Response of eggplant to irrigation water quality, fertilization and organic extracts under urban agriculture system.

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ABSTRACT

The current pot experiment was carried out at the Experimental Farm of Environment and Bio-Agric. Dept., Fac. of Agric., Al-Azhar Univ., Cairo, Egypt, during 2017/2018 and 2018/2019 seasons for evaluating the effect of water types, fertilization treatments and organic extracts foliar spray on the growth, yield characteristics and chemical analysis of eggplant. The experiment arranged as a factorial completely randomized at 18 treatments and five replications. The treatments were as follows; water irrigation types (W); tap water (W_1), gray water (W_2), mixture of gray water and tap water in 1:1 (v:v) ratio (W_3), fertilization types (F): NPK recommended dose (F_1), 100% compost as recommended N (F_2), and organic extract: without extract as a control treatment (WE), azolla extract (AE) at 500 ml / 100 g fresh material and moringa leaf extract (MLE) at 500 ml / 100 g fresh material, as a foliar spray. W_1-plants revealed maximum growth and yield traits. But W_2-plants recorded the highest nutrients content (N, P, K, Ca, Mg and Fe). F_1-plant achieved the highest productivity and chemical analysis. While the highest Mg and Fe content was given by F_2-plants. MLF gave the highest values of all studied characters except Fe content was given by AE application for both seasons. The treatment of $W_1 \times F_1 \times$ MLE gave the highest values of total yield/plant and carotenoids content. But highest Fe value was given by $W_2 \times F_2 \times$ AE treatment.

Keywords: Eggplant, gray water, compost, Azolla extract, and moringa leaf extract.

INTRODUCTION

Egypt is the most populous country in North Africa and the Arab world with a population of 103 million in 2020. Many parts of the world including Egypt will face a severe problem to allocate irrigation water to agriculture owing to the expected low water supplies, increasing population growth and the negative impacts of climate change (Ouda *et al*., 2020). Use of non-potable alternative water sources such as gray water and reclaimed wastewaters to irrigate suitable agricultural crops can be a beneficial and efficient use of these alternative waters while at the same time it results in reducing pressure on potable supplies (Asano *et al*., 2007). To be more precise, the discussed solution has already been used by farmers worldwide since it is estimated that 10% of the world's population consumes foods which are irrigated with wastewater (WHO, 2006). Gray water is defined as water collected from sewage discharge of clothes washers, bathtubs, showers and sinks, excluding wastewater from toilets (Al-Jayyousi, 2003). Gray water has been applied widely in landscape irrigation, groundwater recharge and crop irrigation and other areas. Consequently, many studies related to the effects of gray water on plant growth, yield and soil properties have been conducted and reported worldwide over the decades (Misra *et al*., 2009). Some results suggest that there are no apparent detrimental effects of gray water irrigation on plant growth; However, these results are in sharp contrast with the findings of the past studies that proposed some detrimental effects of gray water on plant growth (Wiel-Shafran *et al*., 2006). In the same time, to steady decline traditional organic supplements demand the development and designing of management practices for the enhancement of organic matter in soil and facing global decline in organic content of soil, municipal solid waste compost (MSWC) is gaining popularity as an alternate organic soil supplement. This should also make up for the effective disposal of solid waste. (Bhattacharyya *et al*., 2008). Furthermore, there is a rapid increase in the amount of municipal solid waste due to the rise in population and economic development (Huang *et al*., 2006).

Azolla is a genus of small, fast growing aquatic ferns that has a symbiotic association with a nitrogen fixing cynobacterium (*Anabaena azollae*) floats freely on the surface of water and has a global distribution (Peters *et al*., 1978 and Espinoza and Gutiérrez 2003). It can be exploited as a potential source of biofertilizer to increase the production of plants (Saurabh *et al*., 2014 and Maswada *et al*., 2020). It is well established that freshly separated *Anabaena azollae* releases about 40-50% of nitrogen fixed as ammonia into the immediate environment (Meeks *et al.*, 1988). *Moringa oleifera* is one of such alternatives, being investigated to ascertain its effect on growth and yield of crops and thus can be promoted among farmers as a possible supplement or substitute to inorganic fertilizers (Phiri, 2010), which is native to India but it is a widely grown tree in Ethiopia, Pacific Islands, Florida, Sudan Caribbean, Philippines, South Africa, Asia, and Latin America (Fahey, 2005). Moreover, several researches have indicated that *M. oleifera* Lam (family: Moringaceae) is a highly valued plant with multipurpose effects (Yang *et al*., 2006). Foliar spray of crops with moringa leaf extract (MLE) accelerates plant growth, promotes resistance to stress and increases yield of crops (Marcu, 2005). The aim of this study is to evaluate the effect of water types, organic and chemical fertilization, as well as evaluating using of azolla and moringa extracts as foliar fertilization on growth and productivity of some vegetables crops under urban agriculture system.

MATERIALS AND METHODS

Site description:

Four pot experiments were carried out during 2017/2018 and 2018/2019 seasons at the Experimental Farm of Environment and Bio-Agric. Dept., Fac. of Agric., Al-Azhar Univ., Cairo, Egypt. The farm is characterized by its semi-desert land and located at Nasr City, Cairo, Egypt. The geographical position of site was 30o 03′ 12′′N and 31o 19′ 05.2″ E, with elevation of 92 m above the sea level. Soil used for the pot experiments was collected from the experimental site, from the surface layer depth (0 to 15 cm). Physical and Chemical analyses of experimental soil was carried out according to Wilde *et al*., (1985) as shown in Table (1). Meteorological data of air temperature during the two seasons are given in Table (2). The monthly data of maximum, minimum and average air temperature (°C) were collected from the Central Laboratory for Agriculture Climate (CLAC), Giza, Egypt.

Experimental design:

The experimental design was a factorial completely randomized with 18 treatments and five replications. The treatments were combinations of three types of water, two types of fertilization and three kinds of organic extract as follows:

Water types (W):

Tap water (W_1).

Gray water (W_2).

Mixture of gray water and tap water in 1:1(v:v) ratio (W_3).

Fertilization treatments (F):

Inorganic: Recommended dose of inorganic NPK recommendation of Ministry of Agriculture (F_1).

Organic: 100% compost as recommended N (F_2).

Organic extract:

Without extract (WE) as a control treatment.

Azolla extract (AE) as a foliar spray, (500 ml / 100 g fresh material).

Moringa leaf extract (MLE) (500 ml / 100 g fresh material).

Gray water used in the study was coming in building of the Environment and Bio-Agriculture Department Faculty of Agriculture. The resulting average values of pH, EC, total N and total P, total suspended solids (TSS), of the gray water, water and tap water in 1:1 v :v ratio, along with those of tap water are given in Table 3. Gray water, tap water and mixture gray water samples were taken from barrels that received water over 48 h while treated W2 samples were collected from barrels that received treated GW. The barrels were cleaned before GW collection and the contents of the barrels were mixed thoroughly before sampling. The physico-chemical properties of tab water, gray water and mixture of tab water and gray water are given in Table (3). The analysis of the 3 water types was carried out according to APHA, (1998).

The recommended dose of NPK was 200 kg fed^{-1} ammonium sulphate (20.5 % N), 150 kg fed^{-1} calcium super phosphate (15.5 % P_2O_5) and 50 kg fed^{-1} potassium sulphate (48 % K_2O)according to the recommendation of Ministry of Agriculture, Egypt. Ammonium sulphate was added in two doses 200 kg fed^{-1}, Inorganic nitrogen fertilizer was applied after three weeks from transplanting the seedlings second where at flowering stage (after 45 days from transplanting). While both phosphorus and potassium fertilizers were applied in two doses the first where after three weeks from transplanting and the second where at flowering stage (after 45 days from transplanting).

