RESEARCH ARTICLE

GENETIC VARIABILITY, HERITABILITY AND GENETIC ADVANCE STUDIES IN FINGER MILLET (*ELEUSINE CORACANA* (L.) GAERTN) CULTIVARS UNDER FOOTHILL CONDITION OF NAGALAND

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Abstract: A set of 42 cultivars were studied for genetic variability, heritability and genetic advance of grain yield and its eleven component traits in finger millet. The analysis of variance revealed highly significant differences among the genotypes for all the twelve characters studied. The highest PCV and GCV were recorded for finger length and ear head length indicating presence of ample variation for these traits in the present material. In the present study, high estimates of heritability and genetic advance was obtained for finger length and ear head length. Thus selection for these traits is likely to accumulate more additive genes leading to further improvement of their performance and these traits may be used as selection criteria in finger millet breeding program.

Keywords: Genetic variability, Heritability, Genetic advance, Finger millet

INTRODUCTION

Finger millet (*Eleucine coracana (L.*) Gaertn, 2n=4x=36) is highly self-pollinating crop belongs to the Poaceae family. It ranks third among millets after sorghum and pearl millet. This crop is well adapted to warmness drought and poor soil fertility areas. Finger millet is rich in protein, fibre, minerals viz., calcium, iron, potassium, magnesium, zinc, antioxidants and vitamins. A high intake of millet based dietary fiber, improves glycemic control, decreases hyperinsulinemia and lowers plasma lipid concentrations in patients with type 2 diabetes (Jali *et al*., 2012). Today millets are garnering the much-deserved attention across India because of their high nutritional value. In the past 60 years, India's agriculture policy has focused mainly on rice and wheat and neglected millets. In general millet promotion is plagued by low produce.

Grain yield is a complex trait governed by many genes and is influenced by the nearby environment (Owere *et al.,* 2015). Hence, direct selection for these traits is not worthy. Selection will be effective when traits are highly heritable. Partitioning of total phenotypic variation into heritable and non-heritable components is very useful, because, only heritable portion of variation is exploitable through selection. This becomes necessary to have thorough knowledge on variability owing to genetic factors, actual heritable genetic variation present in the progeny and the genetic advance that can be achieved through selection for planning successful selection procedure for evolving high yielding genotypes.

Millets have long been cultivated in the hilly terrain of the Eastern part of *Nagaland*. It has been part of the staple diet of the people. They were also particularly known to be insurance during natural calamities like food scarcity and climate change. However, the crop was not grown much in the foothill and plain in Nagaland so far. Therefore, the present investigation was undertaken to estimate the genetic variability, heritability and genetic advance for grain yield and twelve component traits in finger millet under foothill condition of Nagaland.

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MATERIALS AND METHODS

The present investigation was conducted on the experimental field of School of Agricultural Sciences and Rural Development, Nagaland University, Medziphema, Nagaland during the Kharif season of 2019 with 42 cultivars (Table- 1). The experiment was laid out in randomised complete block design with three replications. Data were recorded on five randomly sampled plants in each plot on 12 quantitative characters viz. plant height, days to 50% flowering, number of tillers per plant, days to 80% maturity, number of fingers per ear, ear head length, flag leaf length, finger length, ear weight per plant, test weight, straw yield and grain yield. The mean values were subjected to statistical analysis to work out analysis of variance for all the characters as suggested Panse and Sukhatme (1967). The phenotypic, genotypic and environmental coefficient of variation was calculated according to Burton and De Vane (1953). Heritability estimate was calculated according to Allard (1960) and genetic gain was estimated using the method of Johanson et al. (1955).

RESULTS AND DISCUSSION

The analysis of variation revealed significant differences among the genotypes for all characters (Table 2) studied indicating high degree of variability present in the material. In accordance to the data from ((Table 3 and 4), following results were obtained.

