Effect of salinity, humic acid, biozote and vermicompost on soil physicochemical properties and olive plants species

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Received 2nd February 2018; Accepted 9th April 2018

ABSTRACT: The study was carried out at National Agricultural Research Centre (NARC) Islamabad during August, 2017 to October, 2017 to evaluate the impact of salinity plus humic acid, Biozote and Vermicompost on 3 olive varieties (*Nocellera*, *Frontoio* and *Carolea*) on physicochemical properties of soil and plant ionic concentration used in plastic nursery bags of three months olive sprouted cuttings in tunnel under saline conditions. The completely randomized design was applied with three replications. Olive soil salinity was developed artificially with the mixture of different salts at 2.0 dSm⁻¹. Biozote, humic acid, and Vermicompost were applied in the artificially developed soil salinity filled in polythene bags planted three months olive cuttings. Treatments were; humic acid solid mixed with soil at the time of planting, humic acid liquid to the soil at the time of planting, humic acid sprayed to cuttings (after every 10 days), dip cuttings in humic acid at the time of planting. Addition of vermizote in soil at the time of planting, addition of Biozote in soil at the time of planting and dip cutting in biozote at the time of planting. Results showed that salinity negatively affected the uptake of nutrient elements. Physiochemical properties of soil showed significant variations among different treatments when interacted with varieties at P<0.05. This study pointed out the tolerance and sensitivity levels against salinity in three olive varieties at 2.0 dSm⁻¹. *Nocellera* olive variety is the most tolerant variety in terms of Na uptake as compared to the others. Whereas the *Frontoio* olive cultivar is the most susceptible olive variety against salinity stresses. As K uptake is concerned, *Nocellera* is the variety of maximum uptake and *Carolea* olive variety with the minimum. The results depicted that *Nocellera* olive variety proved to be the most salinity tolerant variety.

Key Words: Biozote *Carolea*, *Frontoio* and *Nocellera*, olive varieties, humic acid, ionic concentration, soil properties, vermicompost.

INTRODUCTION

Humic acids are technically not a fertilizer, even though in some ways people do think it. Humic acids are an effectual mediator to use as a hormone to synthetic or organic fertilizers. Humic acids are an important soil component that can improve nutrient availability and impact on other important chemical, biological, and physical properties of soils. In many examples, regular humic acids use will lessen the need for fertilization due to the soil and plant

ability to make better use of it. In some ways, nutrition can be eliminated entirely if sufficient organic material is present and the soil can become self-sustaining through microbial processes and humus production (Hauser and Horie, 2010). Defline et al. (2005) investigated the effect of foliar application of N and humic acids on the growth and yield of corn. Moreover, other researchers specified that the foliar application of humic acids caused a transitional

production of plant dry mass with respect to the unfertilized control (Guo et al., 2001, 2004 and Halfter et al., 2000).

As mentioned above, one way the plant growth can be improved is through the structural improvement of sandy clay soil allowing for a better root growth development (Ren et al., 2005 and Ishitani et al., 2000). The plant growth is also improved by the ability of the plant to uptake and receives more nutrients. Humic acids are especially beneficial in freeing up nutrients in the soil so that they are made available to the plant as needed. For instance, if an aluminum molecule is bound to one of phosphorus, humic acids detach them making the phosphorus available for the plant. Humic acids are also important because of their ability to chelate micronutrients, thus increasing their bio-availability (Sunarpi et al., 2005). According to the analysed results, the application of 20 mM NaCl increased the dry weight, N, P, K, Ca, Mg, Fe, Cu, and Mn contents of the plants, but the amounts decreased with the application of 60 mM NaCl. Particularly, the effect of NaCl application at a dose of 60 mM had a negatively significant effect on the dry weight and mineral elements uptake of corn (Pardo et al., 2006).

