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ORIGINAL ARTICLES

Influence of Water Stress and Organic and Inorganic Fertilization on Quality, Storability and Chemical Analysis of Potato (*Solanum Tuberosum*, L)

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ABSTRACT

Two field experiments were conducted at the Experimental Station, Faculty of Agriculture, Mansoura University, Egypt during 2007 and 2008 seasons. The objectives of this investigation is aimed to study the effect of water tension treatments, organic and inorganic fertilizer combinations and their interactions on quality, storability and chemical analysis of potato Spunta cultivar. Each irrigation treatments were conducted in a separate experiment. Every separate experiment laid-out in randomized complete block design with four replicates. Results indicated that highest averages of tuber length and diameter, nitrogen content in foliage and protein content in tubers were recorded with irrigation at irrigation at 26cb (5360.17 m^3 water/ha) *i.e.* 54.1% from field capacity in both seasons. Application of 60% mineral nitrogen fertilizer (238 Kg N/ha) plus 40 % organic chicken manure (158 Kg N/ha) produced the highest averages of tuber length, tuber diameter, nitrogen content in foliage and protein content in tubers in both seasons. Adding 80% mineral nitrogen fertilizer (317 Kg N/ha) plus 20 % organic chicken manure (79 Kg N/ha) recorded the highest averages of dry matter content after storage in Newalla & refrigerator. Results indicated that irrigation at 34cb (3449.62 m^3 water/ha) *i.e.* 45.8% from field capacity and adding 20% mineral nitrogen fertilizer (79 Kg N/ha) plus 80 % organic chicken manure (317 Kg N/ha) produced the maximum values of dry matter content. It could be accomplished that irrigation at 26cb (5360.17 m^3 water/ha) *i.e.* 54.1% from field capacity as well as application of 60% mineral nitrogen fertilizer (238 Kg N/ha) plus 40 % organic chicken manure (158 Kg N/ha) maximized averages of tuber length, diameter, nitrogen content in plant foliage and protein content in tubers.

Key words: Irrigation treatments and Field capacity, organic chicken manure and mineral nitrogen fertilizer combinations, Total soluble solid and Storage methods

Introduction

Potato (*Solanum tuberosum* L.) is one of the majority important field crops grown in all over the world. It is considered to be one of the fourth important energy vegetable crops of the world. In Egypt it is cultivated not only to local consumption but also to exportation. It is economically important vegetable and has a great potential to provide nutritious food in diversity of environments for increasing hungry world and ranks after wheat, rice and maize as the fourth most important crops for human consumption (Ewing, 1997).

Water is considered an economical scare resource in many areas of the world especially in arid and semi arid regions like Egypt. It is painstaking a limiting factor in agricultural development in all countries all over the world. Potato plants considered drought sensitive compared with other crops. Water affecting potato quality, storability and chemical analysis, in this relation, Augustin *et al.* (1977) indicated that nitrate and nitrite content in potato tubers were condensed by increasing the amount of irrigation water, this reduction resulted from movement of soil nitrogen below the root zone by greater water applications. Bezerra *et al.* (1998) and Onder *et al.* (2005) concluded that potato tuber length; diameter and quality can be compact by water stress occurring at any time during the growing season. Zhivkov and Kaltcheva (1997) found that reducing the amount of irrigation by 20, 40, and 60% compared with the optimum treatments resulted in production losses of 13.2,

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18.4 and 22.5%, respectively. Avander and Rossouw (1998) and Yuan *et al.* (2003) indicated that drought rising specific gravity and nitrogen content. Hammad and Abd-El-Ati (1998) reported that potatoes generally contain less than 200 mg kg^{-1} fresh weight of nitrate concentration. Bonstak *et al.* (2004) found that irrigation exhibited no effect on specific gravity as well as on contents of total and reducing sugars. Moreover, Alva (2008) showed that deficit irrigated in generally showed negative impact on tuber quality.

Nitrogen fertilization is a necessary factor for increasing total tuber yield and tuber quality of potato. Several studies have been carried to explain the efficiency of nitrogen levels on quality, storability and chemical analysis of potato plants. In this association, White and Sanderson (1983) showed that nitrogen application compact specific gravity on potato tubers. Abo-Sedra and Shehata (1994) reported that specific gravity of potato tubers did not affect by application nitrogen at the rate of 180 kg N/ha. Ghosh *et al.* (2000) found that increasing nitrogen fertilizer significantly increased nitrogen content in foliage and tuber as well as total soluble solids and decreased tuber dry matter O'Beirne and Cassidy (1990) found that dry matter content was significantly diminished by amount of nitrogen up to 150 kg N/ha. Rogozinska et al (2001) and Kumar *et. al.* (2007) concluded that total soluble solids, specific gravity, nitrogen content in foliage and tuber were increased with rising in nitrogen application. Martin (1995) pointed out that nitrogen fertilization increased nitrogen, nitrate and nitrite content in tubers and tuber dry matter content decreased. Kolbe *et al.* (1995) found that weight loss was enhanced with higher nitrogen fertilization, total soluble solids and reducing sugars was increased. Moreover, high initial nitrate content of tubers seemed to be increased and low nitrate values were decreased during storage period. Sharma and Dubey (1998), Belanger, et al, 2002) and Millard (2006) found that increasing nitrogen application resulted significant increases in N and protein contents in tubers. Kumar *et al.* (1996) stated that tuber dry matter and storage quality of tuber percentages decreased with increasing nitrogen rate. Koch *et al.*. (1997) and Mohammed *et al.* (1999) pointed out that specific gravity was the highest with no nitrogen fertilizer. Helaly *et al.* (2009) and Zelalem *et al.* (2009) found that protein, nitrogen content, TSS and specific gravity were increased with increasing of nitrogen rates. Moreover, nitrate and nitrite concentration were decreased significantly with decreasing mineral fertilizers doses.

Sources of N fertilizers especially NO_3 salts, accumulate more as NO_3 and NO_2 ions within the plant tissue, which represented a serious problems for human health because of their absorption into the blood, they may oxidize Fe^{++} of hemoglobin to Fe^{+++} and producing methemoglobin, which cannot transport oxygen (Swann, 1975). Toxicity of No_3 may be due to the formation of carcinogenic N-nitrous compounds by reaction with amino compounds. The toxic ions of nitrate and nitrite forming from nitrification are well knows as an environmental polluted (Alexander, 1977).