Compost was applied in one dose during soil preparation. The used compost was analyzed at the Laboratory of Soil and Water Research Institute, Agricultural Research Center, Giza, Egypt according to the method of Jackson (1973) as shown in Table (4).

Preparation of azolla and moringa extracts:

Azolla and moringa extracts extraction were performed according to Yasmeen *et al*., (2012) and Taha and El-Shahat (2017). Aqueous extract at the rate of 20% (100 g fresh material/500 ml distilled water) was hardly crushed and blended in a mixture till giving a suspension. The resulted suspension was filtered by muslin cloth represents the azolla extract (AE) and moringa leaf extract (MLE) which will be used in spray treatments. Analyses of used azolla and moringa extracts are displayed in Table (5).

Eggplant plants were foliar sprayed with AE or MLE every two weeks during the experiment. Control plants were foliar sprayed with tap water at the same application time during both seasons.

Plant material:

Seedlings of eggplant (*Solanum melongena* var. Tasca hybrid) were obtained from Al-Amana nursery, Al-Nahda, Alexandria, Egypt. After sixty-five days from seed sowing healthy seedlings of uniform size were selected and transplanted on at 1st and 7th February in the first and the second seasons, respectively. Uniform seedlings were transplanted into plastic pots, 30 cm diameter. Each pot was filled with 12 kg air dried soil and contained one seedling.

Data recorded:

At harvest time (after 166 days from transplanting of eggplant) the plants of etch pots were collected separately and recorded the following data: plant height (cm), number of leaves / plant, number of flowers / plant, number of fruits/ plant, fruit weight (g), fresh weight / plant (g) and dry weight / plant (g).

At marketable mature stage, all the fruits of each plant (fruit yield / plant (g), were harvested every 20 days starting from 101 days after transplanting and lasted up to 165 days, where by 3 picking were taken and the total yield all over the season was calculated as g/plant.

Photosynthetic pigments determination

Leaves samples were randomly collected for chlorophyll determination as described by Dere *et al*., (1998). Leaf dices (0.2 g) were homogenized with 10 ml methanol (96%) in a homogenizer at 1000 rpm for a minute. Two-layer cheese cloths were used to filtrate the homogenate, and then centrifuged at 2500 rpm for 10 min. The supernatant was separated and used for chlorophyll analysis using UVVIS spectrophotometer (Model SM1200; Randolph, NJ, USA) at wavelength of 666 nm for chlorophyll (a), 653 nm for chlorophyll (b) and 470 nm for total carotene and calculated using following equations:

Chlorophyll a =15.65 A_{666} - 7.340 A_{653}

Chlorophyll b =27.05 A_{653} - 11.21 A_{666}

Total carotene = 1000 A_{470} - 2.860 C_a - 129.2 C_b/245.

Photosynthetic pigments were presented as mg g^{-1} FW.

Nutrient determination: nutrients were extracted from a known weight of dried fruits samples (0.2g dried leaves). The concentrated sulphuric acid was added to the samples and the mixture was heated for 10 min, and then 1 ml hydrogen peroxide was added to the mixture and heated until a clear solution was developed. The digested solution was quantitively transferred to a 100 ml volumetric flask using deionized water (Piper, 1947). In the digested solution N, P, K, Ca, Fe and Mg were determined using the following procedures:

Total nitrogen concentration (%) was determined by using Micro Kjeldahl method as described by Page *et al*., (1982).

Phosphorous was determined colourimetrically using ammonium molybdate and ammonium metavanadate according to procedure outlined by Ryan *et al*., (1996).

Potassium concentration (%) was estimated by using a Flame photometer, which was standardized with standard solution according to Jackson (1965).

Calcium concentration (%) was determined by Atomic Absorption as described by Cottenie *et al*., (1982).

Magnesium was determined titrimetrically by Versenate method using (Ryan *et al*., 1996).

Iron concentration (ppm) was determined by Atomic Absorption as described by Jones (1981).

Statistical analysis:

Data was statistically analyzed by analysis of variance (ANOVA) using MSTAT-C (Nissen, 1989) for data set of the two independent experiments and combined analysis was performed. Duncan multiple range test was used according to Steel and Torrie (1960) in order to compare the means at the P ≤ 0.05 probability level. Results were presented as average means of the two seasons ± SE.

RESULTS AND DISCUSSION

Growth and yield:

Water types:

Results presented in Fig (1, 2 and 3) revealed that water types significantly affected all studied characters of both seasons. W_1-plants revealed maximum values of the plant height, number of leaves, number of flowers, number of fruits, total yield/plant, fresh weight, dry weight, chlorophyll a, chlorophyll b, and total chlorophyll as well as carotenoids content. While the highest fruit weight was given by W_2-plants (309.46 g). These results are in accordance with Bubenheim *et al*., (1997); Saeed *et al*., (2015); Al-Isawi *et al*., (2016) and Ikhajiagbe *et al*., (2017). This means that gray water could have negative effect on eggplant production. Mzini and Winter (2015) reported that beetroot yield was reduced by 47% (4.7 t ha^{-1}) when irrigated with greywater compared to the control. Studies also revealed that high sodium and chloride concentrations caused leaf damage to crops when greywater was sprayed onto the foliage (Bauder *et al*., 2014).

Fertilization:

Fertilization treatments significantly enhanced the growth and productivity of eggplants for both seasons Fig (1, 2 and 3). F_1-Eggplant achieved the highest values of plant height, number of leaves, number of flowers, number of fruits, total yield/plant, fresh weight, dry weight, chlorophyll a, chlorophyll b, total chlorophyll and carotenoids content. The results agreed with the results of Omogoye (2015) and Alhrout (2017), they reported that NPK gave the maximum growth and yield as compared with organic fertilization. On the other hand, the following results were on conflict with our results; Shahid *et al*., (2017) found that the maximum yield of Eggplant was detected in plants grown under organic regime. It is well known that the chemical fertilizers promote plant growth through the role of nitrogen in protein synthesis, nucleic acids synthesis, protoplasm and increasing the meristematic activity (Silva-Junior and Vizzotto (1989); Singer *et al*., (1998) and Abd El-Kawy, (2003). In this respect, Marschner (1995) stated that a change in the supply nutrients to the roots, nitrogen in particular, can markedly modulate not only the levels but also the balance of phytohormones in plant. The application of nitrogen fertilizers can therefore affect growth and development not only directly (supplying nitrogen as a constituent of protein) but also indirectly by changing the phytohormones balance.

Organic extracts:

Foliar application with AE or MLE significantly improved vegetative growth and yield of eggplant compared to control. In this respect, MLF gave the highest values of vegetative growth traits for both seasons. Similar results were reported by Ozobia, (2014); Al-Isawi *et al*., (2016) and El-Serafy and El-Sheshtawy (2020). MLE due to the increase in phytohormones content (Yasmeen *et al*., 2013). Auxins and gibberellins play a vital role in cell elongation and stimulate stem growth and plant height (Taiz and Zeiger, 2010). In addition, MLE contains high amount of Mg, which is an important element in chlorophyll biosynthesis (Taiz and Zeiger, 2010).