The soil applications of humus had a significant effect on the uptake of N in corn (Laila et al., 2017). When compared with the control treatment, the dry weight and mineral nutrients uptake of corn was found higher at both application doses of humus. The highest dry weight and nutrients uptake were obtained with 2 g humus/kg treatment. The dry weight and nutrients uptake were negatively affected by the application of 4 g humus/kg (Davenport et al., 2007; Mäser et al., 2002a). Angelova et al. (2013) reported that compost and vermicompost treatments had significant effect on soil physical and chemical properties like electrical conductivity (EC), pH, organic matter, macro, and micronutrients content. Horie et al. (2001) compared with unamended soil and soil treated with organic amendments showed apparent increases of organic matter, total N, pH, EC and available macro elements (P, K, Ca and Mg).

Foliar applications of humic acid had a significant effect on the dry weight and mineral elements uptake in corn (Sunarpi et al., 2005; Uozumi et al., 2000). Addition of organic matter amendments, such as compost, fertilizers, and wastes, is a common practice for immobilization of heavy metals and soil amelioration of contaminated soils (Xue et al., 2011). Some researchers showed that amendment of contaminated soils with organic matter reduced the bioavailability of heavy metals (Khan et al., 2000; Liu et al., 2000; Qiu et al., 2002). Tavakkoli et al. (2010) reported that salinity caused by high concentrations of NaCl can reduce growth by the accumulation of high concentrations of both Na^+ and Cl^- simultaneously, but the effects of the two ions may differ. High Cl^- concentration reduces the photosynthetic capacity and quantum yield due to chlorophyll degradation which may result from a structural impact of high Cl^- concentration on PSII (Davenport et al., 2007; Møller et al., 2009). High Na^+

interferes with K^+ and Ca^{2+} nutrition and disturbs efficient stomata regulation which results in a depression of photosynthesis and growth. These results suggest that the importance of Cl^- toxicity as a cause of reductions in growth and yield under salinity stress may have been underestimated. Salinity is a major constraint to crop production in Australia (Rengasamy, 2002; Mäser et al., 2002b) but there has been some recent debate about the importance of soil Cl and by implication plant Cl^- uptake, as the principal cause of damage and yield loss at field level (Dang et al., 2010). Based on analysis of a number of field trials of wheat and chickpea crops, Dang et al. (2008) concluded that the Cl^- concentration in the soil was more important in reducing growth and yield than Na^+ . Plants must cope with both osmotic and ionic stress under high salinity conditions. Osmotic stress reduces water uptake and cell expansion and delays lateral bud development (Munns and Tester, 2008; Berthomieu et al., 2003).

High cytosolic K^+/Na^+ ratios in the shoot are critical for salt tolerance in glycophytes, which can only tolerate relatively low salt concentrations (Blumwald, 2000, Yamaguchi and Blumwald, 2005). When a Na^+ ion enters the plant root, it can be selectively transported through three independent biological membranes: the plasma membrane in epidermal cells, the vacuolar membrane in root and shoot cells, and the plasma membrane in xylem parenchyma cells (Horie et al., 2012). Accumulated cytosolic Na^+ can be removed by efflux systems such as Na^+/H^+ antiporters, which transport Na^+ across the plasma membrane (Blumwald, 2000), as well as the Salt-Overly Sensitive (SOS) pathway (Park et al., 2016).

Humin, which is composed of humic and fulvic acids (commonly known as humic substances [HS]), is a complex supramolecular association of abiotically transformed biomolecules that are released into soils after cell lysis (Orsi, 2014). These substances can improve soil properties such as aggregation, aeration, permeability, water holding capacity, micronutrient transport, and availability. Furthermore, the direct uptake of HS into plant tissues results in diverse biochemical outcomes (Arancon et al., 2006; Nardi et al., 2002; Selim et al., 2009; Tan, 2003). Humic acid (HA) improves plant development by regulating metabolic and signaling pathways by acting directly on certain targets in diverse physiological processes (Quaggiotti et al., 2004; Trevisan et al., 2010). HA treatment enhances the mobilization of toxic heavy metals, especially from abandoned mine tailings, indicating that HA could be utilized as a possible remedy to reduce further soil contamination (Wang and Mulligan, 2009). Moreover, HA has protective effects against high saline stress by inhibiting Na^+ uptake in barley (Marketa et al., 2016), and it reduces yield losses in maize under salt stress (Masciandaro et al., 2002). However, this study was conducted to investigate the effect of biozote, vermicompost and humic acid on soil physiochemical properties as well as plant ionic concentration under saline conditions.

