

10.1071/FP16154_AC

© CSIRO 2017

Supplementary Material: *Functional Plant Biology*, 2017, 44(2), 235–252.

Supplementary material

Genotypic variation in soil water use and root distribution and their implications for drought tolerance in chickpea

Ramamoorthy Purushothaman^{A,B}, *Lakshmanan Krishnamurthy*^{A,F}, *Hari D. Upadhyaya*^{A,C,D}, *Vincent Vadez*^A and *Rajeev K. Varshney*^{A,E}

^AInternational Crops Research Institute for the Semi-arid Tropics (ICRISAT), Patancheru 502 324, Telangana, India.

^BJawaharlal Nehru Technological University Hyderabad (JNTUH), Hyderabad 500 085, Telangana, India.

^CDepartment of Agronomy, Kansas State University, 2004 Throckmorton PSC, 1712 Claflin Road, Manhattan, KS 66506, USA.

^DUWA Institute of Agriculture, University of Western Australia, 35 Stirling Highway, Crawley, Perth, WA 6009, Australia.

^ESchool of Plant Biology and Institute of Agriculture, The University of Western Australia, 35 Stirling Highway, Crawley, Perth, WA 6009, Australia.

^FCorresponding author. Email: lkm1949@gmail.com

Table S1. Trial means and analysis of variance of root length density and crop utilized soil moisture of 12 diverse genotypes of chickpea at different soil depths and days after sowing (DAS) under optimal irrigation in a Vertisol during 2009-10 post-rainy season

Sampling time/ treatment	Root length density					Crop utilised soil moisture				
	Trial mean	Range of means	s.e.d.	σ^2_g (α level)	Heritability (h^2_b)	Trial mean	Range of means	s.e.d.	σ^2_g (α level)	Heritability (h^2_b)
35 DAS										
0-15	0.352	0.265 - 0.481	0.015	39.0 (***)	0.927	15.0	13.9 - 17.0	0.497	7.68 (***)	0.690
15-30	0.304	0.228 - 0.367	0.016	12.7 (***)	0.796	13.2	11.4 - 16.5	1.28	2.27 (*)	0.298
30-45	0.192	0.144 - 0.238	0.017	4.86 (***)	0.562	8.53	7.54 - 9.22	1.08	0.660 (n.s.)	0.129
45-60	0.091	0.000 - 0.258	0.013	84.1 (***)	0.965	5.76	4.15 - 7.30	1.07	2.04 (n.s.)	0.257
50 DAS										
0-15	0.613	0.464 - 0.760	0.021	38.4 (***)	0.926	22.9	20.7 - 26.5	0.600	15.56 (***)	0.829
15-30	0.507	0.341 - 0.692	0.019	65.4 (***)	0.955	22.6	19.9 - 28.2	1.36	5.34 (***)	0.591
30-45	0.337	0.232 - 0.444	0.021	30.2 (***)	0.907	16.1	15.0 - 17.2	1.24	0.530 (n.s.)	0.185
45-60	0.313	0.169 - 0.403	0.021	17.8 (***)	0.848	11.5	9.0 - 13.0	1.29	1.67 (n.s.)	0.183
60-75	0.157	0.119 - 0.191	0.021	2.64 (*)	0.354	6.84	4.56 - 8.43	1.35	1.63 (n.s.)	0.174
75-90	0.052	0.026 - 0.082	0.009	9.62 (***)	0.742	4.64	3.63 - 6.08	1.56	0.530 (n.s.)	0.187
80 DAS										
0-15	0.728	0.533 - 0.988	0.019	95.2 (***)	0.969	46.6	44.7 - 48.5	0.527	8.58 (***)	0.716
15-30	0.357	0.284 - 0.490	0.019	18.8 (***)	0.855	45.1	43.1 - 47.0	1.64	1.25 (n.s.)	0.076
30-45	0.275	0.225 - 0.316	0.02	3.65 (**)	0.469	36.7	34.8 - 38.9	1.16	3.10 (***)	0.411
45-60	0.227	0.168 - 0.291	0.014	11.9 (***)	0.784	35.7	32.8 - 38.3	1.44	3.05 (***)	0.406
60-75	0.172	0.114 - 0.224	0.014	13.0 (***)	0.800	29.5	24.1 - 35.3	1.72	9.36 (***)	0.736
75-90	0.093	0.033 - 0.146	0.014	14.0 (***)	0.813	24.7	15.8 - 30.3	2.39	6.53 (***)	0.648
90-105	0.094	0.053 - 0.128	0.014	6.79 (***)	0.659	13.0	9.75 - 17.0	2.96	1.33 (n.s.)	0.100
105-120	0.055	0.034 - 0.070	0.007	4.27 (**)	0.521	7.62	2.30 - 13.7	2.72	2.70 (*)	0.361

