Progress Report for IFAR 2006

"Identification and field-testing of salinity tolerant groundnut in saline areas of India"

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Background.

Salinity is an ever-increasing abiotic stress affecting approximately 100 M ha arable land world wide, which severely decreases agricultural productivity. Improving salt tolerance of crop plants is one of the possible approaches to bring the saline areas under cultivation. In fact, there are also management options, but these require substantial investments, something that goes often against the short term necessities of poor subsistence farmers. Groundnut is a very important crop in many developing countries, particularly in India where the nitrogen crop residues are also used as fodder. In India alone where 40% of world's groundnut is produced, around 13.3 million ha land is affected by salinity. In this work, our goal was to select groundnut genotypes having tolerance to salinity, and build up on preliminary work done in that respect in 2005.

Work development.

A repeated screening in 2006 for the conformation of previous year screening, of 288 accessions of groundnut including the mini core collection of ICRISAT, selected land races putatively from saline areas, some collaborative releases and high yielding breeding lines. The difference with the 2005 screening is that we measured final pod yield this year, whereas only pod number and biomass at 60 days after sowing were assessed in 2005.

The experiment was planted on 22 April 2006 for pod yield evaluation under rain out shelter in 10.5 inches diameter pots containing 9 kg of Alfisol collected from the experimental station at ICRISAT. Four seeds were planted in each pot and later thinned to two plants per pot in each experiment. The experimental design for the experiment was a alpha lattice design (18x16) with three replications and two treatments (100 mM NaCl, and non saline control) in an out door facility equipped with a rainout shelter. The average maximum temperatures ranged 36.4 -29.6°C and 21.8-22.2°C maximum and minimum respectively during the period of experiment. The soil was fertilized with diammonium phosphate (DAP) at 300 mg kg^{-1} soil. The saline treatment was applied as a 100 mM solution of NaCl in a sufficient volume to saturate the soil profile to field capacity. This corresponded to an addition of 1.8 L of 100 mM NaCl solution to each pot, i.e. an application of 10.4 g NaCl pot^{-1} in to three split doses, equivalent to 1.16 g

NaCl kg^{-1} soil. The saline treatment was in three split doses (one third of the dose each time) applied at the time of sowing. Thereafter, pots were irrigated with tap water, not containing significant amount of NaCl, and maintained close to field capacity (determined gravimetrically) to avoid an increase in salt concentration in the soil solution. The bottom of the pots was sealed to avoid any salt leakage. Non-saline treated controls were brought initially to field capacity with non-saline water. The experiment was harvested on 30 August, 2006. Plants were oven dried at 80°C for two days and separated in to leaves, stems and pods.

Here, we found a more than six-fold range of variation for pod yield under salinity (100mM NaCl) (Figure 1). The range of variation for pod yield under salinity was three folds for breeding lines and land races nevertheless, it was more than six folds for mini core collection indicating that mini core collection provided higher contrasts compare to land races and breeding lines to initiate the breeding for salinity tolerance in groundnut. A list of most tolerant and most susceptible lines is indicated in Table 1. More detail of the entire list can be supplied upon request.

There was non significant (r^2 =0.01) relationship for ratio shoot biomass and ratio pod number revealed the poor relationship between performance at vegetative and performance at reproductive stages under salinity. In fact, no significant correlation was found between the shoot dry weight ratio and the yield ratio, indicating that differences in salinity tolerance among genotypes could not be inferred from measurements in the vegetative stage. The significant relationship for ratio pod number (r^2=0.31) and individual pod weight (r^2=0.33) with the ratio mature pod weight, i.e. our index for salinity tolerance, marked that salinity tolerance could be manifested by the minimum reduction in pod number and individual pod weight *per se*. The major trait related to salinity tolerance was the ability to maintain a large number of filled pods; therefore the seed size (100 seed weight) needs to be worked out in future screenings for salinity tolerance in groundnut. Salinity tolerance was not related to the shoot Na^+ and K^+ concentrations at vegetative stages for ratio shoot biomass at 60 DAS.

Prospects.

These same 288 entries are currently under similar testing, in another season (planting was done in late November and harvest will take place around March-April 2007). With the data from that third screening, we will be in a strong position to select very contrasting parents to undertake the crossing work and initiate the development of mapping population to identify QTL for salinity tolerance. In fact, crosses are already underway and will be further advanced when contrast between parental lines will be confirmed.

Budget.

Money (US$ 11,000 total) was spent as follows.

