)	Qinq
	Control	1.00	4.44	3.59	17.15	1.00	4.68	3.67	17.08
	Zn 400	86.0	4.85	3.77	18.26	0.95	4.86	3.75	17.85
	Zn 800	0.93	5.02	3.99	18.88	0.93	5.17	4.01	18.38
8	Mn 300	86.0	4.86	3.88	18.55	0.94	4.90	3.87	18.08
kin	Mn 600	0.95	5.16	4.16	19.05	0.91	5.27	4.13	18.75
sos	Cu 200	0.95	4.87	3.95	18.73	0.93	5.03	3.93	18.25
1	Cu 400	0.95	5.14	4.01	19.04	0.91	5.22	4.10	18.55
	Zn 400+Mn 300 +Cu 200)	0.92	5.40	4.13	19.09	0.89	5.46	4.22	18.85
	Zn 800+Mn 600 +Cu 400)	06.0	5.45	4.88	19.15	0.88	5.65	4.29	19.08
	Zn 300	0.93	4.96	3.72	17.63	0.94	4.73	3.73	17.63
	Zn 600	0.93	5.30	3.86	18.62	0.92	5.18	3.92	17.90
	Mn 200	0.90	5.33	3.87	18.80	0.92	5.20	3.98	18.97
	Mn 400	0.93	5.44	3.92	18.94	68.0	5.36	4.08	19.05
ısil	Cu 100	0.93	5.14	3.78	18.23	0.93	4.94	3.88	17.85
οЯ	Cu 200	06.0	5.37	3.91	18.81	0.92	5.28	4.10	19.00
	Zn 300+Mn 200 +Cu 100)	0.93	5.62	4.48	19.11	68.0	5.65	4.20	19.27
	Zn 600+Mn 400 +Cu 200)	06.0	5.68	4.12	19.15	0.88	5.69	4.26	19.27
	L.S.D. at 0.05	90.0	0.36	0.24	1.29	n.s.	0.31	0.22	1.08

of soaking cloves in 800 ppm Zn + 600 ppm Mn + 400 ppmCu. However, the maximum, increments of neck diameter were recorded by the control treatments in both seasons of study. In the same time, the lowest value was obtained with the highest used concentration of Zn, Mn and Cu. (800 ppm Zn + 600 ppm Mn + 400 ppm Cu). Obtained results are in conformity with those reported by *Maksoud et al.* (1983), *Shaker* (1992), *Hassan et al.* (1993), *Ismail* (1995) and *Abd El-Hamed* (1997) all working on garlic. They found that application of micronutrients as foliar spray at different rate increased all bulb characters i.e. bulb height and diameter of garlic.

4-2-3-Bulbing ratio:-

Data in Table (14) reveal the effect of pre-sowing soaking garlic cloves or plant foliar application with some micronutrients on bulbing ratio at 90, 120, 150 and 180 days after planting. Such data reveal that there were no significant differences among the studied treatments and the check one. Such results affected greatly by the genotype factors rather than the agricultural treatments.

4-2- 4-Yield and its components:-

It is clear from the data in Table (15) that there are significant increases in cloves weight, bulb fresh and dry weight,

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F.W.) in Table (16): Effect of some micronutrients on photosynthetic pigments contents (mg /100g leaves of garlic plants.