Plant Height (cm):

Plant height from all sampled plants averaged out to be 109.88 cm, the tallest plants are observed in OEB-532 cultivar (132 cm),and dwarf cultivars are found to be VL-149 (78.8 cm),the GCV & PCV(10.646 & 11.349) for a trait are moderate, heritability(85%) for a trait found to be highest although GAM (6.59) is low.

Days to50% flowering (days):

MR-2,MR-6 took more days of 85.33 than the average of 73.54 days for half of its population to flower, whereas Dibyashina took around 61 days for 50% of its plants to flower, the GCV &PCV(7.855&10.645) values for a trait are lower than the optimum, although heritability (54.4%) and GAM (12.011) was moderate

Number of tillers/plant:

The mean number of tillers/plant, is 5.57, the highest number of tillers/plant found in OUAT-2(7) where as lowest number of tillers was seen in GPU-66 (4.13). GCV & PCV (10.027&15.035) for a trait found to be moderate; although heritability (44.41) was moderate GAM (1.062) for a trait is very low.

Days to 80% maturity:

On an average around 80% plant population irrespective of all genotypes took mean of 109.56 day, to reach physiological maturity. Varieties like VL-347 and GPU-45 took longer period of 124 days where as GPU-26; a short duration variety took around 84 days. GCV (8.096) and PCV (8.787) for a character being moderate, although a heritability (84.8%) value comes out to be greater but the GAM (14.198) was moderate.

Number of Fingers/ear:

More fingers/plant was observed in VR-762(9.63) whereas lowest number of fingers was seen in TRY-1(5.26) with the average number of fingers (7.31), the GCV & PCV (12.884 & 17.66) values for a are moderate. Similarly heritability (53.1%) and GAM (14.1) was also moderate.

Ear head length (cm):

Mean ear head length of the sampled plants from all genotypes comes out be 8.86 cm, with the maximum and minimum ear head length of 12.36 cm (RAU-8) & 6.26 cm (PPR-2700).genotypic and phenotypic coefficient of variation (GCV: 16.89 & PCV: 20.34) for a character are moderate indicating presence of sufficient amount of inherent variability within the population, heritability (68.9%) and GAM (23.717) found to be high.

Flag leaf Length(cm):

It is considered to be one of the important traits which indicate photosynthetic activity, GPU-26 has longest flag leaf of 46.4 cm where as MR-2 has shortest leaf length of 28.8 cm, over all mean of the population lies at 35.8 cm. The GCV (10.94) & PCV (14.38) for a trait are moderate, heritability (57.8%) and GAM (11.21) was moderate.

Finger Length (cm):

For the trait, there is wide range of variation is seen from 3.76 cm(VL-352),to 9.96 cm (KOPN-235),with the mean length of fingers from all sampled plants, found out to be 7.12 cm, greater GCV(21.608) & PCV(24.968) for a trait indicated greater inherent variability, high heritability(74.8%) conjugated with high GAM(26.01). .

Ear weight/plant (grams):

BM-2 cultivar found to be good with the highest ear weight of 54.07 grams and lowest weighed in GPU-66(29.5) with the mean ear weight from all sampled plants of 44.67 grams, the GCV (7.132) & PCV (15.399) for a trait found to be moderate.

Test-Weight (grams):

1000 grain weight of VL-762(3.5) found out be greater, bolder among all varieties, KOPN- 235 has lowest test weight of 2.33 grams, very narrow range of variability is seen, with the average mean of 3.25 grams. although GCV is very low(2.613),the PCV (6.0338), found to be thrice that of GCV indicating the greater influence of environmental factors, followed by lower heritability(18.7%) and GAM(2.06).

Straw Yield (kilo gram/plant):

C0-13 variety recorded highest straw yield of 7.36 kilograms/plant, the average straw yield found out be 6.20 the lowest straw yield found out be 4.86 kg/plant, the GCV (7.065)& PCV(13.878) for a trait found out bee moderate, GAM (21.6) for a trait is high, although heritability(25.9%) is found to be low.

