



# Screening of Bamboo genotypes for salt tolerance using growth performance and osmolytes accumulation as indicators



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# Plan of Presentation

Introduction



Problem status



Causes & Effects of salinity



Need for Research and development



Aim & Objectives of the study



Why Bamboo?



Experimental set-up



Results & Discussion



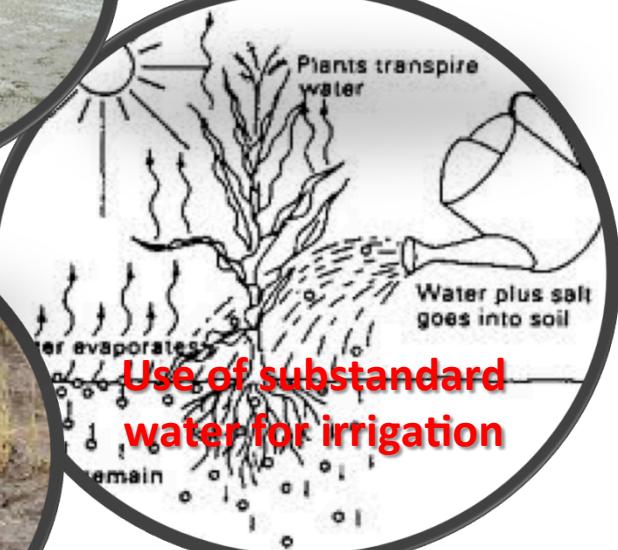
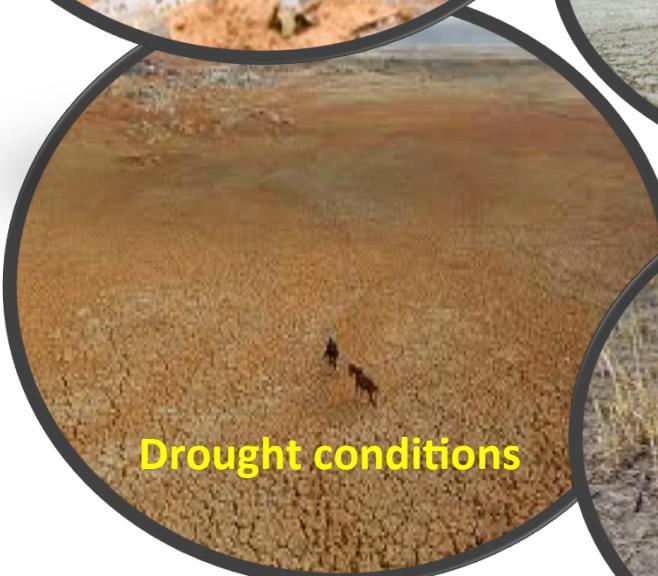
Summary & Conclusion



# INTRODUCTION

- Salinity is one of the major forms of abiotic stress affecting the plant growth and productivity
- A soil is classified as saline once its saturated paste EC will reach 4.00 deciSiemens/meter (dS/m), which is about 4 mmohs / cm ,having 2000- 5000 ppm of total dissolved salts
- Salinity leads to accumulation of inorganics such as  $\text{NaCl}$  ,  $\text{CaCl}_2$ ,  $\text{Na}_2\text{SO}_4$  and  $\text{MgSO}_4$  which dissolve in water and release free cations such as  $\text{Na}^+$ ,  $\text{Ca}^{2+}$ , and  $\text{Mg}^{2+}$  and anions like  $\text{Cl}^-$  and  $\text{SO}_4^{2-}$
- Thus alters physico- chemical properties of the soil and becomes stressor for plant growth