α level = Significance level; * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$; n.s., not significant ($P > 0.05$)

Table S2. Trial means and analysis of variance of root length density and crop utilised soil moisture of 12 diverse genotypes of chickpea at different soil depths and days after sowing (DAS) under optimal irrigation in a Vertisol during 2010–11 post-rainy season

Sampling time/ treatment	Root length density					Crop utilised soil moisture				
	Trial mean	Range of means	s.e.d.	σ^2_g (α level)	Heritability (h^2_b)	Trial mean	Range of means	s.e.d.	σ^2_g (α level)	Heritability (h^2_b)
35 DAS										
0-15	0.268	0.186 - 0.395	0.024	13.8 (***)	0.810	7.90	4.23 - 9.88	1.96	1.37 (n.s.)	0.109
15-30	0.155	0.107 - 0.195	0.012	10.1 (***)	0.752	6.89	4.36 - 8.61	1.71	1.07 (n.s.)	0.022
30-45	0.057	0.028 - 0.086	0.008	9.98 (***)	0.750	13.1	9.56 - 15.3	2.01	1.66 (n.s.)	0.180
45 DAS										
0-15	0.623	0.343 - 0.794	0.026	47.7 (***)	0.940	11.3	6.58 - 13.9	2.27	1.70 (n.s.)	0.189
15-30	0.312	0.157 - 0.484	0.014	85.0 (***)	0.966	10.5	7.05 - 12.8	2.06	1.07 (n.s.)	0.022
30-45	0.120	0.046 - 0.164	0.014	15.7 (***)	0.831	18.2	14.4 - 21.3	2.34	1.79 (n.s.)	0.208
45-60	0.083	0.041 - 0.129	0.010	12.2 (***)	0.788	16.1	12.1 - 17.9	1.59	2.07 (n.s.)	0.262
60-75	0.029	0.008 - 0.051	0.006	9.01 (***)	0.728	16.6	12.5 - 19.3	1.69	2.36 (*)	0.312
55 DAS										
0-15	0.659	0.422 - 0.89	0.033	54.7 (***)	0.947	15.9	11.6 - 17.6	2.01	1.48 (n.s.)	0.138
15-30	0.312	0.170 - 0.402	0.028	13.6 (***)	0.807	18.1	13.6 - 21.2	1.82	3.00 (*)	0.401
30-45	0.293	0.131 - 0.393	0.024	20.4 (***)	0.866	25.9	20.8 - 31.0	2.24	3.13 (*)	0.416
45-60	0.144	0.057 - 0.213	0.025	7.46 (***)	0.683	18.8	17.0 - 22.2	1.58	2.14 (n.s.)	0.276
60-75	0.125	0.083 - 0.159	0.022	2.24 (n.s.)	0.293	18.9	15.7 - 21.2	1.97	1.42 (n.s.)	0.124
75-90	0.036	0.012 - 0.057	0.009	5.57 (***)	0.604	9.43	7.53 - 11.4	1.24	1.88 (n.s.)	0.227
65 DAS										
0-15	0.798	0.699 - 0.984	0.054	5.19 (***)	0.582	17.7	12.7 - 19.6	1.98	1.96 (n.s.)	0.243
15-30	0.586	0.467 - 0.697	0.032	12.2 (***)	0.788	20.2	15.1 - 23.4	1.82	3.40 (**)	0.444
30-45	0.560	0.403 - 0.702	0.025	27.9 (***)	0.900	29.5	23.5 - 34.7	2.38	3.12 (*)	0.414
45-60	0.431	0.342 - 0.548	0.027	9.3 (***)	0.734	21.4	19.2 - 25.2	1.72	2.26 (*)	0.296
60-75	0.313	0.173 - 0.454	0.031	16.2 (***)	0.835	22.4	17.2 - 25.2	2.15	2.65 (*)	0.355
75-90	0.161	0.080 - 0.233	0.023	8.35 (***)	0.710	10.4	8.66 - 12.6	1.44	1.47 (n.s.)	0.137
90-105	0.102	0.054 - 0.145	0.019	5.10 (***)	0.577	9.85	6.54 - 13.0	2.19	1.65 (n.s.)	0.178
75 DAS										
0-15	0.683	0.479 - 0.872	0.022	79.4 (***)	0.963	19.8	14.2 - 21.9	2.01	2.4 (*)	0.319
15-30	0.421	0.310 - 0.504	0.020	20.4 (***)	0.866	22.9	17.1 - 26.2	1.87	3.71 (**)	0.475
30-45	0.387	0.301 - 0.416	0.018	8.93 (***)	0.725	33.4	26.5 - 38.7	2.62	3.05 (*)	0.406

