Effects of NaCl salinity on the performance of some citrus cultivars at early growth seedling stage

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Abstract

In current research, salt tolerance of five citrus cultivars namely: Pearl tangelo (*Citrus reticulata*× *Citrus paradisi*), Local orange (*Citrus sinensis*), Local sweet lime (*Citrus limetta*), Local sour lime (*Citrus aurantifolia*) and Meyer lemon (*Citrus limon*) during germination, emergence, and early seedling stage was investigated. Increasing salt concentration delayed the early emergence of seedling and increased the time to 50% emergence. Among all of the cultivars, Local orange and Pearl tangelo were the latest and the earliest, respectively. The results showed that salinity had a significant effect on emergence spread and final percent emergence. In the meantime, Meyer lemon had the highest final percent emergence. Salinity also altered the mineral status of citrus cultivar seedlings. With increasing salinity levels, Na and Cl concentrations were increased in both leaves and roots of all cultivars. The lowest Cl and Na concentrations were observed in leaves of Pearl tangelo (1.95 and 0.35 at 60 mM NaCl, respectively) and this cultivar could accumulate these ions in its root.

Keywords: Citrus, Seed emergence, Salt tolerance, Seedling.

Introduction

Citrus species have been classified as salt-sensitive trees (Alireza et al., 2011). Citrus species differ in their ability to exclude Cl and/or Na from the scion. Several authors have compared the relative abilities of rootstocks to limit movement of salts to the scions (Banuls and Primo-Millo, 1995; Chen, 1992; Levy et al., 1999). Cleopatra mandarin and Rangpur lime rootstocks are relatively effective in restricting Cl^- transport to different scions, while Carrizo citrange was found to be less restrictive. The mechanism on the restriction of ion transport by plants is still unknown but it may depend on the vigor of the scion and on water requirements (Gamze etal., 2004). Germination and seedling growth are reduced in saline conditions with varying responses among genotypes (Ghoulam and Fares, 2001) causing unsynchronized seedling emergence (Garcia–Sanchez, 2006) and later affecting the uniformity of plant density with unfavorable effect on yield (Gamze et al., 2004), which is mainly associated with high external osmotic potential and/or toxic effects of Na and Cl ions (Shafieizargar et al., 2013). This study was initiated to evaluate the effect of salinity on seedling emergence and early stages of seedling development of various citrus cultivars.

Materials and methods

The experiment was conducted at Safiabad Agricultural Research and Education and Natural Resources Center under natural photoperiod conditions during 2015-16, in a completely randomized block design (RCBD) with four replications. The study involved five

commercial cultivars, Pearl tangelo (*Citrus reticulata*× *Citrus paradisi*), Local orange (*Citrus sinensis*), Local sweet lime (*Citrus limetta*), Local sour lime (*Citrus aurantifolia*) and Meyer lemon (*Citrus limon*). Salt treatments were 0, 20, 40 and 60 mM of NaCl a complete nutrition solution. Emerged seedlings were counted daily for 2 months after the appearance of the first seedlings. A number of days to the emergence of the first seedling, number of days between the emergence of the first and last seedling (emergence spread), and final percent emergence were calculated from the daily counts. At the end of study, the roots samples and expanded leaves were harvested and washed with deionized water and dried at 70°C for 72 h. The Na and Cl contents were measured using the method described by Awang et al. (2009).

Result and Discussion

The emergence of the first seedling varied among citrus cultivars regardless of NaCl treatment (Fig 1). Local sour lime seedlings were the first emergence. At 60 mM NaCl, the emergence of Pearl tangelo and Local sweet lime were the slowest, while Local orange and Meyer lemon were intermediate in terms of the emergence of the first seedling. Delay in seed germination in relations to salinity had been reported for other tree species such as on pistachio (Karimi et al., 2009).

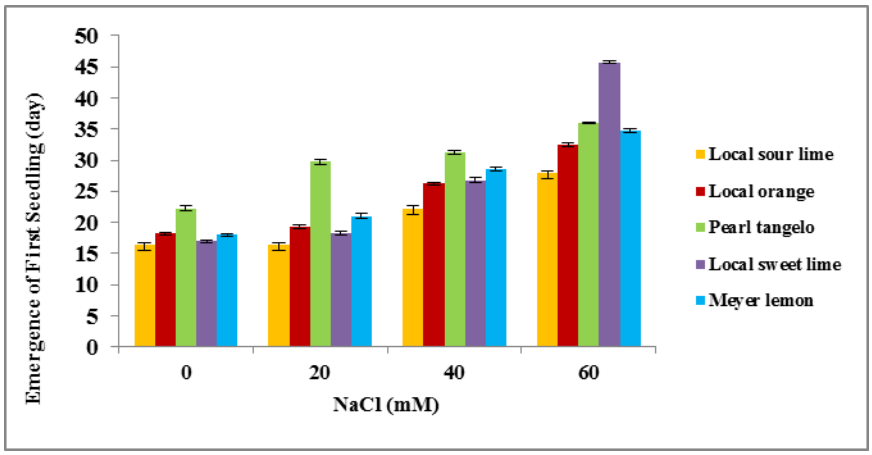

Fig 1: The effects of salinity on emergence of the first seedling of citrus cultivar seedlings. Different bars indicate significant differences at P≤5 % level according to DMRT.

