Content list available at http://epubs.icar.org.in, www.kiran.nic.in; ISSN: 0970-6429

Indian Journal of Hill Farming

December 2019, Volume 32, Issue 2, Page 216-221

Genotype ranking of soybean genotypes under acidic soil condition in Meghalaya

Yenkhom Linthoingambi Devi* • K. Noren Singh

College of Post Graduate studies in Agricultural Sciences, CAU, Umiam-793103, Meghalaya

ARTICLE INFO

Article history:
Received 13 June 2019
Revision Received 9 October 2019
Accepted 26 October 2019

Key words:
Acidic soil, soybean, hydroponics, aluminium toxicity

ABSTRACT

In the world scenario, although soybean is considered an important oilseed crop with India holding 5th position by contributing about 3.95% share in it's total production, its production in north-eastern region of India especially in Meghalaya is quite less due to its acidic soil condition. This necessitates the requirement of better performing genotypes along with the study for genetic diversity of genotypes to develop new and improved cultivars. With the highlight of the above fact, the present research was conducted using 40 different soybean. Two concentrations of 25µM and 75µM were used along with the re-growth study. Different ranking of the genotypes found for different concentration under Al treated solution. The ranking of genotypes based on yield performance was closely related with ranking based on the re-growth length of the genotypes after treatment. The result showed genotype TS 53 as tolerant genotype followed by the genotype JS-335 and MACS-1493. Based on the re-growth study, genotype TS 53 with more re-growth ability followed by the genotype MACS 1493 and SL 1068. Least re-growth ability found in the genotype MAC-1575, NRC 130, RSC 11-07. With these findings, it will be useful for breeders to further undergo molecular level studies to find out the gene responsible for tolerance. Also, the genotypes showing tolerance to Al toxicity could be used for further molecular and field analysis and helpful in faster screening of the genotypes under acidic condition.

1. Introduction

Soybean domestication started back to 7000 BC in central China. Soybean was dated to introduce in India since 1000 AD through Himalayan mountain. But the commercial cultivation of soybean was started since 1970s in Madhya Pradesh. Miracle Crop of 20th Century and Golden bean are the popular name of soybean. Soybean has rich source of minerals copper, molybdenum, manganese, potassium, phosphorus, vitamin B, omega -3-fatty acid and riboflavin. Soybean ranked top in both edible oil and oil seed production in the world. Highest edible oil and oil seed production crop in the world is soybean Zheng (2010). studied an acidic soil condition and how to solve the problem of acidic soil with reference to aluminium and phosphorus toxicity. It revealed the best mechanism of Al resistance to be the production of anionic organic acid in response to aluminium in the surrounding root apex. Also, it proved the best mechanism for Al resistance to be malate efflux. Villagarcia *et al.* (2001) hydroponic experiment on 3 days old soybean seedling and sand culture to rank the genotypes based on its tolerance to aluminium toxicity. The seedling were tested in 0, 2 micromolar and 5 micromolar Al3+ treated solution and 0 and 450 micromolar Al3+ activity for sand culture. Root length was measured for hydroponic solution and for Al3+ treated sand culture. Singh *et al.* (2012) did scoring of root staining with haematoxylin which did not show correlation with growth response method. Global soybean production forecast to 360.1 million metric tons for 2018/19 (www.usda.in). India ranked 5th in its contribution to world soybean production but is 2nd among the asian countries, next to China).

*Corresponding author: linthoiyengkhom123@gmail.com

In India, the contribution of soybean production is mainly fulfilled by 2 major states namely Maharashtra and Madhya Pradesh accounting 89% of total production of the country. In India, 11.5 million hectare of land produce 10.5 million tons of soybean during 2016-17 (Anonymous, 2017). In Meghalaya, the area of production is 1853 ha giving production of 3874 tons of soybean for 2016-17 (www.meghaagriculture.gov.in) which is less as compare to whole India production scenario. For optimum production of soybean, sandy loam soil with soil pH of 6.3 is best. Acidic soil occupies about 2.24 Mha area in Meghalaya which limits soybean production in these area. So, developing acid-adaptive soybean varieties in these area will increase domestic soybean production. Hydroponic culture is being used to get the best performing genotypes under acidic soil condition (Villargarcia *et al.* (2001).