Interactions effects:

The interaction between water types and fertilization treatments significantly enhanced total yield/plant, chlorophyll a, total chlorophyll and carotenoids content of eggplants (Fig 1, 2 and 3). The treatment of $W_1 \times F_1$ recorded the maximum growth and yield values as well as photosynthetic pigments content except fruit weight which was improved by $W_2 \times F_2$ treatment.

The interaction between water types and organic extracts significantly affected all studied characters except chlorophyll b (Fig 1, 2 and 3). The treatment of W_1 × MLE gave the highest values of plant height, number of leaves, number of flowers, number of fruits, total yield/plant, fresh weight, dry weight, chlorophyll a, chlorophyll b, total chlorophyll and carotenoids content.

The interaction between fertilization and organic extracts significantly affected total yield/plant and carotenoids content Fig (1, 2 and 3). The treatment of F_1 × MLE gave the highest values of total yield/plant and carotenoids content. These results are in harmony with Anyaegbu (2014), who, reported that the highest fruit yield was obtained from stands of garden egg that received Moringa leaf extract combined with NPK fertilizer.

The interaction of water types × fertilization × organic extracts significantly affected total yield/plant and carotenoids content Table (6 and 7). The treatment of W_1 × F_1 × MLE gave the highest values of total yield/plant (3732.3 g).

Fruits chemical composition

Water types:

Results presented in Fig (4 and 5) showed that water types significantly affected the chemical composition of eggplant (N, P, K, Ca, Mg and Fe). W_2-plants recorded the highest values of N, P, K, Ca, Mg, and Fe content of eggplant fruits. These studies are in agreement with these results Landon (1991); Zimmo *et al*., (2003) and Pinto *et al.,* (2010).

Fertilization:

Results presented in Fig (4 and 5) illustrated the effect of fertilization treatments on chemical analysis of eggplant fruits. F_1-Eggplant achieved the highest values of N, P and K content. While the highest Mg and Fe content was given by F_2-plants. These results are in harmony with Rizk, (1997); Feleafel, and El-Araby (2001) and Paul *et al*., (2017).

Organic extracts:

Foliar application with MLE or AE significantly improved N, P, K, Ca, Mg and Fe content of eggplant fruits compared to control plants. In this respect, MLF gave the highest values of all studied elements except Fe content. These results are in agreement with Wiel-Shafran *et al.,* (2006) and Sudadi and Sumarno, (2014). The high content of nutrients in MLE is needed by the plant for maximum yield and improved nutrient uptake by plant (Nurzyńska-Wierdak, 2013).

Interactions effects:

The interaction between water types and fertilization treatments appeared varied differences of N, P, K, Ca, Mg and Fe contents (Fig 4 and 5). The treatment of W_2 × F_1 gave the highest values of N, P, K and Ca content. While the highest Mg and Fe content was given by W_2 × F_2-plants.

Regarding the interaction between water types and organic extracts, W_2 × MLE treatment gave the highest values of N, P, K, Ca and Mg content. While the highest Fe content was given by W_2 × AE-plants.

The interaction between fertilization and organic extracts significantly affected N, P, K and Fe content Fig (4 and 5). The treatment of F_1 × MLE gave the highest values of N, P and K content. While the highest fruit Fe content was given by F_2 × AE-plants.

The interaction of water types × fertilization × organic extracts significantly affected all estimated elements (Table 7). The treatment of W_2 × F_2 × MLE gave the highest values of N and Mg content, while the highest P, K and Ca content was given by W_2 × F_1 × MLE treatment. On the other hand, the highest value of Fe was recorded by W_2 × F_2 × AE treatment.

CONCLUSION

It can be concluded that irrigated eggplant with tap or mixed water may enhance the vegetative growth, flower induction, photosynthesis rate, and total yield. Chemical fertilization increased plant productivity and nutrients content. Plant productivity was also increased with moringa leaf extract application. Increasing eggplant fruit yield with quality traits may impact Egyptian food security, if tap or mixed water applied with chemical fertilization along with moringa leaf extract foliar application under urban agriculture conditions.

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Table 1. Some physical and chemical properties of experiment soil.

a. Soil physical properties	1st Season (2017/2018)	2nd Season (2018/2019)
Particle size distribution (%):		
Sand	36.00	34.65
Silt	26.00	26.60
Clay	38.00	38.75
Textural class	Clay loam	Clay loam
b. Soil chemical properties		
Soil pH (1:2.5)*	7.64	7.66
EC (dSm^{-1})**	1.06	1.12
$CaCO_3$ (%)	3.00	3.12
Cations (mmolc L^{-1}):		
Ca^{++}	1.50	1.65
Mg^{++}	0.90	1.10
Na^{+}	7.50	7.77
K^{+}	0.70	0.68
Anions (mmolc L^{-1}):		
CO_3^{--}	0.00	0.00
HCO_3^{-}	1.90	2.05
Cl^{-}	8.20	8.50
SO_4^{--}	0.50	0.65
Available nutrients		
N (ppm)	36.80	37.20
P (ppm)	7.60	7.75
K (ppm)	318.5	316.9

1:2.5 w/v soil: water suspension, **Soil paste extract

Table 2. Maximum, minimum and average monthly temperature (°C) during 2017/2018 and 2018/2019 seasons.

Seasons	**1st season (2017/2018)**			**2nd season (2018/2019)**		
Months	**Max.** (°C)	**Min.** (°C)	**Aver.** (°C)	**Max.** (°C)	**Min.** (°C)	**Aver.** (°C)
December	22.2	14.0	18.1	20.1	13.5	16.8
January	19.4	11.9	15.7	18.2	9.6	13.9
February	23.5	14.1	18.8	20.4	11.1	15.8
March	28.0	16.8	22.4	22.5	13.3	17.9
April	28.3	18.3	23.3	26.8	15.5	21.2
May	34.1	23.2	28.7	34.6	20.1	27.4
June	35.4	24.5	30.0	35.5	23.8	29.7
July	35.8	25.6	30.7	35.9	25.3	30.6
August	35.4	25.7	30.6	35.9	25.6	30.8

Table 3. Physico-chemical properties of tab water, gray water and mixture of tab water and gray water.

Parameter	Tab water	Gray water	Mixture (1:1)	Permissible limitsa
pH	7.57	6.72	7.19	6.5-8.5
EC(ms/cm)	336	687	510	-
DO (mg O_2/L)	7.92	1.41	4.42	Not less than 6
TDS (mg/L)	235.17	511	372	Not to exceed 500
TSS (mg/L)	16.80	105	89.60	-
COD (mg O_2/L)	1.17	390	200	≤10
BOD (mg O_2/L)	0.96	295	159	Not to exceed 6
Total N (mg/L)	2.96	10.39	5.12	≤ 3.5
Total P (mg/L)	0.00	8.00	3.00	≤ 2.0
Ca^{+2} (mg/L)	41.00	155.41	102.18	-
Mg^{+2}(mg/L)	14.25	47.5	33.32	-
Oil & grease (mg/L)	-	-	-	Not to exceed 1

EC; Electrical Conductivity, DO; Dissolved Oxygen, TDS; Total Dissolved Solids, TSS; Total Suspended Solids, COD; Chemical Oxygen Demand, BOD; Biological Oxygen Demand. A permissible limits of water reuse for irrigation according to the Egyptian regulations (Law 4/1994, and Law 48/1982).

Table 4. Analysis of compost used.

