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Genotypic Variation and Mechanism for P-efficiency in Peanut

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INTRODUCTION

Low phosphorous availability and insufficient P application (Singh et al 2004) are one of the reasons attributed to low yields in peanut. Identification of P-efficient genotypes for high- and low-input farming systems would reduce P fertilizer costs, minimize environmental pollution and contribute to the maintenance of P resources globally (Vance et al. 2003). Limited study has been conducted in peanut under field conditions for identification of efficient genotypes. Moreover, mechanisms associated with P stress in peanut are unclear. Differences in P-uptake efficiency among genotypes have been attributed to differences in P-influx rates (Bhadoria et al 2009). P efficiency depends on ability of a genotype to take-up P from soil (uptake efficiency) or by use of absorbed P for producing biomass yield (utilisation efficiency) (Blair 1993). Three P efficiency indices (i) relative growth rate (RGR) indicating P efficiency, (ii) root-shoot ratio indicating uptake efficiency and (iii) P-utilisation efficiency were used in this study. Hence, the objective of this study was to evaluate peanut genotypes for P efficiency and to identify the mechanisms of P efficiency.

METHODS

Twenty three genotypes were studied for their P response under low-P (0kg/ha) and high-P (50kg/ha) in a field experiment conducted during Kharif season at Junagadh (lat 21°31'N, long 70°36'E), India in a medium black calcareous soil having 6 ppm available P (low), 7.5 pH, 0.70% organic C, 600 ppm N and 11 ppm available S. Plant samples from genotypes were taken at 40^{th} and 60^{th} days after sowing and separated into shoots and roots for recording of dried mass (g plant^{-1}). P-concentrations ([P]; mg g^{-1}) in samples were estimated by the vanadate-molybdate yellow colour method. P-utilization efficiency (PUE) was determined as the reciprocal of shoot P concentration. Relative growth rate (RGR; g g^{-1} day^{-1}) from 40-60 days was calculated as $RGR = (DW_{60} - DW_{40})/[(t_{60}-t_{40}) * DW_{40}]$, where 'DW' is the plant dry weight at 40 and 60 days and 't' is the time in days. RGR, root-shoot ratio and PUE of all genotypes was represented on bar graph.

RESULTS AND DISCUSSION

In this study, the RGR, root-shoot ratio and PUE was studied (Fig 1). RGR values studied among genotypes showed three situations. At low-P level genotypes Girnar 3, NRCG 13182, NRCG 15049, GPBD 4 and NRCG 3498 had high RGR than at high-P and were more P-efficient (Fig 1A). On the other hand, at high-P level the genotypes NRCG 5007, NRCG 10374 and FeESG 8 had high RGR, with an increase of more than twice over low-P level. But, the RGR of genotypes NRCG 7320, NRCG 10107, NRCG 10126, SP 250A, GG 7 and GG 20 was not affected under low-P supply.

Root-shoot ratio among all genotypes was reduced to half from 40^{th} to 60^{th} day. The root-shoot ratio was high at low-P compared to high-P in most of the genotypes indicating that, when P availability is less genotype tends to divert their resources towards root development which would help in better P exploration from soil. Genotypes GPBD 4, NRCG 15049, FeESG 8 and GG 7 had high root-shoot ratio under low-P during 60^{th} day after sowing. The genotypes NRCG 5007, NRCG 10126 and GG20 had high root-shoot ratio at high-P than at low-P (Fig 1B) as a result their P-efficiency under low-P was low compared to other genotypes (Fig 1A). Increased root-shoot ratio under

low-P was attributed to translocation of more photosynthates to root system for high P exploration from soil. P utilisation efficiency was different among genotypes at high and low P levels. Genotypes Girnar 3, NRCG 10078, NRCG 10126, NRCG 10374 and B 95 had high P utilisation efficiency at low-P level however; genotype NRCG 13182, VRI3 and SP250A had low-P utilisation efficiency at both P levels.

