Original Research Article

Discrimination of root system architectural traits, morphometric traits and identification of potential genotypes in response to drought and irrigated conditions in Pearl millet (*Pennisetum glaucum* (L.) R. Br.)

ABSTRACT

Aims: To identify the potential genotypes and the important traits for drought tolerance based on root system architectural traits and morphometric traits that can be used as a selection criteria in future crop improvement programs.

Study design: Completely randomized design for root system architectural traits and Randomized block design with two replications for morphometric traits.

Place and duration of study: Department of Millets, Tamil Nadu Agricultural University, Coimbatore during *Summer* 2022.

Methodology: The 33 elite genotypes were raised in polybags with two factors, one is genotype and other is treatment for observing root system architectural traits. Also these genotypes were raised in the field with two treatments, irrigated and drought at early stage of the crop for observing morphometric traits.

Results: Based on root system architectural traits,the significant traits were network perimeter, network surface area, network length and network volume. Under irrigated and drought condition, high phenotypic coefficient of variation and high genotypic coefficient of variation were observed for single plant yield, high heritability and high genetic advance for days to 50 per cent flowering, plant height, leaf blade length, spike length, 1000 seed weight and single plant yield. Correlation study revealed that all the characters except number of tillers and days to 50 per cent flowering had positive significant correlation with single plant yield. Path analysis showed that spike length had positive direct effect on single plant yield.

Conclusion: The identified traits for drought tolerance werenetwork perimeter, network surface area, network length, network volume, days to 50 per cent flowering, plant height, leaf blade length, spike length, 1000 seed weight and single plant yield. The identified drought tolerant genotypes were *Nattu cumbu*, ICMB 10444, 86M38 and PT 6752.

Keywords: *Drought; pearl millet; stress; correlation; yield; root*

1. INTRODUCTION

Pearl millet (*Pennisetum glaucum (L.) R. Br.*) is appraised as climate resilient nutricereal for providing economic benefits and food security to Nation (Satyavathi *et al*., 2021). It is a nutritious and energy rich feed becoming healthy alternative to staple foods. It comprises antioxidants, carbohydrates, essential amino acids, vitamins like niacin, thiamine, riboflavin, folic acid and minerals like P, Mg, Fe and Zn. Its cultivation is more profitable as it needs less input, short duration, dual purpose of grain and fodder, high adaptation to stress and photosynthetically effective due to its C_4 nature.

It is majorly grown in tropical and sub-tropical parts of Africa and Asia having an annual rainfall less than 400mm. Equally, its cultivation is predominantly practiced on marginal lands under un-irrigated condition, environmental stresses primarily drought is the major constraint towards crop yield. Pearl millet is notable for its drought tolerance, however moisture stress at early and terminal developmental stage affects the yield (Shivhare and Lata, 2017). In Tamil Nadu, the net irrigated area is 9,226 ha which is only 13% of total area growing pearl millet. The majority of area (87%) comes under rainfed cultivation (Tamil Nadu Salient Statistics on Agriculture, 2021). Thus, there is a need for drought tolerant crop to get more yield.

Pearl millet being monocotyledon exhibits fibrous root system. Initially, the roots sense a water shortage so it is the main organ to improve crop tolerance to moisture stress. Root architectural study was rare in pearl millet due to the difficile in taking direct measurements under the soil. Pearl millet is a deep rooting crop and it can withstand under drought conditions (Satyavathi *et al*., 2021). Genetically improved deep-rooted plants is regarded as an essential criteria to enhance water uptake and stable yield (Kondo *et al*., 2003). Variation in root system architecture are observed to increase plant adaptation under stress conditions by improving water extraction (Malamy and Benfey, 1997). Therefore, this experiment was aimed to study the variation of root system architectural traits under irrigated and drought condition.

Genetic variation is the basic principle in plant breeding. It must be present to determine the possible significant increases in the traits. Genetic variability assessment is beneficial in determining the presence and degree of variability. Heritability and genetic advance estimation are useful in choosing selection strategy and suitable breeding method based on the nature of gene actions. Association studies provide nature and magnitude of association between yield and yield related traits as well as analysing direct and indirect effects of traits on yield. Hence, the details on genetic parameters and characters association paved the way for crop improvement.

The objectives of this study were to assess the root system architectural traits in relation to drought tolerance and to screen and identify the potential genotypes for drought tolerance under field condition.

2. MATERIALS AND METHODS

The experiment was conducted during *Summer* 2022 at Department of Millets, TNAU, Coimbatore. The genetic material consists of 33 elite genotypes that were raised in polybags in completely randomized design with two factors, one is genotype and other is treatment. Also these genotypes were raised in the field in randomized block design with two replications and two treatments, irrigated and drought at early stage of the crop. The genotypes taken for study are listed in the table (Table 1).

Table 1. List of genotypes used for drought tolerance screening

S.No	Genotype	S.No	Genotype	S.No	Genotype	S.No	Genotype
1	CO 9	9	ICMB 10444	18	PT 6029	25	*Cumbu 1*

2	TNBH 1619	10	ICMB 99222	19	PT 6475	26	*Cumbu 2*
3	MP 7878	11	ICMB 93111	20	PT 6476	27	*Nattu cumbu*
4	86 M 38	12	ICMB 06111	21	PT 6674	28	*Kattu cumbu 1*
5	CO Cu 9	13	ICMB 1508	22	PT 6679	29	*Kattu cumbu 2*
6	CO 10	14	PT 6752	23	PT 6686	30	*Kattu cumbu 3*
7	*Dhanasakthi*	15	PT 5456	24	PT 6693	31	*Kizhikuppam local*
8	ICMV 221	16	PT 5721			32	*Uthangiri local*
		17	PT 5748			33	*Shoolagiri local*

The clay loamy soil was sieved and mixed with vermicompost and filled in 35 cm polybags. Before sowing, urea (2g), diammonium phosphate (2g), muriate of potash (1g) were put and mix at the top of the soil. Three seeds were sown in one bag at 3 cm depth. After seedling emerges, it was thinned to one seedling per polybag. The plants were irrigated daily until five leaf stage (25 DAS). Then it was divided into two sets, one as irrigated control and other imposed drought for ten days. After 35 DAS, the plants were harvested and its roots were washed and photographed. The root images were analysed in GiA Roots software (Galkovskyi *et al.,* 2012) for RSA traits. The observed root and shoot traits were average root width (diameter), network bushiness, maximum number of roots, median number of roots, network perimeter, network surface area, network length, network volume, plant height, number of tillers, leaf blade length and leaf blade width.