Parameters	**Values**
M^3 weight (kg)	605
Moisture content (%)	29
pH (1^{-10})	8.18
EC (1^{-10}) (ds.m^{-1})	5.22
Total N (%)	1.25
Organic matter (%)	32.51
Organic carbon (%)	18.81
Ash (%)	67.39
C/N ratio	18.81 : 1.25
Total phosphorus (%)	0.65
Total potassium (%)	1.02

Table 5. Chemical properties of Azolla extract and Moringa extract.

Samples	N	P	K	Mn	Zn	Fe	Cu
				(ppm)			
Azolla	84	48.9	134.0	2.16	0.16	14.71	0.06
Moringa	840	143.0	143.6	0.56	1.56	12.14	0.24

Table 6. Effect of water type, different fertilizers and organic extracts on growth and yield of eggplant (means of two seasons).

Treatments	Plant height (cm)	No. of leaves	No. of flowers	No. of fruits	Fruit weight (g)	Total yield/plant (gm)	Fresh weight /plant (gm)	Dry weight /plant (gm)
$W_1 \times F_1 \times$ WE	$72.00^{a}\pm0.73$	$50.83^{a}\pm1.08$	$13.67^{a}\pm0.33$	$10.67^{a}\pm0.33$	$266.98^{a}\pm8.16$	$2837.12^{hi}\pm55.76$	$400.67^{a}\pm5.82$	$55.67^{a}\pm0.52$
$W_1 \times F_1 \times$ AE	$79.33^{a}\pm0.56$	$57.67^{a}\pm0.71$	$15.17^{a}\pm0.31$	$12.33^{a}\pm0.21$	$292.26^{a}\pm4.87$	$3600.69^{bc}\pm43.29$	$430.00^{a}\pm5.68$	$58.00^{a}\pm0.37$
$W_1 \times F_1 \times$ MLE	$82.83^{a}\pm0.70$	$59.50^{a}\pm0.99$	$16.00^{a}\pm0.37$	$13.33^{a}\pm0.33$	$280.94^{a}\pm8.57$	$3732.33^{a}\pm38.67$	$452.67^{a}\pm7.36$	$60.83^{a}\pm0.95$
$W_1 \times b_2 \times$ WE	$68.17^{a}\pm0.94$	$49.33^{a}\pm0.49$	$13.17^{a}\pm0.31$	$9.83^{a}\pm0.17$	$291.54^{a}\pm6.81$	$2861.66^{h}\pm29.81$	$382.50^{a}\pm4.54$	$53.67^{a}\pm0.56$
$W_1 \times F_2 \times$ AE	$78.83^{a}\pm0.48$	$56.67^{a}\pm0.49$	$14.67^{a}\pm0.33$	$12.17^{a}\pm0.31$	$297.37^{a}\pm11.21$	$3601.76^{bc}\pm51.55$	$422.67^{a}\pm5.83$	$57.50^{a}\pm0.43$
$W_1 \times F_2 \times$ MLE	$81.67^{a}\pm0.42$	$58.33^{a}\pm0.99$	$15.50^{a}\pm0.43$	$13.00^{a}\pm0.63$	$283.43^{a}\pm9.37$	$3674.89^{ab}\pm76.87$	$447.00^{a}\pm6.73$	$60.83^{a}\pm0.87$
$W_2 \times F_1 \times$ WE	$63.33^{a}\pm0.84$	$42.83^{a}\pm0.54$	$10.83^{a}\pm0.60$	$8.50^{a}\pm0.22$	$314.79^{a}\pm8.03$	$2668.07^{ik}\pm36.86$	$297.33^{a}\pm4.65$	$44.33^{a}\pm0.56$
$W_2 \times F_1 \times$ AE	$75.50^{a}\pm0.85$	$47.33^{a}\pm1.52$	$13.00^{a}\pm0.26$	$10.33^{a}\pm0.42$	$300.60^{a}\pm11.85$	$3082.07^{f}\pm29.58$	$316.00^{a}\pm5.06$	$47.17^{a}\pm0.79$
$W_2 \times F_1 \times$ MLE	$77.17^{a}\pm0.60$	$53.00^{a}\pm0.45$	$14.00^{a}\pm0.26$	$10.83^{a}\pm0.31$	$301.83^{a}\pm5.28$	$3263.92^{e}\pm64.20$	$325.33^{a}\pm3.66$	$49.33^{a}\pm0.56$
$W_2 \times F_2 \times$ WE	$61.33^{a}\pm0.56$	$42.33^{a}\pm0.42$	$10.33^{a}\pm0.49$	$8.50^{a}\pm0.22$	$310.04^{a}\pm6.64$	$2628.87^{k}\pm33.63$	$279.67^{a}\pm6.94$	$43.17^{a}\pm0.75$
$W_2 \times F_2 \times$ AE	$73.50^{a}\pm1.15$	$47.17^{a}\pm1.49$	$13.00^{a}\pm0.37$	$9.67^{a}\pm0.33$	$308.64^{a}\pm10.35$	$2967.29^{g}\pm30.05$	$298.00^{a}\pm3.39$	$46.00^{a}\pm0.63$
$W_2 \times F_2 \times$ MLE	$76.17^{a}\pm0.65$	$52.17^{a}\pm0.48$	$14.17^{a}\pm0.31$	$10.17^{a}\pm0.31$	$320.86^{a}\pm10.27$	$3247.39^{e}\pm34.65$	$310.00^{a}\pm3.52$	$47.17^{a}\pm0.70$
$W_3 \times F_1 \times$ WE	$67.33^{a}\pm0.71$	$47.83^{a}\pm0.60$	$12.67^{a}\pm0.33$	$9.83^{a}\pm0.31$	$279.52^{a}\pm10.94$	$2733.22^{j}\pm43.74$	$352.50^{a}\pm4.72$	$51.83^{a}\pm0.58$
$W_3 \times F_1 \times$ AE	$77.83^{a}\pm0.60$	$55.00^{a}\pm0.52$	$13.83^{a}\pm0.31$	$11.00^{a}\pm0.26$	$308.94^{a}\pm6.65$	$3394.63^{d}\pm81.66$	$371.00^{a}\pm7.99$	$55.50^{a}\pm0.61$
$W_3 \times F_1 \times$ MLE	$81.17^{a}\pm0.41$	$56.33^{a}\pm0.67$	$14.83^{a}\pm0.31$	$12.33^{a}\pm0.21$	$288.06^{a}\pm6.02$	$3547.13^{c}\pm35.73$	$391.50^{a}\pm8.21$	$57.67^{a}\pm0.56$
$W_3 \times F_2 \times$ WE	$66.83^{a}\pm0.70$	$45.83^{a}\pm1.01$	$12.33^{a}\pm0.33$	$9.50^{a}\pm0.22$	$291.14^{a}\pm8.52$	$2758.44^{ij}\pm48.85$	$349.83^{a}\pm6.27$	$50.50^{a}\pm0.49$
$W_3 \times F_2 \times$ AE	$76.00^{a}\pm0.82$	$53.50^{a}\pm0.43$	$13.50^{a}\pm0.43$	$10.83^{a}\pm0.31$	$297.84^{a}\pm8.97$	$3215.11^{e}\pm53.97$	$369.00^{a}\pm8.19$	$54.17^{a}\pm0.54$
$W_3 \times F_2 \times$ MLE	$79.17^{a}\pm0.60$	$55.67^{a}\pm0.49$	$14.50^{a}\pm0.34$	$12.00^{a}\pm0.26$	$280.89^{a}\pm6.54$	$3363.49^{d}\pm43.56$	$381.67^{a}\pm8.20$	$56.50^{a}\pm0.50$
Significance at 0.05	NS	NS	NS	NS	NS	S	NS	NS

W_1; Tap water, W_2; Gray water, W_3; Mixture of gray water and tap, F_1; Inorganic, F_2; Organic, WE; Without extract, AE; Azolla extract, MLE; Moringa leaf extract.
*In each column, Data are means ± SE of *n*= 5. The mean values with the same letters do not differ significantly at 0.05 probability level.

