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Comparison of Correlations and Path Analyses between Well Watered and Drought Stress Condition in Finger Millet

V. Ramya and Y. A. Nanja Reddy
Department of Crop Physiology, College of Agriculture, UAS, GKVK, Bengaluru - 560 065
e-Mail : sowramya.ydv@gmail.com

Authors Contribution

V. Ramya :
Conceptualized and wrote the manuscript
Y. A. Nanjareddy :
The manuscript correction and suggestions

***Corresponding Author*:**
V. Ramya
Department of Crop Physiology, College of Agriculture, UAS, GKVK, Bengaluru

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Abstract

Finger millet is a staple food and fodder crop mainly in African and Indian countries. It is cultivated mostly as rainfed crop. Finger millet is known for drought tolerance, the grain yield has been reported to decrease up to 100 per cent depending on the intensity and duration of stress (during rainy season). Over the last decade, yield improvement has plateaued, hence, trait-specific selection is preferred for crop improvement. Identification of yield-contributing traits and selection of pre-breeding lines for such traits are important for breeding programmes. One of the approaches for trait selection is correlation analysis and partitioning of the correlation coefficients into direct and indirect effects on grain yield. Therefore, to identify traits associated with grain yield and their effects on grain yield, a field experiment was conducted during rainy season of 2016 under well-watered (WW) and drought stress (DS) conditions using 181 accessions. Analysis of variance revealed that the phenotypic variations observed for most of the traits were true genotypic expression and there was no block effect under both WW and DS conditions. The results revealed that both the direction and magnitude of correlations and path coefficients differed between WW and DS conditions. Correlation and path analysis revealed that among the physiological traits, leaf width and specific leaf weight were prominent in determining grain yield. Among the agronomic traits, mean ear weight, followed by productive tillers per hill, was the most influential trait for grain yield in finger millet. Hence, selection can be made for mean ear weight, followed by productive tillers, in addition to higher leaf width and specific leaf weight under both WW and DS conditions.

Keywords : Finger millet, Accessions, Well-watered, Drought-stress, Path analysis

Finger millet is currently gaining importance and is expected to grow in the future, owing to its wider adaptability to climate change scenarios. It is cultivated in more than 25 African and Asian countries and accounts for 12 per cent of the global millet cultivation area (http://exploreit.icrisat.org). In India, finger millet occupies an area of 1.004 m ha with a production of 1.755 m t during 2019-2020. The productivity of finger millet is highest (1747 kg/ha) in comparison with other major rainfed millet crops like sorghum (989 kg/ha) and pearl millet (1374 kg/ha) (www.indiastatagri.com). Finger millet is best suited to semi-arid regions (Thilakarathna and Raizada, 2015; Wafula *et al*., 2016; Puranik *et al*., 2017 and Nanja Reddy *et al*., 2020). It is also superior in nutritional contexts such as calcium, iron, fibre, polyphenols, other health benefits (Upadhyaya *et al*., 2011; Chandra *et al*., 2016; Kumar *et al*., 2016; Badigannanavar & Ganapathi, 2018; Netravati *et al*., 2018; Nanja Reddy *et al*., 2019a and Hassan *et al*., 2021).

Finger millet, a C_4 cereal crop (Ueno *et al*., 2006) and is mostly cultivated as a rainfed crop (Davis *et al*., 2019) that experiences intermittent moisture stress during one or more crop growth stages.

Drought episodes are increasing with fewer rainy days in climate change scenario (Dash *et al*., 2009; Anonymous, 2019 and Jalihal *et al*., 2019) and yield losses are reported up to 100 per cent depending on crop growth stage, duration and intensity of stress (Maqsood and Ali, 2007 and Krishna *et al*., 2021). The reproductive phase is the most sensitive stage starting from ear emergence to grain-filling (Krishna *et al*., 2021).

