

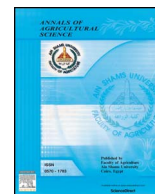
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Effect of the foliar enrichment and herbicides on maize and associated weeds irrigated with drainage water

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ABSTRACT

A two-year field experiment was conducted during summer seasons of 2013 and 2014, which were irrigated by drainage water which belong to salinity class (C3S1 to C4S2), to study the effect of the foliar enrichment namely (Anti-stress) and weed management treatments (some pre and post-emergence herbicides and two-hand hoeing) on maize growth, yield, yield components and chemical composition of maize grains and associated weeds (*Portulaca oleracea*, *Amaranthus retroflexus* and *Echinochloa colonum*). The results illustrated that application of the foliar enrichment enhanced the dry weight of weeds and increased maize growth characters, yield and yield components and total crude protein and total oil percentage of grain maize, as compared with untreated treatment. All weed management treatments caused a significant reduction in total dry weight of weeds at 60 and 80 days after sowing in both seasons. Two-hand hoeing treatment exerted the highest decrease in total dry weight of weeds followed by metribuzin, oxadiagyl, fluroxypyr and bentazon, respectively at 60 and 80 days after sowing compared with other weed management treatments. While, the highest values of maize growth, yield, yield components and maize grains' content of protein and oil was obtained with two-hand hoeing followed by metribuzin, oxadiagyl, fluroxypyr and bentazon, respectively. While, two hands hoeing produced the maximum values of leaf area, ear length, the weight of kernels plant⁻¹, but applying of metribuzin treatment gave the highest values of total oil percentage of grain maize when the foliar enrichment was used.

Introduction

Maize (*Zea mays* L.) is third important cereal crops, after wheat and rice, not only in Egypt but also all over the world. In Egypt, the cultivated area with maize is lack to meet the increasing demand for human consumption and animal feedings. Maize has been classified as moderately sensitive to soil salinity (threshold soil salinity (ECe) = 1.7 dS m⁻¹) (Maas and Hoffman, 1977). Thus, a great attention should be paid to raise its productivity per unit area through horizontal expansion in the soil, which is exposed to salinity in the El-Serw area, which is mostly irrigated with drainage water, such as El-Serw drainage with quality water belong to C3 S1 and C4 S2 classes, therefore it could have been reused for irrigation purposes under special management (Khafagy et al., 2014). This can be achieved through planting the high yield cultivars and the enhancement of agronomic practices such as weed management and suitable enrichments.

Salt tolerance is the capability of plants to germinate and complete their life cycle on a substrate that contains high concentrations of soluble salt (Parida and Das, 2005). Salinity in soil has three potential

effects on plants: 1 – lowering of the potential water by directly absorbed toxicity of Na⁺ and Cl⁻ and limiting the uptake of essential nutrients, 2 – decreases the osmotic potential of soil water and consequently and 3 – reduces the availability of soil water for plants (Rasool et al., 2013). On the other hand, salt stress inhibits photosynthesis by reducing water potential. So the main aim of salt tolerance is to increase water use efficiency under salinity (Parida and Das, 2005).

As stated in the guide to the use of the foliar enrichment namely, Anti-stress, protects against the plant from bad effects of salinity in irrigation water and soil and there is an increase in vegetative growth, flowering and fertility percentage of the plant as well as, increasing the weight of the crop by more than 20% in the production of cereal yield and increasing resistance to disease and insects. This is due to the containment of a group of elements and chemical compounds such as: (Potassium K, Sulphur S, Boron B, Salicylic acid SA, Linoleic acid LA, Oleic acid OA, Palmitic acid PA and Citric acid CA). Potassium plays a role in osmotic regulation and turgor pressure via low osmotic potential in the stele of the roots that is required to drive solute transport in the xylem and is involved in the stomatal movement (Lebaudy et al., 2007).

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While, Sulphur element is necessary for abiotic stress tolerance of plants being an integral part of major metabolic compounds, such as amino acids, antioxidants, proteins and sulfolipids (Khan et al., 2013). But, salicylic acid is a naturally occurring plant hormone, acts as an important signaling molecule and has diverse effects on tolerance to biotic and abiotic stress (Wang et al., 2010, 2011) by induces the synthesis of antioxidants (ascorbate and glutathione), antioxidant enzymes (glutathione transferase, glutathione peroxidase, ascorbate peroxidase) and provides increased tolerance against biotic and abiotic stress factors (UrbanekKrajnc et al., 2008). Fatty acids such as Linoleic acid, Oleic acid and Palmitic acid desaturases play important role in plant responses to abiotic stresses including cold, high temperature, drought and osmotic stress (Zhang et al., 2009). Citric acid is a common antioxidant component in the apoplast and had effects on plant growth and many physiological processes. L-Ascorbic acid serves as a co-factor for many enzymes (Arrioni and DeTullio, 2002).