Table 7. Effect of water type, different fertilizers and organic extracts on leaf photosynthetic pigments and fruit elements content of eggplant (means of two seasons).

Treatments	Chlorophyll *a* (mg g^{-1} FW)	Chlorophyll *b* (mg g^{-1} FW)	Total chlorophyll (mg g^{-1} FW)	Carotenoids (mg g^{-1} FW)	N (%)	P (%)	K (%)	Ca (%)	Mg (ppm)	Fe (ppm)
$W_1 \times F_1 \times$ WE	1.02^{a}±0.04	0.55^{a}±0.02	1.57^{a}±0.06	0.429^{bcd}±0.01	2.596^{k}±0.0	0.193^{j}±0.002	3.469^{j}±0.03	0.137^{gh}±0.00	0.233^{i}±0.004	121.12^{o}±0.1
$W_1 \times F_1 \times$ AE	1.05^{a}±0.05	0.62^{a}±0.02	1.66^{a}±0.06	0.435^{b}±0.01	3.004^{g}±0.0	0.237^{g}±0.00	3.800^{gh}±0.03	0.153^{ef}±0.00	0.290^{h}±0.00	153.36^{gh}±0.7
$W_1 \times F_1 \times$ MLE	1.12^{a}±0.05	0.67^{a}±0.02	1.78^{a}±0.07	0.459^{a}±0.01	3.135^{ef}±0.0	0.247^{f}±0.003	4.065^{de}±0.02	0.163^{e}±0.002	0.307^{g}±0.00	125.99^{m}±0.6
$W_1 \times b_2 \times$ WE	0.99^{a}±0.05	0.51^{a}±0.02	1.50^{a}±0.08	0.425^{def}±0.01	2.400^{l}±0.03	0.183^{j}±0.002	3.335^{k}±0.02	0.130^{h}±0.00	0.303^{g}±0.00	123.56^{n}±0.5
$W_1 \times F_2 \times$ AE	1.03^{a}±0.05	0.56^{a}±0.02	1.59^{a}±0.07	0.441^{bcd}±0.01	2.539^{k}±0.0	0.213^{i}±0.004	3.639^{i}±0.03	0.150^{ef}±0.00	0.323^{f}±0.007	234.97^{e}±0.57
$W_1 \times F_2 \times$ MLE	1.10^{a}±0.06	0.60^{a}±0.01	1.69^{a}±0.07	0.454^{b}±0.01	2.617^{jk}±0.0	0.223^{gh}±0.00	3.696^{hi}±0.05	0.160^{de}±0.00	0.347^{d}±0.00	130.04^{l}±0.74
$W_2 \times F_1 \times$ WE	0.87^{a}±0.08	0.43^{a}±0.05	1.30^{a}±0.012	0.408^{fg}±0.01	3.196^{de}±0.0	0.263^{de}±0.00	4.000^{ef}±0.08	0.157^{de}±0.00	0.344^{de}±0.00	146.83^{i}±0.65
$W_2 \times F_1 \times$ AE	0.97^{a}±0.07	0.49^{a}±0.02	1.46^{a}±0.08	0.410^{g}±0.02	3.543^{c}±0.04	0.367^{b}±0.00	4.200^{bc}±0.05	0.177^{bc}±0.00	0.363^{c}±0.007	306.78^{b}±0.7
$W_2 \times F_1 \times$ MLE	1.00^{a}±0.06	0.56^{a}±0.03	1.56^{a}±0.08	0.433^{cde}±0.01	3.683^{b}±0.0	0.400^{a}±0.003	4.535^{a}±0.04	0.210^{a}±0.00	0.413^{b}±0.00	155.35^{g}±0.8
$W_2 \times F_2 \times$ WE	0.82^{a}±0.07	0.40^{a}±0.06	1.22^{a}±0.13	0.385^{h}±0.02	2.796^{hi}±0.0	0.257^{def}±0.0	3.926^{fg}±0.04	0.153^{ef}±0.00	0.373^{c}±0.006	148.10^{i}±0.56
$W_2 \times F_2 \times$ AE	0.92^{a}±0.08	0.48^{a}±0.05	1.40^{a}±0.12	0.388^{h}±0.02	3.308^{d}±0.0	0.260^{d}±0.00	4.235^{bc}±0.02	0.163^{de}±0.00	0.414^{b}±0.00	325.30^{a}±0.67
$W_2 \times F_2 \times$ MLE	0.97^{a}±0.07	0.54^{a}±0.02	1.51^{a}±0.09	0.427^{cde}±0.01	3.841^{a}±0.0	0.377^{b}±0.00	4.500^{a}±0.05	0.187^{b}±0.00	0.450^{a}±0.005	161.09^{f}±0.84
$W_3 \times F_1 \times$ WE	0.95^{a}±0.07	0.43^{a}±0.05	1.38^{a}±0.11	0.416^{efg}±0.01	2.731^{ij}±0.0	0.230^{g}±0.00	3.692^{hi}±0.05	0.143^{fg}±0.00	0.323^{f}±0.003	133.73^{k}±0.8
$W_3 \times F_1 \times$ AE	0.99^{a}±0.07	0.55^{a}±0.02	1.53^{a}±0.09	0.431^{bcde}±0.0	3.035^{fg}±0.0	0.250^{ef}±0.00	3.996^{ef}±0.03	0.160^{de}±0.00	0.340^{de}±0.00	262.08^{d}±0.7
$W_3 \times F_1 \times$ MLE	1.07^{a}±0.04	0.62^{a}±0.04	1.70^{a}±0.08	0.442^{bc}±0.01	3.717^{ab}±0.0	0.280^{c}±0.003	4.304^{b}±0.03	0.177^{bc}±0.00	0.370^{c}±0.003	134.02^{k}±0.5
$W_3 \times F_2 \times$ WE	0.91^{a}±0.08	0.43^{a}±0.04	1.34^{a}±0.12	0.416^{efg}±0.01	2.761^{hi}±0.0	0.207^{hi}±0.00	3.835^{g}±0.02	0.143^{fg}±0.00	0.333^{ef}±0.00	139.87^{j}±0.61
$W_3 \times F_2 \times$ AE	0.94^{a}±0.08	0.52^{a}±0.02	1.47^{a}±0.10	0.422^{cde}±0.01	2.865^{h}±0.0	0.223^{gh}±0.00	4.039^{def}±0.0	0.163^{de}±0.00	0.367^{c}±0.004	295.36^{c}±0.95
$W_3 \times F_2 \times$ MLE	1.03^{a}±0.06	0.56^{a}±0.02	1.58^{a}±0.08	0.432^{bcd}±0.01	3.769^{ab}±0.0	0.233^{g}±0.00	4.135^{cd}±0.04	0.173^{cd}±0.00	0.420^{b}±0.00	151.90^{h}±0.6
Significance at 0.05	NS	NS	NS	S	S	S	S	S	S	S

W_1; Tap water, W_2; Gray water, W_3; Mixture of gray water and tap, F_1; Inorganic, F_2; Organic, WE; Without extract, AE; Azolla extract, MLE; Moringa leaf extract.
*In each column, Data are means ± SE of *n*= 5. The mean values with the same letters do not differ significantly at 0.05 probability level.