Grain Yield (quintal/ha):

Indaf-9 has recorded highest yield of 53.4 quintal/ha, where as Indaf-8 found to be poor yielder (12.97quintol/ha), the mean yield of the population is 28.15,GCV(13.05) for a trait is moderate, whereas PCV(33.068) is very high indicating greater influence of environment, the trait is governed by non-additive gene actions not affordable to selection, is evidential from lower values of heritability(15.5%) and genetic advance (4.26) as a percent of mean.

The estimates of phenotypic coefficient of variation (PCV) were higher than those of genotypic coefficient of variation (GCV) for all the traits indicating environmental factors influencing the characters (Table 2). The highest PCV and GCV were recorded for finger length and ear head length indicating presence of ample variation for these traits in the present material. Similar results have also been reported by Suryanarayana et.al (2014) Abhinav. Sao (2016), Sarjansinh et.al (2018) for ear head length and Patnaik and Jana (1973) and Setty et al. (1974) for finger length.

Burton (1952) has suggested that genotypic coefficient of variation together with heritability estimates gives best option expected for selection. A fair measure of efficiency of selection for any quantitative traits can be derived from the estimates of heritability for the characters under consideration. But reliability of selection depends not only on heritability but it should also be accompanied by high genetic advance (Johnson *et al*., 1955). High heritability coupled with high genetic advance shows that a progress can be made through selection as it suggests the presence of additive gene effects (Panse, 1957). In the present study, high estimates of heritability and genetic advance were obtained for finer length and ear head length. Thus selection for these traits is likely to accumulate more additive genes leading to further improvement of their performance and these traits may be used as selection criteria in finger millet breeding program. Similar observation was reported by Suryanarayana et.al (2014) Abhinav. Sao (2016), Sarjansinh et.al (2018) for ear head length and Patnaik and Jana (1973) and Setty et al. (1974) for finger length.

Table 1. List of cultivars used in experimentation

Sl.NO	**Cultivar name(year of release)**	**Pedigree**	**Institute released**
	PR 2614(1995)		
1	VL 352	MR-1*Kalyani	**ARS Perumallapalle(AP)**
2	KMR 204(2012)	VR 708*VL 159	**VPKAS Almora Uttarkhand**
3		GPU 26*GE 1409	**VC farm UAS(B)**
	OEB 532(2012)		**Mandya,Karnataka**
4	OEB526(2011)	GPU26*L-5	**OUA&T Berhampur Odisha**
5	BM-9-1(1999)	SDFM*PE 244	**OUA&T Berhampur Odisha**
6	Nilachal	Mutant of Budha mandia	**OUA&T Berhampur Odisha**
7	MR-1(1990)	Mutant of AKP-7	**OUA&T Berhampur Odisha**
8		Hamsa*IE 927	**VC farm UAS(B) Mandya,**
	Indaf -7		**Karnataka**
9		Annapurna*IE 642	**VC farm UAS(B) Mandya,**
	Indaf -9(1985)		**Karnataka**
10		K1*IE 980R	**VC farm UAS(B) Mandya, (knk)**
	HR 374(1975)		**VC farm UAS(B) Mandya,**
11		EC 4336*PLR 1	**Karnataka**
	GPU 66		
12	GPU 45(2001)	Pure line selection	**AICSMP GKVK BENGALURU**
13	L-5(1999)	GPU 26*L-5	**AICSMP GKVK BENGALURU**
14	GPU 26(	Malavi*Indaf 9	**AICSMP GKVK BENGALURU**
15		Indaf 5*(AIL of Indaf 9*IE 1012)	**AICSMP GKVK BENGALURU**
	VL 149(1991)	VL 204*IE 882	
16	VL347(2010)	VL 708*VL 149	**VPKAS Almora Uttarkhand**
17	VL 315	SDFM 69*VL 231	**VPKAS Almora Uttarkhand**
18	Indaf 8(1986)	Hullubele*IE 929	**VPKAS Almora Uttarkhand**
19	Poorna(1959)	CO-1*Aruna	**VPKAS Almora Uttarkhand**
20			**VC farm UAS(B) Mandya,**
	TRY-1(1989)	Pure line seletion from HR 374	**Karnataka**
21			**Soil salinity research centre tirchy**
		BR 407*Ranchi local	
	RAU-8(1989)		
22		Pure line selection	**RAU Dholi Bihar**
	CO -12		
23		EC 4336*PLR 1	**Millet Breeding Station TNAU**
	CO-9(1970)		**Coimbatore**
24		CO-7*TAH 107	**Millet Breeding Station TNAU Co**
	CO-13(1989)		
25			**Millet Breeding Station TNAU**
		Pure line selection from local	**Coimbatore**
	GN 1(1976)	Pure line selection	
26			**NAU Waghai .Gujarat**
	GN 5	Pure line selection from local	
27		variety WN-259	**NAU Waghai .Gujarat**
	GNN-6	Mutant of AKP-7	
28			**NAU Waghai .Gujarat**
	Dibhyashina (1971)	Pure line selection from PM 629	
29		Pure line selection	**OUA&T Berhampur Odisha**
	PR 1044(1985)		
30			**ARS peddapuram (A P)**
	PRM-2	Pure line selection	
31			**GBPAU&T Ranichauri**
		KM 55*V 221 B	**Uttarkhnada**
	PRM 230(1998)		
32		Pure line selection	**ANGARU Palerumallapalle (A P)**

