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Stability Analysis of Naga King Chilli (*Capsicum Chinense* Jacq.)

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ABSTRACT

Eight landraces of Naga King Chilli (Capsicum chinense Jacq.) were evaluated under three environmental conditions viz. polyhouse conditions, experimental open field condition and open farmer's field condition for various genetic parameters, under Randomized Block Design. Study revealed that all the landraces except landrace from Medziphema (C5) were below average stable for all the 12 characters under study and landrace from Mon (C2) and Jaluki (C6) exhibited below average stability for fruit yield per plant. On the basis of all the stability parameters, landraces from Medziphema (C5), Jaluki 1(C6) and Jaluki 2 (C7) with average stability for most of the characters for yield potential were found to be best.

1. Introduction

Chilli a dicotyledonous flowering plant belongs to the family Solanaceae and is cultivated exclusively in tropical and temperate zones of the world. In 2016 it was estimated that the global production of chilli was 34.5 million tonnes (*Chilli Wikipedia*). The cultivated species of the genus are *Capsicum annuum, Capsicum chinense, Capsicum frutescens, Capsicum baccatum* and *Capsicum pubescens*. Naga King Chilli (*Capsicum chinense* Jacq.) is native to the Northeastern states of India and is considered as India's hottest chilli measuring at 8,55,000 Schoville Heat Unit (Mathur et al., 2000). Most of the chilli species and varieties cultivated in India contain around 1% capsaicin but Naga King chilli has around 2–4% capsaicin as reported by various researchers (Mathur *et al*., 2000 and Sanatombi and Sharma, 2008) and is mainly used as a spice, as food additive, and in pharmacological applications. As a medicine, it has been reported to show anticancer effect (Moore and Moore, 2003 and Baek *et al.,* 2008) and it also provides relief in arthritis and respiratory ailments (Mazzone and Geraghty, 1999). Capsaicin has also been reported to show protective effects against cholesterol and obesity (Kempaiah *et al.,* 2005).

The occurrence of high cross pollination and adaptation to micro-climatic conditions has led to the formation of variants and landraces within the species (Kehie *et al*., 2012 b). Phenotypic expression of the genotype is variable when grown in different environments. It is observed that G × E interaction is widely present and contributes substantially to the non-realization of expected gain from the selection (Comstock & Moll 1963). Considering the differential response of landraces to varying environmental conditions the present investigation was carried out to identify stable and high yielding genotypes of the king chilli landraces.

Table 1. Particulars of the landraces

Code	Place of collection	District
C1	Mangkolemba	Mokokchung
C2	Mon	Mon
C3	Tsiephama	Dimapur
C4	Rhazaphema	Dimapur
C5	Medziphema	Dimapur
C6	Jaluki 1	Peren
C7	Jaluki 2	Peren
C8	Thekrezhüma	Kohima

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Table 2: Pooled analysis of variance for landrace - environment interaction and phenotypic stability for different characters of Naga King Chilli

Source of variation	df	Mean Squares											
		Days to first flowering	Plant height (cm)	Days to 50% fruiting	Number of fruit per plant	Fresh fruit weight (g)	Fruit length (cm)	Fruit width (cm)	Number of fruits per cluster	Number of seed per fruit	Dry fruit weight (g)	1000 seed weight (g)	Fruit yield per plant (g)
Replication within Environment	12	3.329	154.566	1.764	124.960	0.048	0.015	0.009**	0.068**	10.467**	0.004	0.010	3419.559
Landraces	7	124.148**	621.048*	81.734**	873.667*	0.553**	1.051**	0.081**	0.099**	85.673**	0.016**	0.231**	19191.836**
Env. + Landraces * Env.)	40	860.351**	1343.745**	960.028**	676.941**	0.916**	0.707**	0.016**	0.236**	74.589**	0.045**	0.061**	25968.241**
Environment	5	6721.943**	9365.393**	7579.600**	3273.180**	6.256**	4.768**	0.042**	1.553**	515.846**	0.335**	0.305**	163606.767**
Landraces * Environment	35	22.981	197.796	14.375	306.050	0.153**	0.127*	0.012**	0.048**	11.552**	0.003	0.026*	6305.595
Env. (Linear)	1	33609.715**	46826.967**	37897.999**	16365.899**	31.281**	23.838**	0.210**	7.765**	2579.229**	1.673**	1.525**	818033.834**
Landraces * Env. (Linear)	7	27.651	86.433	33.321**	225.044	0.466**	0.313**	0.049**	0.149**	45.391**	0.006*	0.076**	10910.978*
Pooled Deviation	32	19.086**	197.432**	8.433**	285.514**	0.066	0.071	0.002	0.019	2.706	0.002	0.012	4509.968
Pooled Error	84	1.017	69.626	2.129	144.424	0.096	0.054	0.010	0.029	7.556	0.004	0.011	3260.174
Total	47	750.704	1236.109	829.218	706.241	0.862	0.759	0.025	0.215	76.240	0.040	0.087	24958.990