To meet the increasing demands of regional food security, breeding efforts have improved the grain yield of finger millet in rainfed situations through hybridization and selection of transgressive segregants (Swetha, 2011 and Gowda *et al*., 2014). However, selection based on yield under rainfed conditions has plateaued in the last decade (Adugna *et al*., 2011; Swetha, 2011 and Megha, 2022) and yield can be improved through trait selection (Nanja Reddy *et al*., 2021). Therefore, identification of trait-specific pre-breeding lines from available large germplasm could be a continuous process for crop improvement (Upadhyaya *et al*., 2007 and Reynolds & Langridge, 2016).

However, in selection of genotypes for specific traits, it is essential to analyze contribution of traits that contribute to grain yield; one of the approaches for this could be correlation analyses. Partitioning the degree of correlation into direct and indirect effects of variables on grain yield would provide additional basis for trait selection (Wright, 1921). Although several research works are reported on correlation analyses, this study was intended for comparison between well-watered (WW) and drought-stress (DS) conditions and the number of germplasm are high. Therefore, present study was conducted to correlate different physiological and yield-contributing parameters to grain yield and to identify their direct and indirect effects on grain yield in a large number of germplasm accessions (181) that provide authenticated information useful for conclusions.

Material and Methods

The experiment was conducted during rainy season of 2016 in the experimental field of All-India Coordinated Research Project on Small Millets at the University of Agricultural Sciences, GKVK, Bengaluru, India. A set of 181 germplasm were evaluated under field conditions. Factorial augmented design with two treatments (well-watered, WW and drought-stress, DS) was adopted in six blocks using three check varieties (GPU 28, GPU 67 and PR 202) in each block with single replication. Each block had a total of 33 entries in rows of 2m length consisting of 30 entries and three check varieties. Drought stress was imposed for 30 days during reproductive stage, starting from the ear emergence stage to grain filling by with holding irrigation.

The physiological parameters *viz.,* SPAD chlorophyll meter reading (SCMR; Konica Minolta SPAD chlorophyll meter), leaf temperature (Raytek-MINITEMP), specific leaf weight (SLW), leaf angle using protractor (Fig. 1) and leaf droopiness (the ratio of leaf lamina length drooped from the cut position to the tip of the leaf to the total leaf length) were measured between 20 and 25 days after imposition of stress on the fully expanded third leaf from the apex of a main tiller.

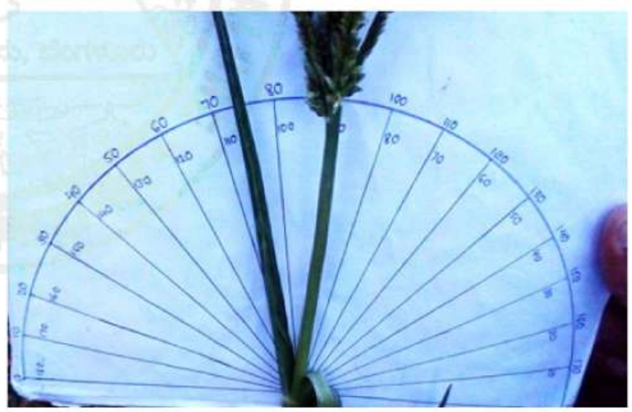

Fig.1 : Measurement of leaf angle (°) using a protractor

In addition, the leaf length and leaf width of top 3rd leaf of main tiller was measured to calculate the leaf area index (LAI). The yield parameters were measured at the time of crop maturity. The plant height (cm) from the base of the main tiller to the tip of the ear, peduncle length (cm) and productive tillers (no. m^{-2}), finger number per ear, finger length, finger width, test weight (g/1000 seeds), mean ear weight (g ear^{-1}) and grain yield (gm^{-2}) were measured.

