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Short Communication

Effect of different soil moisture regimes on biomass partitioning and yield of chickpea genotypes under intermediate zone of J&K

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Chickpea (*Cicer arietinum* L.) is most important pulse crop in the Indian sub -continent. It is generally grown on stored soil moisture, making terminal drought stress a major constraint to productivity. A considerable area of about 43,435 ha remains unutilized during r*abi* season in most parts of the intermediate zone and foothills of the Shivalik ranges in subtropical rainfed area of Jammu region especially after the harvest of long duration rice and maize crops. Chickpea can be a good alternate crop under these conditions to encourage double cropping in otherwise mono-cropped area. As the temperature during sowing time varies in different growing areas of Jammu province due to variable agro-climatic conditions so there is a requirement of chickpea genotypes that can perform well across these regions. On the other hand water deficit is another constraint in the area during crop growth. However, the influence of water deficit on distribution of assimilate depends on stage of the growth and relative sensitivity of various plant organs to water deficit. Greater proportions of photosynthates are allocated to pods and seeds when the crop is stressed after flowering or when raised completely without irrigation (Deshmukh *et al*. 2004). The development of moisture stress leads to a wide range of changes in plant processes like diversion of biomass to undesirable plant parts. The chickpea genotypes with better biomass partitioning and mobilization efficiency will be suitable for cultivation in the rainfed. Therefore, the present investigation was conducted with the objectives to identify suitable chickpea genotypes that can perform well under water deficit conditions and can be used as substitute of wheat crop in rice-wheat or maize-wheat cropping system and to increase the production of *rabi* pulse in the region.

The experimental material consisted of 10 cultivars obtained from IARI, New Delhi. These genotypes were planted in randomized block design with three replications at Regional Agricultural Research station, SKUAST-J, Rajouri during r*abi* season 2007-08 and 2008-09. Each plot consisted of 4 rows of 3 m length with row to row and plant to plant spacing of 40 x 10 cm. Each genotype was sown under two environments, namely irrigated and rainfed. The recommended agronomic packages of practices and plant protection measures were followed for raising the crop successfully. There was no rain during the growing season. Plants were taken randomly from each replication for recording growth parameters. Recording of biomass in leaves, stem and other reproductive plant parts (seeds/pod) was done at two growth stages i.e., at full bloom and physiological maturity for all the genotypes under different environments. Five plants were taken out randomly from each plot with roots by digging of soil and thereafter thorough washing of roots was done under gently running water. After washing plants were separated into different parts viz., leaves, stem, pods and root for recording observations on partitioning of biomass. The height of shoot and root length was measured from soil surface (crown position) to terminal point and the tip of root, respectively. The average of five plants in each replication was worked out for each treatment. The plant parts were dried at 70^{0}C temperature till constant weight. Yield attributes were recorded from five plant samples taken from each plot at harvest. Seed and biological yield were recorded from individual plants. The statistical analysis for different parameters and yield was done as per standard procedures.

Chickpea plants attained the maximum plant height and rooting depth at full bloom stage (Table 1). Moisture stress reduced the plant height significantly but the reverse was true for root depth. Among genotypes, the plants of PUSA-1103 were the tallest followed by BGD-72 at full bloom stage. However, the roots of PUSA-1053, PUSA-1103 and PUSA-362 were statistically at par and penetrated significantly deeper in the soil profile than the roots of other genotypes at full bloom stage.

At full bloom stage, the biomass allocation in roots, leaves and stem was 20.78, 33.15 and 37.24 per cent of total biomass, respectively. The dominating role of the stem, with respect to biomass accumulation, followed by leaves indicate that chickpea needs strong stem to bear more number of pods through increased branching and higher leaf area to produce more food to fill the pods. These findings are in concomitance with the earlier observations (Ahlawat 1990, Singh 1995). Among the genotypes, percentage of total dry matter accumulation in stem, leaves and roots was higher in PUSA-1103, PUSA-1053, PUSA-1108 and PUSA-362. The contribution of stem and leaves increased to total biomass because of less pod development at the time of full booming stage.

Table 1. Biomass partitioning of chickpea genotypes at full bloom and harvest stage under irrigated and rainfed conditions.