Note: * and **: Significant at 5% and 1% level of significance respectively

Table 3. Stability parameters for days to first flowering and plant height and Days to 50% fruiting

Landraces	Env. I		Env. II		Env. III		Pooled mean	β_i	S^2Di
	2014	2015	2014	2015	2014	2015			
C1	5.240	5.227	5.400	5.477	4.197	4.363	4.984	0.579*	-0.032
C2	5.440	5.507	7.730	6.920	4.540	4.263	5.733	1.478	0.053
C3	5.103	5.250	6.793	6.553	3.960	4.153	5.302	1.329**	-0.077
C4	5.277	5.283	7.043	6.597	4.323	4.513	5.506	1.226	-0.051
C5	4.993	4.877	5.610	5.650	4.250	4.997	5.063	0.536*	-0.034
C6	5.950	6.257	6.697	6.557	4.833	4.850	5.857	0.895	-0.017
C7	5.133	5.263	6.293	6.330	4.433	4.970	5.404	0.834	-0.052
C8	5.403	5.527	6.227	6.273	3.573	4.597	5.267	1.122	0.013
Environmental index	-0.072	0.009	1.085	0.905	-1.126	-0.081	5.39		
CV	12.662	6.894	8.664	6.842	16.473	8.197			
CD @ 5%	-	0.652	0.982	0.754	-	0.659			

2. Materials and Methods

The present investigation was conducted for two growing seasons *i.e.* 2014 and 2015 under three environmental conditions *viz.* Polyhouse Condition of Central Institute of Horticulture, Medziphema, Nagaland designated as Environment I; open field condition located in the Experimental Farm of Genetics and Plant Breeding NU: SASRD designated as Environment II and under farmers' field condition near bamboo groove located on the hill slope land of SASRD farm designated as Environment III. The experiment was conducted in Randomized Block Design (RBD) with three replications accommodating 12 plants in each plot of (3x2.25) m^2 with a spacing of 75 cm between the plants and rows. The experimental materials in the present study comprise of eight landraces of Naga King Chilli procured from five districts of different growing locations in Nagaland. The particulars of the landraces are presented in Table I. The observations were recorded for the characters such as days to first flowering, plant height, days to 50% fruiting, number of fruits per plant, fruit yield per plant, fresh fruit weight (g), dry fruit weight (g), number of seeds per fruit, 1000-seed weight (g), fruit length (cm), fruit width (cm) and number of fruits per cluster.

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3. Results and Discussion

The mean square values from the pooled analysis of variance indicated highly significant variation due to landraces for all the traits (Table II). This revealed the presence of genetic variability in the breeding material under investigation. Highly significant environmental variance represented adequate heterogeneity between the environments and their suitability for evaluating the landraces for all the component characters. The additive environmental variance was found to be of considerable magnitude as indicated by the significant variance due to environment (linear) for all the characters. The pooled deviation is significant for days to first flowering, plant height, days to 50% fruiting and number of fruits per plant indicating that the unpredictable portion formed the major part of the G × E interaction that the landraces tested differed considerably in their stability for these characters. Significant variance due to Genotype X Environment (linear) interaction was observed for all the characters except days to first flowering, plant height and number of fruits per plant which suggest that the landraces possessed considerable variation among them and also additive environmental variation interacted significantly with for all the characters under study. This is in conformity with findings as reported by Srividhya and Ponnuswami (2010) for fruit weight, yield per plant and dry fruit weight.