Under field condition, nine morphometric traits *viz.,* days to 50 per cent flowering, number of tillers, plant height, spike length, spike girth, leaf blade length, leaf blade width, 1000 seed weight and single plant yield were taken in randomly selected five plants in each replication in the field under irrigated and drought condition. Drought was given at early stage that is in the vegetative stage of the crop for three weeks by withholding irrigation. All the management practices were followed to maintain the crop stand except irrigation scheduling. All the obtained data pertaining to genetic analysis were statistically analysed using GRAPES version 1.1.0 software (Gopinath *et al.,* 2021) and Window STAT version 7.1.

3.RESULTS AND DISCUSSION

3.1 ROOT SYSTEM ARCHITECTURAL TRAITS

The structure and functioning of plants depend on their roots. It facilitates anchoring of plants in soils and give access to belowground water and nutrients. Plant adaptability to drought stress is significantly influenced by the architecture of the root system. The number and length of the main and lateral roots, as well as the density and length of the root hairs, are all structural factors that comprise the root system architecture (RSA). These characteristics are adaptable in areas with restricted water availability and are necessary to develop crops with effective root systems for drought adaptation. Therefore, in this study a total of thirty three pearl millet genotypes were observed for several root characteristics in relation to water stress.Root studies were rare in pearl millet due to the difficile in taking direct measurements under the soil. So, roots are explored and studied with the help of image processing software (GiA Roots). The identified traits as well as genotypes were utilized in the further breeding works.

The two way ANOVA for RSA traits revealed that the effect of genotype, treatment and the interaction between genotype and treatment were significant for network perimeter, network surface area, network length, network volume, plant height, number of tillers and leaf blade width (Table 2). It indicate that the traits had significant variations and responding to drought and irrigated conditions. Similar findings were reported by Li *et al.* (2018) in lettuce, Nguyen and Stangoulis. (2019) in wheat. These traits were taken into consideration for further crop improvement in pearl millet.

Table 2. Two factor analysis of variance for RSA traits

Source of variation	**Genotype(G)**	**Treatment(T)**	**G X T**	**Error**
Degrees of freedom	32	1	32	65
Average Root Width (Diameter) (cm)	9.37E-06^{ns}	1.22E-06^{ns}	1.56E-05^{ns}	1.08E-05
Network Bushiness (n/n)	0.20^{ns}	0.17^{ns}	0.15^{ns}	0.13
Maximum Number of Roots (n)	759.73**	4148.48**	372.94^{ns}	250.56
Median Number of Roots (n)	315.48**	2112.00**	153.39^{ns}	117.41
Network Perimeter (m)	254.83**	1491.70**	100.57**	38.06
Network Surface Area (cm2)	5742.74**	30367.91**	2050.94**	813.60
Network Length (m)	80.66**	440.66**	31.92**	13.01
Network Volume (cm3)	0.45**	1.56**	0.13**	0.06
Plant height (cm)	263.36**	1941.20**	43.08*	23.01
No of tillers (n)	1.66**	3.34**	1.32**	0.55
Leaf blade length (cm)	99.28**	88.36^{ns}	27.55^{ns}	26.98
Leaf blade width (cm)	0.29**	41.82**	0.11**	0.06

ns – non significant, * - 5% significance, ** - 1% significance

Among the studied root traits like root diameter, network bushiness, maximum number of roots, median number of roots, network perimeter, network surface area, network length and network volume, plants having smaller root diameter, more number of roots, increased root perimeter, increased root surface area, increased root length and increased root volume would better adopt in water stressed conditions. Under drought, root architecture changed by producing more number of lateral roots. It had been found that plants having specified root lengths with fine roots and smaller root diameters were better suited to arid environments. Reduced root elongation in excessively dry soils may be recompensed by increased root surface area and volume provided by root hairs. Hence, the important root traits considered for drought tolerant were network perimeter, network surface area, network length and network volume.

Based on mean performance under irrigated and drought, thirteen groups were formed for network perimeter, network surface area, network length and network volume and seven groups for maximum number of roots and median number of roots. Among thirteen groups, the genotypes *viz., Nattu* *cumbu*, ICMB 10444, PT 6674, PT 5748 possessed higher network perimeter, network surface area, network length, network volume and found to be drought tolerant as it had lengthy root and covered more surface area for effective water absorption (Cosmos *et al*., 2013, Wasaya *et al*., 2018). The genotypes having more maximum number of roots and more median number of roots were *Nattu cumbu, Kizhikuppam local,* PT 6679, ICMB 10444 and PT 5762 and it was considered as drought tolerant as the number of roots increased under drought for better adaptation (Wasaya *et al*., 2018). Alternatively, the genotype *Kattu cumbu 3, Kattu cumbu 2* and PT 6475 possessed lower network perimeter, network surface area, network length, network volume and less maximum number of roots, median number of roots so it was considered as drought susceptible.