	Season		200	2000-2001			200	2001-2002	
	Treatment	О	Chlorophyll	11	Carotinoides	D	Chlorophyll	п	Carotinoides
Application methods	Micronutrients (ppm)	(a)	(p)	Total (a+b)		(a)	(q)	Total (a+b)	
	Control	174.7	83.67	258.40	177.00	171.7	84.33	256.00	181.30
	Zn 400	198.0	29.86	296.67	198.70	190.0	100.00 290.00	290.00	203.30
	Zn 800	220.7	125.0	345.70	227.30	206.7	126.00	332.70	233.00
Bu	Mn 300	188.0	95.00	283.00	196.00	186.0	95.67 281.67	281.67	200.70
aki	Mn 600	234.3	137.30	371.60	239.00	221.7	139.00 360.70	360.70	245.00
oS	Cu 200	207.0	111.00	111.00 318.00	212.00	197.0	112.00 309.00	309.00	217.00
	Cu 400	229.0	135.00	364.00	237.00	217.0	136.30 353.30	353.30	242.70
	Zn 400+Mn 300 +Cu 200)	239.0	140.00	379.00	239.00	224.7	141.70 366.40	366.40	245.00
	Zn 800+Mn 600 +Cu 400)	243.7	146.00	389.70	243.70	229.0	147.70 376.70	376.70	249.70
	Zn 300	183.3	88.33	271.63	184.30	180.0	89.00	269.00	189.00
	Zn 600	193.7	29.96	290.37	195.30	187.7	00.86	285.70	200.00
	Mn 200	198.7	102.00	300.70	204.70	191.0	103.30 294.30	294.30	209.70
11.	Mn 400	212.0	117.30	329.30	217.70	198.3	118.30	118.30 316.60	223.00
silo	Cu 100	186.7	92.67	279.37	192.30	183.3	93.33	276.63	197.00
H	Cu 200	200.0	106.30	306.30	208.70	192.7	107.30 300.00	300.00	213.70
	Zn 300+Mn 200 +Cu 100)	217.3	120.70	338.00	220.70	201.3	121.70 323.00	323.00	226.30
	Zn 600+Mn 400 +Cu 200)	226.3	129.00	355.30	230.30	209.7	130.70	130.70 340.40	236.00
	L.S.D. at 0.05	5.31	3.94	9.24	9.24	7.21	2.30	9.51	9.51

assayed photosynthetic pigments were connected with soaking cloves with Mn at 600 ppm and that in the highest used concentration as mixture of 800 ppm Zn + 600 ppm Mn + 400 ppm Cu. followed by the treatments which contain 400 ppm Zn + 300 ppm Mn + 200 ppm Cu, respectively. Obtained results may be attributed to the increase of micronutrients uptake (Table 18) specially Zinc element, which are considered the major constituents of photosynthetic pigments. Obtained results are in agreement with those found by Shaniyazov and Dailev (1978) who mentioned that seeds of the onion cv. Karatal were soaked for 4 h in 0.11% solutions of CuSO₄ or ZnSO₄. Zn and Cu increased leaf chlorophyll contents by 15.4 and 11.5% respectively. Such results are expected to be due to the main role of such micronutrients in constitution of photosynthetic ingredients. Obtained results are in agreement with those found by Eid et al. (1991) on garlic plants cv. Japanese on a clay loam soil where they found that when plants were supplied with Cu, Zn and Fe (each at 50, 100 or 150 ppm) chlorophylls-a and b and carotinoides, were increased. Contra results were obtained by Melnik (1973) on garlic who found that spraying with MnSO₄ at 0.1%, boric acid at 0.02%, CuSO₄ at 0.02% or ZnSO₄ at 0.02% stimulated chlorophyll breakdown.

4-2-5-2-Macronutrients content:-

Data in Table (17) show the effect of some micronutrients application as soaking cloves or foliar spray on N, P and K contents of both leaves and bulbs of garlic plants. Obtained data reveal that NPK contents of plant foliage and bulbs were gradually increased with increasing the concentration of studied micronutrients. The highest values were obtained as a result of using micronutrients as soaking application at mixture rate (800 ppm Zn + 600 ppm Mn + 400 ppm Cu followed by (400 ppm Zn + 300 ppm Mn + 200 ppm Cu). Generally, soaking application gave the greatest result than foliar spray treatments during both seasons. In this regard, Abed et al. (1988) on garlic who reported that the highest N, P and K content of different garlic plant parts was connected with the highest used rate of micronutrients concentrations (1000, 1000 and 400 ppm.) of Zn, Mn. or Cu, respectively. Furthermore, similar findings were reported by Ibrahim et al. (1980 a) on onion showed that nitrogen and potassium uptake was significantly increased with pre-sowing soaking onion transplants of cv. Giza 6 for 3 hrs. before transplanting in 0.2% of zinc solution in comparison with soaking for 1.5 and 4.5 hrs. and the control (soaking in distilled water).

Table (17): Effect of some micronutrients application on mineral contents (mg/100 g D.W) of garlic plants.