TABLE 1

Analysis of variance (ANOVA) for physiological and yield attributes in finger millet accessions

Sources of variation	df	Leaf temperature (°C)		SCMR		SLW (mg/cm²)		Leaf angle (°)		roopyness ratio	
		WW	DS	WW	DS	WW	DS	WW	DS	WW	DS
Block	5	3.92	11.6 *	19.8	66.3	8.88	11.9 *	49.8	98.1 *	0.013	0.004
Checks	2	0.18	11.5 *	173.8 **	47.9	1.57	22.3 *	16.8	18.1	0.005	0.003
Accessions (un-rep)	180	4.57	7.2 *	60.5 *	42.5	3.89	4.84	40.5	53.9 *	0.009	0.007
Acc. v/s checks	1	0.14	0.2	170.4 *	0.03	16.5	502.1 *	164.6 *	47.4	0.001	0.003
Error	10	3.02	2.4	20.3	26.1	6.4	2.73	19.8	22.9	0.005	0.004

Sources of variation	df	Plant height (cm)		Peduncle length (cm)		Finger length (cm)		Finger width (cm)		Finger number/ ear	
		WW	DS	WW	DS	WW	DS	WW	DS	WW	DS
Block	5	202.2 ***	33.4	2.8	4.1	0.52	0.69	0.01	0.002	0.57	0.98
Checks	2	542.2 ***	1552.6 ***	19.1	73.4 ***	16.8 ***	10.2 ***	0.03	0.006	3.12 *	2.48
Accessions (un-rep)	180	178.9 ***	158.8 **	10.2	11.3 **	2.26 **	2.15 **	0.04 **	0.004	3.08 **	1.91
Acc. v/s checks	1	539.9 ***	950.3 ***	19.3	36.6 **	0.11	2.41 *	0.01	0.003	1.51	0.09
Error	10	16.0	33.1	5.6	2.7	0.5	0.49	0.01	0.002	0.4	0.77

Sources of variation	df	Prod. Tillers / m 2		Mean ear weight (g)		Threshing %		Test weight		Grain yield (g/m2)	
		WW	DS	WW	DS	WW	DS	WW	DS	WW	DS
Block	5	239.4	407.8	9.2	0.55	14.9	1150	0.08	0.04	4794	16928
Checks	2	843.7	897.8	56.0 *	14.9 ***	36.5	400.2	0.17	0.32 *	36709 *	106310 *
Accessions (un-rep)	180	455.3 *	344.7	6.5	2.92 ***	333.7 ***	964.2	0.16 *	0.11	12687	9913
Acc. v/s checks	1	88.6	420.9	1862 ***	9.41 ***	0.003	665.3	0.41 *	0.13	41	18686
Error	10	135.7	270.3	6.3	1.1	19.4	1536	0.06	0.04	5871.0	15963

Threshing percentage (grain yield / total ear weight) was computed. The data collected for all quantitative traits were subjected to analysis of variance (ANOVA) and correlations and path analyses were performed using OPSTAT software statistical package (Sheoran *et al*., 1998).

Results and Discussion

Analysis of variance (ANOVA) for quantitative traits revealed no significant block effect on any parameter except plant height under WW conditions and; the leaf temperature, SLW and leaf angle under DS conditions (Table 1). ANOVA suggested that the phenotypic variations observed for most of the parameters represented the true genotypic expression of genotypes under both WW and DS conditions as there was no block effect.

The germplasm accessions differed significantly in most yield-attributing traits under both WW and DS conditions, suggesting the potential expression of individual genotypes for yield-attributing traits (Table 1; Ganapathi *et al*., 2011; Shinde *et al*., 2014; Kumari & Singh, 2015; Patil *et al*., 2018 and Krishna *et al*., 2021). However, grain yield did not differ between the accessions, adding to the necessity for trait-specific selection of genotypes rather than directly for yield.

Under WW conditions, the check varieties differed significantly in SPAD value, plant height, productive tillers, ear number, finger length, mean ear weight and grain yield. Under DS conditions the check varieties differed significantly in leaf temperature, SLW, plant height, ear number, finger length, mean ear weight, test weight and grain yield (Table 1). This is expected to differ because the three varieties, GPU 28, GPU 67, and MR 6, are morphologically different and selection of genotypes superior to these check varieties would be appropriate.

