Nod Factor (Lipo-chitooligosaccharide) Induced Salt Tolerance of Maize

E Somasundaram* and UN Dhandayuthapani
Department of Sustainable Organic Agriculture, Tamil Nadu Agricultural University, Coimbatore-3, Tamil Nadu, India

Abstract
In agriculture, salinity is an extensive problem that reduces the productivity of crops. Research in the use of signaling molecules to enhance crop performance is still in the nascent stage in India. Lipo-chitooligosaccharide(LCO) is a unique signaling molecule that, when present at the time of planting, enhances a plant's nutritional capabilities and drives the natural growth processes such as root and shoot development, immediately and irrespective of the variety, soil, and other environmental conditions. Germination and early seedling growth are important phases for maize as it is sensitive to salt stress. In the present study, the effect of priming with LCO signaling compound on growth and establishment of maize seedling grown under induced salinity levels in a lab experiment in FCRD was studied. Primed and non primed seeds of maize were sown in petri dishes and watered with saline solutions of six concentrations (0, 2, 4, 6 8 and 10 dsm^{-1}). Results of analysis of variance showed that salinity levels and priming affected seed establishment parameters of maize significantly. LCO primed seeds increased the tolerance of maize towards salinity and reduced the phytotoxicity, whereas the phytotoxicity of the non primed maize seedling increased and salt tolerance decreased with increasing levels of salinity.

Keywords: Lipo-chitooligosaccharide, Phytotoxicity, Salinity and signaling molecule, Salt tolerance
****Corresponding author:*** eagansomu@rediffmail.com

Introduction

Salinity is one of the most significant environmental issues around the world, which limits the crop seed germination and establishment. Root and shoot length were found to be decreased significantly by saline stress as compared to control. Length of root and shoot were reported to decrease perhaps due to accumulation of ions near the root surface in maize (Khatoon *et al.*, 2010).

To alleviate the problem of seed germination under salt stress condition, priming techniques are found to produce improvement in seed germination and synchronize establishment. The priming is done with materials of inorganic, biological and organic origin, which has a unique compound to alleviate stress. One among such compound is nod factor (Lipo-chitooligosaccharide). Legume-rhizobia symbiosis produces an organic compound called LipoChito-Oligosaccarides (nod factor) which enhances crop growth by actings as a growth promoting substance in non-leguminous plants even. Nandhini *et al.* (2015) have shown that LCOs seemed to be more effective on maize germination and they significantly increased seed germination percentage (up to 45%).

Maize is one of the most important cereals after rice and wheat and is reported as a salt sensitive species among the cereals. Maize is a dual crop grown for both grain and animal feed, widely cultivated in all the region of the world.

At present, research is in progress to ameliorate the effect of salinity on seed germination of some crops by employing biologically produced compounds like Nod factors. But an understanding of the physiology of seed germination under saline condition is important. Hence, this laboratory study attempted to investigate the effects of priming maize in LCO on germination and establishment purely under saline conditions.

Materials and Methods

The experiment was conducted in Tamil Nadu Agricultural University, under laboratory conditions to study the effect of LCO priming on germination and seedling establishment of maize under salt stress. Seeds of maize hybrid CoHM (6) were primed by soaking in LCO @ 4ml/kg of seed for 12h at room temperature.

The experiment was laid out in factorial CRD with 2 factors such as six salinity levels (0, 2,4,6,8 and 10 dSm^{-1}) and 2 levels of priming (LCO primed and unprimed seeds) and replicated four times. The experiment was carried out in 48 petri dishes that is 24 for LCO primed seeds and 24 for unprimed (Control) seeds. The salinity levels were obtained by dissolving 1.28, 2.56, 3.84, 5.12, 6.4 g of NaCl in a litre distilled water, respectively. Distilled water (0 dSm^{-1}) was used as a control. Seeds were

sown on 10 cm diameter petridishes, lined with whatman No1. Filter paper and were supplied with 10 ml of each treatment solution daily.

Everyday germination count was recorded after 48 hrs of sowing, and terminated when no further germination occurred. The experiment was conducted up to 14 days and seedling parameters, salt tolerance and phytotoxicity of roots and shoots were calculated. The data of germination percentage was transformed using by arcsine values prior to statistical analysis. For comparing the differences among treatment means, LSD test was applied at 5% probability level.

Salt tolerance index (%) = (TDW at Sx / TDW at So) x 100

$$\text{Phytotoxicity of Shoot (\%)} = \frac{\text{Shoot length of control} - \text{Shoot length of treatment}}{\text{Shoot length of control}} \times 100$$

$$\text{Phytotoxicity of Root (\%)} = \frac{\text{Shoot length of control} - \text{Shoot length of treatment}}{\text{Root length of control}} \times 100$$

Results and Discussion

Results of the study showed that both salinity and LCO influenced seed germinable characters both independently and interactively. The responses of seed germination percentage, vigour index, salt tolerance index and phytotoxicity of roots and shoots of maize to LCO priming and NaCl concentration were significant. Outcome of the experiment on the affect of LCO on maize seed germination is presented in Table 1.