Owing to the presence of sufficient GE interaction the population was screened for phenotypic stability by estimating the stability parameters proposed by Eberhart and Russell (1966), viz. mean over environments (mi), regression co-efficient (bi) and deviation mean squares (S^2di).

From the stability analysis (Table III to VI), it was revealed that C5 exhibited average stability for number of seeds per fruit; C6 exhibited average stability for fruit width and 1000 seed weight. C8 exhibited average stability for 1000 seed weight.

Both C2 and C4 exhibited above average stability for number of fruits per cluster while C6 exhibited above average stability for fresh fruit weight and fruit length and C7 exhibited above average stability for fresh fruit weight. The stability in yielding ability result from genetic homeostasis (Lerner, 1954) in which component character may respond differently to fluctuating environment but component characters compensate in such a way as to give stability to the final characters (Thoday, 1958; Grafius,l956).

On the basis of all the stability parameters, landraces collected from Medziphema (C5), Jaluki 1 (C6) and Jaluki 2 (C7) with average stability for most of the characters for yield potential were found to be best. These genotypes may be used in various breeding programmes adaptable to a wide range of environments.

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Table 4. Stability parameters for fruit length of Naga King Chilli over the environments

Landraces	Env. I		Env. II		Env. III		Pooled mean	β_i	S^2Di
	2014	2015	2014	2015	2014	2015			
C1	5.323	5.180	5.867	5.583	4.293	4.290	5.089	0.823	-0.008
C2	5.137	5.090	5.730	5.703	3.807	4.807	5.046	0.856	0.031
C3	5.143	5.140	7.173	7.187	4.187	4.947	5.629	1.554	0.109*
C4	5.330	5.347	6.773	6.737	4.570	4.840	5.599	1.200	-0.011
C5	5.360	5.057	5.830	5.760	4.637	4.717	5.227	0.651**	-0.040
C6	6.273	6.383	6.820	6.717	5.210	5.037	6.073	0.928	0.041
C7	5.713	5.590	5.723	5.793	4.513	4.657	5.332	0.671	0.041
C8	5.857	5.777	7.433	7.390	5.073	5.237	6.128	1.317	0.009
Environmental index	0.002	-0.070	0.903	0.843	-0.979	-0.699	5.52		
CV	7.869	5.591	6.668	5.836	11.530	6.683			
CD @ 5%	0.760	0.533	0.750	0.650	0.916	0.564			

Note: * and **: Significant at 5% and 1% level of significance respectively

Table 5. Stability parameters for fruit width of Naga King Chilli over the environments

Landraces	Env. I		Env. II		Env. III		Pooled mean	β_i	S^2Di
	2014	2015	2014	2015	2014	2015			
C1	2.820	2.743	2.993	2.850	2.627	2.743	2.796	1.531	-0.006
C2	2.937	2.850	3.257	3.257	2.870	2.850	3.003	2.693**	-0.008
C3	2.667	2.730	2.643	2.630	2.667	2.730	2.678	-0.414**	-0.009
C4	2.757	2.733	2.767	2.707	2.757	2.733	2.742	-0.046**	-0.009
C5	2.653	2.653	2.643	2.700	2.653	2.653	2.659	0.113**	-0.009
C6	2.877	2.887	2.813	2.933	2.743	2.887	2.857	0.281	-0.005
C7	2.660	2.647	3.140	3.117	2.660	2.647	2.812	3.304**	-0.006
C8	2.667	2.633	2.750	2.703	2.667	2.633	2.676	0.539*	-0.009
Environmental index	-0.023	-0.043	0.098	0.084	-0.072	-0.043	2.78		
CV	6.149	6.994	6.018	5.286	5.504	6.994			
CD @ 5%	-	-	0.303	0.265	-	-			