33	PPR 2700(2012)	Pure line selection from VEMC 134	**ANGARU Palerumallapalle (A P)**
34	VR 708	Pure line selection	**ANGARU Palerumallapalle (A P)**
35	VR 762(2006)	Indaf 5 *PR 202	**ANGARU Palerumallapalle (A P)**
36	VL 324	African white *RoH 2	**VPKAS Almora Uttarkhnad**
37	MR -2(1994)	Pure line selection	**RRS Navile Shimoga UAS(B) Karnataka**
38	MR-6	Malavi1305*CO-9	**VC farm UAS(B) Mandya, Karnataka**
39	BM-2(1995)	Selection from local germplasm	**BAU Ranchi Jharkhand**
40	CO-14(2004)	Mutant of CO-9	**TNAU Ciombatore (TN)**
41	KOPN-235(2011)		**MPKVV Rahuri Maharashtra**
42	OUAT-2(1999)		**OUA&T Berhampur Odisha**

Table 2. Analysis of Variance for 12 characters of finger millet cultivars

SOURCES	df	PH	DTF	T/P	DTM	F/P	EHL	LL	FL	EW/P	TW	SY	GY
Replications	2	0.871	29.113	0.077	9.738	6.295	0.607	13.479	3.798	371.697	0.001	1.220	91.784
Genotypes	41	421.848**	129.762**	1.339**	250.789**	3.481**	7.658**	57.845**	7.971**	76.664**	0.053*	1.127**	120.221**
Error	82	23.414	28.300	0.393	14.047	0.789	0.999	11.293	0.801	41.952	0.031	0.550	77.365

* Significant at 5% level of significance,

** Significant at 1% level of significance

Table 3. Mean performance of twelve quantitative characters studied in forty-two genotypes of Finger-millet