2. Materials and Methods

2.1 Plants under 25μM aluminium treated solution

10 best performing lines and 10 inferior performing lines are selected for hydroponic study. The hydroponic study is done to check the best tolerant genotype to the aluminium toxicity which is the major causal factor of acidic soil, the most prevalent problematic soil problem. The selected seeds of the above genotypes are kept in double moist layer filter paper in petri plate kept in seed germinator with controlled temperature and humidity. After 3 days, the germinated seeds are transferred to 800μM $CaSO_4.2H_2O$ for 24 hours and the next day transferred to Hoagland solution maintaining the pH to 4.3 ± 1 with 0.025M H_2SO_4. From each genotype 5 plants are randomly chosen and transferred to Hoagland solution supported by thermocoil where holes are punctured and the plants are supported by net and cotton. 5 plants were transferred to control solution where Al^{3+} toxicity is not available and 5 plants were transferred to solution treated with Al^{3+} activity. The aluminium toxic solution was made by adding 6ppm of $AlCl_3$ to the solution.

The following data are being recorded are root length before transfer to the solution, root length after transfer to the solution, comparison of the root length in control and treated solution along with photo

2.2 Re-growth study

Seeds were disinfected with 0.1% $HgCl_2$ for 2-3 minutes and rinsed with distilled water and kept in filter paper for germination in growth chamber.

Table 1. List of 10 best genotypes and list of inferior genotypes used for hydroponics

Sl. No.	Genotype	Sl no.	Genotype name
1	TS 53	11	VLS-95
2	SKF SPS-11	12	NRC-129
3	MACS 1493	13	CSB 10084
4	KDS 992	14	AMS 100-39
5	SL 1068	15	RSC 11-07
6	RVS 2011-3	16	RVS 2011-1
7	JS 20-116	17	NRC 137
8	MAUS 725	18	NRC 131
9	PS 1556	19	NRC 130
10	JS 335	20	MACS 1575

After germination, the plants are growned in the nutrient solution for 2 days. Following 2 days, the seeds were transferred in nutrient solution containing 75μM aluminium concentration for 1 day. After that the roots are washed with distilled water for 30 minutes to remove Al on the root surface. The plants are dipped in stain solution containing 2g/l of haematoxylin solution and 0.02g/l of KIO_3 .The roots of the plant after 30 minutes of dipping in stain solution, is washed 3 times in deionized water for 20-30 minutes. After that the plants are ranked based on the staining of primary root staining. After that the plants are transferred back to the nutrient solution to check the regrowth of the plant. The response of each genotype was determined as the regrowth of the primary root after staining. Data was recorded, recoding of degree of staining of primary root with haematoxylin stain and measure the length of regrowth of the stained primary root after transferring back to nutrient solution.

3. Results and Discussion

In 25μM aluminium treated solution, the plants were measured for tap root length in both before transferring to the nutrient solution and after taken out from the nutrient solution. By checking the difference in length of the tap root extension of the treated plant from the control, the genotype ranking was decided. If the difference in the root length difference is less, then the genotype was recorded as tolerant and if the root length difference is more, the genotype was categorized as susceptible. Based on this, the genotype TS-53 was found to have least root length difference from the mean value so was recorded as tolerant genotype which was followed by the genotype JS 335 and MACS 1493. The genotype NRC 130 was found to have more root length difference and was recorded as susceptible genotypes and was succeeded by the genotype MACS 1575 and NRC 137. And most of the genotypes falled under the moderate category. A different procedure was followed for plants treating under 75μM