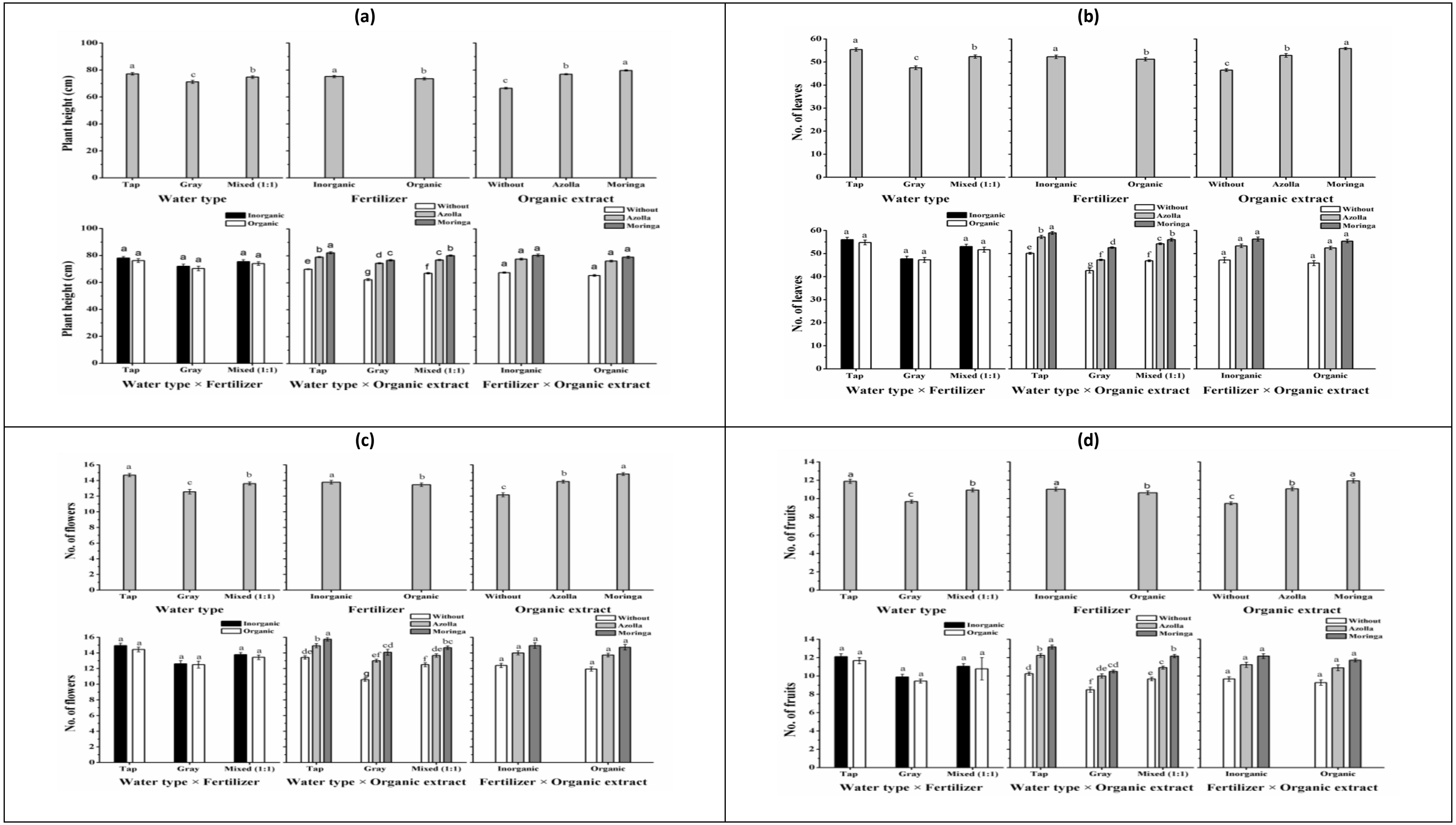

Figure. 1. Effect of water type, different fertilizers and organic extracts on **a** plant height, **b** no. of leaves, **c** no. of flowers and **d** no. of fruits of eggplant (means of two seasons). Data are means ± SE of n= 5. The mean values with the same letters do not differ significantly at 0.05 probability level.