S.No	Genotypes	PH	DTF	T/P	DAM	F/P	EHL	LL	FL	EW/P	TW	SY	GY
1	PR 2614(1995)	105.36	70.66	5.43	105.66	7.86	8.4	28.83	4.86	45.1	3.4	*6.73*	31.03
2	VL 352	118.53	68.66	5.33	101	8.83	8.4	29.13	3.76	48.66	3.33	*4.86*	34.3
3	KMR 204(2012)	111.44	70	5.73	104	5.56	9	31.46	6.8	53.3	3.13	*5.36*	32.16
4	OEB 532(2012)	132	74	6.33	111.33	6.63	8.9	38.56	6.7	46.56	3.26	*6.06*	24.6
5	OEB526(2011)	104.6	72	4.33	106	6.6	9	40.23	4.13	50.1	3.36	*6.36*	25.3
6	BM-9-1(1999)	88.6	73	4.33	124	8.5	8.7	38.96	4.26	51.16	3.23	*6.06*	29.36
7	Nilachal	92.6	78.33	5.33	121	6.6	7.9	31.33	6.9	39.86	3.33	*6.6*	27.53
8	MR-1(1990)	103.6	80	6.3	121	6.66	8.8	34.26	6.66	42.46	3.23	*5.86*	32.46
9	Indaf -7	104.53	79.66	5.66	97	7.53	8.63	35.4	5.96	51.93	2.33	*4.96*	37.46
10	Indaf -9(1985)	115.4	58.66	5.2	114	6.6	7.9	33.43	5.5	40.76	3.33	*5.8*	53.4
11	HR 374(1975)	124	78	5.4	104	7.4	10.43	42.16	6.5	41.06	3.4	*5.56*	38.53
12	GPU 66	125.66	75.66	4.13	113	7.33	8.8	33.3	7.1	29.5	3.4	*6.13*	26.3
13	GPU 45(2001)	94.88	78.66	5.46	124	6.53	7.6	33.63	7.2	37.8	3.43	*6.53*	1.06
14	L-5(1999)	126	84.66	4.93	106	7.53	8.46	36.26	6.2	46.8	3.1	*5.1*	26.46
15	GPU 26	100	72.66	4.46	84	8.6	10.9	46.4	8.63	46.73	3	*5.66*	22.03
16	VL 149(1991)	79.8	58.66	5.66	108	8.46	6.46	30.06	7.26	41.5	3.4	*6.6*	21.83
17	VL347(2010)	121.53	74	5.9	124	8.2	7.83	33.4	6.03	45.4	3.43	*6.76*	26.03
18	VL 315	119.53	79.66	5.06	114	6.3	6.56	43.4	8.6	48.63	3.26	*6.5*	21.97
19	Indaf 8(1986)	92.33	73	4.4	103	7.83	7.06	37.43	7.73	56.96	3.26	*6.7*	12.97
20	poorna(1959)	114.46	74.33	5.6	110	7.6	7.1	30.43	6.23	44.9	3.43	*6.66*	42.67
21	TRY-1(1989)	114.33	71	6	121	5.26	11.16	33.5	7.6	46	3.23	*5.36*	32.33
22	RAU-8(1989)	118.4	75.66	5.2	115	6.2	6.26	31.53	6.86	53.66	3.3	*6.4*	31.5
23	CO -12	119.46	82	5.46	97.33	7.5	7.3	36.66	6.5	50.96	3.23	*5.9*	28.93
24	CO-9(1970)	119.53	70.66	5.53	110	11.16	8.16	35.96	6.6	49.4	3.1	*5.9*	28.97
25	CO-13(1989)	107.4	78	5.3	112.33	8.73	7.3	41.1	6.66	46.8	3.2	*7.36*	27.1
26	GN 1(1976)	110.4	78.66	6.1	111	7.3	7.3	36.23	6.2		3.13	*6.83*	29.1
27	GN 5	110.4	73	6.3	94.66	7.16	7.03	33.23	6.23	46.63	3.23	*6.27*	26.33
28	GNN-6	96.8	73.33	5.33	104	6.46	9.8	30.43	6.63	46.4	3.16	*7*	28.5
29	Dibhyashina (1971)	124.6	61	5.5	103	6.33	7.63	36.06	6.16	45.2	3.06	*6.6*	28.13

