Journal of the Saudi Society of Agricultural Sciences (2015) xxx, xxx–xxx

King Saud University

Journal of the Saudi Society of Agricultural Sciences

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Influence of salicylic acid on seed germination of *Vicia faba* L. under salt stress

Fatima Anaya *, **Rachid Fghire, Said Wahbi, Kenza Loutfi**

Laboratoire de Biotechnologie et Physiologie Végétales, Faculté des Sciences Semlalia, BP2390 Marrakech, Morocco

Received 7 August 2015; revised 12 October 2015; accepted 13 October 2015

KEYWORDS

Salt stress;
Salicylic acid;
Germination percentage;
Germinated seeds fresh and dry weight;
Vicia faba L.

Abstract Seed germination is the critical stage for species survival. Salinity affects germination and seedling growth and yield of several crop species, such as broad bean. That is why this study was carried to evaluate the effects of NaCl on seed germination and influence of salicylic acid on seed in order to improving salt tolerant on broad bean. *Vicia faba* L. is an important pulse crop in the Mediterranean region. In many cases broad bean is grown on saline soils where growth and yield are limited by salinity. The results showed that Irrigation with saline water significantly reduced all seed germination parameters in comparison with the respective control. Alleviation of growth arrest was observed with exogenous applications of salicylic acid (SA) under salt stress conditions. Overall, the positive effect of SA towards resistance to the salinity of *V. faba* L. will provide some practical basis for *V. faba* L cultivation.

1. Introduction

There has been a renewed interest in broad bean (*Vicia faba* L.) throughout the world, which may not be unconnected with its high protein content, rising costs of protein-rich food and feed, national desires for greater self sufficiency in food production and perhaps most importantly, the rapidly increasing human populations (Gueguen and Cerletti, 1994). In Morocco the most cultivated legume is the broad bean (*V. faba* L.), and represents almost half of the sole and the total production of pulses (ONICL, 2013). Nevertheless, climate change has become major constraints to agricultural production in Morocco. Salinity affects large areas of Moroccan soils especially in semi-arid and irrigated areas (Drevon and Sifi, 2003). However, the adaptation to the salinity during seed germination and seedling growth is very important for plant growth, whereas Seed germination is a mechanism, in which morphological and physiological alterations result in activation of the embryo. Before germination, seed absorbs water, resulting in the expansion and elongation of seed embryo. When the radicle has grown out of the covering seed layers, the process of seed germination is completed (Hermann et al., 2007). The period of germination and establishment is the most critical stage in the life cycle, which is a crucial factor in determining the species distribution and community components, and seeds of most plant species have the highest resistance to extreme environmental stresses (Gutterman, 1993). Many researchers have evaluated the processes involved

* Corresponding author.
E-mail address: anaya.fatima@gmail.com (F. Anaya).

Peer review under responsibility of King Saud University.

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http://dx.doi.org/10.1016/j.jssas.2015.10.002
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in seed germination, and how they are affected by abiotic stress. Saline habitat is one kind of the most stressful habitats which is known to affect many physiological and ecological characteristics, such as plant growth, development, reproduction and geographical distribution (Qu and Huang, 2005). The available literature revealed the effects of salinity on the seed germination of various crops such as *Oryza sativa* (Xu et al., 2011), *Triticum aestivum* (Akbarimoghaddam et al., 2011), *Vigna* spp. (Jabeen et al., 2003), and *Helianthus annuus* (Mutlu and Buzcuk, 2007). It is well established that salt stress has negative correlation with seed germination (Anaya et al., 2013). Higher level of salt stress inhibits the germination of seeds while lower level of salinity induces a state of dormancy (Khan and Weber, 2008). Increasing salinity leads to a reduction and/or delay in germination of plants and death of seeds before germination (Song et al., 2005).

Many researchers have evaluated the processes involved in seed germination, and how they are affected by plant hormones in a range of plant families (Hermann et al., 2007). However, salicylic acid (SA) as one of the potential endogenous plant hormones plays an important role in plant growth and development, and this actual role in abiotic stresses remains unresolved. Several methods of application (soaking the seeds prior to sowing, adding to the hydroponic solution, irrigating, or spraying with SA solution) have been shown to protect various plant species against abiotic stress by inducing a wide range of processes involved in stress tolerance mechanisms (Horváth et al., 2007). But to our knowledge there is no study on the effect of SA on the broad bean germination. This study was carried out to obtain information on the effect of salinity (NaCl), salicylic acid (SA) and combined treatment NaCl/SA on the germination. The objective of this research was to study the effect of salt stress and salicylic acid on some characteristics of *V. faba* by measuring seed germination at various concentrations of NaCl (0, 90, 120, 150 and 200 mM) and four levels of salicylic acid (0, 0.25, 0.5 and 1 mM) in order to improving salt tolerant on broad bean.

2. Materials and methods

2.1. Plant material

The study was conducted in the laboratory conditions, to determine the effects of salinity and salicylic acid on germination of *V. faba* L. Reina Mora cv.

2.2. Seed germination experimental design

Broad bean (*V. faba* L.) seeds were selected for uniformity by choosing those homogeneous and identical in size and colour, and free from wrinkles. The seeds were disinfected by sodium hypochlorite (1%) for 10 min, and then rinsed with distilled water to remove all traces of chlorine. However, only healthy seeds are selected for germination tests. Afterwards, seeds were soaked in distilled water for 8 h. The hydrated seeds were placed on Petri dishes. The seeds (4 replicates of 10 seeds) were germinated in darkness at 22 °C for 7 days.

Different concentrations of NaCl and SA were prepared. For each concentration of NaCl (0, 90, 120, 150 and 200 mM), germination tests were carried out at different

Table 1 Experimental design of different treatment combination.

NaCl (mM)	0					90					120					150					200				
SA (mM)	0	0.25	0.5	1		0	0.25	0.5	1		0	0.25	0.5	1		0	0.25	0.5	1		0	0.25	0.5	1	
Treatment NaCl/SA	CONTROL	0/0.25	0/0.5	0/1		90/0	90/0.25	90/0.5	90/1		120/0	120/0.25	120/0.5	120/1		150/0	150/0.25	150/0.5	150/1		200/0	200/0.25	200/0.5	200/1	