Annual Progress Report: 2016-17

6. Physiology

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Contents

Executive summary

Physiological studies are focused on identification of physiological traits associated with yield potential under normal and moisture stress conditions in germplasm accessions and mapping population. A few germplasm accessions for high yield potential and drought tolerance through physiological traits have been identified. Application of zinc either through soil or foliar application did not result in significant increase in grain yield.

Detailed report

1. Identification of physiological traits associated with yield potential in finger millet

In order to identify donor lines for yield potential under optimal conditions, selected germplasm accessions (348) including popular varieties and checks (GPU-28, GPU-67, PR-202) were evaluated during kharif, 2016 for physiological and yield parameters. Wide genotypic variability was observed for all the traits except for leaf

droopiness ratio (Table 1.1). In the present study, no relationship was observed between duration and grain yield (Table 1.2) suggests that, the medium duration genotypes would be better to avoid end season stress. Among the yield attributing traits, most important parameter was productive tillers, which showed a significant positive effect on grain yield (Table 1.2), suggesting that an increase in tiller number can improve the grain yield. The equation (Y=224.4 + 2.02x, where x is the number of productive tillers per square meter area with r=0.38**) showed significant positive relationship between productive tillers and grain yield.

Keeping constant the productive tillers, ear number and finger length, the high yielding accessions with > 500 gm^{-2} (L-5, GE-4398, 5117, 199, 4004, 1855, 436, 1026, 1077, 4683, 1376) had higher LAI, biomass and mean ear weight. Significantly superior donors over the popular GPU-28 for various physiological and yield traits have been identified (Table 1.3). Theses donor lines has grain yield on par or higher than the GPU-28 and these donor lines may be utilized in crop improvement programme aimed at high yield potential.

2. Evaluation of selected contrast accessions and mapping population for moisture stress tolerance under field conditions

In view of identifying drought tolerant donor lines for specific traits, an experiment was conducted using 181 selected germplasm accessions including popular varieties with three check varieties during kharif, 2016. Moisture stress was imposed for 30 days by withholding irrigation during ear emergence to flowering period. Grain yield and physiological traits except leaf droopiness ratio, differed significantly (Table 2.1). The drought tolerant donor lines for specific traits which are superior over the GPU-28 have been identified (Table 2.2).

Two mapping populations generated for moisture stress (GE-208 X GE- 156 (302), GE- 496 X GE- 156 (218)) have been advanced from F3 to F4 during kharif, 2016. Superior lines 11, and 15, with respect to ear weight have been identified in GE-496 x GE-156 and GE-208 x GE-156 respectively (Table 2.3)

3. Enhancing grain zinc content in finger millet

In view of bio-fortifying the finger millet grain with Zn, an experiment was conducted at multi-locations using $ZnSO_4$ as soil and foliar application. Grain yield did not differ significantly at the location GKVK and pooled data between the treatments (Table 3.1). The grain Zn content estimation is under progress.

Physiology Table from 1.1 to 3.1 (Pages from 3 to 6)

Table 1.1 Mean statistics for physiological and yield potential parameters in finger millet under protective irrigation (N= 348)

S. No	Parameter	Range	Mean	SD	CV	F-test	CD @ 5%
1	Days to ear emergence	47-76	62.5	6.1	9.8	**	10.1
2	3rd leaf length (cm)	26.9-73.2	41.4	6.4	15.5	**	15.9
3	3rd leaf width (cm)	0.67-10.63	1.09	0.14	12.9	**	0.36
4	3rd leaf area (cm2)	17.8-66.0	33.9	8.4	24.7	**	20.7
5	3rd leaf angle	38.3-81.7	63.3	8.2	12.9	**	20.7

6	Droopiness ratio	0.24-0.81	0.56	0.09	15.8	NS	-
7	Pollen fertility (%)	6.1-100.0	82.8	14.1	17	**	36.2
8	Leaf temperature (^{0}C)	18.9-31.2	25.8	1.99	7.71	**	3.92
9	SLW (mg cm-2)	6.2-14.0	10.7	2.2	20.7	**	6.5
10	SPAD	26.2-68.3	36.1	11.1	30.6	**	28.6
11	Prod. Tillers (No. m-2)	31.4-133.3	67.8	19.5	28.7	**	48.1
12	TDM (g m-2)	414-1917	939	238	25.4	**	653
13	Ear No (No.m-2)	33.3-181.5	84.6	26.8	31.7	**	57.6
14	Mean Ear (g)	2.0-9.9	5.8	1.74	30.1	**	5.0
15	Seed yield (g m-2)	129-620	361	104	28.7	*	282
16	LAI	0.84-2.45	1.30	0.42	31.8	**	1.39

Table 1.2 Relationship between days to ear emergence (duration) and grain yield and productive tillers and grain yield in finger millet (N=348)