## CAUSES OF SALINITY



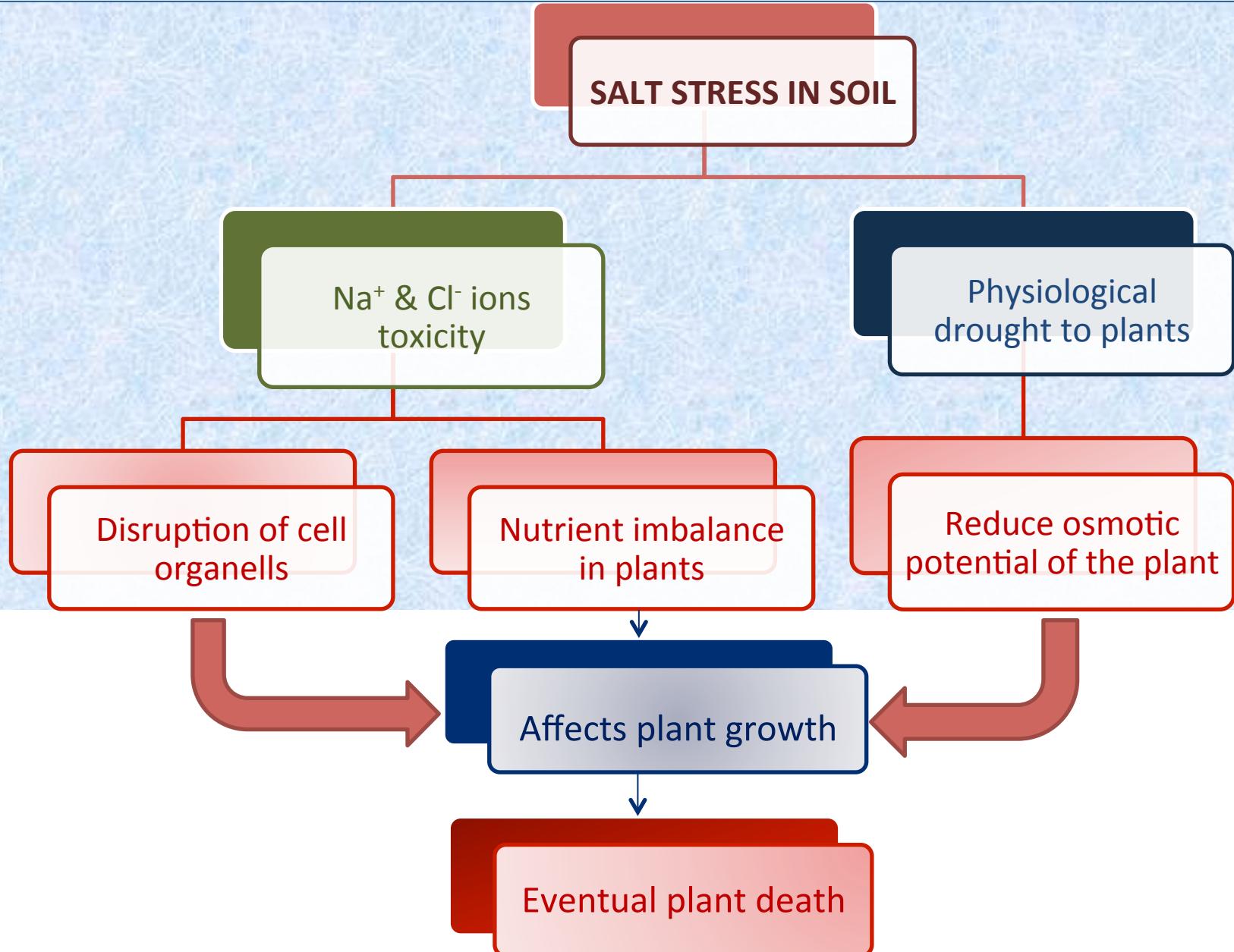
# PROBLEM STATUS

Regions	Total area	Saline soils	%	Sodic soils	Percent
Asia and the pacific and australia	3107.2	195.1	6.3	248.6	8.0
Europe	2010.8	6.7	0.3	72.7	3.6
Latin America	2038.6	60.5	3.0	50.9	2.5
Africa	1899.1	38.7	2.0	33.5	1.8
Near East	1801.9	91.5	5.1	14.1	0.8
North America	1923.7	4.6	0.2	14.5	0.8
Total	12781.3	397.1	3.1%	434.3	3.4%

Country	Total land area cropped Mha	Area irrigated		Area of irrigated land that is salt-affected	
		Mha	%	Mha	%
China	97	45	46	6.7	15
India	169	42	25	7.0	17
Soviet Union	233	21	9	3.7	18
United States	190	18	10	4.2	23
Pakistan	21	16	78	4.2	26
Iran	15	6	39	1.7	30
Thailand	20	4	20	0.4	10
Egypt	3	3	100	0.9	33
Australia	47	2	4	0.2	9
Argentina	36	2	5	0.6	34
South Africa	13	1	9	0.1	9
Subtotal	843	159	19	29.6	20
World	1,474	227	15	45.4	20

Source: FAO: Land and Plant nutrition management services

# EFFECTS OF SALT STRESS ON PLANTS



# Conventional Methods for management of saline soils And their deleterious affects

- Addition of gypsum along with compost and manure
- Leaches Fe & Mn that leads to nutrient deficiency
- Reduces water holding capacity of soils



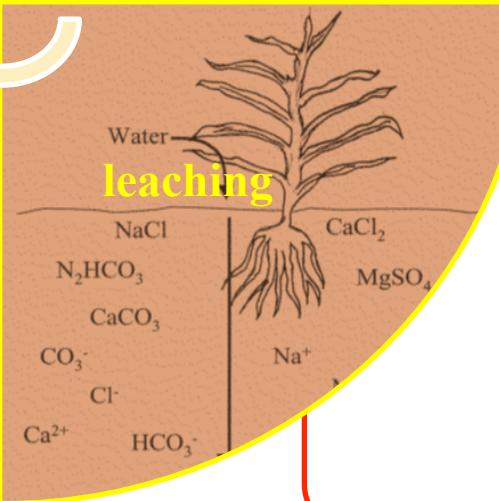
- It includes, the lining of canals, the drainage of borrow pits, and the management of on-site water
- Temporary solution