All the thirty three genotypes were separated into two groups based on the percentage of drought treated increase over irrigated on root traits. The first group was drought tolerant as the treatment had increased per cent over control. The second group was drought susceptible as the treatment had decreased per cent over control. The increased percentage for network perimeter was possessed by the genotypes *viz.,* ICMB 10444 (32.12%), PT 6029 (30.15%), ICMB 06111 (29.91%), ICMB 1508 (20.78%) and *Nattu cumbu* (15.62%) and for network surface area, the genotypes *viz.,* ICMB 10444 (44.31%), PT 6029 (41.33%), PT 5721 (22.70%), PT 6686 (22.33%) and *Nattu cumbu* (4.58%) had increased root surface area. The genotypes viz., ICMB 10444 (30.89%), *Nattu cumbu* (22.25%), PT 6029 (21.81%), ICMB 1508 (19.95%) and PT 6686 (15.70%) had increases network length and for network volume the genotypes *viz.,* ICMB 10444 (64.81%), PT 6029 (34.73%), PT 6686 (32.65%), PT 5721 (28.48%) and *Cumbu 2* (17.14%) had increased root volume. Thus, the genotype having significant for most of the traits and obtained as drought tolerant were ICMB 10444, PT 6029, PT 6686 and *Nattu cumbu* because these genotypes would better adapt under drought by producing lengthy and voluminous roots (Cosmos *et al*., 2013). Similarly, the genotype ICMB 99222 and *Kattu cumbu 1* were considered as drought susceptible as it had decreased percentage of drought treated over irrigated for most of the traits. Therefore, it would suited under irrigated condition. (Figure 1)

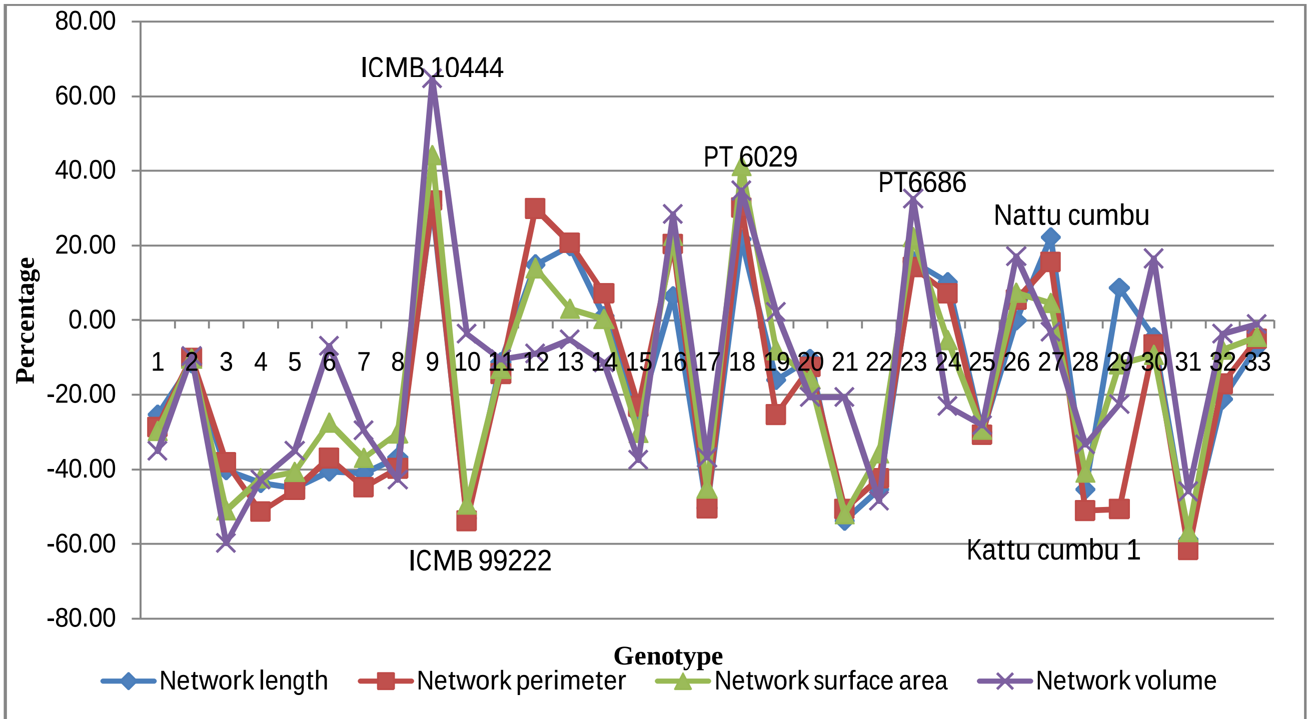


Fig 1. Percentage of drought treated increase over control for RSA traits

Overall, the genotype, *Nattu cumbu* and ICMB 10444 were found to be drought tolerant based on root system architectural traits and percentage of drought treated increase over irrigated.

3.2 MORPHOMETRIC TRAITS

The two way ANOVA on quantitative traits indicated that the genotype effect was significant for all the characters. The effect of treatment and interaction was significant for all the character except spike girth (Table 3). The traits taken for selection to improve the crop were days to 50 per cent flowering, plant height, number of tillers, leaf blade length, leaf blade width, spike length, 1000 seed weight and single plant yield.