1. Applicant	=	US$ 1,495
2. Research Consumables	=	2,595
3. Technical Support	=	1,855
4. Travel	=	1,944
5. Personal Development of Applicant	=	1,061
6. ICRISAT administrative costs	=	2,050
Total Expenditure	=	US$ 11,000

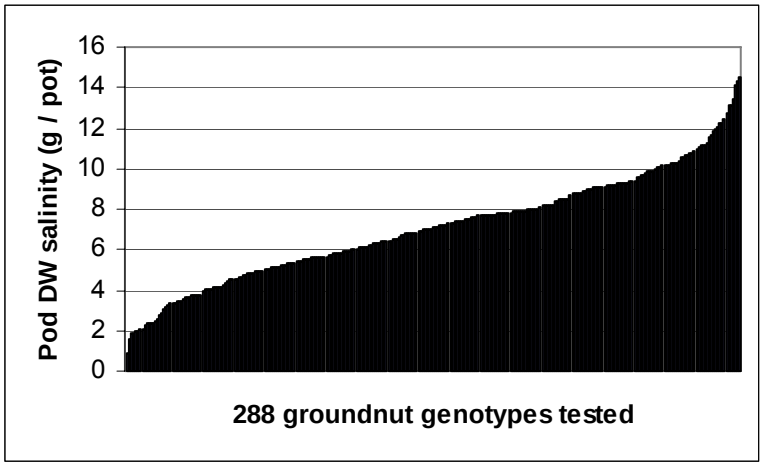

Figure 1: Range of variation for pod yield under salinity in 288 genotypes of groundnut.

Table 1. List of salt sensitive and tolerant genotypes of groundnut, 2006, Patancheru ICRISAT.

Sensitive				Tolerant			
Genotype	Group	Pod weight (S)	Pod weight (C)	Genotype	Group	Pod weight (S)	Pod weight (C)
ICGV 87921	BL	0.00	32.43	ICGV 97257	BL	10.29	30.38
ICG 2777	MC	2.11	29.45	ICGV 87119	BL	10.31	31.64
ICG 4343	MC	2.35	28.21	ICG 7355	LR	10.62	32.23
ICG 721	MC	2.42	29.44	ICGV 92243	BL	10.73	25.96
ICG 6022	MC	2.49	23.30	ICGV 87187	BL	11.20	25.98
ICG 156 C	MC	2.60	27.13	ICG 3027	MC	11.54	41.00
ICG 9037	MC	3.46	26.43	ICGV 86155	BL	11.86	28.36
ICGV 86699	BL	3.55	41.49	ICG 76	MC	11.91	23.29
ICG 2773	MC	3.72	28.57	ICG 5195	MC	12.43	22.35
ICG 4527	MC	4.91	34.04	ICGV 00309	BL	12.75	26.08
–	–	–	–	ICG 6892	MC	13.09	32.47
–	–	–	–	ICGV 93382	BL	13.15	26.85
–	–	–	–	ICGV 97245	BL	14.36	26.30
–	–	–	–	ICG 11651	MC	14.56	21.22

S= Salinity, C=Control, MC=Minicore, LR=Land races, BL=Breeding lines

Publications out of 2006 IFAR grant

- **Srivastava N,** Vadez V, Aruna R, and Nigam SN 2007. Genetic Variability for salinity tolerance in groundnut (*Arachis hypogaea*). Presentation abstract 2002, pp 176, **"International Conference on Sustainable Agriculture for Food, Bio-energy and Livelihood Security"**. (Full paper submitted)

- **Srivastava N,** Vadez V, and Saxena KB Inter and intra specific variability for salinity tolerance in pigeon pea (*Cajanus cajan*) and its wild relatives. Poster abstract 2006, pp 178-179, **"International Conference on Sustainable Agriculture for Food, Bio-energy and Livelihood Security"**

- **Namita Srivastava**, V. Vadez, L. Krishnamurthy, K. B. Saxena, S.N. Nigam and A. Rupakula. 2006. Standardization of Screening Technique for Salinity Tolerance in Groundnut (*Arachis hypogaea*) and Pigeonpea (*Cajanus cajan*) (Accepted Indian Journal of Crop Science).

- **Namita Srivastava**, V.Vadez*, HD Upadhyaya, and K.B. Saxena. 2006. Screening for intra and inter specific variability for salinity tolerance in Pigeonpea (*Cajanus cajan*) and its related wild species. Vol.2 Issue I pp 1, SAT e-journal.

Publications out of previous IFAR grant (2005)

- V. Vadez, **N. Srivastava**, L. Krishnamurthy, A. Rupakula and S.N. Nigam. 2005 Standardization of a protocol to screen for salinity tolerance in groundnut, *International Arachis Newsletter* 25:42-47.
- **N. Srivastava,** V. Vadez, L.Krishnamurthy, K.B.Saxena, S.N.Nigam and A.Rupakula. 2005. Abstract-145, *4th International Food Legumes Research Conference*, Oct. 18-22, 2005, New Delhi, India.