- Salt tolerant varieties to reclaim saline soils
- Reduced Productivity

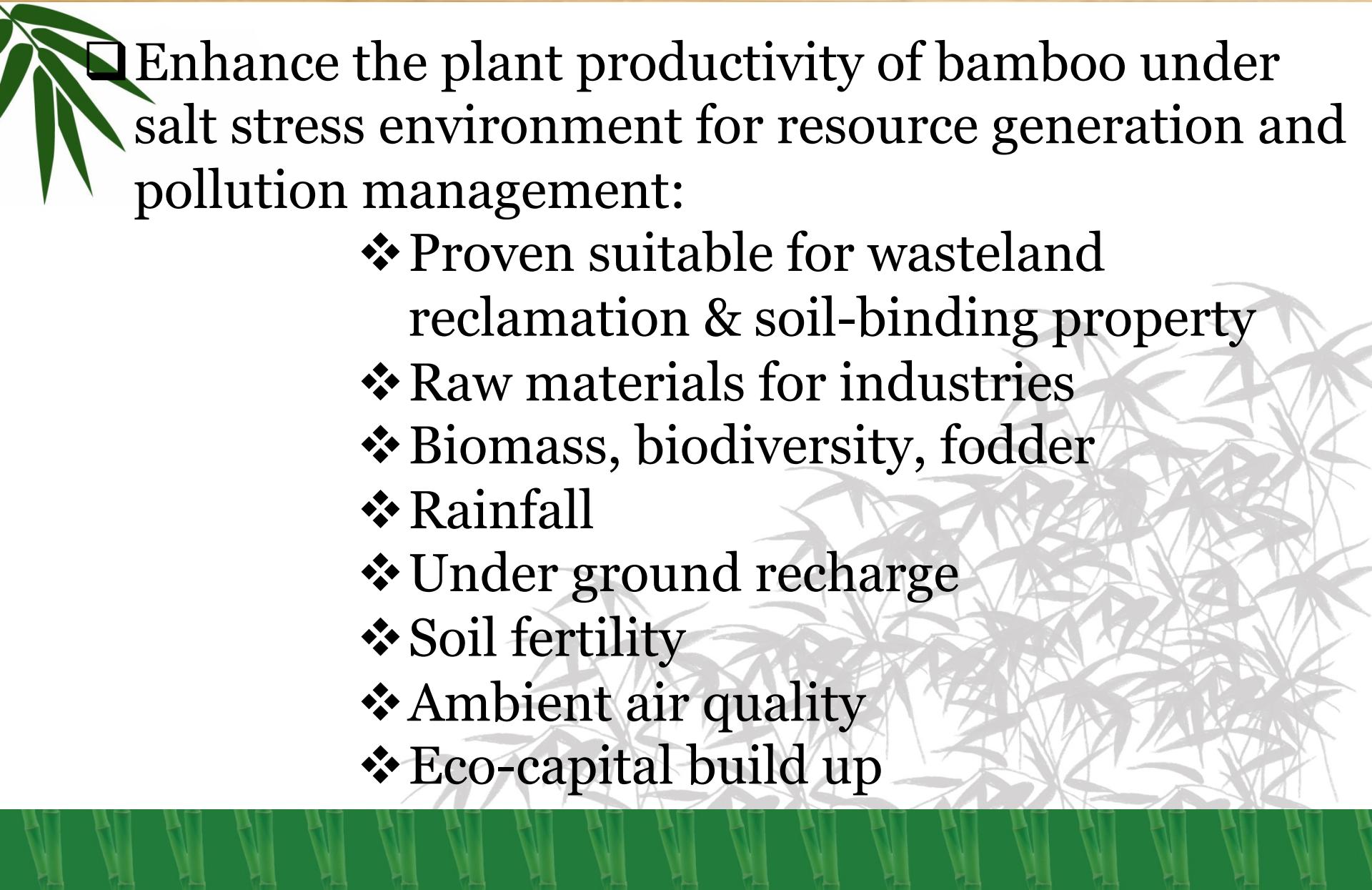


- There are two methods of leaching: continuous ponding and intermittent ponding.
- Water quality & quantity
- Repeated application



# Need for Research & Development

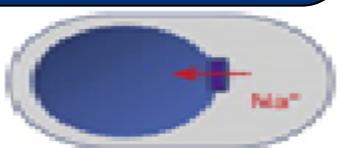
Bamboo: Potential species for reclamation of saline soils & reuse saline water



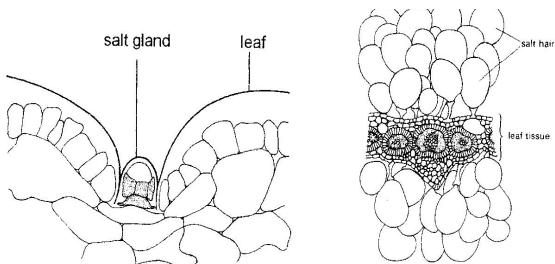
- ❑ Enhance the plant productivity of bamboo under salt stress environment for resource generation and pollution management:
  - ❖ Proven suitable for wasteland reclamation & soil-binding property
  - ❖ Raw materials for industries
  - ❖ Biomass, biodiversity, fodder
  - ❖ Rainfall
  - ❖ Under ground recharge
  - ❖ Soil fertility
  - ❖ Ambient air quality
  - ❖ Eco-capital build up

# Salt tolerance mechanisms

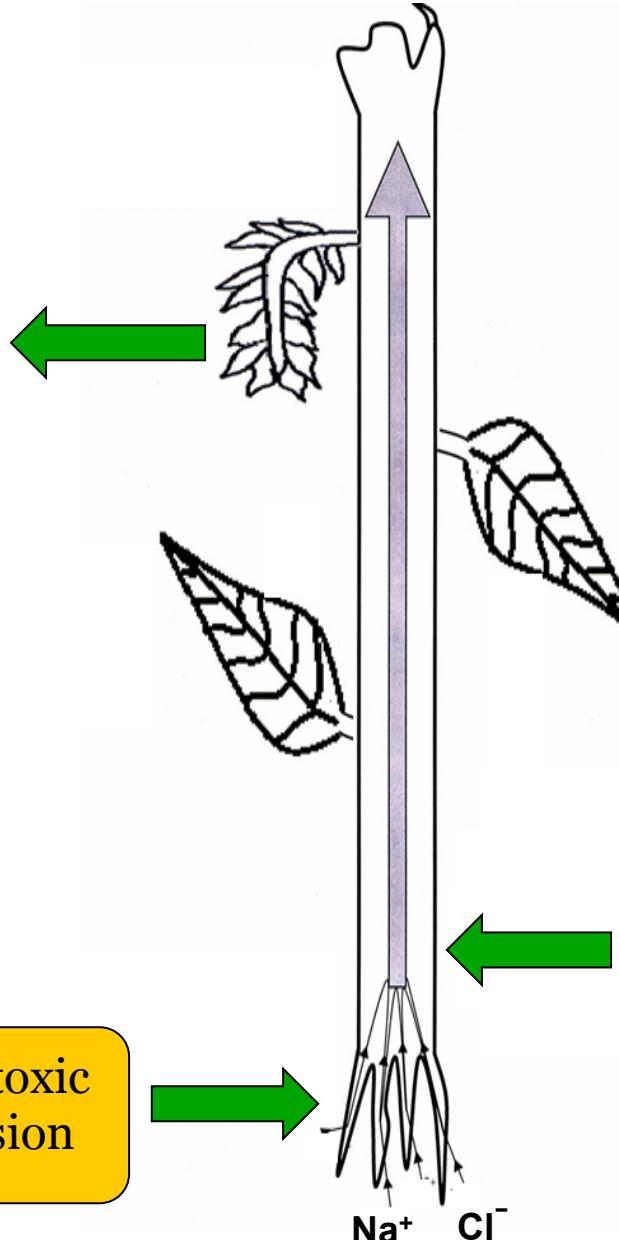
Sequestration of toxic ions to vacuole or cell wall-cell level compartmentation