Seasons			2000	2000-2001					2001-	2001-2002		
	Z	-		Р		X		z) prince	<u>a</u>	1	X
	Leaves	Bulbs	Leaves	Bulbs	Leaves	Bulbs	Leaves	Bulbs	Leaves	Bulbs	Leaves	Bulbs
4	4362	3246	519	378	4014	3315	4357	3247	503	380	4001	3304
4	4405	3360	564	412	4058	3359	4433	3362	547	416	4045	3348
4	4444	3428	624	464	4112	3413	4487	3427	909	467	4099	3402
4	4398	3321	546	394	4041	3342	4021	3311	531	400	4028	3331
4	4473	3467	643	493	4142	3360	4495	3463	624	505	4128	3349
44	4426	3397	280	440	4080	3382	4455	3399	573	445	4067	3371
44	4468	3454	638	487	4131	3443	4497	3454	619	494	4117	3432
4482	22	3479	651	200	4152	3475	4504	3475	631	526	4138	3463
4495	2	3482	099	520	4165	3488	4519	3479	640	536	4150	3476
4382	22	3288	528	384	4023	3324	4375	3286	512	391	4010	3313
4401	=	3340	555	397	4050	3351	4420	3328	538	406	4037	3340
4424	24	3379	699	422	4066	3366	4442	3377	552	424	4053	3355
44	4434	3405	909	449	4091	3394	4471	3401	589	451	4077	3377
4393	93	3310	537	389	4031	3329	4407	3298	522	397	4018	3318
44	4423	3392	580	430	4074	3374	4449	3392	563	435	4062	3363
4	4437	3418	619	456	4100	3400	4484	3417	109	457	4086	3389
4	4461	3442	631	478	4124	3428	4492	3440	611	480	4111	3417
-	18.2	14.5	0.9	7.71	4.6	7.9	10.1	47.8	10.9	7.4	1.8	9.2

With the respect to foliar application, similar, findings have been found by *Fouda* and *Saleh* (1983) and *Eid et al.* (1991) all working on garlic where they supplied plants with Cu, Zn and Fe (each at 50, 100 or 150 ppm). They found that N, K, Cu, Zn and Fe generally increased with increasing micronutrients mixture concentration. Moreover, *Allam* (1999) on onion showed that the highest total nitrogen, phosphorus and potassium content in bulbs of Giza 20 and Giza 6 cvs. were obtained from plants sprayed with Microtrin at 15 ml/1 for mixture of Fe + Zn + Mn at 30 ppm for each.

4-2-5-3- Micronutrients contents:-

Data presented in Table (18) show the effect of pre-sowing soaking cloves and foliar spray with different micronutrients treatments on Zn, Mn and Cu contents in garlic bulbs. Obtained data reveal that, Zn, Mn and Cu contents in bulbs were significantly increased with increasing concentration of each micronutrient in solution during both seasons of this study. In the same time, the highest values of Zn, Mn and Cu contents in garlic bulbs were 570, 358 or 120 mg/kg D.W in the first season while, in the second season they were 755, 300 or 219 respectively, which were produced by adding Zn, Mn and Cu as a mixture solution nutrients 400, 300 and 200 respectively, as

Table (18): Effect of some micronutrients application on Zn, Mn and Cu contents (mg/kg. D.W) in bulbs of garlic.

	s /	Seasons		2000-2001	-		2001-2002	2
	Treatments		Zn	Mn	Cu	Zn	M	J
Application methods	Micronutrients (ppm)	(mdd))
	Control		182	80	20	273	Ξ	30
	Zn 400		207	217	52	677	185	86
,	Zn 800		570	233	55	755	209	102
gui	Mn 300		440	275	53	577	225	86
ЯВ	Mn 600		316	358	58	433	300	108
os	Cu 200		458	142	85	621	163	156
	Cu 400		308	175	120	413	236	219
	Zn 400+Mn 300 +Cu 200)	u 200)	530	237	105	720	232	200
	Zn 800+Mn 600 +Cu 400)	u 400)	436	212	06	582	222	163
	Zn 300		547	217	89	720	195	128
	Zu 600		613	193	77	795	205	140
	Mn 200		442	317	52	587	233	95
31.	Mn 400		327	333	52	440	264	95
ilo	Cu 100		280	200	87	370	187	155
H	Cu 200		330	207	112	445	215	202
	Zn 300+Mn 200 +Cu 100)	100)	477	402	108	633	243	202
	Zn 600+Mn 400 +Cu 200)	1 200)	472	347	87	620	231	165
	L.S.D. at 0.05		84.2	34.3	7.8	28.0	42.19	28.7

soaking garlic cloves. Fowled by using micronutrients as foliar application (300 ppm Zn + 200 ppm Mn + 100 ppm Cu.