Little information is available concerning the efficiency of organic manure on growth, yield, and yield components, quality, storability and chemical analysis. In this connection, Kolbe *et al.* (1995) and Calskan *et al.* (2004) found that application of organic fertilization augmented dry matter and contained about 50% lower nitrate and nitrite content compared with mineral fertilization. Abdel-Ati (1998) declared that application of 15 m^3/fed poultry manure markedly increased N content in leaves and tubers of potato plants.

Concerning the effect of the interaction among water tension and fertilization treatments, Meyer and Marcum (1998) pointed out that optimizing the management of irrigation and nitrogen for potato production is important to maximize quality and minimize the nutrient losses below the root zone. Mehta and Singh (2002) found that the physiological weight losses and total storage increased from 7.5 to 13.7 % and 11 to 21 % between 90 and 120 days of storage, respectively. Physiological weight losses accounted for 65.2 % of the total weight losses in potato, followed by sprout loss 22.1 % and loss due to rotting 12.7 %. They concluded that the combined application of NPK and FYM resulted in higher storage losses compared with FYM alone. Abou-Hussein, et al, (2003) found that application of cattle with chicken manures increased dry matter, total carbohydrates and specific gravity and reducing the content of TSS. Darwish *et al.* (2006) indicated that increasing nitrogen levels or water input showed a significant conflicting impact on dry matter production per unit of applied water.

The objectives of this research were aimed to study the effect of furrow irrigation schedules using water tension treatments (on the basis of soil water depletion) *i.e.* percentage of moisture from field capacity, combination between mineral nitrogen and organic fertilizers and their interactions quality, storability and chemical analysis of potato plants of potato Spunta cultivar.

Materials and methods

Two field experiments were performed at the Experimental Station, Faculty of Agriculture, Mansoura University during 2007 and 2008 season. The objectives of this investigation were aimed to study the effect of water tension treatments (percentage of moisture from field capacity), combination between mineral nitrogen and organic fertilizers and their interactions on quality storability and chemical analysis of potato plants. This study included four irrigation treatments. Each irrigation treatment's was conducted in a separate experiment. Every separate experiment laid-out in randomized complete block design with four replicates, which were devoted for each of the following irrigation treatments. Soil moisture content was determined by tensiometer. Before the start of irrigation treatment, crop received equal amount of water immediately after planting and the enough for the proper establishment of plants. Relation curve between water tension (cb) and soil moisture percentage illustrated in Fig 1

Irrigation numbers and amount of irrigation water per each one in m^3/fed, for irrigation treatments are presented in Table 1. Irrigation treatments as follows:
Irrigation at 22cb. (6209.32 m^3 water/ha) *i.e.* 59.3% from field capacity.
Irrigation at 26cb. (5360.17 m^3 water/ha) *i.e.* 54.1% from field capacity.
Irrigation at 30cb. (3944.95 m^3 water/ha) *i.e.* 52.0% from field capacity.
Irrigation at 34cb. (3449.62 m^3 water/ha) *i.e.* 45.8% from field capacity.

Table 1: Irrigation numbers and amount of irrigation water per each one in m^3/fed, for irrigation treatments.

Treatments	Irrigation of agriculture (m^3/ha)	Amount of water for each irrigation (m^3/ha)	Irrigations number	% Moisture from F.C	Amount of irrigation water (m^3/ha)	Total irrigated water (m^3/ha)
Irrigation at 22cb	689.92	689.92	8	59.3	5519.4	6209.32
Irrigation at 26 cb	689.92	778.37	6	54.1	4670.25	5360.17
Irrigation at 30 cb	689.92	813.75	4	52	3255.03	3944.95
Irrigation at 34 cb	689.92	919.9	3	45.8	2759.7	3449.62

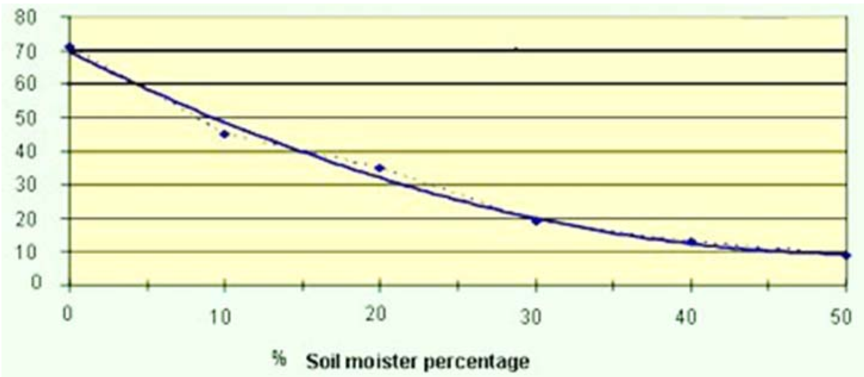

Fig. 1: Relation curve between water tension (cb) and soil moisture percentage.

Every separate experiment laid-out in randomized complete block design with four replicates. Each experimental include six fertilizer treatments were evaluated in each separate irrigation experiment. The experimental site was divided into plots each plot area was 3 X 3.5 m occupying an area of 10.5 m^2 comprising five ridge, 70 cm wide and 3.o m long The experimental treatments of organic chicken manure and mineral nitrogen fertilizers in single or combined applications were conducted as follows:
1-100% mineral nitrogen fertilizer (396 Kg N/ha)
2-80% mineral nitrogen fertilizer (317 Kg N/ha) plus 20 % organic chicken manure (79 Kg N/ha)
3-60% mineral nitrogen fertilizer (238 Kg N/ha) plus 40% organic chicken manure (158 Kg N/ha)
4-40% mineral nitrogen fertilizer (158 Kg N/ha) plus 60% organic chicken manure (238 Kg N/ha)
5-20% mineral nitrogen fertilizer (79 Kg N/ha) plus 80% organic chicken manure (317 Kg N/ha)
6-100% organic chicken manure (396 Kg N/ha)

Potato Spunta cultivar seed pieces (imported from Netherlands) averaging approximately 50 g were hand cut and supersized for approximately 10 days at 15º C and 90% relative humidity prior to planting. Sprouted seed tubers were planted on 3th and 1st February in both seasons and were harvested after 100 days from planting dates. The preceding crop prior to the present study was maize in both seasons. Randomized samples were obtained from the experimental soil at the depth of 0 - 30 cm before planting to determine the physical and chemical contents according to standard method described by Jackson (1967) and results are presented in Table 2. Chemical analysis of organic chicken manure was presented in INK"../AppData/Roaming/Microsoft/Word/Table2:Chemicalanalysisofchickenmanure*duringgrowingseasons"Table 3.