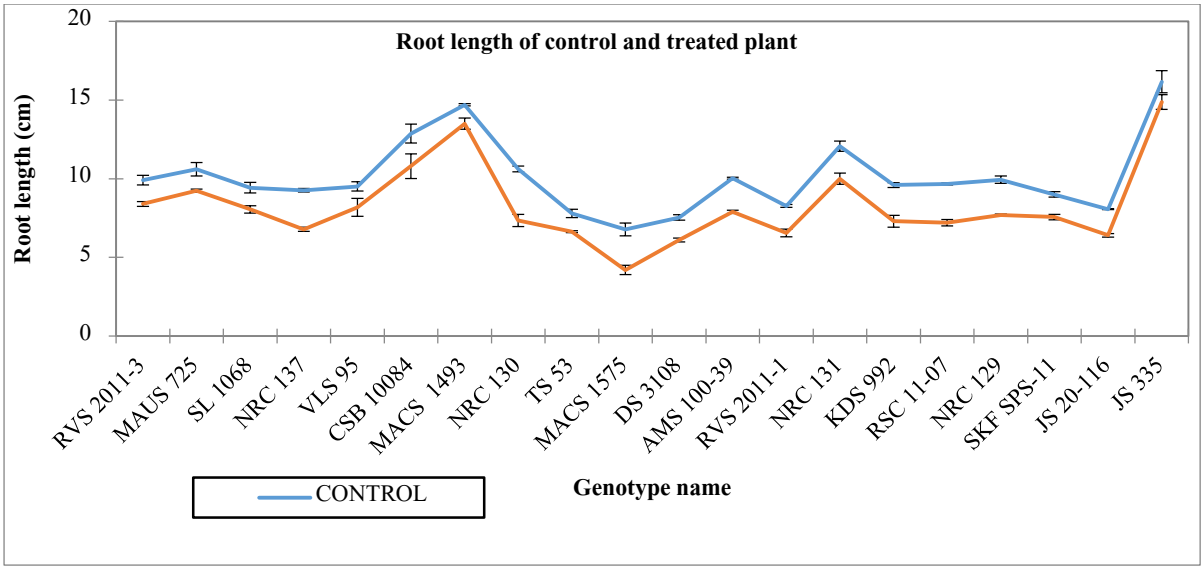

Figure a). Difference in root length of treated and control root length

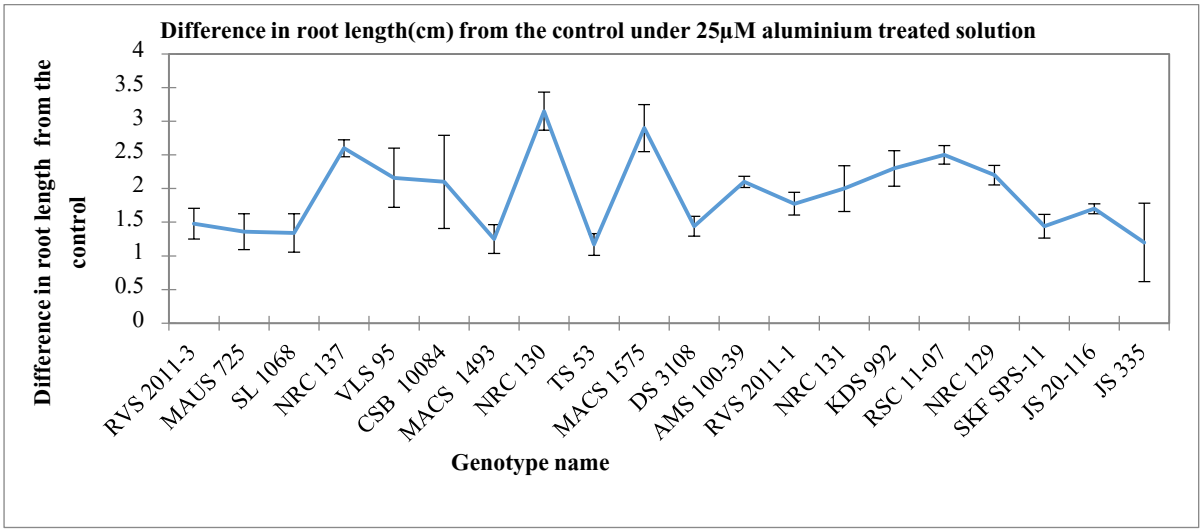

Figure b). Difference in root length from control under 25µM Al treated solution

aluminium treated solution. Recording of taproot length was done before transferring to the nutrient solution, before staining of the taproot and after transferring back the plants to nutrient solution. The result showed genotype TS 53 as tolerant genotype followed by the genotype JS-335 and MACS-1493. More susceptible genotype was MACS 1575 followed by NRC 130 and NRC 129. Based on the re-growth study, the plants showing more ability to re-growth of the root was more tolerant and the genotypes with less ability to give re-growth was more susceptible. The result found genotype TS 53 with more re-growth ability followed by the genotype MACS 1493 and SL 1068. Least re-growth ability found in the genotype macs-1575, NRC 130, RSC 11-07. Correlation study of the 3 parameters with the yield, it showed ranking based on re-growth length to be more positively correlated with the ranking based on yield performance than the ranking of genotypes based on the root length difference from the control of both 25µM and 75µM aluminium treated solution.

Conclusion

The genotypes were studied under two concentrations of 25µM and 75µM along with the re-growth study. The ranking of genotypes based on yield performance was closely related with ranking based on the re-growth length of the genotypes after treatment. With these findings, it will be useful for breeders to further undergo molecular level studies to find out the gene responsible for tolerance. Also, the genotypes showing tolerance to Al toxicity could be used for further molecular and field analysis. The genotypes which are found tolerant through hydroponic study could be used in this area for better production of soybean which will help in better crop production.