30	PR 1044(1985)	118.4	68.66	6.0	111	7.4	7.23	36.3	6.46	48.5	3.33	*6.27*	27.8
31	PRM-2	106.4	73.33	5.4	106	7.6	7.7	34.16	6.33	49.53	3.43	*6.93*	27.7
32	PRM 230(1998)	102.4	75.33	5.0	93.66	6.733	11.16	36.8	7.63	50.5	3.26	*6.86*	26.33
33	PPR 2700(2012)	104.53	66	6.0	111	6.73	12.36	37.16	7.73	51.17	3.46	*6.8*	27
34	VR 708	109.66	64.66	6.0	103	7.66	11.03	39.1	9.16	50.37	3.36		32.53
35	VR 762(2006)	114.5	73.33	6.16	115	9.63	12.3	37.13	11	49.13	3.5	*6.13*	21.96
36	VL 324	122.5	81.33	6.5	121	6.83	10.13	39.33	9.63	49.8	3.46	*5.66*	26.7
37	MR -2(1994)	117.26	85.33	6.83	122.33	7.1	9.9	44.6	9.53	52.3	3.33	*6.4*	30.33
38	MR-6	116	85.33	6.66	122.33	7.1	9.5	36.6	9.16	53.27	3.33	*6.66*	29.06
39	BM-2(1995)	102.5	68	5.86	106	6.33	10.3	42.4	9.7	54.07	3.13	*7*	28.8
40	CO-14(2004)	104.46	70	5.6	107	8.033	8.63	31.33	8	49.5	3.2	*6.33*	28.43
41	KOPN-235(2011)	122.33	75.33	5.93	113.66	7.4	10.63	31.26	9.96	48.8	3.23	*5.86*	30.2
42	OUAT-2(1999)	88.6	85.16	7	122	6.466	10.33	42.26	9.63	49.6	3.13	*6.3*	31.03
	Grand mean	109.88	73.54	5.57	109.56	7.31	8.86	35.88	7.12	47.63	3.25	6.20	28.15
	CD at 5%	7.90	8.68	1.024	6.120	1.45	1.63	5.48	1.461	10.57	0.29	1.21	14.36
	CD at 1%	10.51	11.55	1.36	8.14	1.93	2.17	7.29	1.94	14.06	0.38	1.61	19.10
	SE	2.79	3.071	0.362	2.16	0.51	0.57	1.94	0.51	3.74	0.11	0.43	5.08

Table 4. Estimates of genetic parameters of twelve quantitative character in forty two genotypes of finger millet

			VARIANCE(σ²)			COEFFICIENT OF VARIATION					
Character	Grand Mean	Range	GV	PV	EV	GCV	PCV	ECV	h^2_{bs}	GA	GA as % mean
PH	109.88	132-78.8	6.228	29.642	23.414	10.464	11.349	21.813	85.0	0.533	6.59
DTF	73.54	85.33-61	33.820	62.12	28.300	7.855	10.645	18.5	54.4	8.832	12.011
T/P	5.57	7.0-4.13	0.335	0.728	0.393	10.027	15.035	25.062	44.4	0.781	1.062
DTM	109.56	124-84	78.914	79.307	14.047	8.096	8.787	16.833	84.8	15.556	14.198
F/P	7.31	8.83-5.26	0.8971	16.86	0.789	12.884	17.666	30.55	53.1	1.034	14.1
EHL	8.86	12.36-6.26	2.22	3.21	0.999	16.890	20.341	37.231	68.9	2.087	23.717
LL	35.8	46.4-28.83	15.51	26.8	11.293	10.947	14.389	25.33	57.8	4.001	11.21
FL	7.12	9.096-3.76	2.63	2.71	0.801	21.608	24.968	46.567	74.8	1.379	26.01
EW/P	44.67	54.07-29.5	11.569	53.521	41.952	7.132	15.339	22.471	21.6	2.882	6.052
TW	3.25	2.33-3.5	0.1681	0.1998	0.031	2.613	6.0388	8.6518	18.7	0.067	2.061
SY	6.20	7.36-4.86	0.1999	0.7499	0.550	7.065	13.878	20.943	25.9	0.395	6.36
GY	28.15	53.4-12.97	14.285	91.652	77.365	13.05	33.068	46.118	15.5	1.206	4.286

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