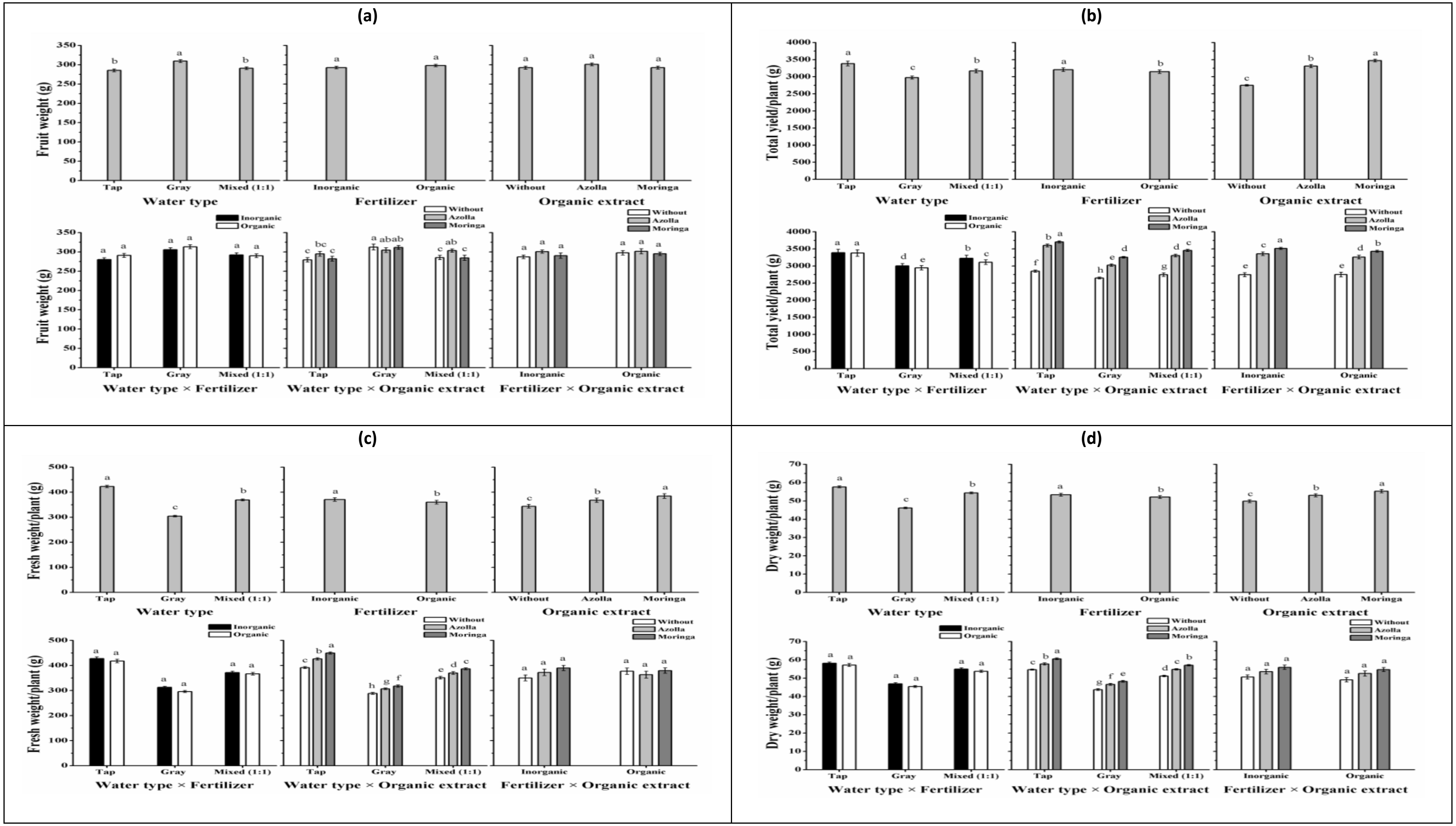

Figure. 2. Effect of water type, different fertilizers and organic extracts on **a** fruit weight, **b** total yield/plant, **c** fresh weight/plant and **d** dry weight/plant of eggplant (means of two seasons). Data are means ± SE of *n*= 5. The mean values with the same letters do not differ significantly at 0.05 probability level.

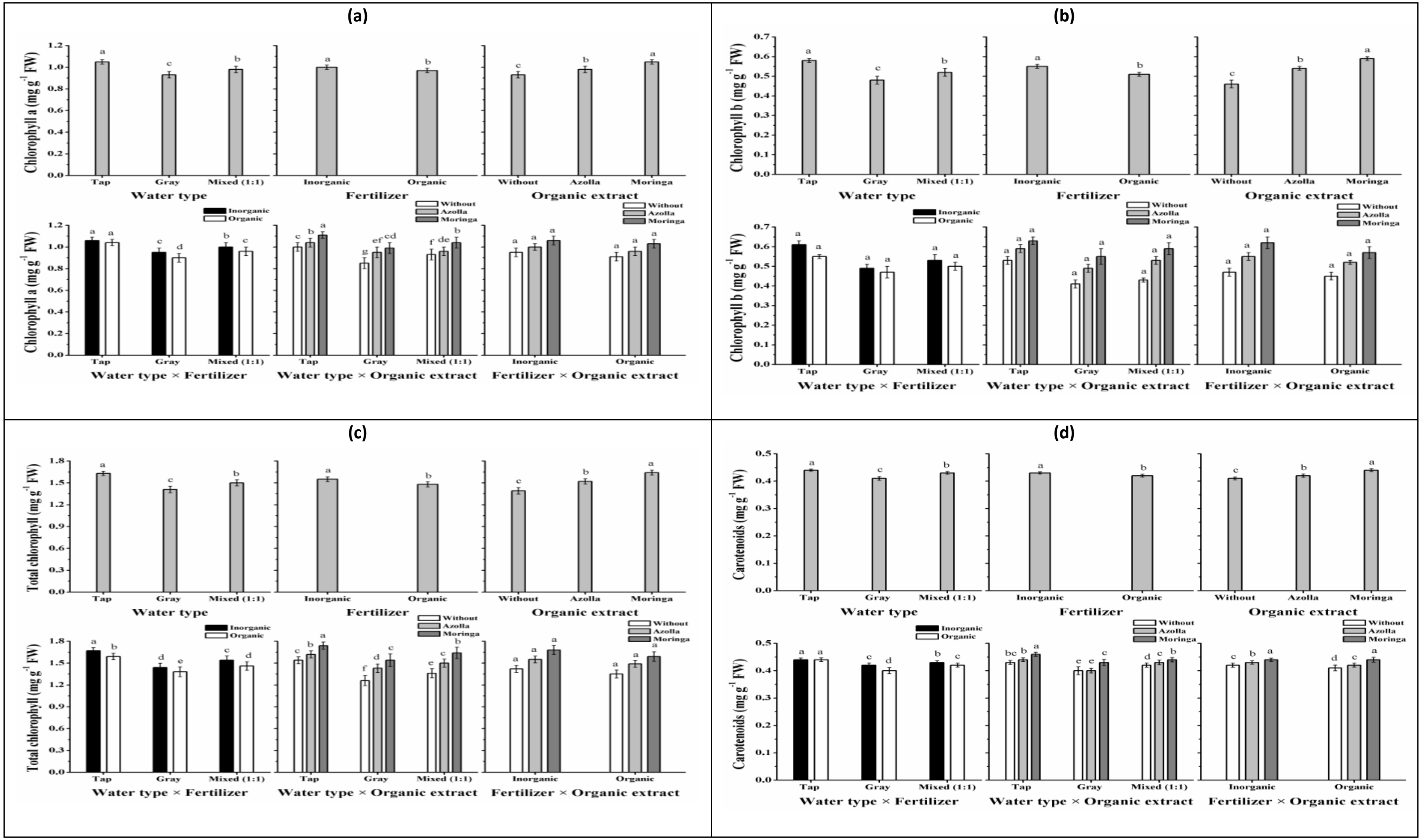

Figure. 3. Effect of water type, different fertilizers and organic extracts on leaf photosynthetic pigments **a** chlorophyll a, **b** chlorophyll b, **c** total chlorophyll and **d** carotenoids of eggplant (means of two seasons). Data are means ± SE of *n*= 5. The mean values with the same letters do not differ significantly at 0.05 probability level.