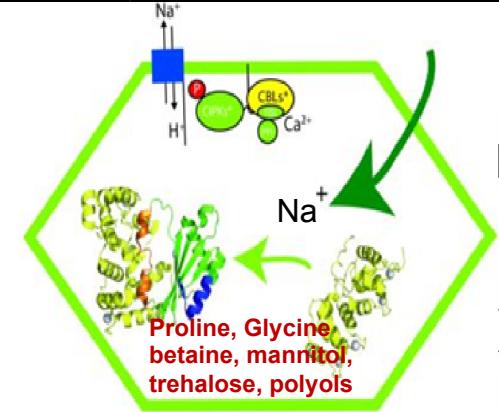
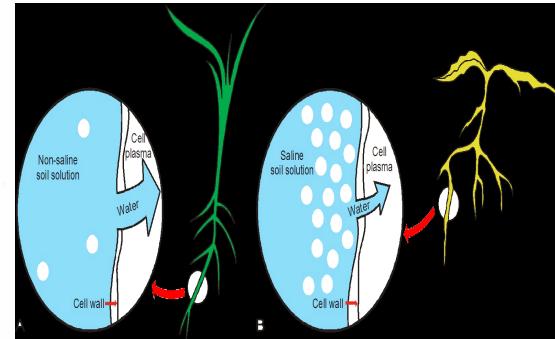
Excretion of salt through salt glands or bladders- in Most of the halophytes



Restricting the entry of toxic ions at root level- Exclusion



Role of osmolytes



Transporting the toxic ions to stem, leaf sheath or older leaves- Plant level compartmentation

# AIM & OBJECTIVES OF THE STUDY

## AIM:

To screen salt tolerant and sensitive species among the three species i.e. *Dendrocalamus strictus*, *Dendrocalamus longispathus* & *Bambusa bambos*

## OBJECTIVES:

- a) Assess salinity (NaCl) stress tolerance under different concentrations of NaCl in hydroponics
- b) Study morphological variations after completion of treatment duration
- c) Estimate osmolytes (proline & glycine betaine) synthesized due to stress treatment