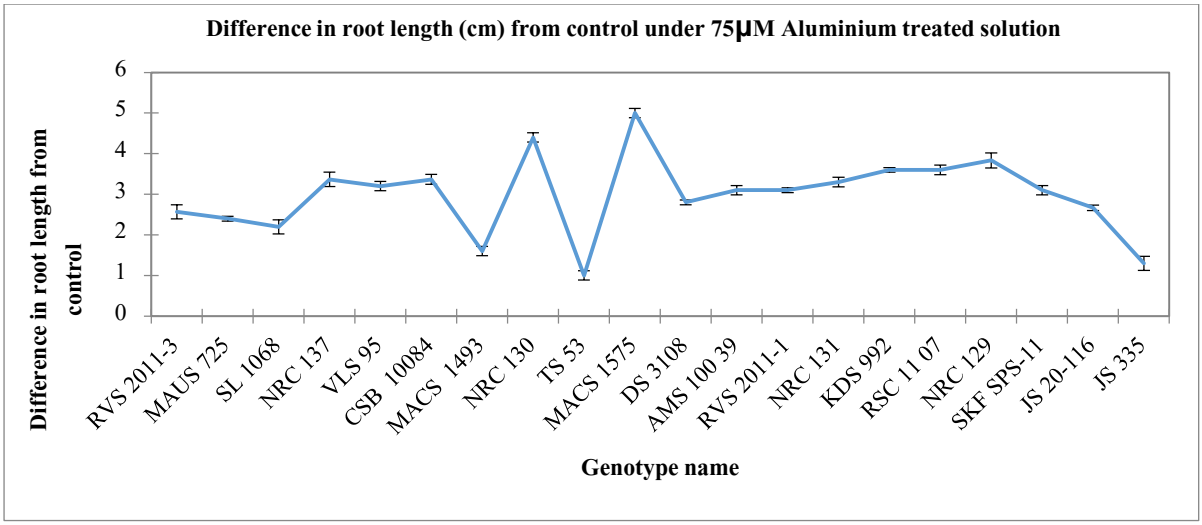

Figure c). Difference in root length from control under 75µM Al treated solution

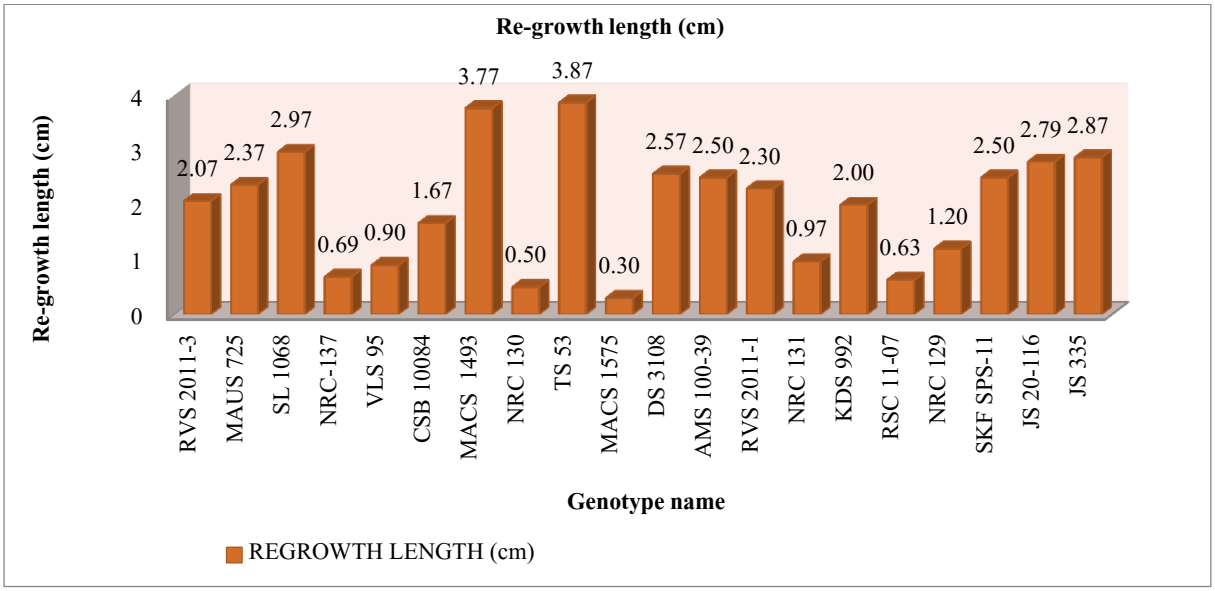

Figure d). Re-growth length of the taproot after treatment

Acknowledgement

The author are grateful to Dr. Noren Singh, for guiding me throughout the research work. I would also like to take the privilege to thank Dr. N.B Singh Dean, College of Post Graduate Studies, Umiam, Meghalaya and all the staff members of the college for the ceaseless support I received during the course of my study. I extend my profound thanks to the College of Post Graduate Studies for providing me scholarship and financial assistance for completion of my master's programme.

References

Annual report 2016-17, ICAR, Indian Institute of Soybean Research, Indore, India.

Villagarcia, M.R., Carter, T.E., Rufty, T.W., Niewoehner, A.S., Jennette, M.W., and C. Arrellano, (2001). Genotypic Ranking for Aluminium Tolerance of Soybean Roots grown in Hydroponics and sand culture. *Crop Sci*ence, 41: 1499-1507.