In order to identify P-efficient genotypes, with all three indices considered together genotypes Girnar 3, NRCG 13182, NRCG 15049 and GPBD 4 were rated as P-efficient. Girnar 3 had RGR which may be attributed to its ability to transport and utilise absorbed nutrients for shoot growth and thus exhibited high P-utilisation efficiency (Fig 1C). Genotype NRCG 15049 had high RGR and high root-shoot ratio and was P-efficient. The other two P-efficient genotypes NRCG 13182 and GPBD 4 had low P-utilisation efficiency, but their high root-shoot ratio contributed to their high P-efficiency overall.

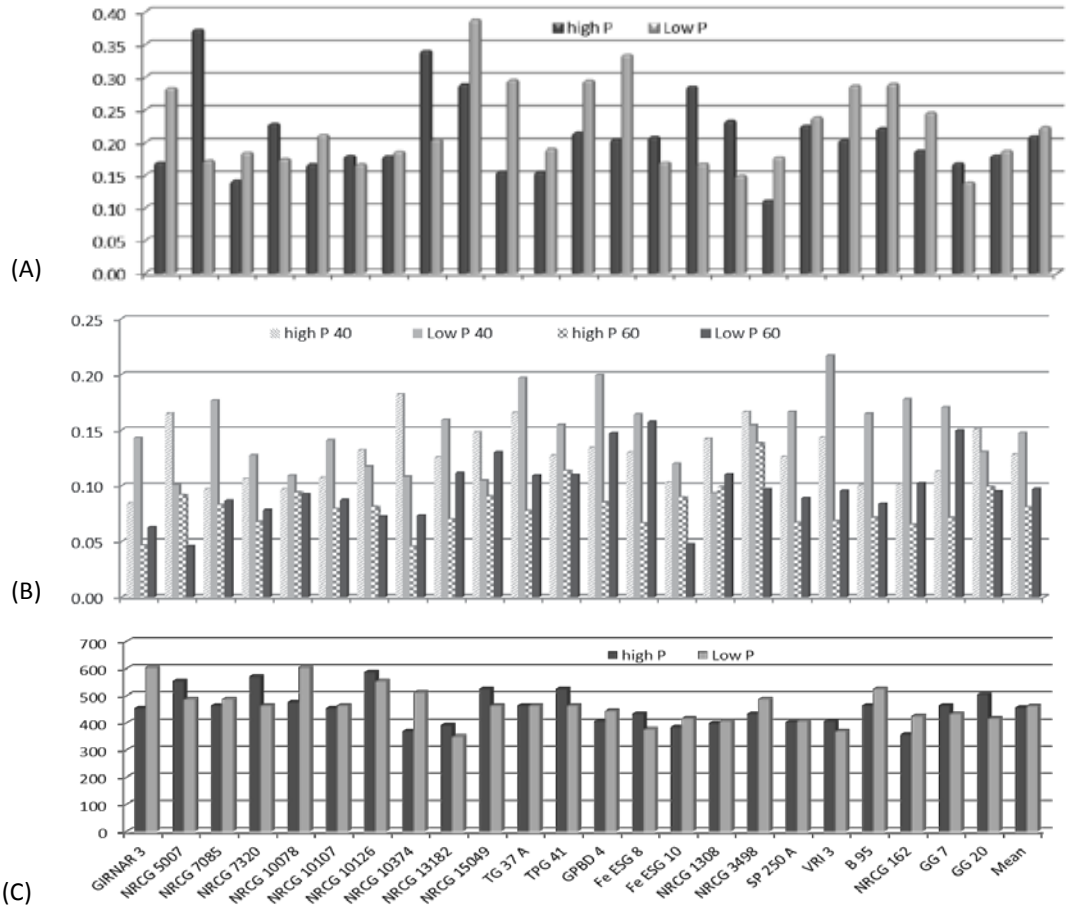

Fig 1: Relative growth rates between 40-60 days (g g^{-1} day^{-1}) (A), root: shoot ratio (B) and P utilisation efficiency (g dry mass g^{-1} P) (C) of peanut genotypes at high and low P levels.

CONCLUSION

The study concludes that the P-efficient genotypes exhibited either high root: shoot ratio or high P utilisation efficiency, or both. Genotypes Girnar 3, NRCG 15049, GPBD 4 and NRCG 13182 were more suitable for low-P conditions.

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