

STABILITY ANALYSIS FOR TUBER YIELD COMPONENTS IN POTATO

A. HAYDAR¹, M. A. ISLAM¹, T. ARA¹, E. H. KHOKAN¹ and M. M. HOSSAIN¹

¹Department of Botany, University of Rajshahi, Bangladesh

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ABSTRACT

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Thirty potato genotypes were evaluated for four successive years (environments) for their stability analysis using Eberhart and Russell's model at Botanical Research Field, Rajshahi University, Rajshahi, Bangladesh during the rabi crop seasons of 2004-2008. Analysis of variance, mean, regression co-efficient (bi) and deviation from regression (s^2di) of the individual genotypes were estimated to evaluate the stable performance of the genotypes. The mean squares due to genotypes, environments and genotype-environment interaction were significant for all the characters studied suggesting a lot of variability among the genotypes environments and the genotypes interacted significantly with environments. Among all the genotypes, Petronese and Calwhite showed stable performance for tuber number and tuber yield under all environments. The genotypes Yucon gold was highly responsive and suitable for favorable environments only.

Keywords: Stability, Genotype, Potato and Interaction

INTRODUCTION

Potato (*Solanum tuberosum* L.) is one of the most important horticultural and economical food crop in Bangladesh as well as many countries of the world. In Bangladesh potato is still used as a major vegetable crop. In Bangladesh potato substantially supplements of food requirements of the country after two cereals, rice and wheat (Sarker and Mostafa, 2002). At present potato is the most important crop that grows well throughout the country occupying 3rd position after rice and wheat. Potato ranks 1st as vegetable in terms of area and production in Bangladesh. Yield in potato as in other crops, is a very complex character and is dependent on many other characters (Mondal, 2003). The environment has many influences over productivity of a potato genotype. A study of stability analysis is of much value in the selection of better genotypes.

High yield stability usually refers to a genotypes ability to perform consistently, whether at high or low yield levels, across a wide range of environments (Annicchiario, 2002). Genotypes are selected primarily on the basis of the mean performance across environments for that crop year, although those selected may not be the most stable (Yau and Hamblin, 1994). Yield stability targets for breeding programs can be defined from yields of trials through estimation of variance components for the target environments. One of the major stability measures is the static stability concept (Lin *et al.*, 1986; Becker and Leon, 1988). This can be estimated by measuring (i) the environmental variance i.e. the variance of genotype yields recorded across test or selection environments, and (ii) the regression coefficient of genotype yield in individual environments as a function of the environment mean yield. When genotype environment interaction significant, stability parameters are estimated for selecting superior genotypes across a range of environment. The objective of this study was to investigate the stability of agronomic characters of thirty genotypes grown in four successive years using variance and regression analysis.

MATERIALS AND METHODS

The experiment was carried out four successive years in the botanical research field of Rajshahi University, Bangladesh during the year 2004-2008. Thirty potato genotypes viz. Petronese, Conestoga, Granulla, Raja, Calwhite, Hagrai, Japanese red, Atlas, TPS-573, Diamont, Banana, Russet burbank, Green mountain, Atlantic, Shilbilati, Cheroki, Lapakri, Blondy, Superior, Prelude, Fundy, Yucon gold, GMO, TPS-67, Elvera, Multa, Shepody, TPS-7, All blue and Monona were collected from Plant Breeding and Gene Engineering Lab, Dept. of Botany, University of Rajshahi, Bangladesh and used as experimental materials. In each year the experiment was conducted in a randomized block design with three replications. In order to investigate the stability, following six yield related characters were evaluated viz. plant height (PH), number of leaves/plant (NLP), fresh weight/plant (FWP), number of tubers/plant (NTP), average tuber weight of plant (ATW) and tuber yield/plant (TYP). To select the desirable genotypes, the mean performance, regression co-efficient (bi) and deviation from regression (s^2di) were calculated following Eberhart and Russells model (1966).

RESULTS AND DISCUSSION

Analysis of variance for various yield related characters are presented in Table 1. Mean squares due to genotypes (G) and environments (E) were found significant for all the characters when tested against pooled error suggested that lot of variability among the genotypes and environments exists (Table 1).