Days to ear emergence	Grain yield (g m^{-2})	Productive tillers (No. m^{-2})	Grain yield (g m^{-2})
52	367	59	349
62	365	93	398
70	346	131	474
CD	NS	CD	48

Table 1.3 Superior germplasm accessions for various physiological and agronomic traits in finger millet (N=348)

S. No	Parameter	GPU-28	CD	Accessions
1	Leaf length (cm)	41.0	16	GE-2963, 4745, 4748, 4777, 5175
2	Leaf angle	63.1	-20.7	GE-1914, 4172
3	Leaf temperature	25.6	-3.92	GE-824, 1013
4	SLW (mg cm^{-2})	10.6	6.5	GE-1260, 2628
5	SPAD	38.0	28.6	GE-997, 1914, 2162, 3219, 4172

6	Prod. Tillers (No. m^{-2})	60.4	48.1	GE-292, 997, 1050, 1200, 3090, 4172, 4398, 4404, 4995
7	Finger number (No $plant^{-1}$)	7.38	3.58	GE-1264-A, 3510, 4983, 5078
8	Finger length (cm)	7.03	1.93	GE-2963, 4600, 4683, 4963
9	Total biomass (g m^{-2})	965	653	GE-50, 1264-A, 5117
10	LAI	1.17	1.39	GE-1026, 1050, 1855, 2056, 2963, 3003, 3510, 4995, 5175

Table 2.1 Mean performance of genotypes for moisture stress tolerance in finger millet

Parameter	Control	Stress	F-test	F-test	% Change (+/ -)
			Treatment	Accessions	
Grain yield (g m^{-2})	442.1	313.4	*	*	29.1
SLW (mg cm^{-2})	11.2	11.7	*	*	4.5
Leaf angle	63.3	59.4	*	*	6.2
Leaf droopiness	0.57	0.56	NS	*	1.8
SPAD	34.1	28.7	*	*	15.8
Leaf temperature	24.7	28.2	*	*	14.0

Table 2.2 Superior accessions for grain yield and physiological parameters under moisture

Stress conditions in finger millet

Parameter	GPU-28 (Stress)	CD	Basis for selection (stress) (Mean of GPU-28 + Sd)	Superior Accessions
Grain yield (g m^{-2})	313.4	204	204	GE-1264-A, 4597, 6370
SLW (mg cm^{-2})	13.2	4.9	Sd (2.1)	VL-315
Leaf angle	59.4	16.3	Sd (7.4)	GE-97,496,808, 837, 1037, 3303, 4794, 4937
Leaf droopiness	0.56	0.23	Sd (0.09)	GE-202, 1193, 469, 1013, 3315, 1855, 104, 6370, 4777
SPAD	25.6	9.1	Sd (6.4)	GE-549, 463, 1037, 4798, 1664
Leaf temperature	28.2	5.9	Sd (-2.68)	GE-1571, 4683, 449, 524, 514, 6224, 294,

				3101, 303, 463, 4929

Table 2.3 Performance of population (F4) for mean ear weight and grain yield (g ear^{-1})

Population	Mean ear wt. (g ear^{-1})	Mean seed yield (g ear^{-1})	Threshing (%)	Selection criteria	Superior Populations
GE-496 x GE-156 (n=218)	5.6	4.2	74.7	2Sd	15-81,15-117, 15-17,15-69,15-9, 15-87,15-54,15-7, 15-50,13-64,15-71
Sd	1.8	1.6			
GE-496	8.4	6.7	79.8		
GE-156	7.4	5.7	77.0		
CV (%)	32.9	38.2			
GE-208 x GE-156 (n=302)	6.2	4.7	75.8	1Sd	3-41,4-58,3-3,3-7, 3-2,4-36,4-81,4-64, 3-91,4-94,3-90,4-86, 3-70,3-105,10-12-1
Sd	2.0	1.7			
GE-208	6.9	5.1	73.9		
GE-156	7.9	5.7	72.2		
CV (%)	32.2	34.9			

Table 3.1 Effect of $ZnSO_4$ on grain yield of finger millet (Cv. GPU-28)

Sl. No.	Treatments ($ZnSO_4$)	GKVK	Rank	Vizianagaram	Rank	Athiyandal	Rank	Perumalapalle	Rank	Average	Rank
		Grain yield (kg ha^{-1})									
1	Control	2604	3	3990	1	954	1	3074	1	2656	1
2	Soil application @12.5 kg/ha	2660	4	4832	4	1056	4	3580	3	3032	4
3	Foliar application @ 0.75 % at flowering	2500	2	4042	2	1232	2	3566	2	2835	2
4	Foliar application @0.5 % at flowering and 20 days after	2360	1	4126	3	1368	3	3762	4	2904	3
MEAN		2531		4248		1153		3496		2857	
C.D. (5%)		NS		615		100		181		NS	
C.V. (%)		18.79		10.51		6.3		3.75		8.91	