45-60	0.305	0.225 - 0.387	0.019	10.8 (***)	0.766	24.3	21.6 - 28.3	1.91	2.29 (*)	0.302
60-75	0.250	0.144 - 0.320	0.020	13.3 (***)	0.803	25.8	18.9 - 29.4	2.46	2.97 (*)	0.396
75-90	0.163	0.093 - 0.277	0.015	27.4 (***)	0.898	11.8	9.26 - 15.1	1.71	2.15 (n.s.)	0.277
90-105	0.122	0.038 - 0.204	0.013	35.4 (***)	0.920	10.4	7.39 - 14.5	2.36	1.45 (n.s.)	0.129
105-120	0.067	0.050 - 0.087	0.012	2.18 (0.058)	0.282	10.2	6.35 - 15.7	2.55	2.68 (*)	0.359
90 DAS										
0-15	0.846	0.316 - 1.26	0.027	201.9 (***)	0.985	27.5	21.86 - 29.7	2.17	2.68 (*)	0.359
15-30	0.462	0.302 - 0.682	0.027	51.5 (***)	0.944	33.3	25.13 - 36.7	2.06	4.65 (***)	0.549
30-45	0.441	0.290 - 0.547	0.029	12.5 (***)	0.793	44.7	34.72 - 49.8	2.80	4.05 (**)	0.504
45-60	0.289	0.178 - 0.402	0.030	12.5 (***)	0.793	30.2	26.62 - 33.5	2.07	3.05 (*)	0.406
60-75	0.252	0.165 - 0.335	0.029	6.30 (***)	0.638	31.1	25.05 - 35.1	3.46	1.61 (n.s.)	0.169
75-90	0.170	0.065 - 0.283	0.029	9.30 (***)	0.735	13.9	11.34 - 18.7	2.12	2.71 (*)	0.364
90-105	0.150	0.034 - 0.266	0.026	13.7 (***)	0.809	12.0	7.99 - 16.9	2.82	1.85 (n.s.)	0.222
105-120	0.046	0.007 - 0.138	0.013	18.2 (***)	0.851	11.5	6.58 - 19.1	2.99	3.37 (**)	0.441

α level = Significance level; * P < 0.05; ** P < 0.01; *** P < 0.001; n.s., not significant (P > 0.05)

Table S3. Interaction of genotype with days after sowing (DAS), treatment and year for the root length density and crop utilised soil moisture of 12 diverse genotypes of chickpea in a Vertisol during post-rainy seasons of 2009–10 and 2010–11

	Genotype \times DAS Variance component (s.e.)	Genotype \times DAS \times Treatment Variance component (s.e.)	Genotype \times DAS \times Treatment \times Year Variance component (s.e.)
Root length density			
0-15	0.0164 (0.0046)	0.0170 (0.0038)	0.0063 (0.0019)
15-30	0.0096 (0.0023)	0.0101 (0.0017)	0.0221 (0.0032)
30-45	0.0133 (0.0026)	0.0081 (0.0012)	0.0168 (0.0024)