ANOVA for comparison between checks and accessions provides opportunities for better selection over ruling checks. The SCMR value, leaf angle, plant height, ear number, mean ear weight and test weight differed significantly under WW conditions.

Table 2

Comparison of correlations of physiological traits in finger millet under well watered and drought stress conditions

Parameter	GY (WW)	GY (DS)	LAI (WW)	LAI (DS)	LL (WW)	LL (DS)	LW (WW)	LW (DS)	LT (WW)	LT (DS)	SCMR (WW)	SCMR (DS)	SLW (WW)	SLW (DS)	LA (WW)	LA (DS)
LAI	0.399	0.552														
LL	0.036	0.089	0.039	0.204												
LW	0.196	0.342	0.158	0.157	0.313	0.305										
LT	0.058	-0.137	-0.103	-0.250	-0.024	0.033	0.039	0.128								
SCMR	0.070	-0.028	0.092	-0.061	0.100	0.076	-0.038	-0.025	0.284	0.176						
SLW	0.129	0.074	-0.364	-0.245	-0.175	-0.044	-0.135	-0.092	0.111	0.171	-0.106	0.021				
LA	0.008	0.138	0.109	0.166	0.131	0.260	0.237	0.175	-0.083	-0.288	-0.019	-0.122	-0.017	0.028		
DR	0.265	0.166	0.097	0.034	-0.041	0.065	0.222	0.215	0.253	0.161	0.010	0.018	0.077	0.051	0.016	-0.068

**P >0.01 (0.254) and *P>0.05 (0.195) , WW- Well watered; DS- Drought stress; LAI- Leaf area index; LL- Leaf length; LW- Leaf width; LT- Leaf temperature, SCMR-SPAD chlorophyll meter reading, SLW- Specific leaf weight, LA-Leaf angle, DR-Droopiness ratio; GY-Grain yield

TABLE 3

Comparison of direct and indirect effects of physiological traits on grain yield in finger millet under well-watered and drought-stress conditions

Parameter	LAI	LL	LW	LT	SCMR	SLW	LA	DR	GYG (r)
LAI (WW)	0.481	0.002	0.021	0.000	0.005	-0.117	-0.008	0.016	0.399
LAI (DS)	0.563	-0.023	0.048	0.024	-0.002	-0.060	-0.001	0.003	0.552
LL (WW)	0.018	0.044	0.042	0.000	0.006	-0.056	-0.010	-0.007	0.036
LL (DS)	0.115	-0.112	0.093	-0.003	0.002	-0.011	-0.001	0.006	0.089
LW (WW)	0.076	0.014	0.133	0.000	-0.002	-0.043	-0.018	0.037	0.196
LW (DS)	0.089	-0.034	0.305	-0.012	-0.001	-0.023	-0.001	0.020	0.342
LT (WW)	-0.049	-0.001	0.005	0.003	0.016	0.036	0.006	0.042	0.058
LT (DS)	-0.141	-0.004	0.039	-0.095	0.006	0.042	0.001	0.015	-0.137
SCMR (WW)	0.044	0.004	-0.005	0.001	0.057	-0.034	0.001	0.002	0.070
SCMR (DS)	-0.035	-0.009	-0.008	-0.017	0.032	0.005	0.000	0.002	-0.028
SLW (WW)	-0.175	-0.008	-0.018	0.000	-0.006	0.321	0.001	0.013	0.129
SLW (DS)	-0.138	0.005	-0.028	-0.016	0.001	0.246	0.000	0.005	0.074
LA (WW)	0.053	0.006	0.032	0.000	-0.001	-0.005	-0.078	0.003	0.008
LA (DS)	0.094	-0.029	0.053	0.027	-0.004	0.007	-0.004	-0.006	0.138
DR (WW)	0.046	-0.002	0.030	0.001	0.001	0.025	-0.001	0.166	0.265
DR (DS)	0.019	-0.007	0.065	-0.015	0.001	0.012	0.000	0.091	0.166