Table 2: Mechanical and chemical soil characteristics at the experimental sites during the two growing seasons (2007/2008).

Soil analysis	First season (2007)	Second season (2008)
Mechanical analysis		
Clay (%)	49.87	48.45
Silt (%)	25.49	27.21
Fine Sand (%)	20.02	19.59
Coarse sand (%)	3.02	3.11
$CaCO_3$ (%)	3.43	2.99
Organic matter (%)	1.60	1.64
Texture	Clayey	Clayey
Chemical analysis		
Available nitrogen (ppm)	24.5	26.0
Available Potassium (ppm)	513	522
Available Phosphate (ppm)	9.8	8.7
EC (ds/m) at 25^0C	1.5	1.9
pH	7.6	8.1

EC: Was determined in soil paste extract. PH: was determined in saturation soil paste.

Table 3: Chemical analysis of chicken manure* during the two growing seasons.

Chicken manure	First season (2007)	Second season (2008)
Chemical analysis:		
Available nitrogen (%)	0.6906	0.5601
Available Phosphorous (%)	0.0621	0.0935
Available Potassium (%)	0.176	0.365
Organic matter (%)	43.70	40.11
pH	7.83	8.12
EC (ds/m^{-1})	0.81	0.75

*Soil and Water Analysis Institute, Mansoura Lab., Agricultural Research Center (ARC).

The soil was well prepared through two ploughing, leveling, compacting, ridging and division and then divided into the experimental units. Calcium superphosphate (15.5 % P_2O_5) was applied during soil preparation at the rate of 240 kg/ha. Organic chicken manure was distributed, spreaded and thoroughly mixed with the surface soil layer (0-20 cm) after divided and before planting. The soil was irrigated, after 15 days from soil irrigation, farmers planted the ridges with sprouting seed pieces at 25 cm in ridge on depth of 10-15 cm, and each plot contained 60 cut seed pieces of tubers. Nitrogen fertilizer was added at the rate of 396 kg N/ha at three equal doses, in the form of ammonium nitrate (33.3 % N) *i.e.*, the first with planting, then the second dose were applied after complete emergence and the third dose was applied with the second irrigation. Potassium sulphate (50 % K_2O) was used as a source of potassium at the rate of 230.4 kg K_2O /ha Potassium was added at two times, one half was added with the second addition of N-fertilizer and the second half was added with the third doses of N-fertilizer. The common agricultural practices for growing potato plants according to the recommendations of Ministry of Agriculture were followed, except the factors under study.

At harvest, (after approximately 100 days from planting) plants that produced from the three inner ridges of each plot were harvested and data were recorded for the following traits. A representative sample of 10 healthy tubers from each plot was selected to obtain quality data:

1- Tuber length (cm)
2- Tuber diameter (cm)
3- Dry matter percent in tubers (%): it was determined by allowing 300 g of fresh tuber to dry at 70° C till constant weight.
4- Specific gravity
5- Total soluble solids (TSS %): the percentage of TSS in tubers was estimated by hand refractometer according to Cox and Pearson (1962).

Marketable tuber yield i.e. 10 kg of each plot were placed in common burlap bags and kept under normal storage conditions at Newalla and under refrigerator conditions, tubers were stored at 4°C and 90% relative humidity for 120 days which marketable potato tubers had been given a 10-day curing period after harvest, i.e., heaped under a thick layer of rice straw for healing wounds and bruises.

Newalla is a local Egyptian method for potato storage i.e. potato store in a building its wall from clay bricks and the roof covered by wood and crop residuals to reduce the effect of high temperature, walls of slots exchanged on all sides except the southern.

After storage period, potato tubers were left 10 days for sprouting and then the following data were recorded:

1- Sprout length (cm): all the sprouting on the surface of 10 tubers was removed and their length (cm) was recorded, then sprout length was calculated as average.

2- Total soluble solids (TSS %)
3- Specific gravity
4- Percentage of weight loss: it was estimated using the following formula:-

$$\text{Weight loss (\%)} = \frac{\text{(Tuber weight before storage – Tuber weight after storage)}}{\text{Tuber weight before storage}} \times 100$$

Nitrogen percentages were determined in foliage at 90 days after planting and tuber at harvesting time, at 105 days after planting as follows: The wet ash was prepared and nitrogen was determined calorimetrically in the acid digest using the method recommended by Kock and McMeekin (1924). Then crude protein percentage was calculated by multiplying total nitrogen percent by 6.25 as described by Bolton (1962). Nitrate and nitrite determinations were measured as described by Singh (1988).
All obtained data were statistically analyzed, as the technique of analysis of variance (ANOVA) for the randomized complete block design to each experiment (irrigation tension), then combined analysis was done between irrigation treatments as mentioned by Gomez and Gomez (1984). To compare treatment means, a New Least Significant Difference (NLSD) was used according to Waller and Duncan (1969).