45-60	0.0122 (0.0023)	0.0016 (0.0016)	0.0034 (0.0014)
60-75	0.0079 (0.0017)	0.0043 (0.0007)	-
75-90	0.0027 (0.0015)	0.0085 (0.0014)	-
90-105	0.0028 (0.0012)	0.0101 (0.0021)	-
105-120	0.0013 (0.0008)	0.0057 (0.0014)	-

Crop utilised soil moisture

0-15	17.1 (9.07)	37.2 (12.4)	30.7 (8.76)
15-30	20.1 (9.86)	47.3 (11.9)	23.3 (6.92)
30-45	4.24 (12.8)	117.0 (18.4)	8.05 (2.74)
45-60	34.8 (7.96)	16.5 (5.62)	13.3 (4.05)
60-75	20.3 (9.59)	40.3 (12.16)	27.4 (8.17)
75-90	24.4 (4.96)	3.82 (3.26)	9.89 (3.0)
90-105	12.7 (2.61)	2.62 (1.20)	9.81 (2.43)
105-120	12.9 (2.67)	5.92 (1.70)	13.27 (2.62)

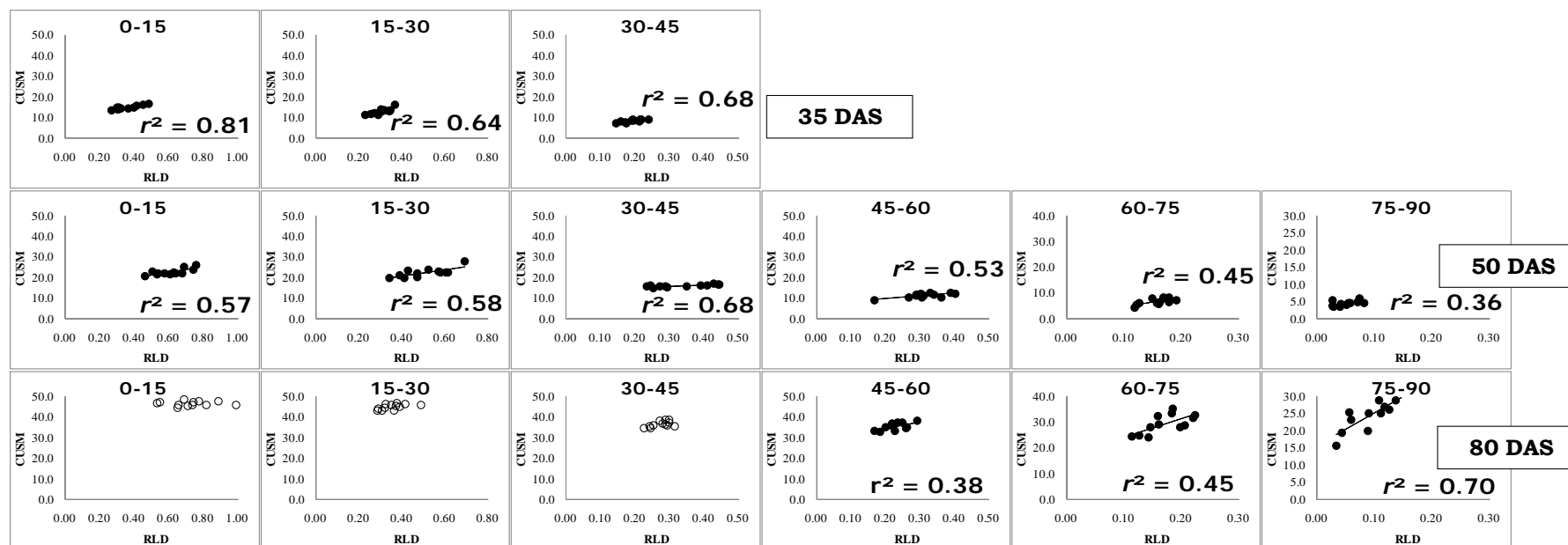


Fig. S1. Relationship between root length density (RLD) and crop utilised soil moisture (CUSM) at various soil depths at different days after sowing (DAS) under optimal irrigation in 2009–10. Non-significant associations of RLD with CUSM in figures were represented with open circles.