Table 3. Two factor analysis of variance for quantitative traits

Source of variation	**Replication**	**Genotype(G)**	**Treatment(T)**	**G X T**	**Error**
Degrees of freedom	1	32	1	32	65
Days to 50% flowering (days)	0.92	135.117**	9.28**	10.624**	0.30
Plant height (cm)	8.81	2760.47**	30584.59**	191.29**	12.45
Number of tillers	0.01	0.45**	11.21**	0.16**	0.03
Leaf blade length (cm)	0.00	205.98**	5353.86**	84.98**	1.81
Leaf blade width (cm)	0.03	0.36**	14.46**	0.18**	0.02
Spike length (cm)	0.11	47.76**	25.37**	4.82**	2.13
Spike girth (cm)	0.28	7.23**	1.72^{ns}	0.71^{ns}	0.64
1000 seed weight (g)	0.28	14.19**	75.52**	1.05**	0.18

Single plant yield (g)	19.31	1148.40**	11099.00**	73.61**	10.51

ns - non significant, ** - 1% significance

The mean of genotypes was less in drought when compared to irrigated condition except days to 50 per cent flowering, it shows early flowering during stress condition. The mean of spike length and spike girth were less deviated in drought. Hence, the traits like days to 50 per cent flowering, spike length and spike girth were taken as selection indices for improving drought tolerance.

Among the genetic variability parameters, the PCV was higher than GCV under both the condition for all the traits which indicates the environmental influence on trait expression. Similar observations were obtained in pearl millet by Subi and Idris (2013), Subbulakshmi *et al*. (2018) and Mithlesh Kumar *et al.* (2020). Under irrigated condition, the high PCV and high GCV were observed for single plant yield and medium PCV and GCV for remaining traits except leaf blade width which had low PCV and GCV. High PCV and high GCV for single plant yield was also observed by Naveen *et al.* (2016) and Subbulakshmi *et al*. (2018) in pearl millet. Therefore, it indicated that greater amount of variability exist among the studied population and selection could be effective for identifying potential traits. High heritability and high genetic advance indicates additive gene effects that elicit effective selection that were observed for all the traits except leaf blade width. Talawar *et al.,* 2017, Singh and Chhabra (2018) also found that high heritability and high genetic advance for spike length, seed weight and yield in pearl millet.

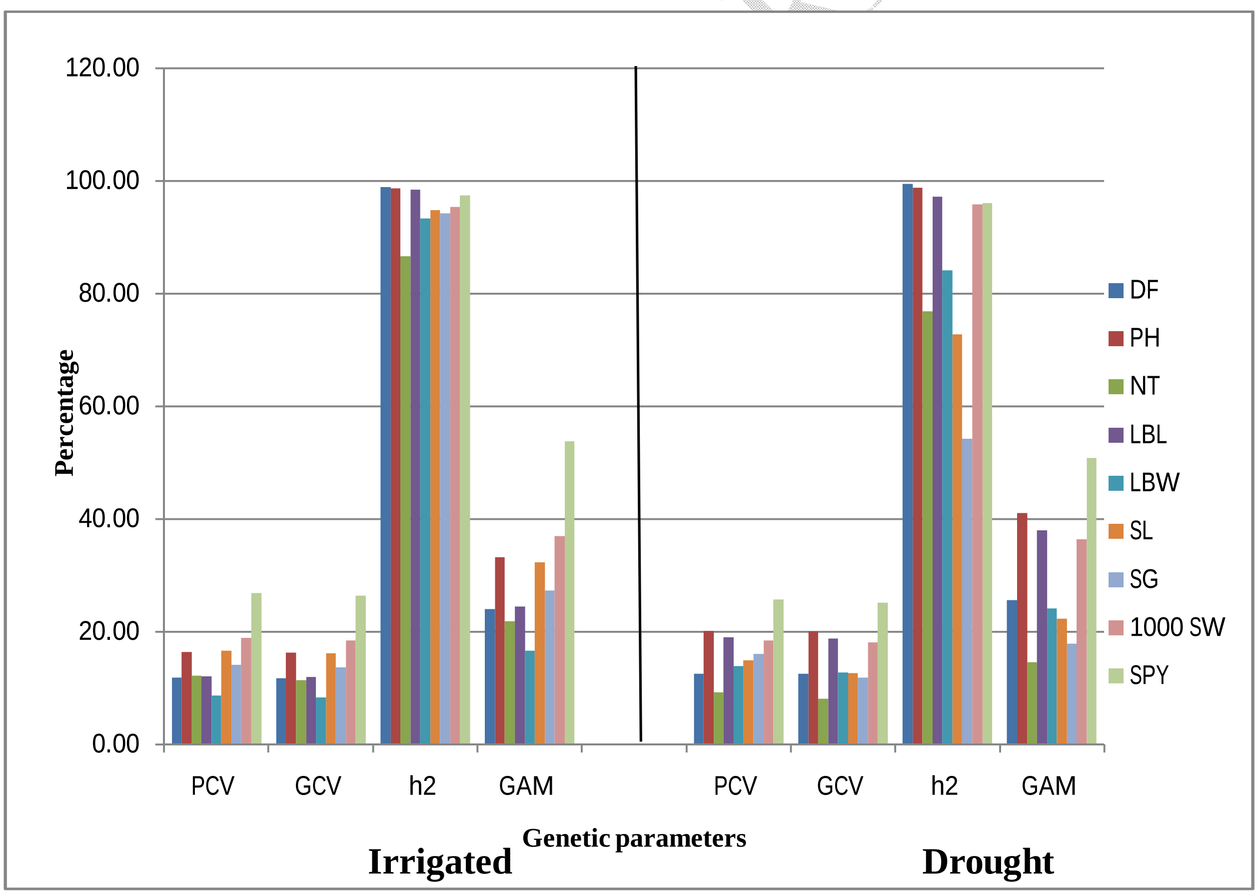
Comparatively in drought condition, high PCV and GCV were observed for single plant yield and plant height. Kumar *et al.* (2014) reported the same in pearl millet for single plant yield under rainfed condition. Medium PCV and GCV were observed for days to 50 per cent flowering, leaf blade length, leaf blade width, spike length, spike girth and 1000 seed weight. Low PCV and GCV were observed for number of tillers. High heritability was observed for all the characters except spike girth and high genetic advance were observed for all the traits except number of tillers and spike girth. High heritability and high genetic advance indicates additive gene effects that elicit effective selection based on these traits. The number of tillers had high heritability and medium genetic advance and spike girth had low heritability and low genetic advance. So, spike girth had non additive gene action and selection would be ineffective (Table 4). Similar findings were acquired by Subbulakshmi *et al*. (2018) for number of tillers had medium genetic advance in pearl millet. Genetic parameters are represented graphically to compare the variations between irrigated and drought condition (Figure 2).