Results and discussion

3.1. Effect of irrigation tension (moisture percentage from the field capacity):

Concerning the effect of irrigation tension *i.e.* moisture percentage from the field capacity (amount of water in m^3/ha), the results in Tables 4 and 5 clearly showed that irrigation tension significantly affected on tuber length, tuber diameter, dry matter content and total soluble solids in both seasons. The results indicated that irrigation at 26cb (5360.17 m^3 water/ha) *i.e.* 54.1% from field capacity produced highest averages of tuber length (13.30 and 13.60 cm), tuber diameter (6.99 and 6.56 cm) and specific gravity (1.054 g/cm^3) after storage in refrigerator in the second seasons only. Whereas irrigation at 34cb (3449.62 m^3 water/ha) *i.e.* 45.8% from field capacity produced the greatest dry matter content at harvest, after storage in Newalla & refrigerator (20.48 and 21.99 %), (25.05 and 25.42 %) and (21.71 and 23.69 %) and specific gravity (1.070, 1.050 and 1.055 g/cm^3) in the first season only. Regarding the effect of irrigation tension *i.e.* moisture percentage from the field capacity (amount of water in m^3/ha), the results in Tables 6 and 7 clearly showed that irrigation tension significantly affected on sprout length, weight loses % after storage in Newalla and refrigerator, nitrogen content in foliage, protein content in tubers and nitrate as well as nitrite concentration in tubers in both seasons. The results indicated that irrigation at 26cb (5360.17 m^3 water/ha) *i.e.* 54.1% from field capacity produced highest of percentages of nitrogen in plant foliage (1.760 and 1.730 %), protein percentage in tubers (12.25 and 16.13 %) in both seasons. Whereas irrigation at 34cb (3449.62 m^3 water/ha) *i.e.* 45.8% from field capacity produced the greatest total soluble solids in tubers (6.508 and 6.598 %), (7.109 and 7.394 %) and (8.054 and 7.798 %) in both seasons. On the other hand increasing irrigation tension from 22cb (6209.32 m^3 water/ha) *i.e.* 59.3% from field capacity through 34cb (3449.62 m^3 water/ha) *i.e.* 45.8% from field capacity markedly reduced sprout length, weight loses % after storage in Newalla and refrigerator and nitrate as well as nitrite concentration in tubers. The utmost values of tuber length, tuber diameter, dry matter content in tubers at harvest, after storage in Newalla & refrigerator, total soluble solids, sprout length, weight loses % after storage in Newalla and refrigerator, nitrogen content in foliage, protein content in tubers and nitrate as well as nitrite concentration in tubers, were (5.81 and 5.64 cm), (2.045 and 2.60 cm), (30.56 and 31.82 %), (5.31 and 5.93 %), (151.77 and 149.92 ppm) and (0.364 and 0.354 ppm) during growing seasons, correspondingly. Improve these characters may be due to the role of water in translocation of photosynthetic assimilates reflected these increases. Bonstak *et al.* (2004) found that irrigation exhibited no effect on specific gravity as well as on contents of total and reducing sugars. Onder *et al.* (2005) concluded that potato tuber length and diameter and quality could be compact by water stress occurring at any time during the growing season. Moreover, Alva (2008) showed that deficit irrigated in generally showed negative impact on tuber quality. These results are in agreement with those obtained with Avander and Rossouw (1998), Ghosh *et al.* (2000), Abou-Hussein, et al, 2003) & Yuan *et al.* (2003).

Table 4: Averages tuber length (cm) and Tuber diameter (cm) at harvesting and dry matter content (%) after harvesting, after storage in Newalla as well as storage in refrigerator as affected by irrigation tension, fertilization treatments during 2007 and 2008 seasons.

Characters Treatments	Tuber length (Cm)		Tuber diameter (cm0		Dry matter content (%)					
					After harvesting		After storage in Newalla		After storage in refrigerator	
	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
Irrigation Tension:										
Irrigation at 22cb	12.95	13.21	6.56	6.19	18.36	18.62	22.30	22.10	19.49	20.32
Irrigation at 26cb	13.30	13.60	6.99	6.56	18.85	19.41	23.47	22.87	19.99	21.10
Irrigation at 30cb	10.02	10.10	5.51	5.25	19.82	20.78	24.43	24.20	21.00	22.47
Irrigation at 34cb	8.27	7.51	4.86	4.83	20.48	21.99	25.05	25.42	21.71	23.69
F test	**	**	**	**	**	**	**	**	**	**
NLSD at 5%	0.60	0.47	0.08	0.17	0.51	0.41	0.48	0.45	0.49	0.41
NLSD at 1%	0.79	0.62	0.11	0.22	0.71	0.55	0.67	0.59	0.68	0.55
Fertilization treatments (organic and inorganic fertilizer):										
100% N inorganic	11.81	11.94	6.42	6.18	18.46	19.39	22.96	22.74	19.65	21.07
80% N + 20% organic	11.27	11.38	6.15	5.78	19.03	19.85	23.34	23.39	20.15	21.55
60% N + 40% organic	12.27	12.47	6.65	6.42	19.27	20.23	23.66	23.63	20.44	21.93
40% N + 60% organic	10.92	10.83	5.89	5.58	19.41	20.29	23.87	23.78	20.62	21.99
20% N + 80% organic	10.56	10.37	5.57	5.28	20.13	21.26	24.57	24.74	21.13	22.97
100% organic	10.00	9.65	5.19	5.01	19.97	20.16	24.48	23.62	21.28	21.86
F test	**	**	**	**	**	**	**	**	**	**
NLSD at 5%	0.12	0.22	0.06	0.11	0.05	0.01	0.04	0.08	0.15	0.01
NLSD at 1%	0.16	0.29	0.09	0.15	0.07	0.02	0.06	0.11	0.19	0.02
Interaction F test	NS	NS	NS	NS	**	**	**	**	NS	**

Table 5: Averages specific gravity (g/cm^3) and total soluble solids (%) after harvesting, after storage in Newalla and after storage in refrigerator as affected by irrigation tension, fertilization treatments during 2007 and 2008 seasons.

