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Effect of soil moisture stress on physiological process of plant and yield of pigeonpea genotypes

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Abstract
Present investigation was carried out in rainout shelter at PGI, Field, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar (Maharashtra) Fifty genotypes were evaluated in Randomized Block Design with two replications in two separate experiments one under moisture stress only one irrigation and another control three irrigation condition. The studies revealed that the water stress had a strong influence on the growth, yield and physiological character of pigeonpea genotypes under study. Significant differences were observed amongst the genotypes for mean values of dry matter production observations and yield under moisture stress and control conditions. Under control condition the genotypes *viz*., PT-04-292, PT-04-164, PT-04-382 and PT-04-251 found to be promising for yield and yield contributing characters. The performance of genotypes *viz.*, PT-0012, PT-011-6, PT-04-378 and PT-04-259 were found better for most of the morphological characters and yield contributing attribute under moisture stress condition. The genotypes PT-0012, PT-011-6, PT-04-378 and PT-04-259 exhibited higher value dry matter production and grain yield per hector. Therefore, these genotype can be used as a donar for drought tolerance in further breeding programme for developing the drought tolerance varieties in pigeonpea.

Keywords: pigeonpea, soil moisture, dry matter production and yield

Introduction
Pigeonpea (*Cajanus cajan* (L.) Millsp) belonging to the family leguminosae and sub-family papilionaceae holds prestigious position among all the legume crops and it plays an important role in food security and balanced diet (Saxena *et al.*, 2002) [3]. It is mainly used as 'dhal' (Dry, dehulled split seeds) and it virtually an indispensable item in kitchen. Pigeonpea is known by several vernacular names as Red gram, Arhar, Angola pea, Congo pea etc. Pigeonpea is predominantly a self pollinated crop although cross pollination occur upto 40 per cent (Singh, 2003) [2]. Pigeonpea has an inherent ability to withstand environmental stresses especially drought. Pigeonpea is an important component of farming system because of its ability to fix atmospheric nitrogen (Singh, 2003) [2]. Its deep root system improves physical properties of soil and allows extraction of moisture from deep layer of soil. With an unprecedented increasing world population and declining food productivity due to various abiotic stresses like water, it has become imperative to search for avenues of sustaining productivity while minimizing losses due to vagaries of monsoon. Drought is a situation when the actual seasonal rainfall is deficit by more than twice the mean deviation (Ramdas, 1960) [1]. Relevant definition of agricultural drought appears to be a period of dryness during the crop season, sufficiently prolonged which adversely affect the crop yield. The extent of yield loss depends on the crop growth stage and degree of stresses. Drought is the major constraint which reduces the productivity of crop. It is known that pigeonpea thrives well under drought prone condition. However, there is a great variability for yield performance of different pigeonpea genotypes under drought condition. Attempts to measure the degree of tolerance with a single parameter have limited value because of the multiplicity of the factors and their interactions contributing to drought tolerance under field conditions.

Materials and Method
A field experiment on pigeonpea was conducted at in Rainout shelter at Post Graduate Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar. The present investigation was undertaken during the *Kharif*season. The field experiment was consisting of Fifty genotypes were evaluated in Randomized Block Design with two replications in two separate experiments one under moisture stress only one irrigation and another control three irrigation condition. The studies revealed that the water stress had a strong influence on the growth, yield and physiological character of pigeonpea genotypes under study. Under control condition the

genotypes *viz*., PT-04-292, PT-04-164, PT-04-382 and PT-04-251 found to be promising for yield and yield contributing characters.

The performance of genotypes *viz*., PT-0012, PT-011-6, PT-04-378 and PT-04-259 were found better for most of the morphological characters and yield contributing attribute under moisture stress condition. Therefore, these genotype can be used as a donar for drought tolerance in further breeding programme for developing the drought tolerance varieties in pigeonpea.

Results and Discussion

1. Rate of Photosynthesis at 50 per cent flowering

The genotype PT-04-31 recorded significantly the highest rate of photosynthesis (19.15 µmol m^{-2} s^{-1}) which was at par with PT-0012 (18.95 µmol m^{-2} s^{-1}) under moisture stress condition. The genotype PT-0012 recorded significantly the highest rate of photosynthesis (26.8 µmol m^{-2} s^{-1}) which was at par with PT-04-31 (24.7 µmol m^{-2} s^{-1}) under control condition. The genotype ICPL-87 recorded significantly the lowest rate of photosynthesis (13.5 µmol m^{-2} s^{-1}) which was at par with PT-011-18 (14.5 µmol m^{-2} s^{-1}) under moisture stress condition. The genotype PT-011-21 recorded significantly the lowest rate of photosynthesis (21.05 µmol m^{-2} s^{-1}) which was at par with PT-04-264 (21.55 µmol m^{-2} s^{-1}) under control condition.