Table 4. Mean, range, genetic parameters for quantitative traits under irrigated and drought

		Mean	Range	PCV	GCV	h^2 % (Broad sense)	GAM
Days to 50% flowering(days)	**I**	49.53	40.50-61.00	11.79	11.72	98.83	24.00
	D	50.06	37.50-60.00	12.49	12.45	99.46	25.59
Plant height(cm)	**I**	166.14	91.22-203.17	16.33	16.23	98.69	33.21
	D	135.69	65.60-186.52	20.17	20.04	98.74	41.02
Number of tillers	**I**	3.97	3.11-4.50	12.20	11.35	86.60	21.77

	D	3.39	2.67-3.83	9.21	8.07	76.79	14.57
Leaf blade length(cm)	**I**	62.77	40.87-71.75	12.04	11.95	98.41	24.41
	D	50.03	35.90-67.98	18.97	18.70	97.11	37.95
Leaf blade width(cm)	**I**	3.44	2.45-3.98	8.64	8.35	93.25	16.60
	D	2.81	1.97-3.51	13.90	12.74	84.04	24.06
Spike length(cm)	**I**	24.33	15.10-32.75	16.56	16.12	94.73	32.32
	D	23.45	15.12-30.71	14.85	12.66	72.72	22.24
Spike girth(cm)	**I**	10.21	6.75-12.68	14.08	13.66	94.16	27.31
	D	9.98	6.00-12.33	15.99	11.78	54.24	17.87
1000 seed weight(g)	**I**	11.31	6.41-14.81	18.81	18.37	95.32	36.94
	D	9.80	5.01-13.28	18.45	18.06	95.75	36.40
Single plant yield(g)	**I**	75.33	25.56-119.00	26.76	26.42	97.43	53.71
	D	56.99	17.89-89.91	25.67	25.16	96.06	50.80

I – Irrigated condition, D – Drought condition, PCV – Phenotypic coefficient of variation, GCV – Genotypic coefficient of variation, h^2 – Heritability, GAM – Genetic Advance as percentage of Mean



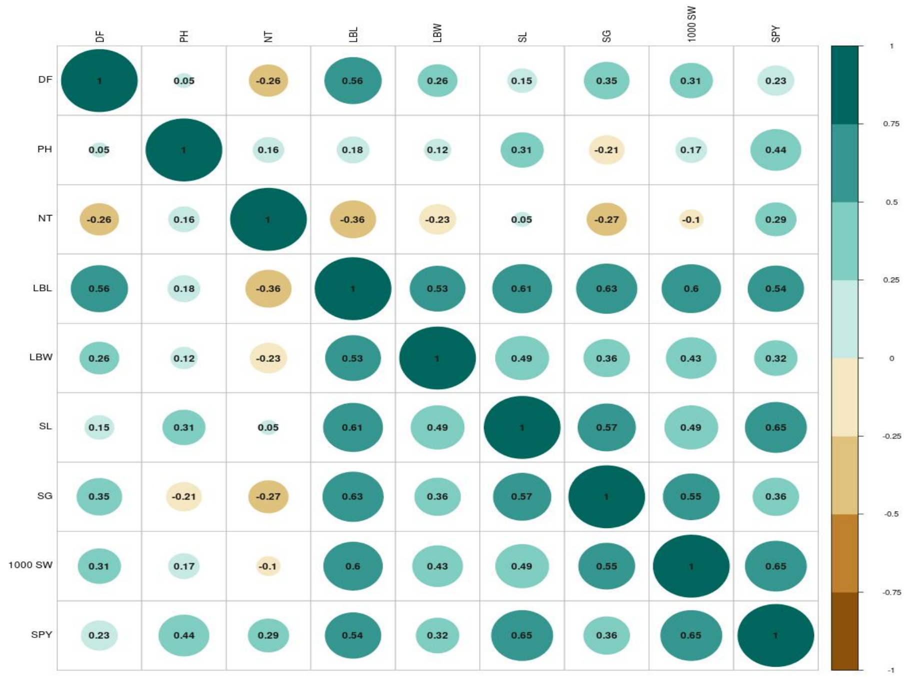
DF - Days to 50% flowering, PH – Plant height, NT – Number of tillers, LBL – Leaf blade length, LBW – Leaf blade width, SL –Spike length, SG – Spike girth, 1000 SW – 1000 Seed weight, SPY – Single plant yield.

Fig 2. Genetic parameters for 9 quantitative traits under irrigated and drought condition

The correlation study analyses the natural relationship between various traits and the path coefficient identify direct and indirect sources of association between traits. Selection based on these traits could be employed to genetically improve the yield. The phenotypic correlation coefficient showed that the single plant yield had positive and significant correlation with plant height, number of tillers, leaf blade length, leaf blade width, spike length, spike girth and 1000 seed weight except days to 50 per cent flowering under irrigated condition (Figure 3). Under drought condition, single plant yield had positive and significant correlation with all the traits except number of tillers (Figure 4). It may be due to the pleiotropy or linkage between the genes that govern those traits. The present result is found to be similar with the early study by Yakubu *et al.* (2015), Talawar *et al.* (2017), Singh and Chhabra (2018) for plant height and panicle length and Sankar *et al.* (2013) for 1000 seed weight, leaf blade width and spike girth in pearl millet.