In the non-salinized plant, the time taken between the emergence of the first and last seedling (emergence spread) differed among citrus cultivars with the least occurring in the Local sour lime and Pearl tangelo and the longest in the Meyer lemon (Fig 2). Zekri (1993) observed that citrus seeds absorbed an insufficient amount of water and accumulated a large amount of Cl when the osmotic pressure of the substrate was increased by salinity and as a result, the seeds emerged slowly and at higher Cl concentrations the seeds failed to germinate (Zekri, 2001).Water and it's quality is the most important factor for initiation of germination processes and early survival of seedlings after germination (Yassin, 2005).

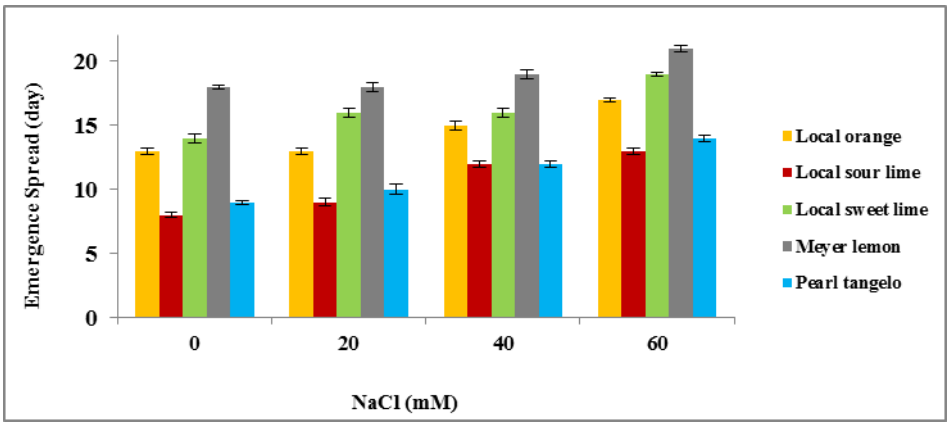

Fig 2: The effects of salinity on emergence spread of citrus cultivar seedlings. Different bars indicate significant differences at P≤5 % level according to DMRT.

Emergence spread of salinized plants increased in most citrus cultivars as compared to those in non-salinized treatment. There was no clear correlation between the emergence of the first seedling and emergence spread. At the highest salinity, time to 50% emergence generally followed the same trend as the emergence of the first seedling with the shortest time occurring in Local orange and the longest was in Local sweet lime and Meyer lemon (Fig 3).

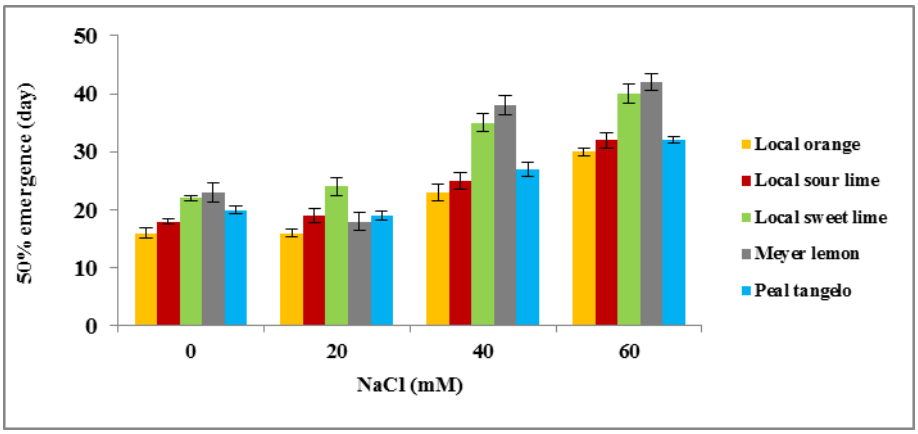

Fig 3: The effects of salinity on 50% emergence of citrus cultivar seedlings. Different bars indicate significant differences at P≤5 % level according to DMRT.

The final seedling emergence of non-salinized treatment was greater than 80% for all citrus cultivars (Fig 4). Final germination ranged from 94.73% for Local sour lime to 81.56% for Local orange. Salinity significantly reduced final germination for all cultivars. At 60 mM NaCl, final germination was reduced to 34.3% in Local sweet lime, to 76.43% in Meyer lemon relative to the non-salinized condition.