Residuals, 0.692 (WW) and 0.550 (DS); Path coefficients (<0.09, Low; 0.11-0.19, low; 0.21-0.29, moderate, 0.30-0.99, high, >1.0 very high, Lenka and Mishra, 1973); WW- Well watered; DS- Drought stress; LAI- Leaf area index; LL- Leaf length; LW- Leaf width; LT- Leaf temperature, SCMR-SPAD chlorophyll meter reading, SLW- Specific leaf weight, LA-Leaf angle, DR-Droopiness ratio; GY-Grain yield

Under DS conditions, the specific leaf weight, plant height, ear number, finger length and mean ear weight differed significantly (Table 1), suggesting the possibility of selecting better genotypes over the check varieties for these traits.

Comparison of Correlations and Effects of Physiological Traits on Grain Yield of Finger Millet under Well-Watered and Drought-Stress Conditions

Crop growth and productivity are determined by canopy photosynthesis (photosynthetic rate and leaf area index). Finger millet is a C_4 species and LAI is a major limitation for biomass production and grain yield, but not the photosynthetic rate (Mujahid *et al*., 2020). In the present study, leaf width and leaf area index were positively and significantly correlated with grain yield under both WW and DS conditions and more significantly under DS conditions (Table 2; Krishna *et al*., 2021). These correlations clearly indicated that leaf length, width, and leaf area indices were affected by DS conditions, probably due to decreased cell turgor, cell division and cell enlargement (Hsiao, 1973). Therefore, to achieve higher grain yields under DS conditions, genotypes should be selected for higher leaf width.

Leaf temperature was negatively correlated with grain yield under DS conditions ($r = -0.137^{ns}$; Table 2; Ramya & Nanja Reddy, 2018 and Krishna *et al*., 2021), as water is a limitation for transpiration. This is further supported by the positive relationship

TABLE 4

Comparison of correlations of yield contributing traits in finger millet under well-watered and drought-stress conditions

Parameter	GY (WW)	GY (DS)	P T (WW)	P T (DS)	MEW (WW)	MEW (DS)	TH (%) W W	T W (WW)	T W (DS)	FN (WW)	T H (%) DS	FN (DS)	FL (WW)	F W (WW)	F W (DS)	P H (WW)	P H (DS)	FL (DS)
P T	0.437	0.421																
MEW	0.314	0.523	-0.296	-0.211														
TH (%)	0.286	0.095	0.038	-0.058	-0.025	0.077												
T W	0.322	0.260	0.098	0.075	0.168	0.203	0.208	0.260										
FN	0.258	0.460	-0.213	0.054	0.642	0.597	0.000	0.020	0.061	0.042								
FL	0.243	0.418	-0.120	-0.051	0.613	0.666	-0.078	-0.030	0.256	0.095	0.474	0.478						
F W	-0.049	0.178	-0.181	0.008	0.197	0.156	0.082	0.000	0.075	0.227	-0.001	0.071	0.011	0.167				
P H	0.127	0.231	-0.204	-0.184	0.415	0.534	-0.040	0.014	0.051	0.008	0.392	0.346	0.535	0.573	-0.059	-0.022		
P L	0.085	-0.150	0.088	-0.104	0.044	-0.173	-0.028	0.068	0.011	-0.023	-0.075	-0.266	0.266	-0.037	-0.092	0.073	0.467	0.299

**P >0.01 (0.254) and *P>0.05 (0.195), WW-Well-watered; DS-Drought stress; GY-Grain yield; PT-productive tillers, MEW-Mean ear weight; Th%-Threshing percentage; TW-Test weight; FN-Finger number per ear; FL-Finger length; FW-Finger width; PH-Plant height , PL-Peduncle length,

between leaf angle and grain yield (r = 0.138^{ns}), as a higher leaf angle (upright leaves) helps to avoid the direct effect of sunlight and reduces leaf temperature under DS conditions. Furthermore, the positive and significant relationship between leaf angle and leaf length clearly indicates that when leaf length is greater, it appears to have leaf acuteness to reduce the heat load on the plant and survive under DS conditions. The relationship between leaf temperature and SLW was positive, especially under DS conditions; the DS-induced high-temperature effect can probably be decreased by increasing SLW (Sastry *et al*., 1982).