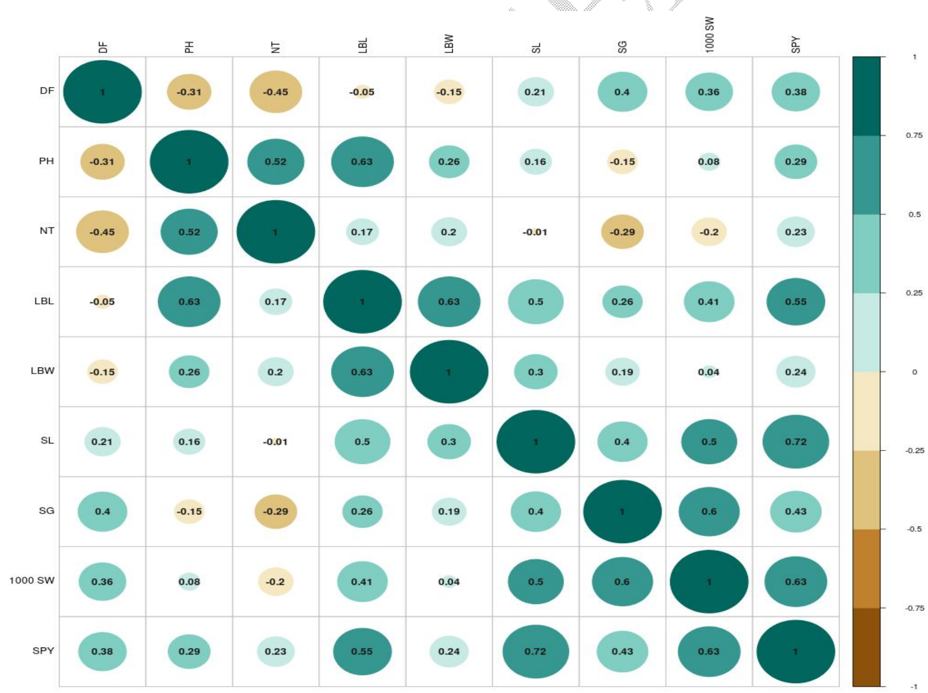
In irrigated condition, inter correlation reported that the plant height had a significant positive correlation with the spike length and single plant yield. Similar report were obtained by Rasitha *et al.* (2019). Number of tillers expressed a negative and significant correlation with days to 50 per cent flowering, leaf blade length and spike girth. This result agreed with Sudarshan Patil *et al.* (2018). Spike length and spike girth had positive and significant correlation with leaf blade length, leaf blade width, 1000 seed weight and single plant yield. The positive significant correlation for 1000 seed weight with days to 50 per cent flowering, leaf blade length, leaf blade width, spike length, spike girth and single plant yield. Sumathi *et al.* (2017) reported similar results that 1000 seed weight had significant positive correlation with single plant yield, spike length and spike girth in pearl millet.

Likewise, in drought condition, inter correlation inform on the plant height had a positive significant correlation with leaf blade length, leaf blade width, number of tillers, single plant yield and negative significant correlation with days to 50 per cent flowering. The number of tillers had negative and significant correlation days to 50 percent flowering and spike girth and significant positive correlation with plant height. Spike length and spike girth had significant positive correlation with leaf blade length, 1000 seed weight and single plant yield. Similar results were noticed by Kumar *et al*. (2014) under rainfed condition for spike length with 1000 seed weight. The significant and positive correlation for 1000 seed weight with days to 50 per cent flowering, leaf blade length, spike length, spike girth, single plant yield.



DF - Days to 50% flowering, PH – Plant height, NT – Number of tillers, , LBL – Leaf blade length, LBW – Leaf blade width, SL –Spike length, SG – Spike girth 1000 SW – 1000 Seed weight, SPY – Single plant yield.

Fig 3. Correlogram for 9 quantitative traits under irrigated condition



DF - Days to 50% flowering, PH – Plant height, NT – Number of tillers, , LBL – Leaf blade length, LBW – Leaf blade width, SL –Spike length, SG – Spike girth 1000 SW – 1000 Seed weight, SPY – Single plant yield.

Fig 4. Correlogram for 9 quantitative traits under drought condition

Path analysis revealed that high direct positive effects of 1000 seed weight (0.43) and spike length (0.273) and negative direct effects of spike girth (-0.053) and number of tillers (-0.078) on single plant yield under optimal condition. Whereas under drought, spike girth (0.986) followed by spike length (0.711), and leaf blade length (0.248) had high positive direct effects and direct negative effects of 1000 seed weight (-0.981) and leaf blade width (-0.189) on single plant yield (Table 5). Hence, these are essential traits to be considered for selection. Similar results were obtained by Kumar *et al.* (2014), Dapke *et al.* (2014) for direct positive effects of spike length and Sankar *et al.* (2013) for spike girth under rainfed condition.

For irrigated, the indirect positive effects of 1000 seed weight on single plant yield through spike girth, spike length and plant height. The present finding agreed with early report by Rasitha *et al.* (2019) for 1000 seed weight with spike length and spike girth. Number of tillers had negative indirect effect on single plant yield through plant height and spike girth. Moreover, under drought conditions, the traits *viz.,* 1000 seed weight, plant height, number of tillers, spike length, days to 50 per cent flowering had indirect positive effects to spike girth on single plant yield. Hence, these traits could be considered for indirect selection.

In pearl millet, genetic variability, correlation and path coefficient analysis under drought condition were previously studied to identify better performed traits and lines of research were important by utilizing these traits for selection in the future breeding program.