Table 1. Impact of salinity plus humic acid, biozote and vermicompost on physicochemical properties of soil.

Treatment	Soil ECE(dSm ⁻¹)				Soil Na(meql ⁻¹)				Soil K(meql ⁻¹)				Soil Ca+Mg (meql ⁻¹)			
	V1	V2	V3	Mean	V1	V2	V3	Mean	V1	V2	V3	Mean	V1	V2	V3	Mean
T1	0.98 ^{ab}	0.93 ^{bc}	0.92 ^{bc}	0.94 ^{BC}	6.3 ^a	6.5 ^a	5.2 ^a	6.2 ^A	13.6 ^a	13.4 ^a	12.3 ^a	13.1 ^A	1.9 ^{ab}	1.7 ^b	1.6 ^b	1.7 ^B
T2	0.92 ^{bc}	0.95 ^{bc}	0.91 ^{bc}	0.92 ^{BC}	5.7 ^a	6.6 ^a	5.2 ^a	5.6 ^A	12.3 ^a	14.6 ^a	11.2 ^{ab}	12.7 ^A	1.7 ^b	1.5 ^b	1.7 ^b	1.6 ^B
T3	0.93 ^{bc}	0.93 ^{bc}	0.94 ^{bc}	0.93 ^{BC}	6.0 ^a	5.9 ^a	5.6 ^a	6.1 ^A	15.6 ^a	15.1 ^a	14.7 ^a	15.1 ^A	1.6 ^b	1.4 ^b	1.8 ^{ab}	1.6 ^B
T4	0.94 ^{bc}	0.93 ^{bc}	0.90 ^{bc}	0.92 ^{BC}	6.9 ^a	6.3 ^a	4.9 ^b	5.9 ^A	17.0 ^a	17.1 ^a	13.8 ^a	16.0 ^A	1.4 ^b	1.5 ^b	1.9 ^{ab}	2.3 ^A
T5	1.43 ^{ab}	1.40 ^b	1.46 ^{ab}	1.43 ^{AB}	4.8 ^{ab}	6.7 ^a	5.2 ^a	5.2 ^A	09.7 ^b	11.3 ^b	09.4 ^b	10.1 ^B	2.6 ^a	2.4 ^a	2.0 ^a	2.3 ^A
T6	1.89 ^a	1.97 ^a	1.99 ^a	1.95 ^A	4.0 ^b	4.0 ^b	4.5 ^b	4.5 ^B	09.3 ^b	08.9 ^b	08.9 ^b	09.0 ^B	1.3 ^b	1.8 ^{ab}	2.1 ^a	1.7 ^B
T7	1.82 ^a	2.00 ^a	1.94 ^a	1.92 ^A	3.9 ^b	4.3 ^b	4.6 ^b	4.6 ^B	09.2 ^b	08.0 ^b	08.8 ^b	08.7 ^B	1.5 ^b	1.6 ^b	1.9 ^{ab}	1.7 ^B
LSD		0.46				1.8				5.7				0.7		

Means with different letters are significantly different at 5% level of probability. Before Plantation: Soil ECE (dSm⁻¹) = 0.194, Soil Na (meql⁻¹) = 1.0, Soil K (meql⁻¹) = 2.4, Soil Ca+Mg (meql⁻¹) = 1.8. V₁ = Nocellera, V₂ = Frontoio, V₃ = Carolea, T₁=Humic acid solid to mix with soil at the time of planting, T₂ =Humic acid liquid to soil at the time of planting, T₃ = Humic acid spray to cuttings (after every 10 days, T₄ = Dip cuttings in humic acid at the time of planting, T₅ = Addition of Vermizote in soil at the time of planting, T₆ = Addition of Biozote in soil at the time of planting, T₇ = Dip cutting in Biozote at the time of planting.