Under WW conditions, the relationship between leaf droopiness and grain yield was positive and more significant (r = 0.265**), indicating that the leaf area could be sufficient under WW conditions and additional leaf area may lead to shading effect, which could be the reason for leaf grazing by cattle in the past (before release of high-yielding varieties). From these results, leaf temperature and leaf angle can be considered as adaptive traits that are adjustable according to DS conditions and are easy to measure.

Path analysis showed that, under WW conditions, the LAI (0.481), SLW (0.321), droopiness (0.166) and leaf width (0.133) had a direct positive effect on grain yield (Table 3). The positive direct effect of droopiness ratio on grain yield indicates that further increase in leaf area index may not be effective as it might lead to shading effect. It is likely that a higher SLW would be helpful to reduce shade effect under WW conditions. Under DS conditions, the LAI (0.563), leaf width (0.305) and SLW (0.246) had direct positive effect on grain yield (Table 3).

Higher SLW under DS reduce the transpiration loss of water. Therefore, higher number of leaves per tiller with medium leaf length, vertical orientation and spiral leaf aestivation (if any) could achieve higher yields under both WW and DS conditions. Although the traits, leaf angle and leaf temperature (based on correlations) are easy to measure, the leaf width and SLW could be effective physiological traits in selection of pre-breeding lines for finger millet yield improvement under both WW and DS conditions.

TABLE 5

Comparison of direct and indirect effects of yield contributing traits on grain yield in finger millet under well-watered and drought-stress conditions

Parameter	PT	MEW	TH (%)	TW	FN	FL	FW	PH	PL	GY (r)
PT (WW)	0.546	-0.119	0.009	0.015	-0.024	0.004	0.010	-0.007	0.002	0.437
PT (DS)	0.528	-0.114	-0.004	0.006	0.005	-0.002	0.000	0.005	-0.003	0.421
MEW WW)	-0.161	0.401	-0.006	0.026	0.071	-0.021	-0.011	0.015	0.001	0.314
MEW (DS)	-0.112	0.539	0.005	0.015	0.058	0.027	0.009	-0.014	-0.005	0.523
TH (%) WW	0.021	-0.010	0.247	0.032	0.000	0.003	-0.005	-0.001	-0.001	0.285
TH (%) DS	-0.030	0.042	0.062	0.020	0.002	-0.001	0.000	0.000	0.002	0.095
TW (WW)	0.053	0.067	0.051	0.154	0.007	-0.009	-0.004	0.002	0.000	0.322
TW (DS)	0.039	0.109	0.016	0.075	0.004	0.004	0.013	0.000	-0.001	0.260
FN (WW)	-0.116	0.257	0.000	0.009	0.111	-0.016	0.000	0.014	-0.002	0.258
FN (DS)	0.029	0.322	0.001	0.003	0.097	0.019	0.004	-0.009	-0.007	0.460
FL (WW)	-0.065	0.246	-0.020	0.039	0.052	-0.034	-0.001	0.019	0.005	0.243
FL (DS)	-0.027	0.359	-0.002	0.007	0.046	0.041	0.009	-0.015	-0.001	0.418
FW (WW)	-0.099	0.079	0.020	0.012	0.000	0.000	-0.056	-0.002	-0.002	-0.049
FW (DS)	0.004	0.084	0.000	0.017	0.007	0.007	0.057	0.001	0.002	0.178
PH (WW)	-0.111	0.166	-0.010	0.008	0.043	-0.018	0.003	0.035	0.010	0.127
PH (DS)	-0.097	0.288	0.001	0.001	0.034	0.023	-0.001	-0.026	0.008	0.231
PL (WW)	0.048	0.017	-0.007	0.002	-0.008	-0.009	0.005	0.017	0.021	0.085
PL (DS)	-0.055	-0.093	0.004	-0.002	-0.026	-0.002	0.004	-0.008	0.027	-0.150