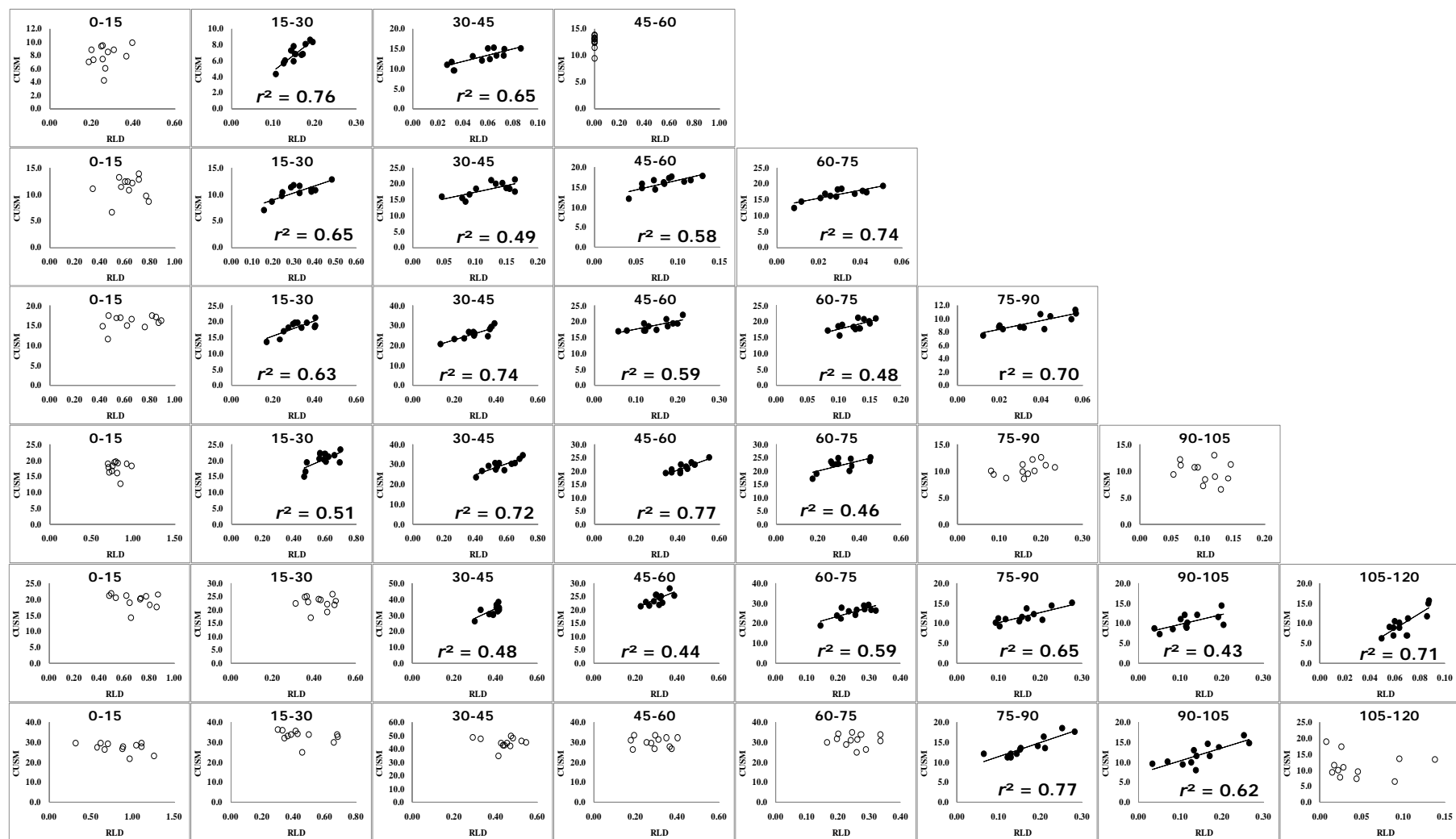


Fig. S2. Relationship between root length density (RLD) and crop utilised soil moisture (CUSM) at various soil depths at different days after sowing (DAS) under optimal irrigation in 2010–11. Non-significant associations of RLD with CUSM in figures were represented with open circles.