Characters Treatments	Specific gravity (g/cm^3)						Total soluble solids (TSS) %					
	After harvesting		After storage in Newalla		After storage in refrigerator		After harvesting		After storage in Newalla		After storage in refrigerator	
	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
Irrigation Tension:												
Irrigation at 22cb	1.06	1.06	1.04	1.06	1.05	1.05	5.656	5.260	5.586	6.102	6.283	6.502
Irrigation at 26cb	1.06	1.06	1.04	1.04	1.05	1.05	5.412	5.827	6.317	6.631	7.207	7.030
Irrigation at 30cb	1.06	1.05	1.04	1.04	1.04	1.04	6.212	6.459	6.825	7.259	7.531	7.659
Irrigation at 34cb	1.07	1.06	1.05	1.04	1.05	1.05	6.508	6.598	7.109	7.394	8.054	7.798
F- test	NS	NS	NS	NS	NS	NS	**	**	**	**	**	**
NLSD at 5%	-	-	-	-	-	-	0.232	0.264	0.196	0.206	0.129	0.206
NLSD at 1%	-	-	-	-	-	-	0.321	0.366	0.258	0.272	0.170	0.272
Fertilization treatments (organic and inorganic fertilizer):												
100% N inorganic	1.05	1.05	1.04	1.03	1.05	1.05	5.845	6.341	6.593	7.197	7.201	7.597
80% N + 20% organic	1.07	1.06	1.05	1.04	1.05	1.05	5.925	6.251	6.473	7.051	7.301	7.541
60% N + 40% organic	1.06	1.06	1.04	1.04	1.05	1.05	5.984	6.110	6.451	6.910	7.365	7.310
40% N + 60% organic	1.07	1.06	1.05	1.04	1.05	1.05	6.047	6.048	6.399	6.848	7.169	7.261
20% N + 80% organic	1.06	1.06	1.04	1.04	1.05	1.05	5.898	5.774	6.331	6.579	7.266	6.979
100% organic	1.06	1.06	1.04	1.04	1.04	1.04	5.983	5.693	6.509	6.493	7.310	6.887
F- test	NS	NS	NS	NS	NS	NS	NS	**	NS	**	NS	**
NLSD at 5%	-	-	-	-	-	-	-	0.113	-	0.107	-	0.106
NLSD at 1%	-	-	-	-	-	-	-	0.149	-	0.141	-	0.140
Interaction F-test	NS	NS	NS	NS	NS	NS	NS	NS	NS	*	NS	0

Table 6: Averages sprout length (cm) and weight losses (%) after storage in Newalla and after storage in refrigerator as affected by irrigation tension, fertilization treatments during 2007 and 2008 seasons.

Characters Treatments	Sprout length (cm)				Weight loses %			
	After storage in Newalla		After storage in refrigerator		After storage in Newalla		After storage in refrigerator	
	2007	2008	2007	2008	2007	2008	2007	2008
Irrigation Tension:								
Irrigation at 22cb	5.81	5.64	2.045	2.60	30.56	31.82	5.31	5.93
Irrigation at 26cb	5.22	5.04	1.70	2.25	25.56	25.36	4.68	5.33
Irrigation at 30cb	4.44	4.20	1.26	1.63	22.83	22.35	4.35	4.73
Irrigation at 34cb	3.50	3.75	0.99	1.06	18.60	18.23	3.05	4.39
F- test	**	**	**	**	**	**	**	**
NLSD at 5%	0.15	0.26	0.26	0.14	0.46	0.09	0.13	0.08
NLSD at 1%	0.19	0.35	0.37	0.18	0.61	0.12	0.17	0.11
Fertilization treatments (organic and inorganic fertilizer):								
100% N inorganic	5.80	5.86	2.08	2.32	29.72	29.86	5.86	6.94
80% N + 20% organic	5.37	5.30	1.78	2.14	27.11	27.34	5.45	6.50
60% N + 40% organic	4.87	4.79	1.54	1.97	24.95	25.03	4.95	5.84
40% N + 60% organic	4.49	4.37	1.35	1.81	23.25	23.16	3.73	4.26
20% N + 80% organic	4.15	3.95	1.20	1.64	21.27	21.38	3.23	3.66
100% organic	3.76	3.66	1.04	1.43	20.03	19.87	2.87	3.35
F -test	**	**	**	**	**	**	**	**
NLSD at 5%	0.06	0.10	0.06	0.03	0.07	0.06	0.46	0.04
NLSD at 1%	0.08	0.13	0.08	0.04	0.09	0.08	0.06	0.05
F- Interaction test	NS	NS	NS	NS	**	**	**	**

Table 7: Averages nitrogen content in foliage plant (%), protein content in tubers (%) ,nitrate and nitrite concentration in tubers (ppm) at harvest as affected by irrigation tension, fertilization treatments during 2007 and 2008 seasons.

Characters Treatments	Nitrogen content in plant foliage %		Protein content in tubers %		Nitrate concentration in tuber (ppm)		Nitrite concentration in tubers (ppm)	
	2007	2008	2007	2008	2007	2008	2007	2008
Irrigation Tension:								
Irrigation at 22cb	1.654	1.708	13.862	15.375	151.77	149.92	0.364	0.354
Irrigation at 26cb	1.762	1.739	14.256	16.137	147.13	144.88	0.325	0.318
Irrigation at 30cb	1.577	1.518	11.093	15.056	143.43	141.09	0.300	0.290
Irrigation at 34cb	1.352	1.361	10.512	13.093	138.33	137.19	0.260	0.255
F- test	**	**	**	**	**	**	**	**
NLSD at 5%	0.018	0.009	0.117	0.061	1.77	1.03	0.013	0.020
NLSD at 1%	0.024	0.012	0.154	0.081	2.33	1.36	0.018	0.030
Fertilization treatments (organic and inorganic fertilizer):								
100% N inorganic	1.712	1.655	12.993	15.625	157.18	156.36	0.406	0.400
80% N + 20% organic	1.554	1.632	12.556	15.306	153.44	151.37	0.358	0.356
60% N + 40% organic	1.750	1.690	13.125	15.937	148.20	146.37	0.336	0.324
40% N + 60% organic	1.534	1.568	12.440	14.512	141.04	138.99	0.289	0.289
20% N + 80% organic	1.517	1.486	12.206	14.181	138.74	136.34	0.263	0.254
100% organic	1.449	1.456	11.256	13.937	132.37	130.18	0.222	0.201
F -test	**	**	**	**	**	**	**	**
NLSD at 5%	0.004	0.003	0.073	0.050	0.503	0.396	0.003	0.004
NLSD at 1%	0.005	0.005	0.096	0.066	0.662	0.522	0.005	0.005
Interaction F -test	**	**	**	**	**	**	**	**