Residuals, 0.487 (WW) and 0.408 (DS); Path coefficients (<0.09, Low; 0.11-0.19, low; 0.21-0.29, moderate, 0.30-0.99, high, >1.0 very high, Lenka and Mishra, 1973); WW-Well-watered; DS-Drought stress; GY-Grain yield; PT-productive tillers, MEW-Mean ear weight; Th%-Threshing percentage; TW-Test weight; FN-Finger number per ear; FL-Finger length; FW-Finger width; PH-Plant height , PL-Peduncle length

Comparison of Correlations and Effects of Yield Contributing Traits on Grain Yield of Finger Millet under Well-Watered and Drought-Stress Conditions

Efficient selection of traits for grain yield depends on the direction and magnitude of the correlation between grain yield and its component traits (Ramaprasad, 2019). The two major agronomic traits that influence the grain yield of finger millet are productive tillers per hill and mean ear weight. Productive tillers and mean ear weight were positively and directly correlated with grain yield under both WW and DS conditions (Table 4; Das, 2013; Bothikar *et al.*, 2014; Jadhav *et al.*, 2015; Krishnamurthy *et al.*, 2016; Manyasa *et al.*, 2016; Lad *et al.*, 2020; Nanja Reddy *et al.*, 2019b; Mujahid *et al.*, 2020; Nanja Reddy *et al.*, 2020; Talwar *et al.*, 2020 and Krishna *et al.*, 2021). However, under WW conditions, the number of productive tillers negatively correlated with ear weight, finger number, finger width and plant height (Table 4), suggesting that tiller number compensate for finger number and ear size.

Hence, the selection should be primarily based on mean ear weight (Ojulong *et al.*, 2017), followed by productive tillers per hill under WW conditions. Under DS conditions, PT was negatively correlated with ear weight and plant height indicating that DS decreases plant height.

The mean ear weight (MEW) or ear size was positively and significantly correlated with its contributing traits, such as finger number, finger length, finger width, test weight and plant height, under both WW and DS conditions (Table 4; Krishna *et al*., 2021), but more significantly under DS conditions. The mean ear weight was negatively associated with peduncle length (r= -0.171^{ns}), indicating that a long peduncle might restrict or slow down the translocation of photo-assimilates to the grain. Longer peduncle length also decreased the number of fingers per ear with negative correlation (r = -0.266**; Table 4).

Test weight was positively and significantly correlated with finger length under WW and finger width under DS conditions (Table 4). Furthermore, the finger characteristics were not negatively correlated with each other. From these correlations, it can be suggested that mean ear weight is more important for achieving grain yield. Therefore, a relatively medium plant height with a short peduncle and large ear size would result in higher grain yields in finger millet under DS conditions.

Correlation coefficients, although provide information regarding the association, partition into corresponding direct and indirect effects path coefficient analysis, would provide the exact contribution of a given trait to the grain yield (Wright, 1921). Path analyses revealed that, under WW conditions, grain yield was directly and positively influenced by productive tillers, followed by mean ear weight, threshing percentage, test weight and finger number per ear. However, under DS condition, mean ear weight and productive tillers had higher equal direct effects on grain yield, and these parameters can be targeted in selection process (Table 5; Lad *et al*., 2020 and Nanja Reddy, 2020).

To break the yield plateau, trait-specific selection is appropriate. Among the physiological parameters, selection of pre-breeding lines for higher leaf width, specific leaf weight and leaf orientation with acute leaf angle are preferable traits for improving the yield of finger millet. Among the agronomic traits, the mean ear weight was preferable followed by productive tillers per hill under both adequate input conditions and drought stress conditions.

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