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Drought-induced Changes in Root and Shoot Growth of Pigeonpea [*Cajanus cajan* (L.) Millspaugh]

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Abstract: *Twenty pigeonpea genotypes were sowed separately under rainfed and irrigated condition for evaluating root traits associated to drought tolerance in kharif 2013. The genotype SKNP 1004 was marked by maximum root length, root dry weight and seed yield in both rainfed and irrigated conditions and it showed highest shoot length in rainfed condition. The genotype SKNP 1005 recorded utmost values for shoot length and shoot dry weight in both conditions. The root/shoot ratio were superior for UPAS 120 in rainfed condition while it was highest for SKNP 1003 in irrigated condition. Therefore, SKNP 1004 and SKNP 1005 were rated as most promising genotype for drought tolerance.*

Keywords: *Pigeonpea, Root length, Shoot length, Root/Shoot ratio.*

INTRODUCTION

Pigeonpea [*Cajanus cajan* (L.) Millspaugh] is also popularly known as Redgram, Tur and Arhar. It is one of the major grain legume crops of the tropics and subtropics grown approximately 50 countries which spread in continents of Asia, Africa and America. Drought stress, characterized by low availability of soil moisture and high evapo-transpiration is considered one of the principal causes which decrease crop productivity worldwide Boyer (1982). Pigeonpea is normally cultivated as a rainy crop and is often subjected to water stress at one or several stages of crop growth and development, since it is a long duration crop, drought stress is considered as a severe threat for sustainable crop production in the conditions of climate change. Accordingly, the present study was planned to find out a simple and precise field method to detect genotypic differences in drought tolerance and to quantify loss in yield.

MATERIAL AND METHODS

Twenty genotypes were evaluated in rainfed and irrigated conditions with three replications and maintaining 60 cm (Row to Row) 20 cm (Plant to Plant) spacing. The crop in rainfed condition was sowed just after monsoon. Three irrigations applied in irrigated set after ceasation of monsoon. The crop was raised in protective root structure which is 6 ft. high from the ground level and it was filled with uniform soil. The roots were extracted carefully by removing soil with the help of water. The root and shoot length were measured for five randomly tagged plants at 60 days after sowing and calculated by the mean of five plants. After harvesting, the fresh roots and shoots were sun dried then oven dried for 48 hrs at 60°C, root and shoot dry weight recorded with help of balance and expressed as g/plant. The root dry weight was divided with shoot dry weight for five randomly tagged plants at 60 days after sowing and root shoot ratio calculated by the mean of five plants. The recommended package of practices were adopted during crop period.

RESULTS AND DISCUSSION

Identification of a drought tolerant variety of pigeonpea is a difficult task for several reasons because so many attributes are related to drought tolerance. It is highly impossible to have a genotype possessing all these attributes responsible for drought tolerance. For the selection of such genotypes, the study on root traits related to plant

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Table 1
Dry matter production and their distribution in component parts of plant under rainfed and irrigated conditions (g/plant).