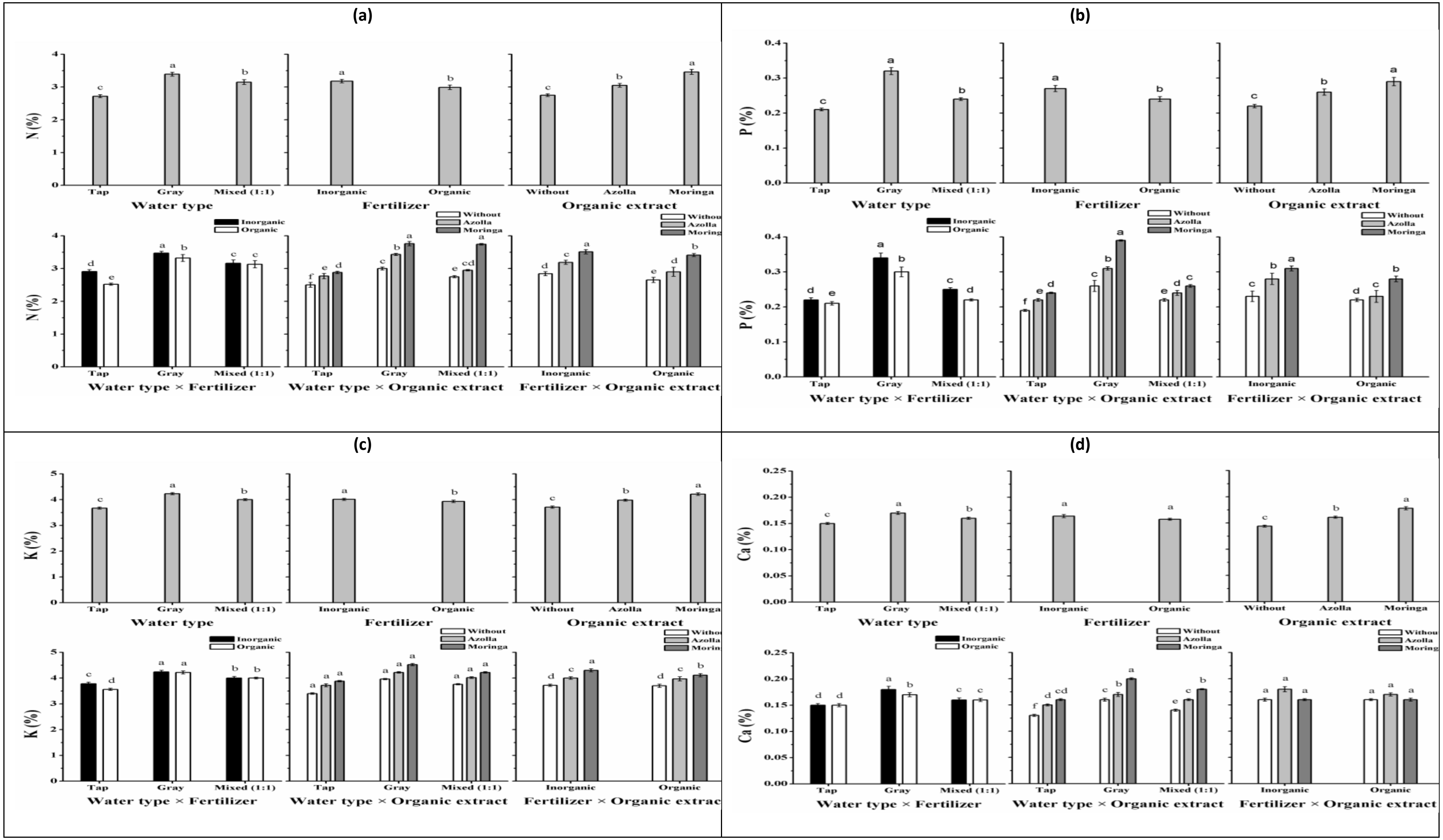

Figure. 4. Effect of water type, different fertilizers and organic extracts on fruit elements content **a** N, **b** P, **c** K **d** Ca of eggplant (means of two seasons). Data are means ± SE of *n*= 5. The mean values with the same letters do not differ significantly at 0.05 probability level.

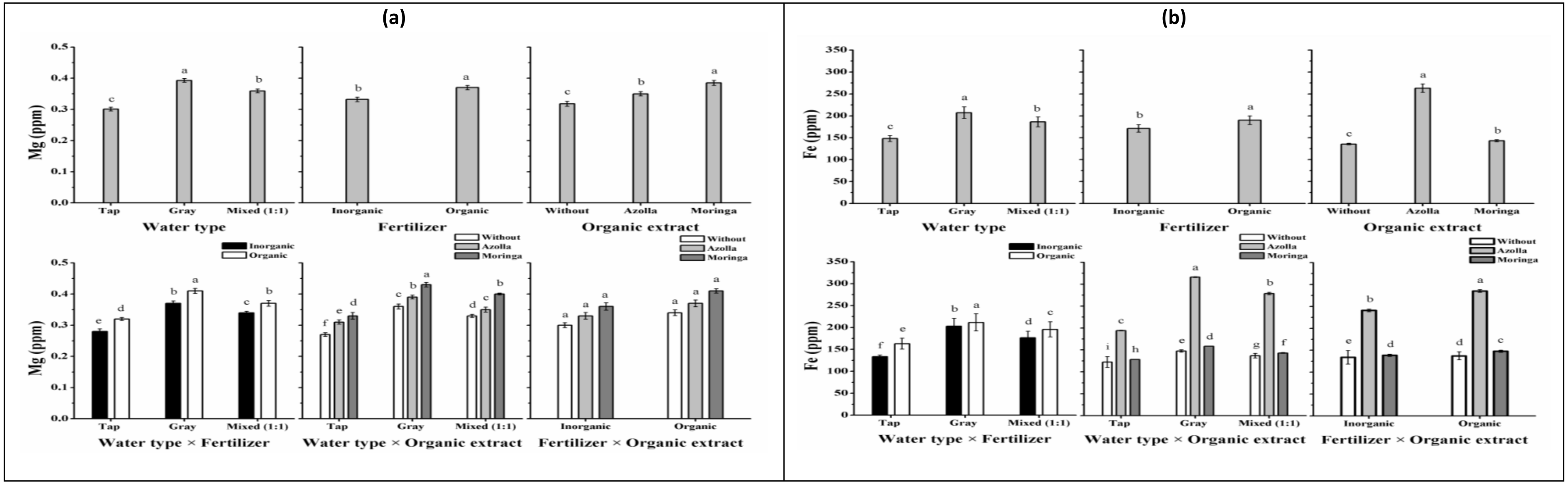

Figure. 5. Effect of water type, different fertilizers and organic extracts on fruit elements content **a** Mg and **b** Fe eggplant (means of two seasons). Data are means ± SE of *n*= 5. The mean values with the same letters do not differ significantly at 0.05 probability level.

إستجابة الباذنجان لجودة مياه الري والتسميد والمستخلصات العضوية تحت نظام الزراعة الحضرية

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الملخص

أجريت تجربة الأصص في المزرعة التجريبية بقسم البيئة والزراعة الحيوية بكلية الزراعة جامعة الأزهر بمدينة نصر بالقاهرة خلال موسمي 2018/2017 و2019/2018 لتقييم تأثير أنواع مياه الري والتسميد والرش الورقى بالمستخلصات العضوية على النمو وخصائص المحصول ومحتوى ثمار الباذنجان من العناصر. حيث وزعت التجربة العاملية بشكل عشوائي تام وأشتملت على 18 معاملة وخمسة مكررات. حيث كانت المعاملات على النحو التالي:ثلاثة أنواع مياه الري؛ ماء الصنبور ، المياه الرمادية ، خليط من المياه الرمادية وماء الصنبور بنسبة (1:1) (حجم:حجم) و التسميد؛ الجرعة الموصى بها من السماد المعدنى NPK ، 100% كمبوست بنفس معدل التسميد النيتروجينى المعدنى و الرش بالمستخلصات العضوية: بدون مستخلص ككنترول ، مستخلص الأزولا ، مستخلص أوراق المورينجا بمعدل 500 مل ماء مقطر/ 100جم مادة نباتية طازجة كرش ورقى. حيث سجلت النباتات المروية بماء الصنبور القيم القصوى لصفات النمو و المحصول. بينما سجلت النباتات المرويه بالمياه الرمادية أعلى محتوى من العناصر بثمار الباذنجان. سجلت النباتات المسمدة بالأسمدة المعدنية أعلى إنتاجية ومحتوى من النيتروجين والفوسفور والبوتاسيوم ، فى حين سجلت النباتات المسمدة بالكمبوست أعلى القيم لمحتوى الثمار من الماغنسيوم والحديد. سجلت معاملة الرش بمستخلص أوراق المورنجا أعلى القيم لجميع الصفات تحت الدراسة باستثناء محتوى الثمار من الحديد حيث سجلت بواسطة الرش بمستخلص الأزولا فى متوسط الموسمين.كذلك سجلت معاملة الرى بماء الصنبور والتسميد المعدنى والرش بستخلص أوراق المورنجا أعلى قيم للمحصول الكلي / نبات ومحتوى الكاروتينات، من جهة أخرى تم تسجيل أعلى قيمة لمحتوى الثمار من الحديد باستخدام معاملة الرى بالمياه الرمادية والتسميد العضوى والرش بمستخلص الأزولا.

الكلمات الاسترشادية: الباذنجان، المياه الرمادية، الكمبوست، مستخلص الأزولا، مستخلص أوراق المورنجا.