3.2 Organic and inorganic fertilization treatments:

Regarding to averages tuber length and tuber diameter and dry matter content, the results indicated that fertilization treatments significantly affected on all of these characters in both seasons as exposed in Tables 4 to 7. Application 60% mineral nitrogen fertilizer (238 Kg N/ha) plus 40 % organic chicken manure (158 Kg N/ha) produced the highest averages of tuber length (12.27 and 12.47 cm), tuber diameter (6.56 and 6.42 cm), nitrogen content in foliage (1.75 and 1.69 %), specific gravity after harvest (1.064 g/cm^3) in the second season only and total soluble solids (7.365 %) in the first season only. Although addition 80% mineral nitrogen fertilizer (317 Kg N/ha) plus 20 % organic chicken manure (79 Kg N/ha) recorded the highest averages of dry matter content after harvest and after storage in Newalla (20.13 and 21.26 %) and (24.57 and 24.47 %). Application 60% mineral nitrogen fertilizer (238 Kg N/ha) plus 40 % organic chicken manure (158 Kg N/ha) produced the highest averages of tuber length, tuber diameter, specific gravity after harvest in the second season only and total soluble solids in the first season only. Regarding to sprout length, weight loses %, nitrogen content in plant foliage, protein content, nitrate and nitrite concentration in tubers, the results indicated that fertilization treatments significantly affected on all of these characters in both seasons as exposed in Tables 6 to 7. Application 60% mineral nitrogen fertilizer (238 Kg N/ha) plus 40 % organic chicken manure (158 Kg N/ha) produced the highest averages of tuber length (12.27 and 12.47 cm), tuber diameter (6.56 and 6.42 cm), nitrogen content in foliage (1.75 and 1.69 %). Furthermore, declining inorganic nitrogen fertilizer from100% mineral nitrogen fertilizer (396 Kg N/ha) to 100 % organic chicken manure (396 Kg N/ha) caused decrease in sprout length, weight losses % after storage in Newalla and refrigerator as well as nitrate and nitrite concentration. Adding 100% mineral nitrogen fertilizer (396 Kg N/ha) created the highest values of sprout length after storage in Newalla and storage in refrigerator (5.81 and 5.86 cm) and (2.08 and 2.32 cm), weight losses % after storage in Newalla and refrigerator (29.72 and 29.86 %) and (5.86 and 6.94 %), nitrate and nitrite concentration (157.18 and 156.36 ppm) and (0.406 and 0.400 ppm), total soluble solids after storage in Newalla (6.593 and 7.197 %) in both seasons and total soluble solids after harvest and after storage in refrigerator (6.341 and 7.597 %) in the second season only. Declining inorganic nitrogen fertilizer from100% mineral nitrogen fertilizer (396 Kg N/ha) to 100 % organic chicken manure (396 Kg N/ha) caused decrease in sprout length, weight losses % after storage in Newalla and refrigerator as well as nitrate and nitrite concentration. Abo-Sedra and Shehata (1994) reported that specific gravity of potato tubers did not affect by application nitrogen at the rate of 180 kg N/ha. Kumar *et al.* (2007) concluded that total soluble solids, specific gravity, nitrogen content in foliage and tuber were increased with rising in nitrogen application. Helaly *et al.* (2009) and Zelalem *et al.* (2009) found that protein, nitrogen content, TSS and specific gravity. Moreover, nitrate and nitrite concentration were decreased significantly with decreasing mineral fertilizers doses. Similar conclusion was reported by Kolbe *et al.* (1995), Mehta and Singh (2002) and Abou-Hussein, et al, 2003).

3.3- Interaction Effects:

Regarding interaction effect among irrigation tension (amount of water in m^3/ha) *i.e.* moisture percentages at field capacity and organic and inorganic fertilization treatments and combination between organic and inorganic fertilization had a significant achieve on dry matter content after harvesting, after storage in Newalla as well as after storage in refrigerator, weight losses, nitrogen content in foliage plant, protein content in tubers, and nitrate as well as nitrite concentrations in tuber in both seasons, and total soluble solid after storage in Newalla and refrigerator as shown in Figures 2 to 12.

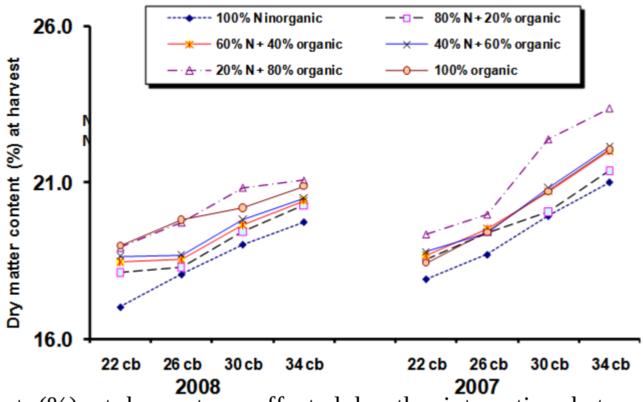

Fig. 2: Dry matter content (%) at harvest as affected by the interaction between irrigation tension and fertilization treatments during 2007 and 2008 seasons.

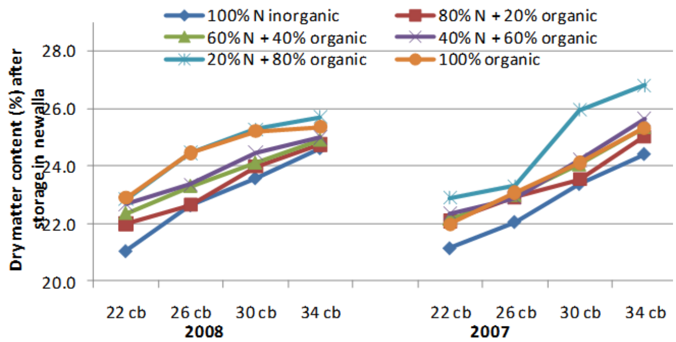

Fig. 3: Dry matter content (%) after storage in Newalla as affected by the interaction between irrigation tension and fertilization treatments during 2007 and 2008 seasons.

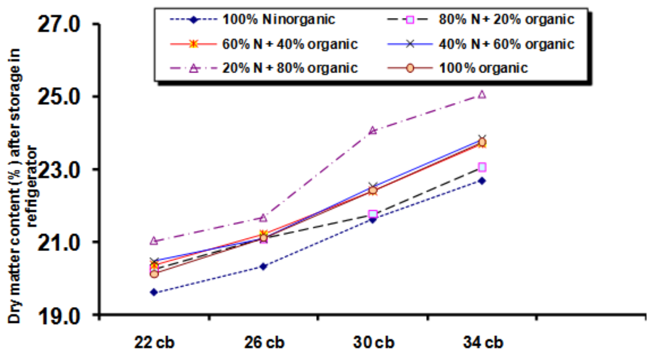

Fig. 4: Dry matter content (%) after storage in refrigerator as affected by the interaction between irrigation tension and fertilization treatments during 2008 season.