Genotypes	*Root length (cm)*		*Shoot length (cm)*		*Root dry weight (g/plant)*		*Shoot dry weight (g/plant)*		*Root/Shoot ratio*		*Seed yield (g/plant)*	
	I_0	I_1	I_0	I_1	I_0	I_0	I_0	I_1	I_0	I_1	I_0	I_1
GT 101	52.93	38.00	36.27	54.93	0.46	0.26	0.88	2.12	0.52	0.12	23.02	59.21
UPAS 120	41.53	34.40	24.93	48.20	0.44	0.19	0.51	1.65	0.87	0.11	15.96	49.29
SKNP 0615	46.93	34.87	32.33	43.33	0.28	0.16	0.55	1.61	0.52	0.10	19.21	46.66
SKNP 0616	48.87	25.67	25.40	43.73	0.30	0.23	0.90	1.59	0.34	0.15	17.58	53.28
SKNP 0805	53.80	36.33	36.33	56.83	0.51	0.29	0.89	2.24	0.57	0.13	24.74	61.87
SKNP 0904	45.07	28.43	26.13	45.20	0.27	0.19	0.56	1.41	0.48	0.13	18.77	46.50
SKNP 0905	35.30	33.67	33.00	53.40	0.30	0.17	0.66	2.01	0.46	0.09	19.55	51.84
SKNP 0920	47.87	34.90	33.47	45.87	0.32	0.18	0.69	1.39	0.46	0.13	17.16	50.25
SKNP 1001	45.27	32.33	32.93	48.67	0.34	0.20	0.62	1.55	0.56	0.13	18.04	45.94
SKNP 1003	34.60	23.67	24.93	43.27	0.22	0.20	0.84	1.13	0.26	0.18	14.25	38.22
SKNP 1004	57.47	47.87	38.80	57.20	0.56	0.38	0.93	2.28	0.61	0.17	29.81	65.11
SKNP 1005	56.20	44.47	37.90	58.33	0.52	0.34	0.95	2.35	0.55	0.15	28.71	61.28
SKNP 1006	42.33	24.47	29.13	50.90	0.37	0.18	0.44	1.84	0.84	0.10	17.64	46.62
SKNP 1211	43.07	26.37	30.80	51.73	0.27	0.21	0.63	1.87	0.43	0.11	16.59	49.27
SKNP 1216	40.53	24.67	30.27	51.67	0.26	0.18	0.71	1.86	0.37	0.10	18.25	47.67
SKNP 1217	40.07	24.47	25.53	48.07	0.28	0.20	0.56	1.48	0.54	0.14	19.19	50.65
SKNP 1109	53.07	35.87	35.28	55.07	0.41	0.21	0.85	2.05	0.49	0.10	21.88	52.11
SKNP 1008	36.40	25.27	28.93	46.20	0.26	0.23	0.66	1.46	0.40	0.16	17.56	46.43
SKNP 1021	52.80	36.67	34.33	54.00	0.45	0.25	0.80	2.11	0.56	0.12	22.69	60.76
BANAS	52.40	35.73	34.27	53.53	0.44	0.23	0.58	1.99	0.75	0.11	23.30	56.35
S.Em ±	2.43	1.54	1.70	2.03	0.02	0.01	0.04	0.09	0.04	0.01	0.98	2.37
CD at 5%	6.96	4.41	4.87	5.80	0.05	0.04	0.12	0.26	0.13	0.03	2.79	6.79
CV %	9.10	8.24	9.35	6.95	7.88	10.40	10.4	8.83	14.4	12.4	8.37	7.92

I_0 : Rainfed condition, I_1 : Irrigated condition, DTE: Drought tolerance efficiency, DSI: Drought susceptibility index.

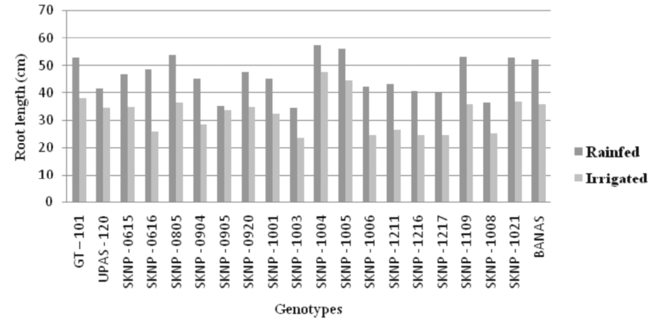

Figure 1: Effect of rainfed and irrigated conditions on root length at 60 days after sowing

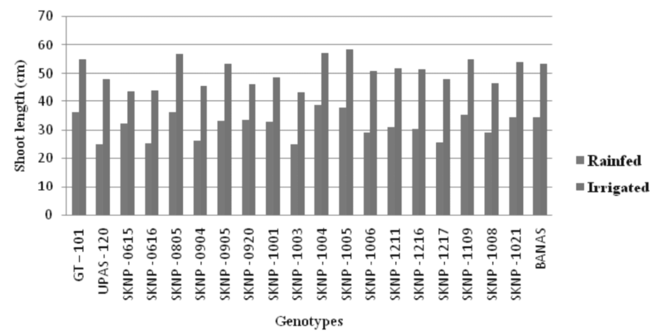

Figure 2: Effect of rainfed and irrigated conditions on shoot length at 60 days after sowing

parts is essential. Twenty pigeonpea genotypes were evaluated for drought tolerance with the attributes like root length, shoot length, root dry weight, shoot dry weight, root shoot ratio and seed yield.