# VARIOUS FIELD VISITS



**Government of India Initiative to  
promote bamboo plantations.**

# Species chosen to conduct Stress treatment Experiments

(S1) *D. strictus*



(S2) *D. longispathus*

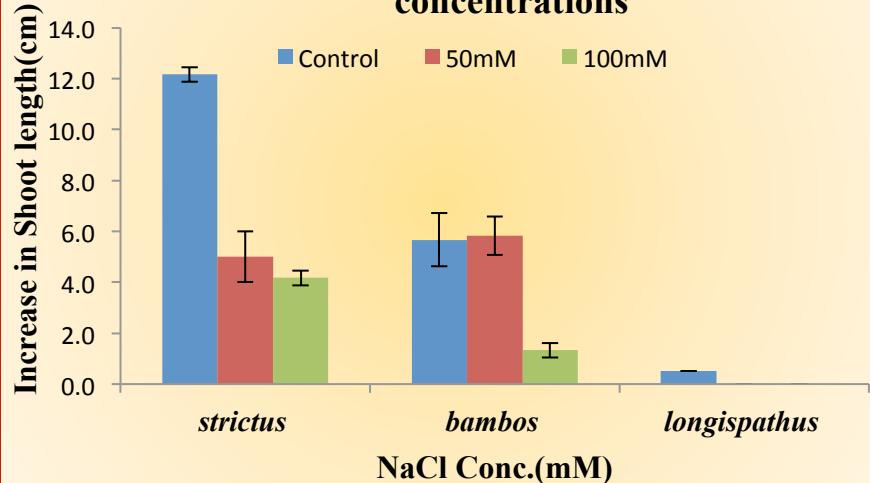


(S3) *B. bambos*



# Changes in Morphological parameters with increase in NaCl concentration

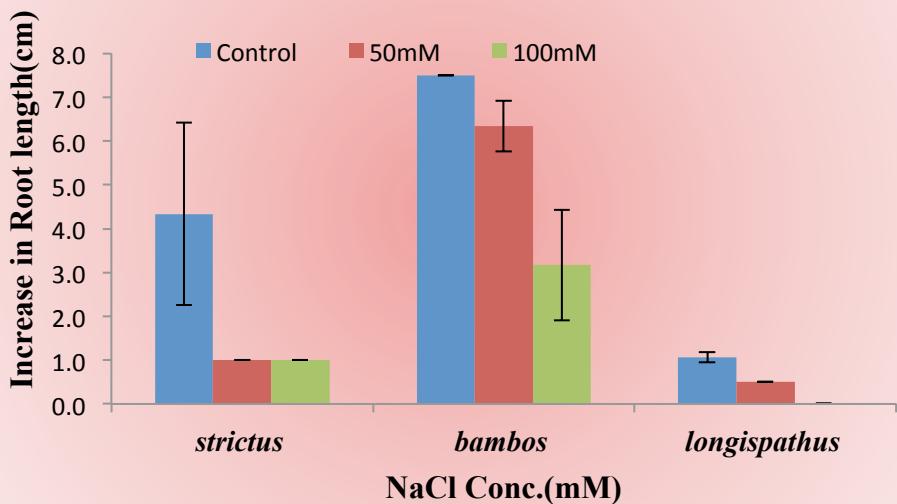
**Increase in Shoot length at different NaCl concentrations**



Source	df	SS	MS	F
PROB				
TOT	26	380.907407	14.650285	45.2066
Trt	8	375.074074	46.884259	144.6714
0.972 NS				
Err	18	5.833333	0.324074	1.0000
s	2	219.462963	109.731481	338.6000
0.000 **				
t	2	83.129630	41.564815	128.2571
0.000 **				
st	4	72.481481	18.120370	55.9143
0.001 **				
Err	18	5.833333	0.324074	1.0000

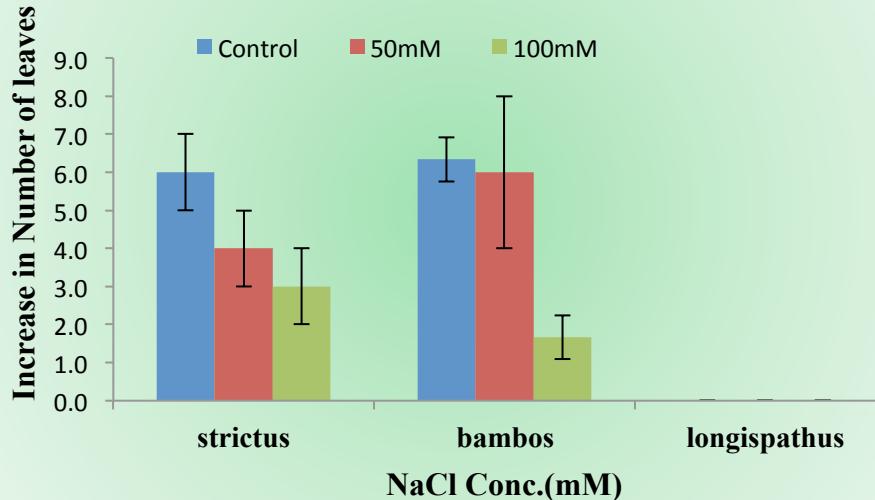
Source	df	SS	MS	F
PROB				
TOT	26	191.520000	7.366154	10.5847
Trt	8	178.993333	22.374167	32.1502
0.167 NS				
Err	18	12.526667	0.695926	1.0000
s	2	124.895556	62.447778	89.7334
0.000 **				
t	2	38.462222	19.231111	27.6338
0.005 **				
st	4	15.635556	3.908889	5.6168
0.062 NS				
Err	18	12.526667	0.695926	1.0000

**Increase in Root length at different NaCl concentrations**



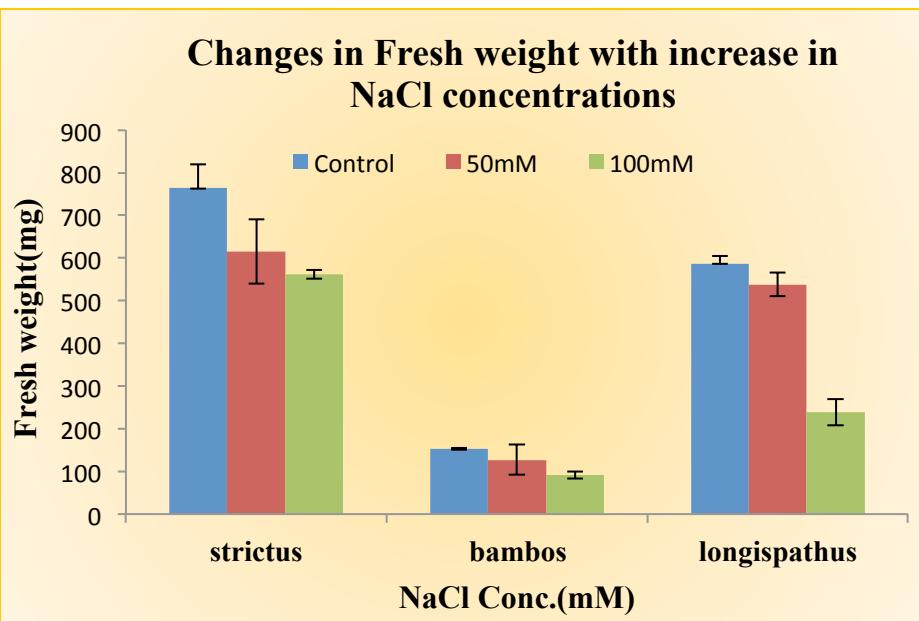
# Changes in Morphological parameters with increase in NaCl concentration

