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Interactive Effects of Salinity and Growth Substances on Germination of Pea (*Pisum sativum*) Seeds

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Summary

Setia R. Ch. & Narang S. 1985. Interactive effects of salinity and growth substances on germination of pea (*Pisum sativum*) seeds. — Phyton (Austria) 25 (1): 87—91. — English with German Summary.

The effects of different levels of sodium bicarbonate (50, 100 and 150 mM) and kinetin, IAA and GA_3 (1 and 10 µg/ml) on pea seed germination are described. Being sensitive to salinity, in 150 mM $NaHCO_3$ the germination percentage of pea seeds decreased to 35%. Growth substances supplemented to nutrient solution increased germination percentage. GA was more effective than kinetin and IAA, and enhanced germination percentage nearly comparable to the control. The possible roles of tested growth substances in alleviating salinity stress are discussed.

Zusammenfassung

Setia R. Ch. & Narang S. 1985. Wechselwirkung von Salinität und Wuchsstoffen auf die Keimung der Erbse (*Pisum sativum*). — Phyton (Austria) 25 (1): 87—91. — Englisch mit deutscher Zusammenfassung.

Die Wirkung verschiedener Konzentrationen von Natriumbicarbonat (50, 100 und 150 mM) und Kinetin, IAA und GA_3 (1 und 10 µg/l) auf die Keimung der Erbsensamen wird untersucht. 150 mM $NaHCO_3$ senkt die Keimung der salzempfindlichen Samen auf 35%. Der Nährlösung zugesetzte Wuchsstoffe erhöhen die Keimprozente, wobei GA_3 wirksamer als Kinetin und IAA war und die Keimprozent bis in die Nähe der Kontrollen anhob. Die mögliche Rolle der streßmindernden Wirkung der Wuchsstoffe wird diskutiert.

(Editor transl.)

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1. Introduction

Poor seed germination and seedling growth resulting from excessive salts are caused by an imbalance in relative concentrations of various ion species with respect to one another and by low water potential in saline soils. Salinity reduces osmotical uptake of water by plant tissues (Reynolds 1975). Several workers have reported that increasing salinity levels reduced seed germination of *Glycine max* and *Oryza sativa* (Abel & Mackenzie 1964, Kaddah 1963, Narále & al. 1969). Growth substances are reported to alleviate salinity stress and improve seed germination and plant growth under saline conditions (Darra & al. 1973, Odegbaro & Smith, 1969, Singh & Darra 1971). Most studies on seed germination in response to salinity have been done with NaCl and very little information exists in relation to bicarbonate ions. The present study reports on some effects of different salinity levels of $NaHCO_3$ and different concentrations of some growth substances on pea seed germination.

2. Materials and Methods

Seeds of pea (*Pisum sativum* L. var. boneville), obtained from Department of Vegetable Crops, Punjab Agricultural University, Ludhiana were pretreated with 10^{-3} M mercuric chloride solution and thoroughly washed with distilled water. The seeds were germinated in Petri dishes in different culture solutions as suggested by Boczuk (1981). The culture solutions used were half strength Hoagland salinized with $NaHCO_3$ at concentrations of 50, 100 and 150 mM. After soaking for 6 hrs in culture solutions, the seeds were germinated on Whatman No. 1 filter paper, moistened by adding 10 ml of appropriate culture solutions to each Petri dish. To study the efficacy of growth substances in recovering the bicarbonate salinity affect on germination, kinetin, IAA (indole-3-acetic acid) and GA (gibberellic acid) were tried at 1 and 10 µg/ml concentrations. These growth substances were added to each salinized culture solutions. The experiments were carried out in dark at 20 ± 2° C. Germination, taken as visible radicle protrusion from the seed coat, was recorded on day 5 for four replicates of 25 seeds each. Analysis of variance was used to test the significant differences between various concentrations of different germination solutions.

3. Results

The data from germination studies indicate that pea seeds are sensitive to bicarbonate salinity. In the controls, the germination percentage was about 90. 50 mM salinity caused slight decrease in germination percentage (Table 1). At 100 and 150mM levels the germination markedly decreased.

The addition of kinetin (1 or 10 µg/ml) in cultures caused very little increase in germination percentage (about 5%) in the controls as well as in seeds stressed with 50 mM $NaHCO_3$. But as the salt concentration was enhanced, kinetin was more effective in promoting germination. With 10 µg/ml kinetin the germination increased over the controls but the increments were not as appreciable as those caused by 1 µg/ml kinetin (Table 1).

Table 1

Effect of salinity and growth regulators on germination of pea seeds.

Each figure represents the germination percentage ± standard error of 4 replicates, each sample containing 25 seeds. The salt and growth regulators were added to half strength of Hoagland solution. All differences between the various concentrations are significant at 1% level (F-test)

Growth regulator concentrations (µg/ml)		Hoagland solution	$NaHCO_3$ concentration (mM)		
			50	100	150
O (Control)		90 ± 2.0	75 ± 3.3	58 ± 2.0	35 ± 3.3
Kinetin	1	95 ± 3.3	85 ± 1.8	70 ± 1.4	60 ± 2.8
	10	95 ± 3.3	80 ± 2.8	65 ± 1.8	45 ± 3.3
IAA	1	90 ± 2.0	80 ± 2.8	53 ± 1.8	60 ± 2.8
	10	92 ± 4.0	86 ± 3.5	80 ± 2.8	66 ± 3.3
GA	1	95 ± 1.8	86 ± 1.4	73 ± 1.8	66 ± 3.3
	10	96 ± 2.8	93 ± 1.8	90 ± 2.0	80 ± 2.8

IAA (10 µg/ml) promoted germination. GA (1 µg/ml) was more effective in alleviating salt stress in comparison with kinetin (1 µg/ml) and IAA (10 µg/ml) and increased germination markedly (Table 1). However, GA (10 µg/ml) caused maximum increments in germination percentage when added to saline cultures. It enhanced percentages of germination to 93, 90 and 80 with respect to those shown by stressed seeds.

The analysis of variance of germination data from treated seeds indicated that salinity alone and salinity-growth regulator interactions were all statistically significant.

4. Discussion

Present results indicate that bicarbonate adversely affects germination of pea seeds. Growth of many crop plants has been shown to be inhibited by this cation (Brown & Wadleigh 1955, Harley & Lindner 1945). The inhibition of pea seed germination due to salinity can be attributed to several factors: the osmotic inhibition i. e. reduced water

uptake which is crucial for seed germination process (KAHN 1960); shift in the balance of growth substances (HSIAO 1973) which otherwise were needed for successful seed germination; reduction or inhibition of protein synthesis (KATZ & al. 1978, MILLER & EVANS 1956); and inactivation of various enzymes of general metabolism which play a significant role during seed germination. In the present investigation, salt stressed inhibition could be overcome by supplementing the nutrient medium with kinetin, GA and IAA as indicated by increase in germination percentage. The recovery of salt induced inhibition by growth substances could be due to their ability to either reduce moisture requirement of the tissue or enhancement of water uptake under salt stressed conditions by affecting membrane permeability (BOCZUK 1981). On the other hand, the growth substances may be acting to enhance the synthesis of enzyme proteins and thereby stimulate germination process. Kinetin helps to overcome decreased protein synthesis induced by osmotic and salt stress of tobacco plants (BEN-ZIONI & al. 1967). Similar reports are available for GA and IAA (LEVITT 1980).

From the present investigation, it appears that growth substances used here, especially GA, is helpful in increasing germination of pea seeds under bicarbonate saline conditions provided increased seedling growth due to GA is reproduced under field conditions.

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