In general, the present results are in conformity with those found by *Abed et al.* (1988) on garlic who reported that pre-sowing soaking cloves in studied micronutrients solutions increased the content of such microelements in both soaked cloves and different parts of produced plants from treated cloves. The highest content of Zn, Mn and Cu in plant parts was connected with the highest used concentrations of such micronutrients. In addition, produced cloves proved to be a good sink for the accumulation of such microelements.

Concerning the foliar spray, *Eid et al.* (1991), Shaker (1992), *Ismail* (1995) and *abd El-Hamed* (1997) working on garlic. Moreover, *Allam* (1999) on onion showed that application of Cu, Zn and Fe (each at 50, 100 or 150 ppm) increased N, K, Cu, Zn and Fe with increasing micronutrients mixture concentration. However, *Sliman et al.* (1999) found that, foliar spray by micronutrients on onion plants did not increase microelements concentration except for ZnSO₄, which increased Zn to its highest concentration and content.

4-2-5-4-Carbohydrates content:-

Data presented in Table (19) demonstrate that the carbohydrates percentage of different plant parts i.e. leaves and bulbs are enhanced with the highest concentrations of micronutrients as pre-sowing soaking cloves or foliar spraying of garlic plants during both seasons of this study. In this regard, the maximum content was obtained due to application of (800 ppm Zn + 600 ppm Mn + 400 ppm Cu.) followed by (Zn at 400 ppm + Mn at 300 ppm + Cu at 200 ppm.) and Mn at 600 ppm. The differences between all pre-sowing soaking treatments were significant during both seasons of this study. The previously mentioned results are in agreement with those obtained by Ibrahim et al. (1980 a) and Ibrahim et al (1980 b) working on onion where they found that the highest increments in content of carbohydrates of onion bulb was recorded by 0.2% of zinc solution Cu and Mn combination at rates of 0.1 and 0.2 % respectively.

Concerning the effect of foliar spray, *Ismail (1995)* on garlic who indicated that foliar spray of garlic plants of cv. Balady grown in calcareous soil with pH 8.1 three times starting at 45 days after planting and 3 weeks intervals with zinc sulphate at 0.2 and 0.4 % improved the bulbs content of carbohydrates.

Table (19): Effect of some micronutrients application on carbohydrates percentage of garlic

	Seasons	2	2000-2001		2.	2001-2002	
	Treatments		:	;	•	:	,
Application methods	Micronutrients (ppm)	Leaves	Sqing	Mean	Leaves	Rulbs	Mean
	Control	18.1	28.2	23.2	18.0	27.9	23.0
	Zn 400	19.5	30.0	24.8	19.3	29.3	24.3
	Zn 800	21.0	32.0	26.5	20.8	31.9	26.4
Вu	Mn 300	18.9	29.1	24.0	18.8	29.0	23.9
іЯв	Mn 600	22.0	32.9	27.5	21.8	32.8	27.3
os	Cu 200	20.33	31.0	25.7	20.2	31.0	25.6
	Cu 400	21.8	32.6	27.2	21.6	32.6	27.1
	Zn 400+Mn 300 +Cu 200)	22.4	33.0	27.7	22.3	32.9	27.6
	Zn 800+Mn 600 +Cu 400)	22.8	33.4	28.1	22.6	33.4	28.0
	Zn 300	18.5	28.5	23.5	18.4	28.4	23.4
	Zn 600	19.2	29.8	24.5	17.1	29.3	23.2
	Mn 200	19.7	30.4	25.1	9.61	30.3	25.0
μ	Mn 400	20.7	31.3	26.0	20.5	31.2	25.9
silo	Cu 100	18.7	28.6	23.7	18.6	28.6	23.6
H	Cu 200	20.7	30.8	25.8	19.9	30.7	25.3
	Zn 300+Mn 200 +Cu 100)	20.9	31.8	26.4	20.7	31.7	26.2
	Zn 600+Mn 400 +Cu 200)	21.6	32.5	27.1	21.4	32.1	26.8
	L.S.D. at 0.05	0.19	0.22	0.21	0.21	0.63	0.42