MATERIAL AND METHODS

The study was carried out at National Agricultural Research Centre (NARC), Islamabad between August to October, 2017 to probe the impact of salinity plus humic acid, Biozote and Vermicompost on 3 olive varieties (*Nocellera*, *Frontoio* and *Carolea*) on physicochemical properties of soil and plant ionic concentration used in plastic nursery bags of three months olive sprouted cuttings in tunnel under saline conditions. A Completely Randomized Design was applied with three replications. Olive Soil salinity was developed artificially with the mixture of different salts at 2.0 dSm⁻¹. Biozote, humic acid, and Vermicompost were applied in the artificially developed soil salinity filled in polythene bags planted three months olive cuttings. Treatments were; T₁ = Humic acid solid to mix with soil at the time of planting, T₂ = Humic acid liquid to soil at the time of planting, T₃ = Humic acid spray to cuttings (after every 10 days, T₄ = Dip cuttings in humic acid at the time of planting, T₅ = Addition of Vermizote in soil at the time of planting,

T₆ = Addition of Biozote in soil at the time of planting, T₇ = Dip cutting in Biozote at the time of planting. Soil and leaf samples were analyzed for various physicochemical properties using standard methods (Ryan et al., 2001; Sparks et al, 1996). Soil EC, Na, K and Ca+ Mg were determined. Leaf Na and K were also determined. The data collected was analysed and the means were compared by LSD at 5% level of probability (Montgomery, 2001).

RESULTS AND DISCUSSION

Three olive varieties were evaluated for salinity tolerance. Physiochemical properties of soil showed significant variations among different treatments when interacted with varieties at P<0.05 (Table 1). Soil EC was significantly higher (2.00 dSm⁻¹) at T₇ in V₂ (Frontoio), followed by 1.99 dSm⁻¹ and 1.97 dSm⁻¹ at T₆ in V₃ and V₂, respectively. Maximum mean of EC was obtained with T₆ followed by T₇ and the maximum mean of soil EC was achieved by V₂ among other two olive varieties.

Soil Na (meql⁻¹) was maximum (6.9 meql⁻¹) at T₄ in V₁ (Nocellera), followed by 6.7 meql⁻¹ and 6.6 meql⁻¹ in V₂ at T₅ and T₂ respectively. Maximum mean soil Na was developed by T₁ and maximum mean achieved in V₃ (Carolea). Salinization is one of the most serious types of land degradation as well as and a major obstacle to the optimal utilization of land resources (Liang et al., 2005). Humin influences plant growth both directly and indirectly by functioning as a major source of organic compounds in soil (Sangeetha et al., 2006).

Soil K was significantly higher (17.1 meql⁻¹) at T₄ in V₂ followed by 17.0 meql⁻¹ at T₄ in V₁. The maximum mean soil K was obtained by T₄ in V₁.

Maximum soil Ca+Mg (2.6 meql⁻¹) was achieved at T₅ by V₁ followed by 2.4 meql⁻¹ and 2.0 meql⁻¹ at T₅ by V₂ and V₃, respectively. The maximum means were achieved by T₄ (2.3 meql⁻¹) and T₅ (1.9 meql⁻¹) by V₃.

Statistical analysis showed that V₁ was more tolerant against treatments T₄, T₅, T₆ and T₇ with the difference of 0.2 meql⁻¹ of Na before and after

Table 2. Leaf analysis before the conductance of the experiment and after the harvest of the experiment.