Germination percentage

From the results of this study, it is clear that the germination and seedling vigour of both primed and non primed seed reduced with increase in NaCl concentration. Salinity caused reduction in germination percentage up to 62 percent at higher NaCl level (10dSm^{-1}) in maize. The increase in germination over nonprimed seeds accounted for 13, 29, 32, 36, 39 and 45 per cent under 0, 2, 4, 6, 8 and 10 dSm^{-1}NaCl salt concentrations.

The increase in emergence percentage in seeds primed with nod factor under saline conditions might be due to increase in cell division activity by the LCO which leads to enhanced oxygen uptake, increased α-amylase activity and the efficiency of mobilizing nutrients from the cotyledons to the embryonic axis.

Salt Tolerance Index (STI)

The results revealed that with the increase in salinity level, there was a significantly decreasing trend in all the treatments, indicating that higher the stress lesser the tolerance.

In general STI will be more in lower level of salinity with priming. Though LCO treatment realized in GP the tolerance to salinity is increased in a gradual manner. At 10 dSm^{-1} the STI is around 8.10 in LCO treated which is 38 per cent higher than non primed seed under saline environment.

Phytotoxicity of root and shoot

The phytotoxicity of shoot and root increased as the concentration of salinity increased. The lowest shoot and root phytotoxicity of NaCl were observed at control treatment, and 2dSm^{-1} concentrations; however the highest phytotoxicity was recorded at 10dSm^{-1} concentrations. The highest phytotoxicity of shoot (67.57%) and root (81.93%) were observed at 10dSm^{-1}. Recently, Isak*et al.* (2013)

Table 1: Effect of lipo- chito oligosaccharides priming on germination percentage (%), salt tolerance index (STI) and phytotoxicity of roots and shoots of maize under different levels of salinity

Salinity (dS m^{-1})	Germination percentage (%)			Salt tolerance index (STI)			Phytotoxicity of roots (PhR)			Phytotoxicity of Shoots (PhSh)		
	P	NP	Mean	P	NP	Mean	P	NP	Mean	P	NP	Mean
0	96.0	83.1	89.6	100.0	100.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0
2	91.3	64.8	78.0	83.2	79.6	81.4	15.5	24.9	20.2	9.2	16.2	12.7
4	83.3	56.4	69.8	62.8	48.3	55.6	19.3	38.2	28.8	13.5	25.3	19.4
6	72.8	46.5	59.6	39.3	36.7	38.0	24.8	22.2	23.5	19.8	29.6	24.7
8	65.3	39.7	52.5	24.3	13.2	18.8	57.9	65.6	61.8	38.7	54.1	46.4
10	57.3	31.3	44.3	8.0	4.6	6.3	78.2	85.6	81.9	57.0	78.1	67.6
Mean	77.6	53.6		52.9	47.1		32.6	39.4		23.0	33.9	
	P	S	P x S	P	S	P x S	P	S	P x S	P	S	P x S
SEd	0.3	0.6	0.8	0.3	0.4	0.6	2.6	4.4	6.3	1.4	2.4	3.4
CD (P=0.05)	0.7	1.1	1.6	0.5	0.9	1.2	5.2	9.0	12.7	2.8	4.8	6.8

Note: P– Priming and non priming S- Salinity levelP x S – Interaction effect

reported that root and shoot phytotoxicity reduced at lower concentration, and increased at higher concentration on wheat. The increase phytotoxicity might be due to NaCl concentration resulted inhibitory or toxic effect of salinity, which is usually observed on elongation of radical. However, LCO primed seeds are found to reduce the phytotoxicity of roots and shoots by inducing the growth of radicle and coleoptile.

Conclusion

Based on the results of the study, it is concluded that priming the maize seeds with LCO enhances the germination and improves tolerance to saline stress conditions. However the mode of action of salt tolerance by LCO at initial stage (seed establishment) needs further investigation.

References

Isak RS, Rajjak PS, Ahmed RS and Abdulla AS 2013.Phytotoxic effects of Heavy metals (Cr, Cd, Mn and Zn) on Wheat (Triticum aestivum L.)Seed Germination and Seedlings growth in Black Cotton Soil of Nanded. India. Res. J. Chemical Sci. 3 (6):14-23.

Khatoon T, Hussain K, Majeed A, Nawaz K and Nisar MF 2010.Morphological Variations in Maize (*Zea mays* L.)Under Different Levels of Nacl at Germinating Stage. Warsaw Agricultural Science Journal. 8(10): 1294-1297.

Nandhini DU, Somasundaram E and Mohamed Amanullah M 2015.Influence of lipochito oligosaccharides on germination of maize under different levels of salinity. The Bioscan (Supplement on Agronomy). 10(1): 363-367.