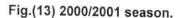
4-2-9-Storageability of garlic bulbs:-

a. Weight loss percentage:-

Data recorded in Table (20) and figs (From 13-24) show that clearly show the effect of pre-sowing soaking cloves and spraying plant with micronutrients on weight loss percentage during the storage period of garlic bulbs. Such data show that all treatments which received micronutrients as pre-sowing soaking cloves or as plant foliar spray gradually decreased the weight loss from the first to the last month during storage period (6 months). In this respect, all micronutrients treatments proved significant differences in values of weight loss through whole storage period (6 months). In this regard, spraying garlic plants with cupper solution at 200 ppm, three times during the vegetative growth period improved the storageability of garlic bulbs and reduced the total weight losses percentage during storage period. Such result is true during both season of study. Such results may be due to the main role of Cu as a micronutrient necessary for bulbing crops and the effect of it on thickness of storage leaves and its effect on respiration and water loss rate during the storage. Obtained results are in agreement with those found by Basilious (1983), Badawi and El-Sheekh (1994) on onion where they reported that, soaking onion seeds before sowing in zinc solution at 300, 400 and 500 ppm in the form of sulphate decreased the total weight loss percentage of

Table (20): Effect of some micronutrients application on dry matter content and total weight loss percentage after storage period of garlic bulbs.

	Seasons	2000-2001	2001	2001-2002	2002
	Treatments	Total	D.M	Total	D.M
Application methods	Micronutrients (ppm)	(%)	(g/100g)	(%)	(g/100g)
	Control	63.54	36.51	65.18	36.08
	Zn 400	60.70	38.83	64.60	38.63
	Zn 800	57.97	40.13	99.09	39.38
81	Mn 300	52.04	39.05	58.19	38.88
hiy	Mn 600	58.98	41.55	61.49	39.50
gog	Cu 200	60.21	39.89	65.71	39.17
S	Cu 400	57.58	40.75	64.11	39.42
	Zn 400+Mn 300 +Cu 200)	60.78	42.03	64.82	40.75
	Zn 800+Mn 600 +Cu 400)	65.38	42.5	66.37	41.15
	Zn 300	60.72	39.36	63.73	37.48
	Zn 600	59.66	40.08	62.04	38.50
	Mn 200	60.58	40.13	62.30	38.78
J	Mn 400	63.32	40.63	64.59	39.89
ısil	Cu 100	51.95	39.63	55.84	38.10
Fo	Cu 200	49.27	39.96	53.40	39.20
	Zn 300+Mn 200 +Cu 100)	52.19	41.26	57.14	40.33
	Zn 600+Mn 400 +Cu 200)	58.93	42.33	61.09	41.05
	L.S.D. at 0.05	5.65	1.16	4.80	0.95
		The second secon			



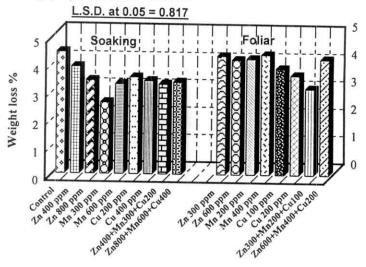
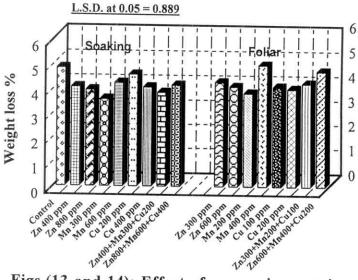


Fig.(14): 2001/2002 season.



Figs.(13 and 14): Effect of some micronutrients application on weight loss perecentage after one month of storage during 2000/2001 and 2001/2002 seasons of garlic bulbs.

Fig. (15):2000/2001 season.

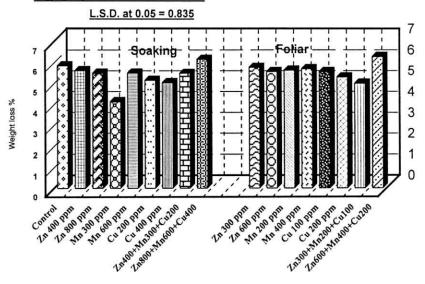
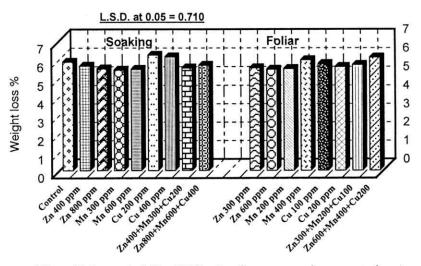


Fig. (16):2001/2002 season.