Note: * and **: Significant at 5% and 1% level of significance respectively

Table 6: Stability parameters for number of fruits per cluster of Naga King Chilli over the environments

Landraces	Env. I		Env. II		Env. III		Pooled mean	β_i	S^2Di
	2014	2015	2014	2015	2014	2015			
C1	2.907	2.690	2.230	1.790	1.820	1.610	2.174	1.129	0.006
C2	2.857	2.343	1.823	2.040	1.650	1.823	2.089	0.962	-0.011
C3	2.553	2.360	1.643	1.800	1.557	1.553	1.911	0.982	-0.030
C4	2.737	2.643	1.743	1.773	1.803	2.153	2.142	0.929	0.010
C5	2.030	2.040	2.147	1.973	1.833	1.700	1.954	0.180	-0.009
C6	3.090	3.057	1.820	2.010	1.757	1.937	2.278	1.388	-0.018
C7	2.517	2.473	1.787	1.810	1.513	1.703	1.967	0.950	-0.030
C8	2.943	2.663	1.713	1.720	1.367	1.517	1.987	1.479	-0.033
Environmental index	0.641	0.471	-0.200	-0.198	-0.400	-0.313	2.06		
CV	10.330	12.444	16.815	15.848	18.767	14.491			
CD @ 5%	0.489	0.552	-	-	-	0.444			

Note: * and **: Significant at 5% and 1% level of significance respectively

Table 7: Stability parameters for number of seeds per fruit of Naga King Chilli over the environments

Landraces	Env. I		Env. II		Env. III		Pooled mean	β_i	S^2Di
	2014	2015	2014	2015	2014	2015			
C1	43.033	42.050	54.933	50.023	42.493	42.050	45.764	0.652*	-5.217
C2	41.697	40.443	55.950	53.667	41.697	40.443	45.649	0.881	-6.489
C3	35.160	37.933	61.517	59.473	36.370	37.933	44.731	1.528**	-7.842
C4	43.307	44.507	54.620	54.737	41.193	44.507	47.145	0.730*	-6.445
C5	34.767	34.767	46.867	46.690	36.203	34.767	39.010	0.746**	-7.134
C6	31.700	32.850	55.113	55.027	36.387	32.850	40.654	1.386*	-3.867
C7	45.987	46.080	56.290	56.467	45.987	46.080	49.482	0.663**	-7.673
C8	28.573	36.640	54.647	53.783	28.573	36.640	39.809	1.414	2.954
Environmental index	-6.003	-4.622	10.961	9.703	-5.418	-4.622	44.03		
CV	11.782	10.464	11.381	7.895	12.887	10.464			
CD @ 5%	7.846	7.222	-	7.429	8.714	7.222			

Note: * and **: Significant at 5% and 1% level of significance respectively

Table 8: Stability parameters for 1000 seed weight of Naga King Chilli over the environments

Landraces	Env. I		Env. II		Env. III		Pooled mean	β_i	S^2Di
	2014	2015	2014	2015	2014	2015			
C1	5.333	5.077	5.103	5.110	5.100	5.047	5.128	-0.158*	0.0010
C2	4.233	4.333	5.033	5.103	4.883	4.827	4.736	1.681	0.0213*
C3	4.267	4.267	4.967	4.903	4.830	4.397	4.605	1.682**	-0.0102
C4	4.967	4.867	5.333	5.280	4.940	4.787	5.029	0.941	0.0099
C5	4.933	4.933	5.070	5.057	4.993	4.807	4.966	0.396	-0.0067
C6	4.467	4.467	4.733	4.967	4.813	4.487	4.656	1.006	-0.0024
C7	4.333	4.433	4.967	4.953	4.933	4.627	4.708	1.398	-0.0042
C8	4.467	4.467	4.987	4.740	4.910	4.563	4.689	1.055	-0.0004
Environmental index	-0.189	-0.209	0.210	0.200	0.111	-0.122	4.81		
CV	6.008	3.322	2.822	3.129	3.110	3.845			
CD @ 5%	0.487	0.268	0.248	0.275	-	0.316			

Note: * and **: Significant at 5% and 1% level of significance respectively

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