Treatment	Leaf Na (meqL ⁻¹)						Leaf K (meqL ⁻¹)					
	V ₁		V ₂		V ₃		V ₁		V ₂		V ₃	
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
T1	2.2 ^b	2.5 ^a	2.5 ^a	2.5 ^a	2.1 ^b	2.0 ^b	10.6	10.8	9.3	9.6	9.2	9.3
T2	2.2 ^b	2.2 ^b	2.2 ^b	2.6 ^a	2.1 ^b	2.3 ^b	10.3	10.7	9.2	9.7	9.0	9.3
T3	2.1 ^b	2.3 ^b	2.3 ^b	2.7 ^a	2.2 ^b	2.1 ^b	10.4	10.4	9.9	9.9	9.9	9.9
T4	2.4 ^a	2.2 ^b	2.2 ^b	2.4 ^a	2.1 ^b	2.2 ^b	09.9	10.4	9.1	9.1	9.1	9.0
T5	2.1 ^b	1.9 ^c	1.9 ^c	2.1 ^b	2.0 ^b	2.6 ^a	09.8	10.8	9.6	9.6	9.6	9.2
T6	2.2 ^b	2.0 ^b	2.0 ^b	2.1 ^b	1.9 ^b	2.2 ^b	10.2	10.4	9.0	9.7	9.0	9.5
T7	2.3 ^b	2.1 ^b	2.1 ^b	2.3 ^b	2.0 ^b	2.1 ^b	10.1	10.5	9.5	9.8	9.3	9.6
LSD	0.4						NS					

Means with different letters are significantly different at 5% level of probability. V₁ = Nocellera, V₂ = Frontoio, V₃ = Carloea, T₁=Humic acid solid to mix with soil at the time of planting, T₂=Humic acid liquid to soil at the time of planting, T₃ = Humic acid spray to cuttings (after every 10 days, T₄ = Dip cuttings in humic acid at the time of planting, T₅ = Addition of Vermizote in soil at the time of planting, T₆ = Addition of Biozote in soil at the time of planting, T₇ = Dip cutting in Biozote at the time of planting.

the applications of soil treatments (Table 2). Analysis of V₂ showed that the Na uptake was nill in T₁ and the Na uptake difference was +0.4 meqL⁻¹ in T₂ and T₃ which shows its sensitiveness. Na uptake by V₃ showed its tolerance of -0.1 meqL⁻¹ with T₁ and T₃ but at T₅ the difference of +0.6 meqL⁻¹ showed the sensitivity of V₃ at T₅ (Table 2).

Statistical analysis of K uptake showed that V₁ attained 1.00 meqL⁻¹ K uptakes by T₅ followed by the difference of +0.5 meqL⁻¹ with T₄. V₂ showed maximum (+0.7 meqL⁻¹) K uptake by T₅ followed by T₂ (+0.5 meqL⁻¹). V₃ achieved highest K uptake of +0.5 meqL⁻¹ by T₆ followed by T₂ and T₃ (+0.3 meqL⁻¹) K uptake. Humic Acid has protective effects against high saline stress by inhibiting Na⁺ uptake in barley (Marketa et al., 2016), and it reduces yield losses in maize under salt stress (Masciandaro et al., 2002).

The statistical analysis confirmed the tolerance and sensitivity levels of three olive varieties. V₁ is the most tolerant variety in terms of Na uptake as compared to the others. Whereas V₂ is the most susceptible variety of olive against salinity stress. As K uptake is concerned, V₁ is the variety with maximum uptake and V₃ with minimum. The results depicted to be the most Salinity tolerant variety. Olive is basically considered as moderately saline tolerant but the plant response to salinity depends on genotypes (Weissbein et al., 2008). Salinity stress ability of olive includes its anatomical, physiological and morphological alteration of leaf level (Aparicio et al., 2014). Whereas NaCl tolerance is related to salt prevention at root level, which inhibits the accumulation of Na⁺ in leaves as well as the ability of olive plant to sustain/retain crucial potassium (K⁺)/sodium (Na⁺) ratio (Chartzoulakis et al., 2002).

CONCLUSION

This study concluded that the tolerance and sensitivity levels against salinity among three olive varieties.

Nocellera olive variety is the most tolerant variety in terms of Na uptake as compared to the others. Whereas Frontoio olive cultivar is the most susceptible variety of olive against salinity stresses. As for as, K uptake is concerned, Nocellera is the variety with maximum uptake and Carloea olive variety with minimum. The results depicted that Nocellera olive variety proved to be the most salinity tolerant variety.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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