Weed is a major problem in maize fields and competes with plants in nutrient, water, light and other essential requirements. The reduction in maize yield due to uncontrolled weed growth reached 32.4–50% (Sharma et al., 2000; Saad El-Din et al., 2004) and 90% (Dalley et al., 2006). Thus, weed management will increase the maize grain yield and improve its quality. As hand labor became scarce and costly, herbicides replaced it as a cheap and easy method for weed management in maize fields. Chemical weed management plays an important role in improving the growth and productivity of maize plants, which considered as one of the vital methods in Egypt. In general, application of herbicides depends not only on its efficiency in management ling weeds but also on its effect on maize plants. Using chemical weed management intensively with maize is easier and more economical than manual or mechanical ones, especially after the labors scarce. Most available herbicides used in maize are assigned to controlling particular weeds, unlike little (e.g. Atrazine) that controls a broad spectrum of weeds. However, one or more of these weed species may show a high resistant to herbicides. Therefore, it is essential to use mixtures (combinations) of herbicides for broadening the spectrum of weed management and for reducing the risk of evolution weed resistance against herbicides. The benefits of using herbicide mixtures include also saving time, control efforts and costs.

Table 1

Electrical conductivity and sodium adsorption ratio of EL-Serw drainage water during the studied period in 2013 and 2014 seasons.

Distance km from El-Serw drainage start	2013		2014	
	EC	SAR	EC	SAR
0	1.53	9.30	1.56	9.41
5	1.72	9.90	1.81	9.71
10	2.31	10.09	2.88	9.71
15	2.64	10.67	3.14	9.96
20	3.05	11.20	3.32	10.67
25	3.31	11.56	3.58	10.81

EC = Electrical conductivity (dS m^{-1}). SAR = Sodium adsorption ratio (%).

Table 2

The chemical and physical analysis of used soil from a point away from the start of the El-Serw drainage about 20 km during the two growing seasons.

Season	Particle size distribution					pH of soil Susp 1:25	E.C ds m^{-1} at 25 $^{\circ}\text{C}$	Organic Matter %	Available N ppm	Available P ppm	Available K ppm
	Coarse sand %	Fine sand %	Silt%	Clay%	Texture						
2013	1.21	16.67	18.35	63.77	Clayey	8.4	3.4	1.27	33	8.34	443
2014	1.67	16.22	17.52	64.59	Clayey	8.7	3.8	1.20	32	8.30	420

Many researchers have been reported that herbicides applications control weed growth and maximize yield of maize (Rapparini et al., 2001; Sharara et al., 2005) by using some post-emergence herbicides, such as fluroxypyr, (Zaciragic and Grabo, 2003); bentazon (Romanjuk and Kolesnik, 2002; Senseovic, 2004) and by using Metribuzin (Subba Rao and Modhulety, 2005). El-Metwally et al. (2006) found that two-hand hoeing was a very effective to control maize weed growth and increase the yield. The using Metosulam (Kremer, 1997) and tribenuron-methyl (Attalla, 2002) control weeds growth and increase maize grain yield.

Therefore, the present study aimed to investigate: (1) the role of the foliar enrichment (Anti-stress) in improving the growth and yield of maize and its effects on the associated weeds under saline conditions and (2) the efficacy of some weed management treatments such as single pre and post-emergence herbicides especially belonged to some new chemical groups such a sulfonyl urea and hand hoeing in sequence on growth, yield, yield components and some chemical compositions of maize grains as well as associated weeds in soil affected by salinity which irrigated with drainage water.

Materials and methods

Two field experiments were conducted during the two successive summer seasons of 2013 and 2014 at El-Serw Agricultural Research Station of Agricultural Research Center in Damietta Governorate, Egypt, in clayey soils to study the effect of the foliar enrichments (Anti-stress) and some pre and post-emergence herbicides on growth, yield and its components and chemical composition of maize as well as associated weeds, which were irrigated by El-Serw drainage water belong to salinity class (EC between 1.53:3.31 and 1.56:3.58 in the 1st and 2nd seasons, respectively) as shown in Table 1.

Water analysis

Water samples were collected during maize cultivation period in 2013 and 2014 seasons, from six sites in EL-Serw drainage along (25 km.) and these sites were at distances (0, 5, 10, 15, 20 and 25 km.) from the beginning at $31^{\circ}14'15.54''\text{N}$ and $31^{\circ}42'23.36''\text{E}$ to downstream at $31^{\circ}15'24.19''\text{N}$ and $31^{\circ}48'41.47''\text{E}$. EL-Serw pumping drainage station in the end of El-Serw lifts the drainage water to diverse it in EL-Salam Canal.

Salts content expressed as EC values was measured using an electrical conductivity meter and soluble cations and anions were determined according to Jackson (1973). Moreover, sodium adsorption ratio (SAR) was calculated using equation by Richards (1954). Table 1 shows that EC and SAR values increased slightly with northward direction, the quality of studied drainage water belong to C3 S1 and C4 S2 classes (USDA Classification, 1954), therefore it's considered to cause increase salinity problem (FAO, 1985), Especially that the plantation of El-Serw agriculture research station is irrigated from El-Serw drainage from a point away from the start of the drainage about 20 km.

The soil chemical and physical analysis were performed according to Chapman and Pratt (1978) and located in Table 2.

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