Singh, D. Dikshit, H.K., and R. Singh, (2012). Variation of aluminium tolerance in lentil (Lens *culinaris* Medik). *Plant breeding,* 131(6): 751-761

Zheng, S.J. (2010). Crop production on acidic soil: overcoming aluminium toxicity and phosphorus deficiency. *Annals of botany*, 106: 183-184

Table 2. comparison of genotype ranking based on yield, 25 µM aluminium treated solution and regrowth length.

Sl no.	Genotype name	Scoring of staining	Genotype ranking based on 25 µM aluminium treated solution	Genotype ranking based on re-growth length	Genotype ranking based on yield performance
1	RVS 2011-3	M	8	11	5
2	MAUS-725	M	5	8	9
3	SL-1068	L	4	6	4
4	NRC-137	D	18	17	11
5	VLS-95	D	14	14	17
6	CSB- 10084	M	13	13	13
7	MACS -1493	L	3	2	3
8	NRC-130	D	20	19	19
9	TS-53	L	1	1	1
10	MACS-1575	D	19	20	20
11	DS-3108	L	9	5	7
12	AMS 100-39	M	12	9	14
13	RVS 2011-1	M	10	10	16
14	NRC-131	D	11	16	18
15	KDS-992	M	16	12	8
16	RSC 11-07	M	17	18	15
17	NRC-129	D	15	15	12
18	SKF-SPS-11	M	7	7	2
19	JS-20-116	M	9	4	6
20	JS-335	L	2	3	10