Figs.(15 and 16): Effect of some micronutrients application on weight loss perecentage after two months of storage during 2000/2001 and 2001/2002 seasons of garlic bulbs.

Fig.(17) 2000/2001 season.

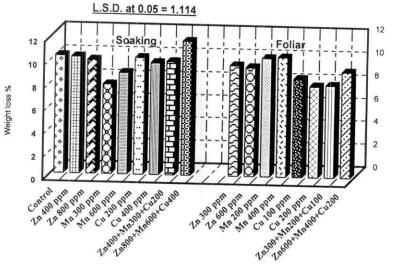
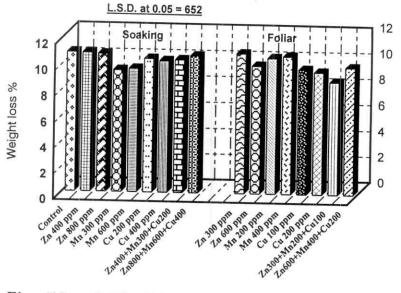


Fig.(18) 2001/2002 season.



Figs.(17 and 18): Effect of some micronutrients application on weight loss perecentage after three months of storage during 2000/2001 and 2001/2002 seasons of garlic bulbs.

FIG. (19):2000/2001 season.

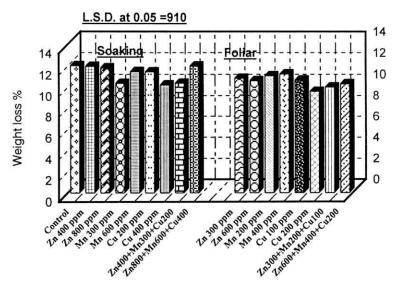
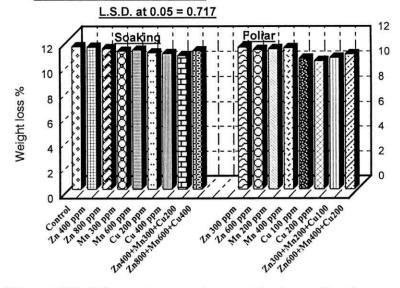


FIG. (20):2001/2002 season.



Figs.(19 and 20): Effect of some micronutrients application on weight loss perecentage after four months of storage during 2000/2001 and 2001/2002 seasons of garlic bulbs.

Fig.(21):2000/2001 season.

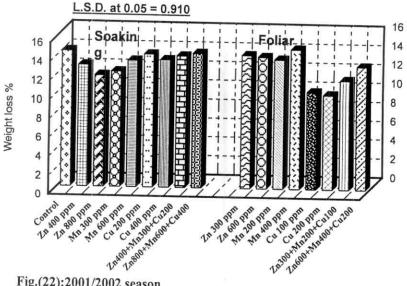
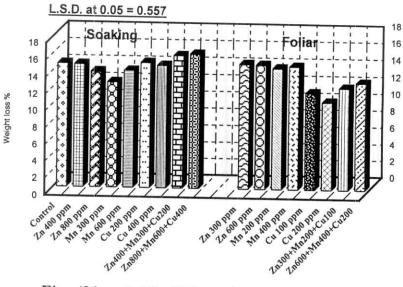


Fig.(22):2001/2002 season.



Figs.(21 and 22): Effect of some micronutrients application on weight loss perecentage after fifth months of storage during 2000/2001 and 2001/2002 seasons of garlic bulbs.

Fig.(23):2000/2001 season.

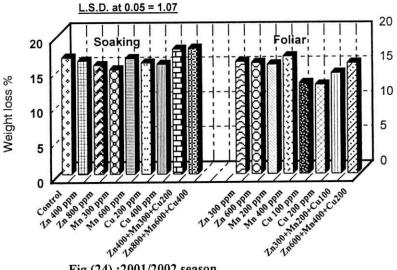
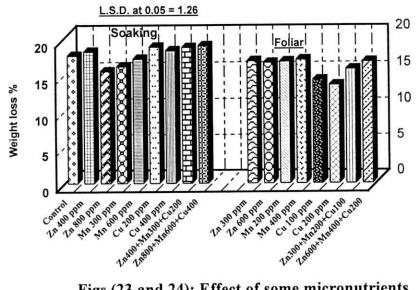


Fig.(24):2001/2002 season.