Table 5. Genotypic path analysisfor quantitative traits under irrigated and drought

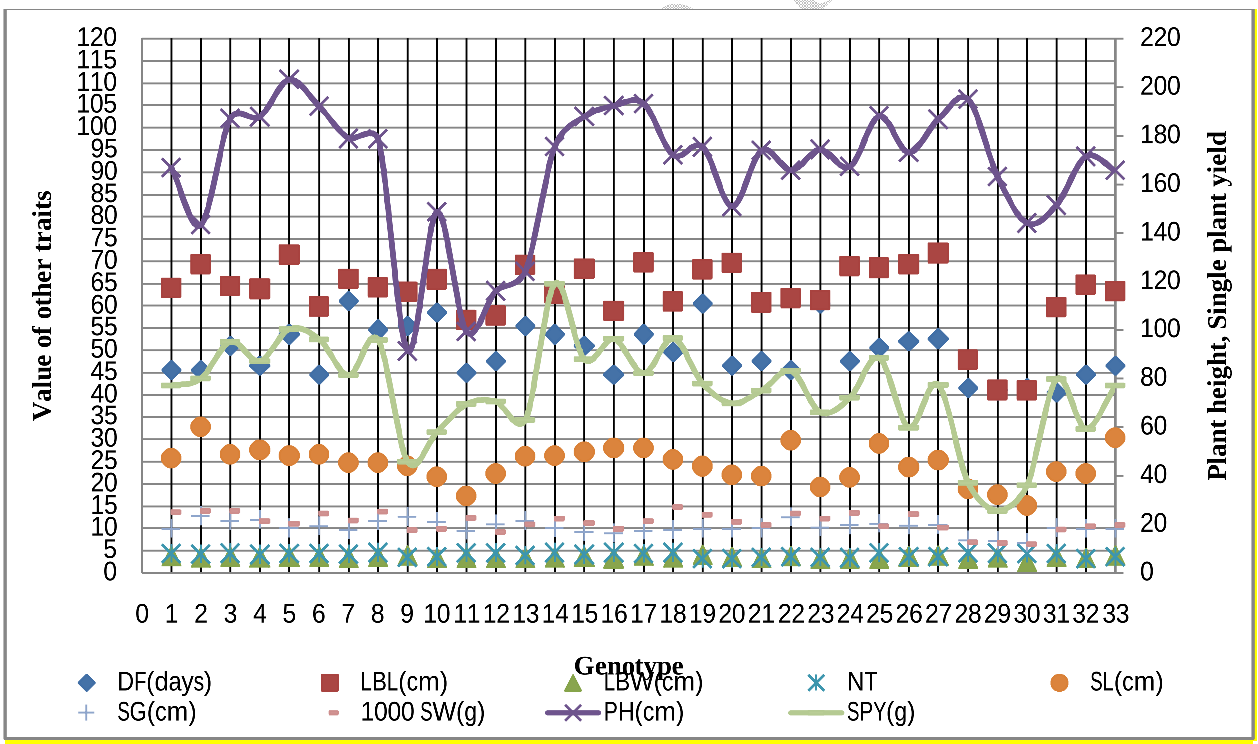
		DF	PH	NT	LBL	LBW	SL	SG	1000 SW
DF	**I**	**0.024**	0.013	0.006	0.001	-0.007	0.004	0.009	0.008
	D	**0.022**	-0.001	-0.004	-0.007	-0.012	0.005	0.012	0.008
PH	**I**	0.009	**0.031**	0.02	0.173	0.03	0.054	-0.04	0.028
	D	-0.095	**0.195**	0.085	0.302	0.179	0.058	-0.065	0.023
NT	**I**	-0.096	-0.139	**-0.078**	0.059	0.346	0.026	-0.104	-0.042
	D	-0.212	0.078	**0.084**	0.236	0.399	-0.01	-0.144	-0.087
LBL	**I**	0.156	0.276	0.154	**0.05**	-0.111	0.176	0.184	0.172
	D	-0.018	0.385	0.261	**0.248**	0.075	0.233	0.145	0.162
LBW	**I**	-0.022	-0.044	-0.08	-0.009	**0.018**	-0.041	-0.03	-0.036
	D	0.146	-0.607	-0.897	-0.253	**-0.189**	-0.402	-0.285	-0.032
SL	**I**	0.042	0.174	0.141	0.086	0.021	**0.273**	0.161	0.14
	D	0.169	0.429	0.318	0.136	-0.017	**0.711**	0.445	0.424
SG	**I**	-0.02	-0.036	-0.02	0.012	0.016	-0.032	**-0.053**	-0.031
	D	0.747	0.519	0.438	-0.295	-0.498	0.864	**0.986**	0.932

1000 SW	**I**	0.139	0.267	0.194	0.068	-0.053	0.22	0.252	**0.43**
	D	-0.376	-0.426	-0.036	-0.077	0.221	-0.603	-0.867	**-0.981**
SPY	**I**	0.233	0.544	0.338	0.441	0.26	0.681	0.379	0.667
	D	0.382	0.572	0.249	0.29	0.158	0.856	0.62	0.667

DF - Days to 50% flowering, PH – Plant height, NT – Number of tillers, , LBL – Leaf blade length, LBW – Leaf blade width, SL –Spike length, SG – Spike girth 1000 SW – 1000 Seed weight, SPY – Single plant yield, I- Irrigated, D- Drought