Increase in Number of leaves at different NaCl concentrations



Source	df	SS	MS	F
PROB				
TOT	26	192.000000	7.384615	8.6689
Trt	8	176.666667	22.083333	25.9239
0.243 NS				
Err	18	15.333333	0.851852	1.0000
s	2	122.000000	61.000000	71.6087
0.001 **				
t	2	30.888889	15.444444	18.1304
0.010 **				
st	4	23.777778	5.944444	6.9783
0.043 *				
Err	18	15.333333	0.851852	1.0000

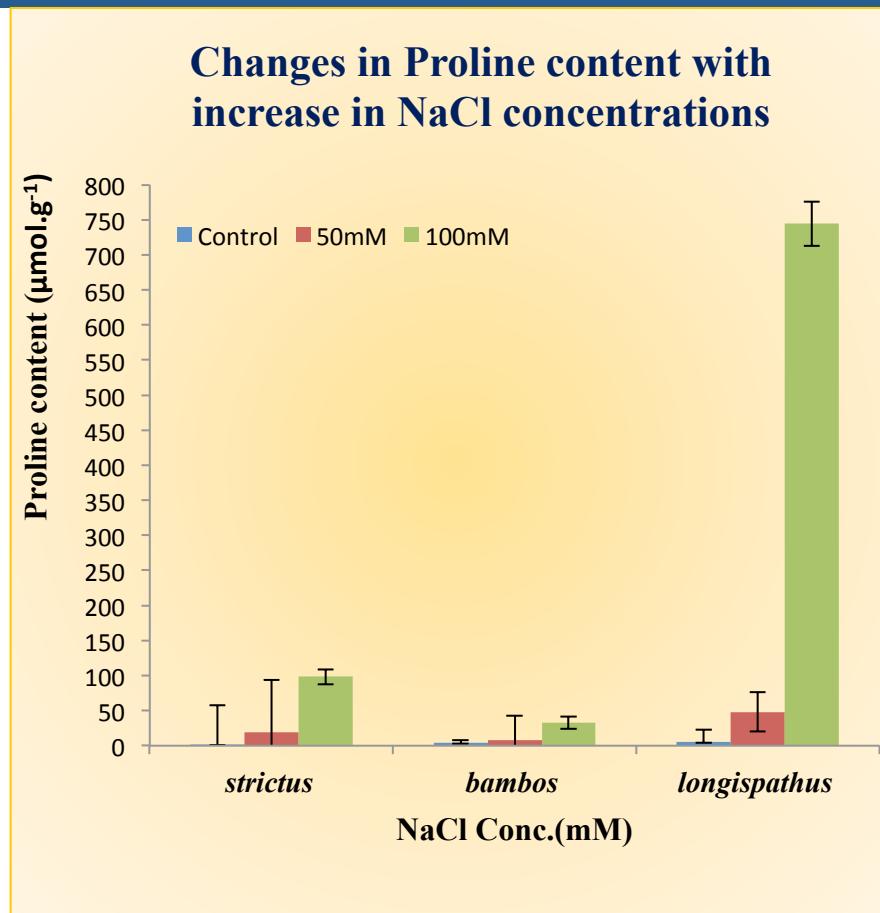
Source	df	SS	MS	F
PROB				
TOT	26	1569759.587407	60375.368746	44.3092
Trt	8	1545232.927407	193154.115926	141.7549
0.853 NS				
Err	18	24526.660000	1362.592222	1.0000
s	2	1260918.836296	630459.418148	462.6912
0.000 **				
t	2	190701.798519	95350.899259	69.9776
0.001 **				
st	4	93612.292593	23403.073148	17.1754
0.009 **				
Err	18	24526.660000	1362.592222	1.0000



# PROLINE ESTIMATION

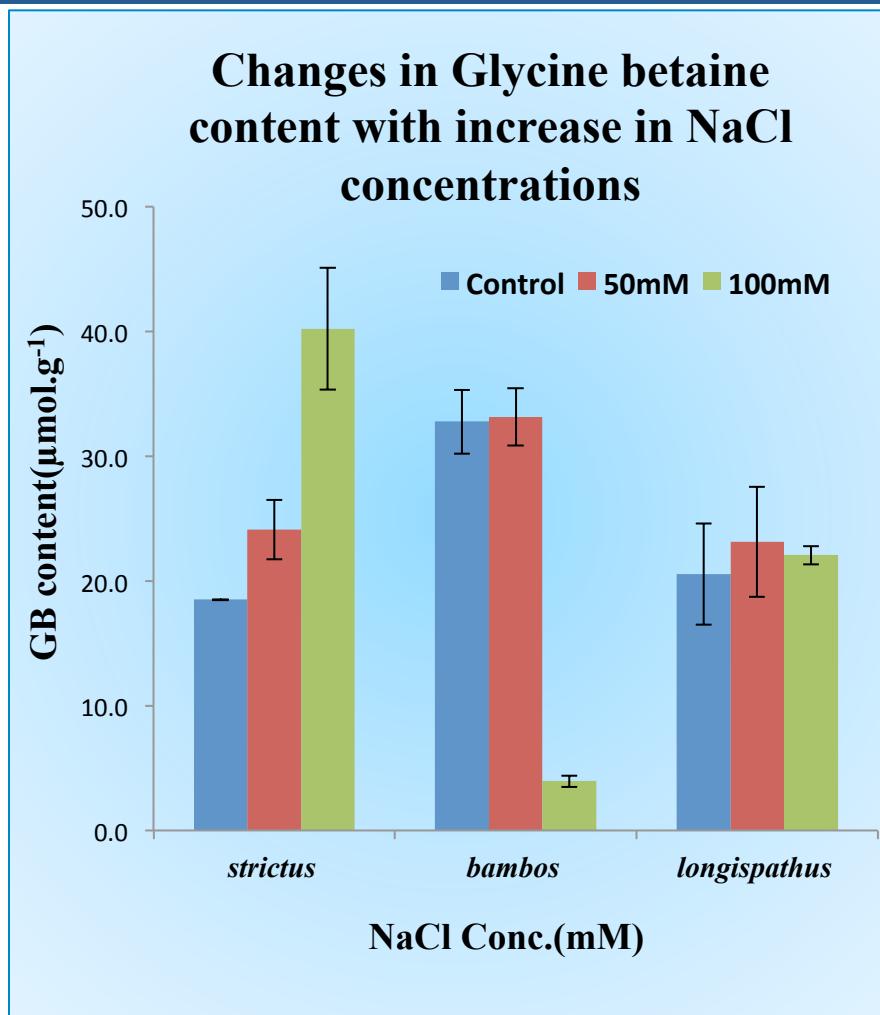
- L- Proline is the osmolyte that scavenge singlet oxygen and free radicals including hydroxyl, protecting the macromolecules like enzymes, membranes, DNA & proteins.
- Proline content increased with increasing NaCl concentration in all the three species.
- It was found that S2 seedlings accumulated highest proline ( $744.05 \pm 32.5$ ) which was 7.57 folds higher than S1 seedlings ( $98.17 \pm 9.8$ ) and 22.85 folds higher than the S3 ( $32.56 \pm 5.3$ ) seedlings treated with 100mM NaCl.