The perusal of the table 1, which represent data of rainfed and irrigated conditions revealed that, the genotype SKNP 1004 was marked by maximum root length. Root elongation during drought help plants to get deeper water, thus avoiding water deficits near the soil surface. Deeper root penetration is potentially an important component of drought resistance, greater proportion of the plant's assimilates can be distributed to the root system, where they can support further root growth. Enhanced root growth into moist soil zones during stress requires allocation of assimilates to the growing root tips. Similar results of increase in root length under moisture stress were recorded by Hossain *et al.* (2014).

In rainfed condition the genotype SKNP 1004 maintained significantly higher shoot length while in case of irrigated condition SKNP 1005 obtained maximum shoot length. The reduction in shoot growth under induced drought stress originates not only from growth inhibitions but also from a loss of

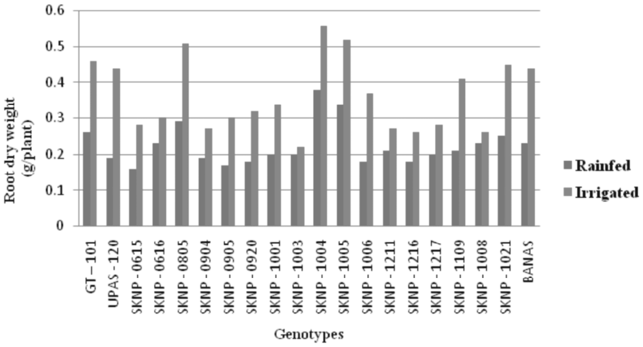

Figure 3: Effect of rainfed and irrigated conditions on root dry weight at 60 days after sowing

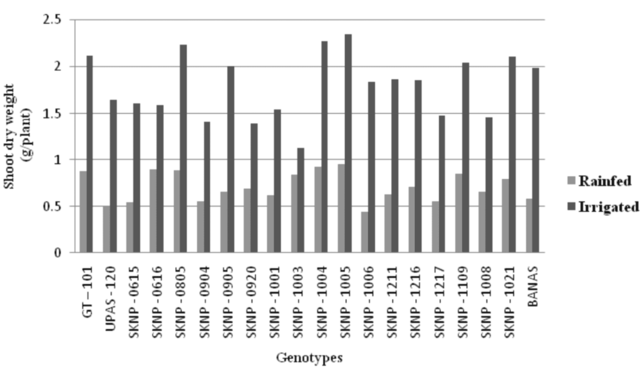

Figure 4: Effect of rainfed and irrigated conditions on shoot dry weight at 60 days after sowing

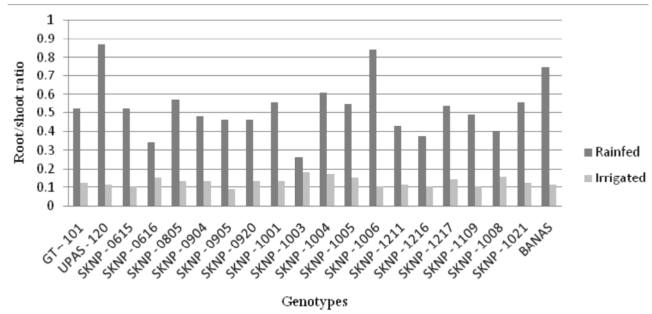

Figure 5: Effect on root/shoot ratio of rainfed and irrigated conditions at 60 days after sowing.

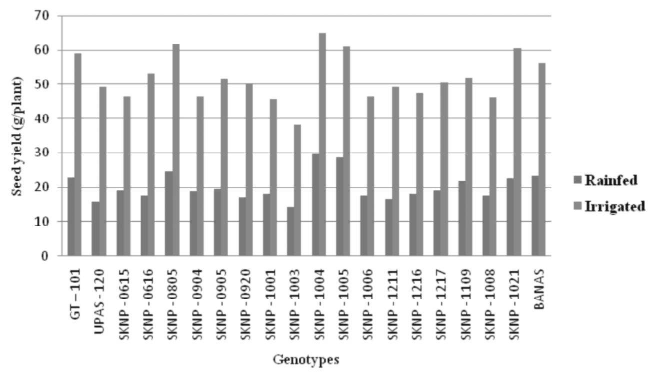

Figure 6: Effect of rainfed and irrigated conditions on seed yield per plant

turgidity. The translocation of assimilates towards the roots due to decreases in shoot growth. Similar results of reduced shoot length were also recorded by Kibreab *et al.* (2013).