Figure a). Tolerant genotype b) Moderately tolerant c) Susceptible genotype

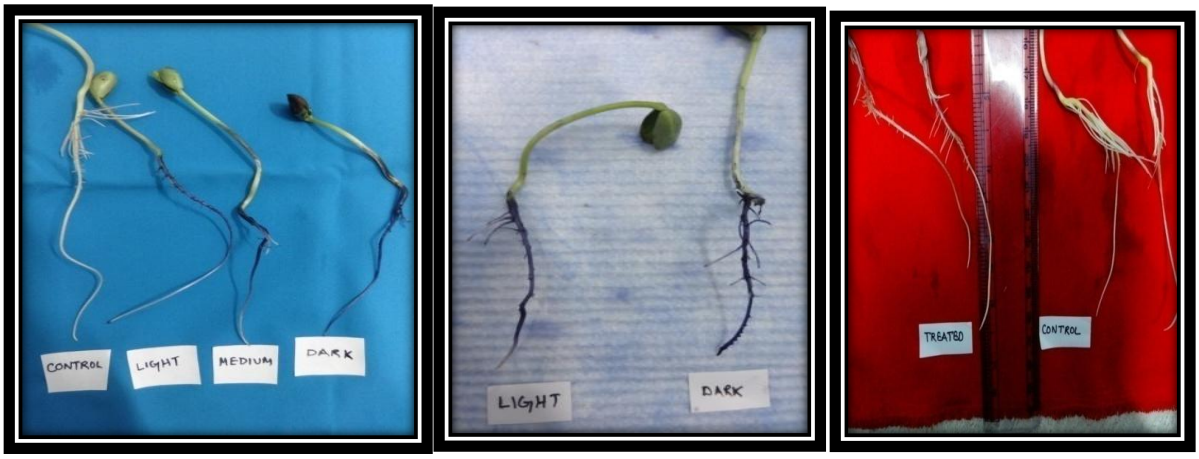

Figure d). scoring of staining of the taproot e) difference in taproot under control and treated

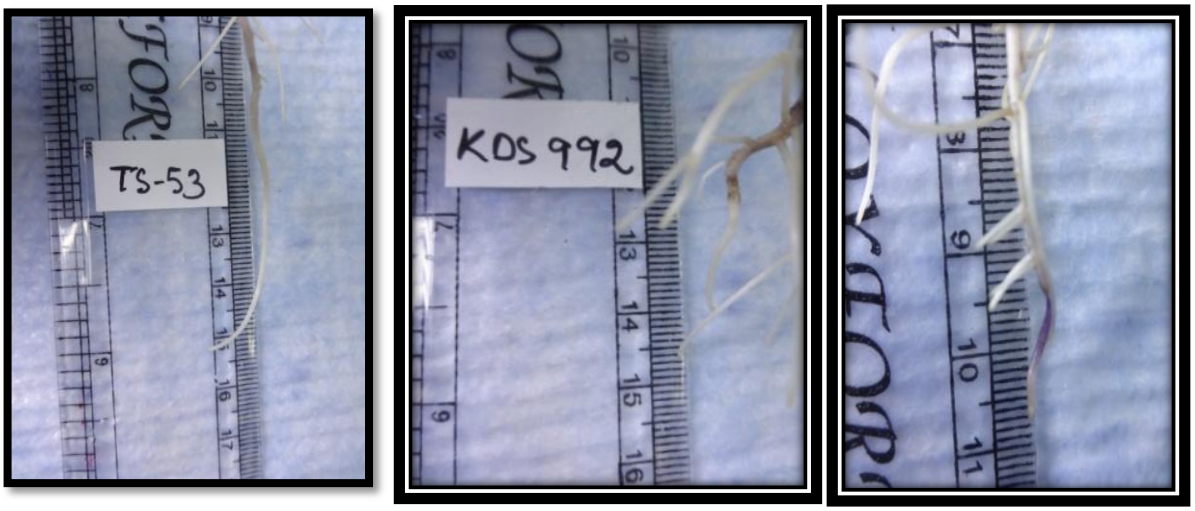

Figure g). Tolerant genotype h) Moderately tolerant genotype i) Susceptible genotype