**μmol Proline/g FW =**  
$$(\mu\text{g Proline/ml} * \text{ml Toluene}) / [115.5 \mu\text{g}/\mu\text{mole}] / [\text{g sample}] / 5$$



# GLYCINE BETAINE ESTIMATION

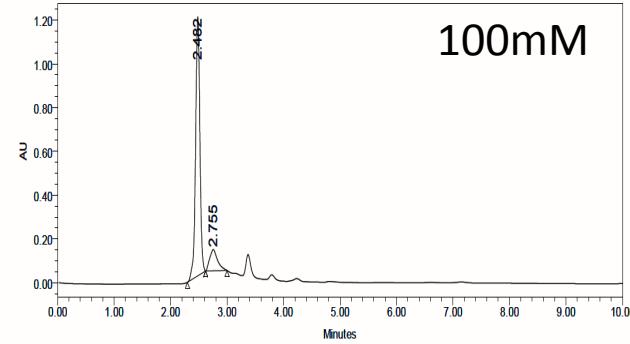
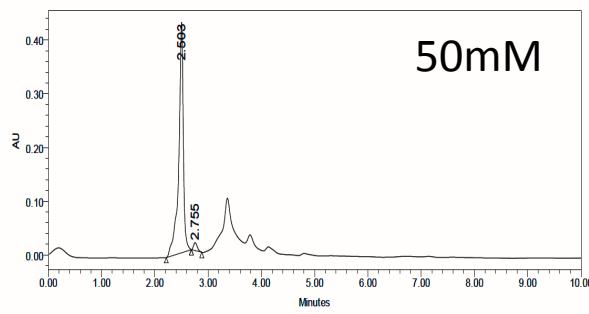
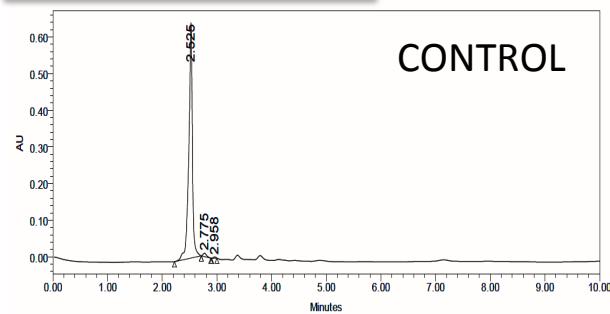
- Glycine betaine (GB) is a low molecular weight quaternary ammonium compound synthesized under stressful conditions
- Glycine betaine content was estimated in the leaf samples by method described by Carillo et al. (2011)
- The S1 species had the highest GB accumulation ( $40.21 \pm 4.8$ ) at 100mM NaCl in comparison to other two species
- In case of S2 species there was no significant variation in GB content, treated had similar GB content to that of control
- Whereas in case of S3 species the pattern of GB accumulation was entirely different from other two species, at 50mM NaCl GB content was similar to that of control, but at 100mM NaCl, GB content declined 8.29 folds in comparison to control.