Figs.(23 and 24): Effect of some micronutrients application on weight loss perecentage after six month of storage during 2000/2001 and 2001/2002 seasons of garlic bulbs.

bulbs during the storage period. In addition, Arafa (1972), Fouda and Saleh (1983) on garlic who reported that micronutrients compounds as foliar application at concentration of 3% which contains 2% Zn, 2% Cu, 1% Fe 0.02 % Co, 2% B, 0.08 % Mo, 8.3 and 30% S improved storageability of the produced bulbs. However, Farrag et al. (1993) on garlic found that, micronutrient treatments had insignificant effect on the percentage of plant weight loss compared with the control at 2, 4 and 6 months after storage. Meanwhile, Ismail (1995) reported that copper sulphate application as foliar spray at 0.2 and 0.4 % to garlic plants of cv. Balady grown in calcareous soil with pH 8.1 three times started at 45 days after planting and 21 days intervals proved to be of intermediate effect on bulbs storageability expressed as percentage of sound bulbs during the storage period, percentage of loss due to moisture loss dumping, as well as total loss compared with the other studied microelements (Zn, Mn, Fe and their mixture) and the control. However, the lowest used concentration (0.2 %) was the best in this regard.

b. Dry matter content:

Data recorded in table (20) indicate the effect of micronutrients as pre-sowing soaking cloves or foliar spray at different used concentrations on dry matter content of garlic bulbs after storage period (6 months). Such data reveal that the dry matter content was constantly increased with increasing the tested concentrations of different used micronutrients either as pre-sowing soaking or as foliar spray during the vegetative growth of plant. In this respect, the highest used concentration in both methods of application for the studied micronutrients in a mixture form i.e. Zn + Mn + Cu at 800, 600 400 in case of soaking and 600, 400 and 200 in case of spraying respectively, reflected the highest dry matter content compared with other tested treatment and or the control one. Such noticed increase in dry matter during storage may be due to attributed to the increase in moisture transpiration and consequently show such increase in dry matter.

4-2-10-Chemical composition after storage:-

4-2-10-a. Macroelements contents:-

Data in Table (21) show the effect of micronutrients treatment either as pre-sowing soaking cloves or as plant foliar spray on NPK contents of bulbs after storage. Such data clearly show that, N, P and K contents in bulb were significantly increased with increasing the concentration of micronutrients that added as pre-sowing soaking cloves compared with control treatment. In this regard, the highest values for NPK content of bulbs were obtained due to combinations of Zn, Mn and Cu

Table (21): Effect of some macronutrients on N, P and K contents (mg/100 g. D.W) and carbohydrates percentage in garlic bulbs after storage.

/									
	Seasons		7	2000-2001			20	2001-2002	
Application methods	Micronutrients (ppm)	z	А	Ж	Carbohydrates	z	٩	×	Carbohydrates
	Control	3140	438	3405	17.9	3045	426	3304	10.7
	Zn 400	3276	495	3455	19.0	3180	481	3443	2000
	Zn 800	3334	548	3498	20.8	3233	534	3486	20.5
gui	Mn 300	3239	481	3441	18.8	3133	468	2420	22.1
ЭК	Mn 600	3366	576	3517	21.5	3265	550	3505	20.1
os	Cu 200	3300	526	3478	20.7	3202	513	3467	22.3
	Cu 400	3359	563	3513	21.2	3257	548	3501	27.4
	Zn 400+Mn 300 +Cu 200)	3379	590	3523	21.8	3279	574	3511	23.2
	Zn 800+Mn 600 +Cu 400)	3390	604	3531	22.0	3292	587	3519	23.3
	Zn 300	3176	457	3427	18.5	3081	445	3416	10.8
	Zu 600	3263	491	3449	18.9	3166	478	3436	20.3
	Mn 200	3219	909	3467	19.6	3191	492	3466	21.0
ar	Mn 400	3315	533	3489	20.4	3218	519	3478	21.0
ilo	Cu 100	3191	468	3432	18.6	3101	455	2471	100
H	Cu 200	3297	519	3469	19.9	3106	505	2450	17.9
	Zn 300+Mn 200 +Cu 100)	3325	539	3495	20.7	3227	525	3483	2.12
	Zn 600+Mn 400 +Cu 200)	3343	554	3500	21.0	3243	540	3488	22.7
	L.S.D. at 0.05	43.5	7.3	5.9	0.17	15.0	3.4	7.1	000

either at the higher used concentration (800 ppm Zn, 600 ppm Mn or 400 ppm Cu) or at the low ones (400 ppm Zn, 300 ppm Mn or 200 ppm Cu).