Results clearly showed that irrigation at 34cb (3449.62 m^3 water/ha) *i.e.* 45.8% from field capacity and adding 20% mineral nitrogen fertilizer (79 Kg N/ha) plus 80 % organic chicken manure (317 Kg N/ha) produced the highest averages of dry matter content in tubers at harvest (21.06 and 23.37 %), after storage in Newalla (25.70 and 26.81 %) in both seasons and after storage in refrigerator (25.07 %) in the second season only as shown in Figs 2 ,3 and 4.

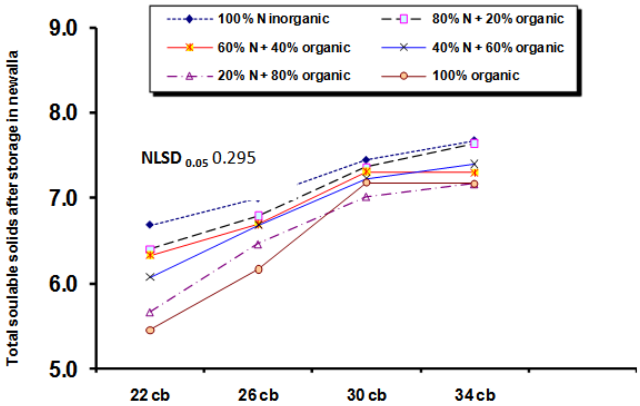

Fig. 5: Total soluble solids % (TSS) after storage in Newalla as affected by the interaction between irrigation tension and fertilization treatments during 2008 growing season.

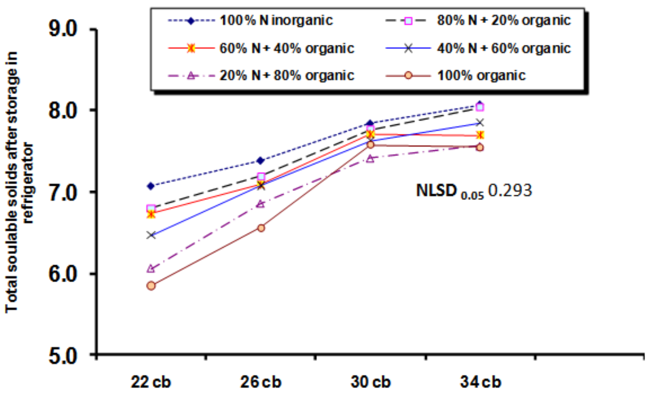

Fig. 6: Total soluble solids % (TSS) after storage in refrigerator as affected by the interaction between irrigation tension and fertilization treatments during 2008 growing season.

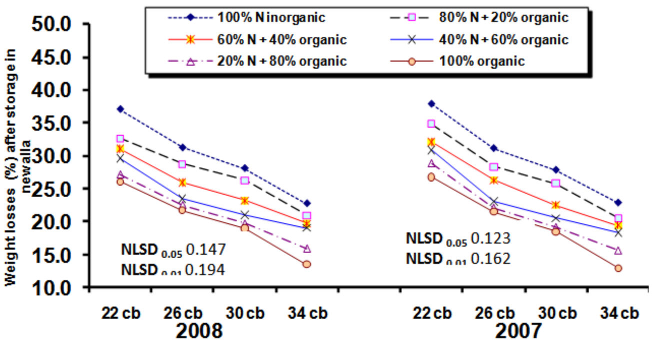

Fig. 7: Weight loses % after storage in Newalla as affected by the interaction between irrigation tension and fertilization treatments during 2007 and 2008 growing seasons.

As irrigation at 34cb (3449.62 m^3 water/ha) *i.e.* 45.8% from field capacity and adding 100% mineral nitrogen fertilizer (396 Kg N/ha) produced utmost values of total soluble solids after storage in Newalla and refrigerator, which were (7.67 and 8.07 %) in the second season, respectively as shown in Figs 5 and 6.

Greatest averages weight losses after storage in Newalla and refrigerator (37.02 and 37.82 %) and (7.06 and 8.02 %) in both seasons were obtained with irrigation at 22cb (6209.32 m^3 water/ha) *i.e.* 59.3% from field capacity and adding 100% mineral nitrogen fertilizer (396 Kg N/ha) as shown in Figs 7 and 8

Moreover, irrigation at 26cb (5360.17 m^3 water/ha) *i.e.* 54.1% from field capacity and adding 60% mineral nitrogen fertilizer (238 Kg N/ha) plus 40 % organic chicken manure (158 Kg N/ha) recorded the highest averages of nitrogen percentage in foliage (1.91 and 1.86 %) and protein percentage in tubers (15.21 and 17.29 %) in both seasons as shown in Figs 9 and 10.

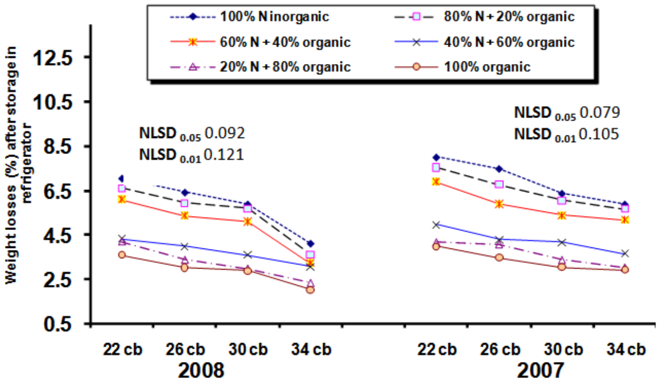

Fig. 8: Weight loses % after storage in refrigerator as affected by the interaction between irrigation tension and fertilization treatments during 2007 and 2008 growing seasons.