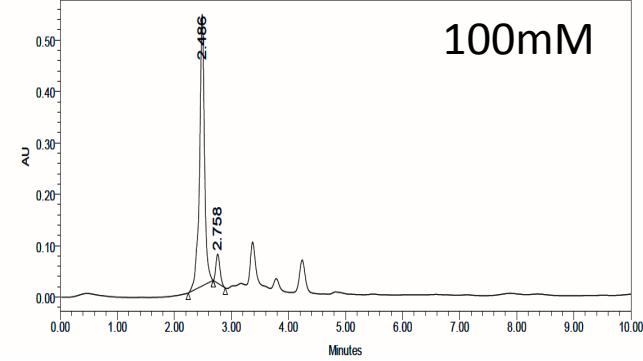
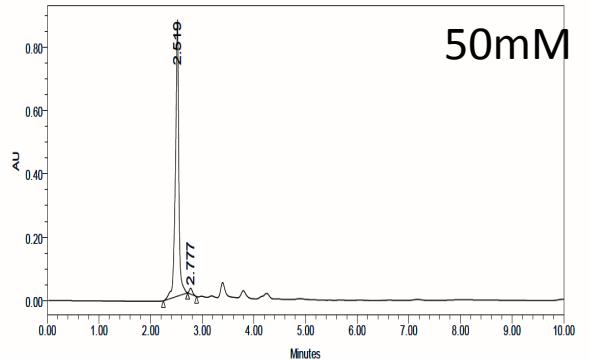
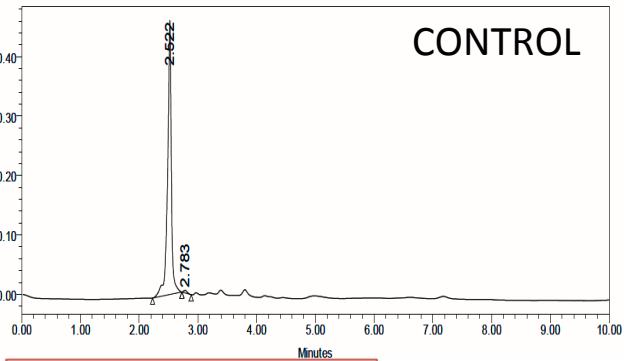
**μmol GB/g FW = Absorbance Peak Area extract /slope\*Vol extract/Vol aliquot\*concentration factor \*1/FW**

# CHROMATOGRAMS OF GB ESTIMATION IN BAMBOO SPECIES

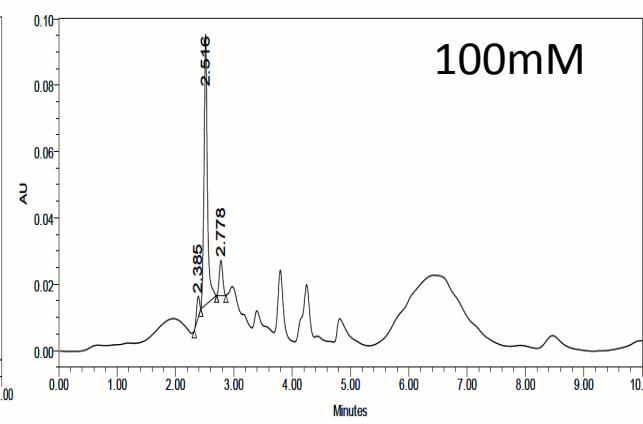
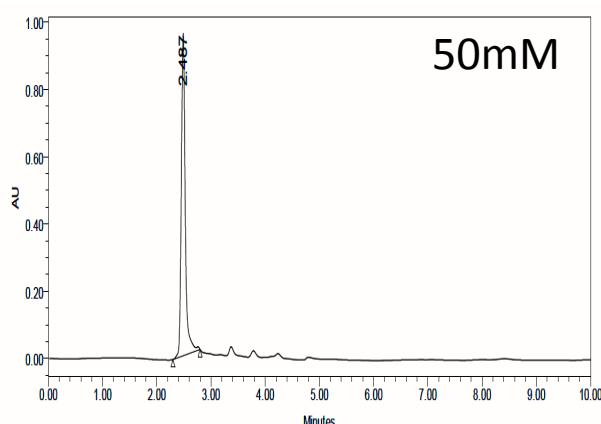
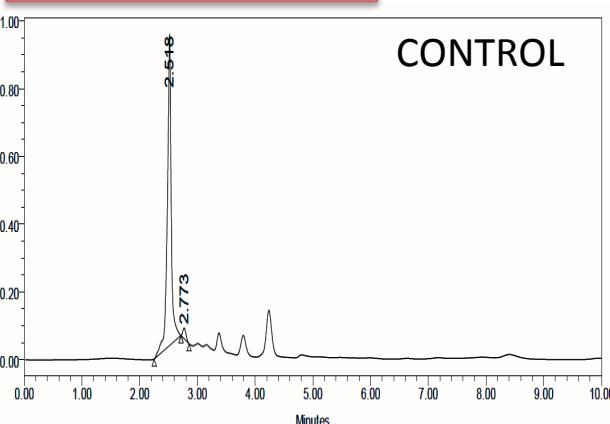
*D.strictus*



*D.longispathus*



*B.bambos*



# Summary

- Proline content increased significantly in all the three species with increasing NaCl concentration
- Highest proline content recorded in S2 (*D.longispathus*) species treated with 100mM NaCl.
- Usually increase in proline content under salt treatment with increasing salt concentration is reported as a salt tolerant trait, but in case of S2 bamboo species there was a different observation
- Although S2 species had highest proline (149 folds higher than control), but poor vegetative growth
- Whereas, in S1 and S3 genotypes increase in proline content at 100mM NaCl with respect to control was only 49 to 11 folds respectively but had a better growth performance compared to S2
- Thus based on these findings it is concluded that S3 (*B. bambos*) & S1 (*D. strictus*) are salt tolerant bamboo varieties showing better vegetative growth although proline concentrations was less than that of S2 species (*D.longispathus*).
- Whereas, S2 (*D. longispathus*) species is the salt sensitive genotype with declined growth performance inspite of highest proline content.



# Outcomes/Deliverables

- Will help to identify the best bamboo species that can be utilized for environmental applications
- Bamboo reserve for direct economic benefit of artisans, individuals and rural mass
- The research will open up avenue to develop genetically engineered plant species with desired characteristic for environmental application

# ACKNOWLEDGMENT

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THANK YOU