2. Rate of transpiration at 50 per cent flowering

The genotypes PT-04-382 recorded significantly the highest rate of transpiration (3.66 mmol m^{-2} s^{-1}) which was at par with PT-03-62 (3.62 mmol m^{-2} s^{-1}) under moisture stress condition. The genotype PT-03-62 recorded significantly the highest rate of transpiration (4.4 mmol m^{-2} s^{-1}) which was at par with PT-378 (4.26 mmol m^{-2} s^{-1}) under control condition. The genotype PT-0012 recorded significantly the lowest rate of transpiration (2.95 mmol m^{-2} s^{-1}) which was at par with PT-04-31 (3.07 mmol m^{-2} s^{-1}) under moisture stress condition. The genotype PT-0012 recorded significantly the lowest rate of transpiration (3.61 mmol m^{-2} s^{-1}) which was at par with PT-04-273 (3.79 mmol m^{-2} s^{-1}) under control condition.

3. Stomatal conductance at 50 per cent flowering

The genotypes PT-0012 recorded significantly the highest stomatal conductance (0.452 µmol H_2O m^{-2} s^{-1}) which was at par with PT-04-31 (0.422 µmol H_2O m^{-2} s^{-1}) under moisture stress condition. The genotype PT-0012 recorded significantly the highest stomatal conductance (0.608 µmol H_2O m^{-2} s^{-1}) followed by PT-04-31 (0.577 µmol H_2O m^{-2} s^{-1}) under control condition. The genotype ICPL-87 recorded significantly the lowest stomatal conductance (0.325 µmol H_2O m^{-2} s^{-1}) which was at par with PT-011-18 (0.326 µmol H_2O m^{-2} s^{-1}) under moisture stress condition. The genotype PT-04-343 recorded significantly the lowest stomatal conductance (0.480 µmol H_2O m^{-2} s^{-1}) which was at par with ICPL-87 (0.485 µmol H_2O m^{-2} s^{-1}) under control condition.

4. Chlorophyll content (SPAD) at 50 per cent flowering

The genotype PT-0012 recorded significantly the highest chlorophyll content (45.8 %) which was at par with PT-04-217 (45.45 %) under moisture stress condition. The genotype PT-04-217 recorded significantly the highest chlorophyll content (53.75 %) which was at par with PT-011-18 (53.1%) under control condition. The genotype PT-011-6 recorded significantly the lowest chlorophyll content (40.15 %) which was at par with PT-04-382 (40.65 %) under moisture stress condition. The genotype PT-04-382 recorded significantly the lowest chlorophyll content (49.60 %) which was at par with PT-04-230 (49.65 %) under control condition.

5. Relative leaf water content (RLWC) at 50 per cent flowering

The genotype PT-0012 recorded significantly the highest amount of RLWC (63.35 %) which was at par with PT-04-31 (62.90 %) under moisture stress condition. The genotype PT-04-321 recorded significantly the highest amount of RLWC (81.20 %) which was at par with PT-04-31 (80.95 %) under control condition. The genotype PT-04-259 recorded significantly the lowest amount of RLWC (54.98 %) which was at par with PT-78-04 (56.80 %) under moisture stress condition. The genotype PT-04-259 recorded significantly the lowest amount of RLWC (72.80 %) which was at par with PT-04-329 (74.65 %) and PT-78-04 (74.95%) under control condition.

6. Grain yield per hector

The grain yield per hectare was higher under control condition than moisture stress condition the yield per hectares ranged between 17.92 to 32.32 (q) per hectares under control condition. The genotypes PT-04-292 and PT-4-221 recorded highest and lowest yield under control condition. The genotype PT-04-169 and PT-0012 recorded the lowest and highest yield per hectare. (4.93) and (9.59 q) under moisture stress condition respectively.

Table 1. Rate of photosynthesis, rate transpiration and stomatal conductance at 50 percent flowering of pigeonpea genotypes

Genotypes	Rate of Photosynthesis (µmol m^{-2} sec^{-1})	Rate of Transpiration (mmol m^{-2} sec^{-1})	Stomatal conductance (µmol m^{-2} sec^{-1})
PT-78-04	14.95	3.13	0.375
PT-04-138	15.50	3.16	0.367
PT-04-164	16.60	3.12	0.383
PT-04-175	15.40	3.17	0.357
PT-04-267	16.00	3.15	0.357
PT-04-360-1	16.00	3.41	0.366
PT-04-365	16.00	3.14	0.345
PT-03-62	15.50	3.62	0.359
PT-03-124	15.80	3.51	0.367
PT-04-169	15.00	3.47	0.364
PT-04-194	16.00	3.24	0.358
PT-04-217	15.90	3.25	0.357
PT-04-221	16.50	3.14	0.354
PT-04-230	16.00	3.27	0.366
PT-04-259	15.60	3.25	0.369
PT-04-261	15.30	3.25	0.360
PT-04-264	14.50	3.57	0.358