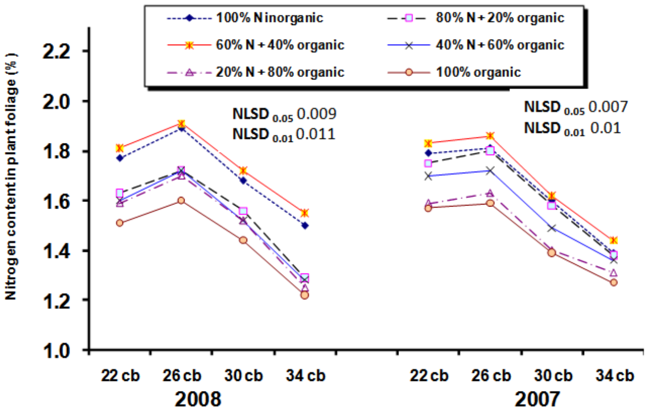

Fig. 9: Nitrogen content in plant foliage % at harvest as affected by the interaction between irrigation tension and fertilization treatments during 2007 and 2008 growing seasons.

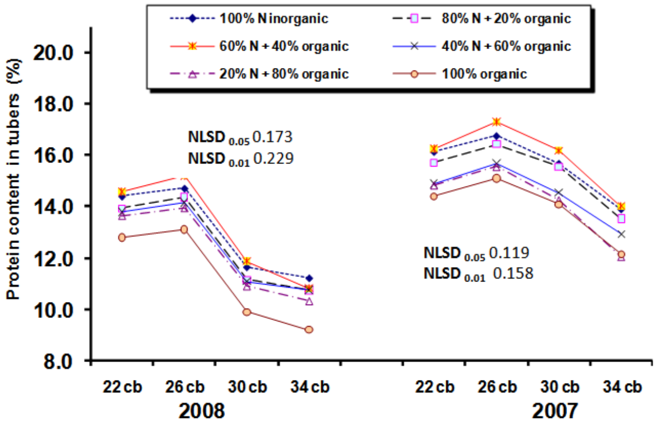

Fig. 10: Protein content in tuber % as affected by the interaction between irrigation tension and fertilization treatments during 2007 and 2008 growing seasons.

Greatest averages nitrate concentration in tubers (164.50 and 165.46 ppm) and nitrite concentration (0.467 and 0.468 ppm) in both seasons were obtained with irrigation at 22cb (6209.32 m^3 water/ha) *i.e.* 59.3% from field capacity and adding 100% mineral nitrogen fertilizer (396 Kg N/ha) as shown in Figs 11and 12.

Mehta and Singh (2002) found that the physiological weight losses and total storage increased from 7.5 to 13.7 % and 11 to 21 % between 90 and 120 days of storage, respectively. Physiological weight losses accounted for 65.2 % of the total weight losses in potato, followed by sprout loss 22.1 % and loss due to rotting 12.7 %. They concluded that the combined application of NPK and FYM resulted in higher storage

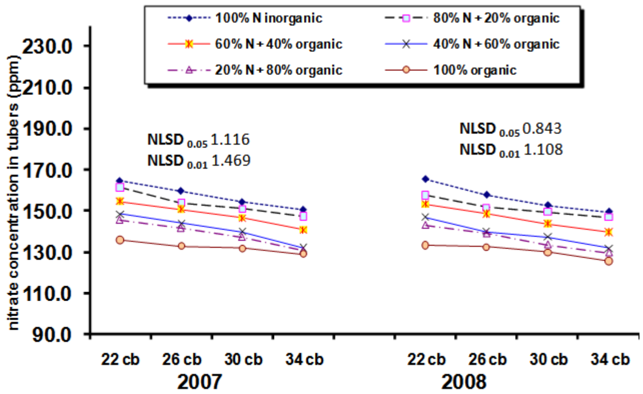

Fig. 11: Nitrate concentration in tubers (ppm) as affected by the interaction between irrigation tension and fertilization treatments during 2007 and 2008 growing seasons.

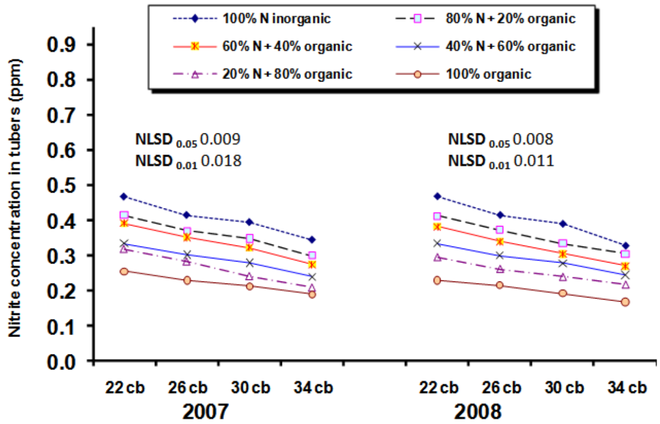

Fig. 12: Nitrite concentration in tubers (ppm) as affected by the interaction between irrigation tension and fertilization treatments during 2007 and 2008 growing seasons.

losses compared with FYM alone. Abou-Hussein, et al, 2003 found that application of cattle with chicken manures increased dry matter, total carbohydrates and specific gravity and reducing the content of TSS. Darwish *et al.* (2006) indicated that increasing nitrogen levels or water input showed a significant conflicting impact on dry matter production per unit of applied water. These results are in conformity with those obtained by Meyer and Marcum (1998).

Conclusions

It could be accomplished that irrigation at 26cb (5360.17 m^3 water/ha) *i.e.* 54.1% from field capacity as well as application of 60% mineral nitrogen fertilizer (238 Kg N/ha) plus 40 % organic chicken manure (158 Kg N/ha) maximized averages of tuber length, diameter, nitrogen content in plant foliage and protein content in tubers. Irrigation at 34cb (3449.62 m^3 water/ha) *i.e.* 45.8% from field capacity as well as application of 100% mineral nitrogen fertilizer (396 Kg N/ha) produced utmost increases in sprout length, weight loses % after storage in Newalla and refrigerator and nitrate and nitrite concentration in tubers during growing seasons. Moreover, irrigation at 34cb (3449.62 m^3 water/ha) *i.e.* 45.8% from field capacity and adding 80% mineral nitrogen fertilizer (317 Kg N/ha) plus 20 % organic chicken manure (79 Kg N/ha) recorded highest averages of dry matter content after harvesting, after storage in Newalla and refrigerator.

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