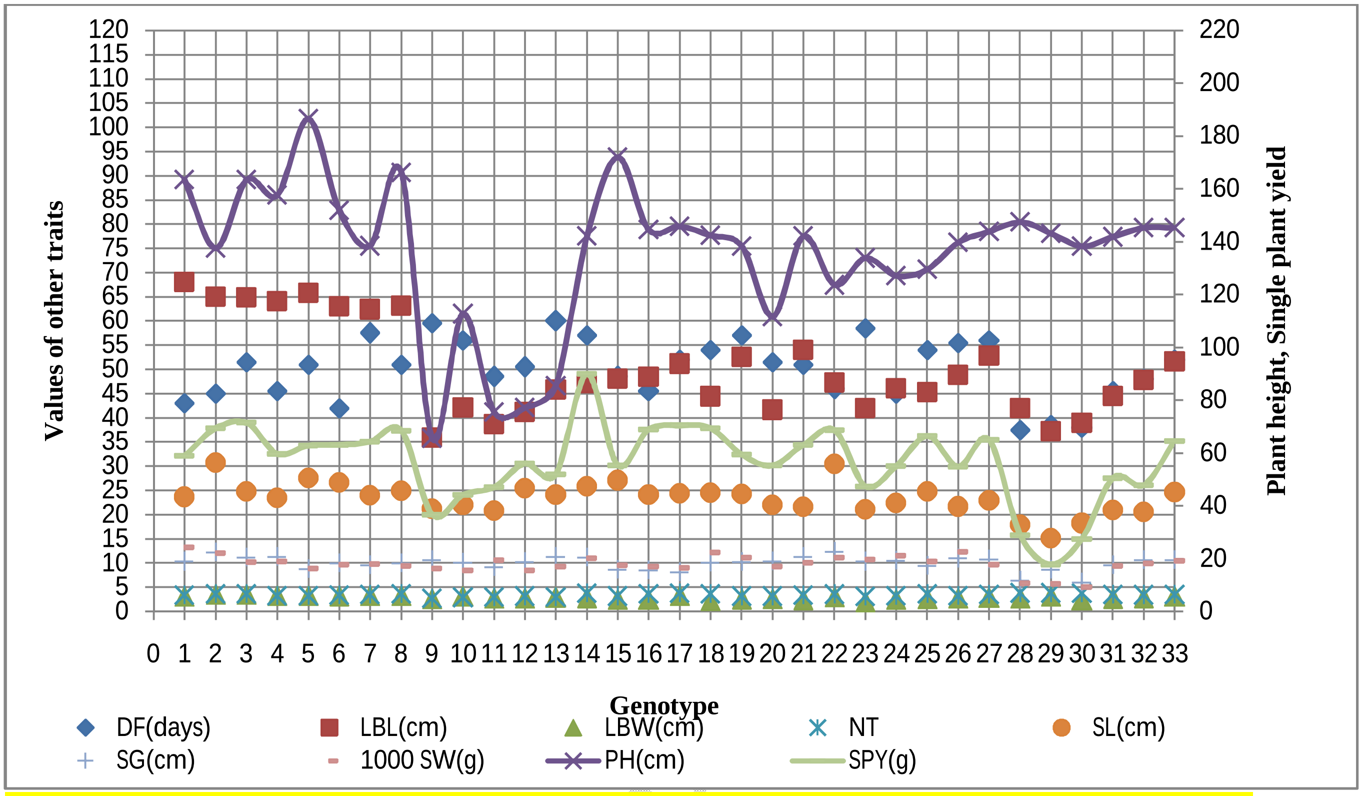
3.3 PERFORMANCE OF GENOTYPES UNDER IRRIGATED AND DROUGHT CONDITIONS

Based on mean performance, under irrigated condition, the genotype PT 5721 followed by PT 6679, 86M38, CO (Cu) 9, PT 6752 , *Nattu cumbu* were significant for most of the traits. (Figure 5). Similarly, in drought condition the genotype TNBH 1619 followed by MP 7878, ICMV 221, PT 6752, 86M38 and CO 9 were found to be the best and it indicated that these genotypes were drought tolerant as it had significant over mean for yield and yield contributing traits. The genotype *viz.,* ICMB 99222, *Kattu cumbu 1, Kattu cumbu 2 and kattu cumbu 3* were found to be drought susceptible as it had significant decrease in yield (Figure 6). Thus, the genotype 86M38 and PT 6752 were performed well under both the conditions.



DF - Days to 50% flowering, PH – Plant height, NT – Number of tillers, , LBL – Leaf blade length, LBW – Leaf blade width, SL –Spike length, SG – Spike girth 1000 SW – 1000 Seed weight, SPY – Single plant yield. DF, LBL, LBW, SL, SG, NT, 1000 SW in primary axis, PH, SPY in secondary axis.

Fig 5. Mean performance of genotypes under irrigated condition



DF - Days to 50% flowering, PH – Plant height, NT – Number of tillers, , LBL – Leaf blade length, LBW – Leaf blade width, SL –Spike length, SG – Spike girth 1000 SW – 1000 Seed weight, SPY – Single plant yield. DF, LBL, LBW, SL, SG, NT, 1000 SW in primary axis, PH, SPY in secondary axis.

Fig 6. Mean performance of genotypes under drought condition

4. CONCLUSION

This study concluded that root system architectural traitslike network length, network perimeter, network surface area and network volume studied via GiA rootswere varied significantly and these could be taken for selection. These traits were improved by the availability of quantitative trait loci (QTLs) connected to the RSA traits that would significantly enhance molecular breeding techniques for creating drought-tolerant crops. Under field study, high heritability and high genetic advance were observed for days to 50 per cent flowering, plant height, leaf blade length, spike length, 1000 seed weight and single plant yield under irrigated and drought condition which indicates additive gene effects that elicit effective selection based on these traits and breeding methods such as synthetic breeding, composite breeding and recurrent selection could be followed for crop advancement. Spike length and spike girth were the important yield contributing traits that were less deviated in drought when compared to irrigated condition. So, selection based on these traits would be benefitted for crop improvement. The potential genotypes under drought condition were identified. *Nattu cumbu* and ICMB 10444 were considered to be drought tolerant tolerant based on RSA traits and the genotype 86M38 and PT 6752 were found to be drought tolerant based on morphometric traits. These genotypes were suggested for utilizing in the further breeding programme. The genotype ICMB 99222 and Kattucumbu 1 were found be drought susceptible and it needs better environments for expressing its full genetic potential.

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