In both rainfed and irrigated conditions the genotype SKNP 1004 showed superiority for the value of root dry weights. Plant productivity under drought stress is strongly related to the processes of dry matter partitioning and biomass distribution. Elongation of the taproots in the rainfed plants occurred at the expense of thickening. These results were also supported by Kataria and Singh (2014).

The genotype SKNP 1005 recorded maximum shoot dry weight in rainfed and irrigated over the rest of other genotypes. The results showed that water stress reduced shoot dry weight even partial dried root systems can lead to decreased allocation of photosynthates to vegetative shoots. Longer roots may reduce shoot dry weight by allowing the partitioning of photosynthate towards roots at the expense of shoots. Water stress lowers the cell turgor and causes slower cell expansion, consequently growth and development of a plant decreased that leads to a lower shoot dry weights. The results of the present study is similar to the findings of Amira and Qados (2014).

The rainfed data showed that utmost root/shoot ratio was observed by the genotype UPAS 120, while in irrigated condition the genotype SKNP 1003 had most prominent root shoot ratio across the left over genotypes. Plants in dry conditions often decrease biomass production and contribute more biomass to roots, maintaining a higher root shoot ratio as an adaptation trait to drought resistance. High root/shoot ratio was found to increase water uptake and have a positive effect on yield under stress. Similar results of increased root shoot ratio were recorded by Uddin *et al.* (2013).

SKNP 1004 is characterized by highest seed yield under rainfed as well as irrigated conditions. Drought inhibited growth by reducing rate of cell division and cell expansion, leaf size, stem elongation as well as root proliferation, by disturbing stomatal oscillations, metabolic activities, plant water and nutrient relations, loss of pollen and stigma viability which affects yield components and all together decreases seed yield. Moisture stress reduced yield due to poor partitioning operated along with terminal drought stress. The present study was supported by Ahmed and suliman (2010).

SUMMARY AND CONCLUSION

It is concluded from results that the genotype SKNP 1004 was found to be a boon for drought tolerance followed by SKNP 1005 under rainfed as well as irrigated conditions. Therefore on the basis of these observations, SKNP 1004 was rated as most promising genotype due to highest seed yield under rainfed as well as irrigated condition. SKNP 1005 was another promising genotype for yield under rainfed and irrigated condition.

REFERENCES

Ahmed, F.E. and Suliman, A.S.H. (2010), Effect of water stress applied at different stages of growth on seed yield and water-use efficiency of Cowpea. *Agriculture and Biology Journal of North America*. **1**(4): 534-540.

Amira, M. S. and Qados, A. (2014), Effect of Ascorbic Acid antioxidant on Soybean (*Glycine max* L.) plants grown under water stress conditions. *International Journal on Advanced Research in Biological Science*. **1**(6): 189-205

Boyer, J.S. (1982), Plant productivity and environment. *Science*. **218**: 443-448.

Hossain, M.A.; Mostofa, M.G.; Burritt, D.J. and Fujita, M. (2014), Modulation of Reactive Oxygen Species and Methylglyoxal Detoxification Systems by Exogenous Glycinebetaine and Proline Improves Drought Tolerance in Mustard (*Brassica juncea* L.). *International Journal of Plant Biology & Research*. **2**(2): 1014-1017.

Kibreab, M.; Ghebremariam, Liang Y.; Zhengcai, Z. and Qiaoli, W. (2013), Effect of drought stress on physiological growth parameters of tomato inbred lines at germination stage. *European Scientific Journal*. **9**: 33.

Kataria, N. and Singh, N. (2014), Assesing the effects of aplied potassium on selected *Vigna radiata* L. genotypes under water deficict. *International Journal of Advanced Research* **2**(10): 369-385.

Uddin, S.; Parwin, S. and Awal, M.A. (2013), Morphophysiological aspects of mungbean (*Vigna radiata* L.) in response to water stress.

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