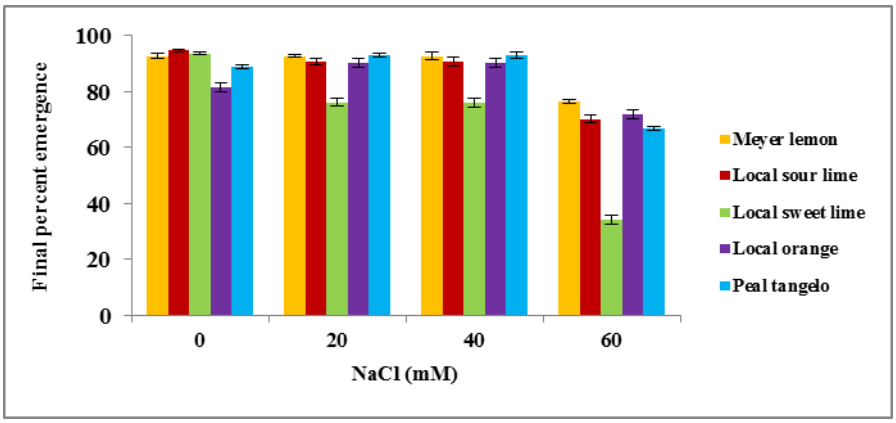

Fig 4: The effects of salinity on final percent emergence of citrus cultivar seedlings. Different bars indicate significant differences at P≤5 % level according to DMRT.

Na and Cl concentrations

Increasing NaCl in the root zone elevated Na and Cl concentrations in both shoots and roots of all citrus cultivars. Overall, accumulation of Na and Cl in roots was lower than the shoots. The concentrations of Na and Cl were higher in Local orange than other citrus cultivars. In contrast leaves of Pearl tangelo contained the lowest concentrations of Cl and Na (Table 1). An important mechanism to avoid the deleterious effects of salinity in citrus trees is the ability to limit uptake and/or transport of sodium and chloride from the root zone to aerial plant parts (Yassin, 2005).

Table 1: Effects of salinity Na(%) and Cl(%)of leaves and root tissue of citrus cultivars

NaCl (mM)	Local orange		Local sour lime		Local sweet lime		Meyer lemon		Pearl tangelo	
Leaf	Na(%)	Cl(%)	Na(%)	Cl(%)	Na(%)	Cl(%)	Na(%)	Cl(%)	Na(%)	Cl(%)
0	0.19	0.56	0.19	0.46	0.21	0.52	0.23	0.55	0.2	0.44
20	0.23	1.22	0.28	1.05	0.48	1.12	0.28	1.28	0.22	0.7
40	0.52	1.49	0.38	1.46	0.57	1.64	0.48	1.72	0.29	1.32
60	0.79	2.94	0.43	2.21	0.72	2.6	0.62	2.37	0.35	1.95
Root	Na(%)	Cl(%)	Na(%)	Cl(%)	Na(%)	Cl(%)	Na(%)	Cl(%)	Na(%)	Cl(%)
0	0.37	1.15	0.41	1.46	0.38	1.10	0.43	0.99	0.41	1.61
20	0.46	1.61	0.46	1.80	0.49	1.59	0.53	1.60	0.49	1.99
40	0.55	1.12	0.52	2.32	0.59	1.81	0.59	1.99	0.9	2.31
60	0.72	2.13	0.62	2.64	0.76	1.99	0.79	2.29	0.67	2.43

Conclusion

In conclusion, the results of this experiment showed that all growth parameters of citrus seedlings were significantly affected and reduced with increasing levels of salt (>20 mM NaCl) in the culture medium. The Pearl tangelo showed higher intrinsic capability to retain morphological traits based upon its ability to manage salt stress relatively better than other evaluated species.

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اثر شوری روی مراحل اولیه رشد تعدادی از ارقام مرکبات

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چکیده

تحمل شوری پنج رقم مرکبات به نام‌های پرل تانجلو (*Citrus reticulata× Citrus paradise*)، پرتقال محلی (*Citrus sinensis*)، لیموشیرین محلی (*Citrus limetta*)، لیموترش محلی (*Citrus aurantifolia*) و لمون مایر (*Citrus limon*) در مراحل جوانه زدن بذر و مراحل اولیه رشد نهال مورد پژوهش قرار گرفت. افزایش غلظت نمک ظهور اولیه نهال و زمان مورد نیاز ۵۰ درصد آن‌ها را به تأخیر انداخت. درمیان تمام ارقام، پرتقال محلی و پرل تانجلو کندترین و زودترین ظهور را نشان دادند. نتایج نشان داد که شوری اثرمعنی‌داری روی پراکنش ظهور و ظهور نهایی نهال‌ها دارد. لمون مایر از بیشترین درصد ظهور برخوردار بود. همچنین شوری غلظت املاح را تغییر داد. با افزایش سطوح شوری میزان غلظت سدیم و کلر در برگ و ریشه‌های تمام ارقام افزایش یافت. کمترین غلظت سدیم و کلر در برگ‌های پرل تانجلو مشاهده شد که مبین انباشته شدن این یون‌ها در ریشه این رقم است.

واژه‌های کلیدی: مرکبات، جوانه زدن، تحمل شوری، نهال بذری.