PT-04-292	14.50	3.15	0.369
PT-04-312	16.50	3.27	0.355
PT-04-316	15.70	3.26	0.365
PT-04-321	15.10	3.46	0.349
PT-04-329	15.00	3.26	0.357
PT-04-336	15.70	3.13	0.369
PT-04-356	15.10	3.55	0.370
PT-04-373	15.05	3.29	0.357
PT-04-378	16.50	3.32	0.366
PT-04-382	16.70	3.66	0.347
PT-04-386	16.50	3.49	0.358
PT-04-391	15.00	3.17	0.356
PT-04-257-1	15.50	3.47	0.355
PT-04-281	15.50	3.13	0.354
PT-04-348-2	15.50	3.44	0.326
PT-04-415-1	15.75	3.15	0.357
Khirpuri Local	16.50	3.46	0.365
PT-011-6	16.50	3.46	0.358
PT-011-14	15.25	3.26	0.326
PT-011-15	16.80	3.47	0.346
PT-011-16	14.95	3.45	0.360
PT-011-18	14.50	3.26	0.326
PT-011-21	14.80	3.45	0.366
PT-011-23	16.15	3.26	0.355
PT-011-34	15.15	3.57	0.361
PT-04-212	16.50	3.43	0.364
PT-04-343	15.00	3.34	0.326
PT-03-129-2	15.00	3.15	0.355
PT-04-273	15.65	3.13	0.370
PT-03-148	15.50	3.55	0.367
PT-04-31	19.15	3.07	0.422
ICPL-87	13.50	3.46	0.325
PT-0012	18.95	2.95	0.452
Mean	15.72	3.31	0.359
SE (±)	0.76	0.12	0.007
CD at (5%)	2.17	0.35	0.020

Table 2. Chlorophyll content (SPAD) and RLWC at 50 % flowering and Grain Yield of pigeonpea genotypes

Genotypes	Chlorophyll content (SPAD)	Relative leaf water content (%)	Grain yield (q/ha)
PT-78-04	42.25	56.80	8.43
PT-04-138	43.50	61.80	6.98
PT-04-164	42.50	60.70	7.18
PT-04-175	43.05	59.65	7.76
PT-04-267	42.65	60.20	5.64
PT-04-360-1	43.40	58.80	6.19
PT-04-365	42.50	57.65	7.45
PT-03-62	43.15	58.35	8.07
PT-03-124	43.15	57.75	8.50
PT-04-169	43.55	57.55	4.93
PT-04-194	41.40	61.90	5.01
PT-04-217	45.45	57.95	6.16
PT-04-221	43.35	59.10	5.78
PT-04-230	41.45	58.65	7.93
PT-04-259	43.05	54.98	8.52
PT-04-261	43.55	57.95	7.33
PT-04-264	42.75	60.60	5.47
PT-04-292	42.25	59.70	5.73
PT-04-312	42.80	57.95	6.00
PT-04-316	43.25	57.50	8.20
PT-04-321	42.10	62.80	5.44
PT-04-329	42.55	56.95	5.36
PT-04-336	43.75	58.85	6.38
PT-04-356	43.65	58.00	6.77
PT-04-373	43.60	58.45	5.73
PT-04-378	42.60	57.40	8.76
PT-04-382	40.65	57.90	8.21
PT-04-386	41.75	58.10	6.73
PT-04-391	42.80	59.90	8.47

PT-04-257-1	42.80	57.35	7.13
PT-04-281	42.00	57.65	7.76
PT-04-348-2	42.75	57.70	7.00
PT-04-415-1	42.35	57.95	6.41
Khirpuri Local	43.75	58.05	7.10
PT-011-6	40.15	59.70	9.20
PT-011-14	42.35	59.65	7.53
PT-011-15	42.25	58.35	6.22
PT-011-16	42.55	59.30	5.02
PT-011-18	44.50	61.50	7.59
PT-011-21	43.15	61.75	7.89
PT-011-23	42.25	62.20	7.00
PT-011-34	42.50	60.35	7.22
PT-04-212	42.85	60.95	7.33
PT-04-343	41.60	59.80	6.69
PT-03-129-2	42.30	56.95	7.55
PT-04-273	42.05	60.30	5.20
PT-03-148	42.10	58.95	6.03
PT-04-31	43.70	62.90	6.35
ICPL-87	43.50	61.40	6.65
PT-0012	45.80	63.35	9.59
Mean	42.79	59.19	6.95
SE (±)	0.78	1.44	0.65
CD at (5%)	2.22	4.11	1.85

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