Treatment	Full bloom						AT harvest					
	Plant height (cm)	Root depth (cm)	Dry weight/plant (g)				Plant height (cm)	Root depth (cm)	Dry weight/plant (g)			
			Stem	Leaf	Root	Pod			Stem	Leaf	Root	Pod
Environment												
Irrigated	59.5	74.6	4.18(40.1)*	3.95(32.4)	2.99(23.2)	1.77(13.6)	57.9	42.7	7.5(39.9)	2.62(13.8)	1.3(6.9)	7.34(39.1)
Rainfed	52	80.2	3.53(34.3)	3.50(33.9)	1.91(18.3)	1.6(15.4)	51.3	53.3	5.94(37.6)	2.13(13.4)	1.0(66.7)	6.61(41.9)
CD (P=0.05)	7.8	6.5	0.32	4.511	3.5	2.4	6.5	19.5	7.2	4.1	1.08	2.3
Genotypes												
PUSA-1103	42.2	52.2	3.55(29.0)	4.03(33.0)	1.62(13.2)	3.16(25.8)	41.2	42.2	5.91(27.9)	2.77(12.9)	1.78(8.4)	10.67(50.6)
BGD-72	41.2	51.4	2.98(33.1)	3.2(35.6)	1.45(16.1)	1.36(15.1)	40.8	23.5	4.68(33.3)	2.09(21.2)	0.6(14.1)	5.77(41.1)
PUSA-1053	41.2	54.5	3.33(31.3)	3.17(29.8)	1.97(18.5)	2.15(20.2)	32.2	29.2	4.27(29.2)	2.74(18.5)	1.05(7.2)	6.55(44.9)
PUSA-1105	37.8	47.5	2.49(25.4)	3.19(32.7)	1.77(18.0)	2.33(23.7)	31.9	31.4	4.18(25.3)	2.53(15.2)	1.02(6.2)	8.66(53.1)
PUSA-372	35.9	49.5	2.28(24.4)	3.09(33.2)	1.70(18.2)	1.21(12.9)	30.8	37.5	3.49(25.3)	2.54(18.3)	1.68(12.8)	6.04(43.9)
PUSA-1108	33.2	50.2	2.17(26.4)	3.15(38.5)	1.38(16.9)	1.48(18.1)	30.2	32.1	5.09(33.9)	1.68(10.8)	1.77(11.5)	6.61(43.9)
PUSA-362	33.2	52.1	2.68(27.0)	3.21(35.5)	1.67(16.9)	2.31(23.3)	29.2	40.2	5.86(26.8)	2.68(12.1)	2.5(11.5)	10.76(49.4)
PUSA-1003	29.2	46.4	2.47(31.4)	3.56(45.3)	0.5(6.36)	1.32(16.7)	24.2	18.8	7.5(39.9)	2.62(13.8)	1.3(6.9)	7.34(39.1)
PUSA-256	27.7	45.2	3.05(33.5)	3.30(36.3)	0.8(8.78)	1.86(20.4)	25.5	20.5	5.94(37.5)	2.13(13.4)	1.0(66.7)	6.61(41.9)
PUSA-391	24.8	39.6	2.07(25.9)	3.49(43.8)	1.06(13.2)	1.36(17.0)	21.7	18.3	6.56(38.6)	2.62(15.0)	0.95(5.4)	7(40.9)
CD (P=0.05)	4.6	0.59	0.1	0.21	0.31	0.28	1.07	0.7	0.37	0.255	4.8	0.32

*Values in parenthesis are per cent contribution to total biomass

At harvest, moisture stress reduced accumulation of dry matter in different plant parts significantly. The dry matter accumulation in vegetative parts (leaves and roots) decreased at harvest as compared to full bloom stage due to mobilization of biomass to the active sink (pods). The mild moisture stress did not affect the biomass partitioning in chickpea but severe moisture stress reduced the allocation of biomass to seeds, pods and root in spite of increase in root length over irrigated control. At harvest, the functional rooting depth decreased as compared to full bloom (Table 1).

Yield attributes viz., number of effective pods/plant, seeds/pod and 100- seed weight along with seed and biological yield and harvest index decreased significantly with increased moisture stress (Table 2). Among the genotypes, the highest pod density and 100-seed weight were observed in PUSA-1103 and seeds per pod were recorded in PUSA-1105 and PUSA-372. Lower harvest index was recorded among all the genotypes in severe moisture stress in environment indicating that the vegetative growth (source) was relatively less affected than the sink. Therefore, only few pods were formed in each plant resulted in more adversely reduced seed yield than the biomass accumulation. Similar reduction in yield attributes under rainfed condition has been reported by Rahman and Uddin (2000) and Kashiwagi *et al.* (2006a). The maximum biomass, seed yield and harvest index were recorded in PUSA-1103. However, the seed yield of PUSA-1103 and BGD-72 were statically at par and significantly higher than all the other tested genotypes. Similar genotypic variation in yield and its attributes in chickpea under moisture stress have already been reported (Kashiwagi *et al*. 2006b).

Table 2. Yield attributes of chickpea genotypes under irrigated and rainfed conditions.

Treatment	Effective pods/ plant	Seeds/ pod	100-seed weight (g)	Seed yield (kg/ha)	Biological yield (kg/ha)	Harvest index (%)
Environment						
Irrigated	67.6	1.3	26.6	1900.0	8158.3	23.4
Rainfed	55.1	1.4	21.5	1683.3	7516.6	22.7
CD (P=0.05)	7.1	0.6	7.1	571.5	445.0	3.7
Genotypes						
PUSA-1103	97.5	1.5	28.3	2966.6	10283.3	31.4
PUSA-1105	93.1	1.8	27.1	1816.6	7100.0	25.6
PUSA-362	77.8	1.4	14.1	2225.7	8000.0	27.7
PUSA-1108	70.3	1.3	21.8	2058.3	9116.6	22.7
PUSA-391	73.7	1.1	21.2	2016.6	8333.3	24.1
BGD-72	67.7	1.1	28.1	2016.6	7450.0	27.0
PUSA-1003	67.8	1.1	24.7	1600.0	6541.6	24.4
PUSA-256	64.5	1.2	25.1	2008.3	8266.6	24.3
PUSA-372	59.8	1.7	13.4	1316.6	6950.0	19.1
PUSA-1053	58.7	1.3	23.6	2116.6	9441.6	22.3
CD (P=0.05)	1.8	0.08	3.2	340.0	668.9	3.6

The associations of biomass partitioning in different plant parts with seed yield at both the stages were observed. At full bloom stage, chickpea showed significant positive association of seed yield with plant height (0.41) and total biomass (0.73). Omar and Singh (1997) reported that plant height had the highest direct effect on biomass yield and consequently to higher seed yield. However, at harvest, these associations further increased over full bloom. Seed yield at harvest had significant positive association with plant height (0.40). Among the yield attributes, with seed yield, the highest association was recorded with number of pods per plant (0.67) and biological yield (0.69). However, the biological yield had highest association (r=0.81) with seed yield. Significant positive association with biomass partitioning in plant parts indicated that higher biomass yield and its maximum partitioning in pods brought about positive improvement in seed yield of chickpea under moisture stress condition.

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