As for the effect of foliar application, the same data presented in Table (21) show the effect of micronutrients application as foliar spray on NPK contents in bulbs after storage period (6 months). All of the micronutrients treatments recorded augmentation in NPK content in bulb compared with the control one. In this respect, combination of Zn, Mn and Cu at the highest tested concentration reflected the maximum increments of macro-elements content for bulbs. These results were true during both seasons of study.

4-2-10-b-Carbohydrates percentage in bulb after storage:-

Data recorded in Tables (21) clearly show that, a carbohydrate percentage in bulb was significantly increased with was different concentrations of studied micronutrients, which applied as pre-sowing soaking cloves. In this regard, the best results, which gave the lowest loss in carbohydrates, were the combination between the used micronutrients at high or low concentrations during both seasons of study. Obtained results may be attributed to the increase of transpiration and reduce the respiration rate from bulbs during storage period (6 months).

The same data presented in Table (21) reveal that, all treatments that received micronutrients as foliar spray at different concentrations gave significant effect on total carbohydrates percentage in bulb compared with the control treatment. In this regard, the combination between Zn, Mn and Cu in the same solution especially in the high level resulted in the highest carbohydrates percentage in garlic bulbs in the first season; meanwhile the low level gave the highest carbohydrates percentage in the second season.

4-2-10-c. Micronutrients content of bulb after storage:-

Data presented in Table (22) show that, Zn, Mn and Cu content in bulbs after storage period (6 months) were significantly increased with increasing micronutrients concentrations in the solution that was used as pre-sowing soaking compared with control treatment. In this regard, application of high level of Mn at 600-ppm improved Zn and Mn contents in garlic bulb in both seasons of study comparing with another treatments. Moreover, application higher level of Cu at 400 ppm or the mixture 400 ppm Zn + 300 ppm Mn + 200 ppm Cu gave the highest value in Cu contents in the first and the second season respectively. In general, copper content was increased in bulb through the storage period (6months) while, Zinc and Manganese were decreased under the same period (6

RESULTS AND DISCUSSION

Table (22): Effect of some micronutrients application on Zn, Mn and Cu contents (mg/kg. D.W) in garlic bulbs after storage period.

	Socons		2000-2001			2001-2002	
	Treatments	Zn	Ž	Ö	Zn	Mn	C
Application methods	Micronutrients (ppm)		27				
	Control	48	65	32	71	91	57
	Zn 400	147	182	55	147	173	115
	Zn 800	185	210	63	186	199	121
8	Mr 300	267	172	63	260	201	117
uix	Mr 600	350	245	69	348	281	125
lso	Cn 200	223	130	108	228	159	175
s	207 10	265	158	144	279	191	231
	Z= 400+M= 300 +Cu 200)	242	207	114	237	217	233
	Z. 800+Mr 600 +Cu 400)	178	193	103	210	210	210
	7300	173	192	68	178	179	140
	22.600	273	187	111	278	195	148
	Mr. 200	192	205	66	191	661	132
•	Mr 400	292	258	120	267	251	133
ısi	C: 100	183	182	137	184	179	167
lo A	0: 300	217	193	168	198	195	224
	Z= 200+Mr 200 +Cu 100)	192	227	131	199	199	223
	Z- 600+Mr 400 +Cu 200)	200	205	125	186	194	170
	I S D at 0.05	27.7	30.6	15.6	24.31	27.9	12.7

months) (Table 18). Obtained data my be attributed to the role of copper in construction of the external envelope for bulb.

As for the effect of foliar application such data presented in Table (22) reveal also that, Zn, Mn and Cu contents in bulb are significantly increased with increasing the micronutrients concentration up to 600 ppm Zn, 400 ppm Mn or 200 ppm Cu respectively whereas, application of Zn, Mn and Cu as a combined treatment did not give the best results specially with the higher used concentration. Spraying plants with 400 ppm Mn gave also the highest values for Zn content of bulbs during both seasons of this study. Generally, Zn and Mn were decreased in stored bulbs while, Cu content was increased during the same periods (6 months) as shown in Table (18 and 22).