The significant $G \times E$ interaction values for these traits indicated that the genotypes interacted differently with the environment. Character wise mean, regression coefficient (bi) and deviation from regression (S^2di) of the individual genotypes are shown in Annexure-1 Table 2. For plant height of genotype Diamond had higher mean than grand mean ($p > \bar{x} = 46.79$), regression coefficient nearly 1.00 (1.131) and non-significant derivation from zero (S^2di value). The genotypes Calwhite, Prelude and All blue were found stable due to high mean number of tubers/plant, near unit regression with non-significant S^2di value. The genotype Yucon Gold was found highly responsive to favorable environment due to higher mean tuber yield (10.08, 1.148 and 0.184) above average response with very small deviation from regression value. The stability parameters for fresh weight/plant, average tuber weight of plant and number of tuber/plant in Calwhite, Shilbilati and Prelude also showed the similar trend. The tuber yield attributes viz. fresh weight/plant and tuber yield/plant showed the similar results. Plant height (46.79, 1.131 and 0.66) fresh weight/plant (41.37, 0.213 and 0.16) average tuber weight (10.10, 0.722 and 0.07) and tuber yield (10.08, 1.148 and 0.84) were found highly responsive to favorable environment due to their mean, above average response with small S^2di value. The genotypes Raja, Fundy, Shepody and Elvera were found stable in poor environment due to lower mean yield, below average response with non-significant S^2di value.

Genotype Banana and Diamont for plant height, Fundy for number of leaves/plant, Conestoga for fresh weight, Granula, All blue for tubers number, Elvera for average tuber weight and GMO for tuber yield with low mean performance (Raja, Fundy and Cherokee, Yucon Gold) regression co-efficient close to 1.00 and non-significant deviation indicated that these six characters of these genotypes were poorly adaptable to all environments. Haydar (2007) also made similar conclusion for stability of tuber yield in potato.

The Fundy genotype has high mean performance (212.00), negative linear effect (-0.971) and its deviation from regression was minimum (0.08) suggested its suitability for poor or unfavorable environments. The genotypes Banana, Shilbilati and Yucon gold showed bi values greater than units (1.303, 1.611 and 1.148, respectively) S^2di values closer to zero (0.190, 0.61, and 0.840, respectively) indicated suitability to grow these genotypes under high yielding genotypes.

Table 1. Mean sum square from the combined analysis of variance for different characters of potato

Source of Variation	df	Mean sum of squares ^a					
		PH	NLPP	FWP	NTPP	ATW	TYP
Genotypes	29	122.462**	14085.6**	2078.14	10.3575**	166.690**	3943.42**
Environment	2	751.679**	1103.29**	6428.48	16.4820**	121.737**	24525.1**
G×E interaction	58	46.4654**	4812.85**	406.190	3.04664**	71.1500**	988.070**
G×E (linear)	29	62.4895**	9187.52**	357.934	4.67866**	60.8925**	1030.15**
Pooled deviation	30	30.4413**	438.187**	454.446	1.41463	81.4075**	945.995**
Pooled error	174	2.058	20.967	0.788	3.307	0.748	1.089

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^a PH = plant height, NLPP = number of leaves/plant, FWP = fresh weight of plant, NTPP = number tuber/plant, ATW = average tuber weight and TYP = tuber yield /plant

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ANNEXURE-1

Table 2. Stability parameters of yield and its components for potato genotypes over four years

Genotypes	PH			NLPP			FWP		
	\bar{X}	bi	S ² di	\bar{X}	bi	S ² di	\bar{X}	bi	S ² di
Petronese	49.59	0.500	9.39	288.60	4.679	144.87	120.74	-1.536	1647.09
Conestoga	46.53	1.031	5.87	301.12	9.973	958.55	41.37	0.213*	0.16
Granula	39.13	1.231	3.34	280.41	1.458	8.03	103.19	1.032	53.72
Raja	45.40	3.560	36.49	284.12	13.935	129.55	110.02	-0.293*	2.03
Calwhite	40.04	0.564	34.37	211.50	2.065	614.60	130.37	1.468	1627.28
Hagrai	35.42	0.172	8.96	214.57	-6.483	406.18	115.81	0.331	69.38
Japnesered	43.97	0.369	28.56	333.37	6.423	28.65	105.17	1.950	192.43
Atlas	41.84	1.516	32.07	290.44	3.089*	1.42	123.24	1.255	111.41
TPS-573	42.62	0.603	4.87	340.18	7.405*	14.37	105.76	1.002	1772.38
Diamont	46.79	1.131	0.66	290.90	5.346	533.72	137.22	2.611	145.37
Banana	30.75	1.303	0.19	166.63	1325	116.86	58.91	1.410	1376.08
Russet burbank	35.41	2.063	2.39	223.42	3.409	6159.86	65.22	1.330	1.06
Green mountain	43.78	0.573	48.24	255.68	3.970	204.65	134.26	0.748	331.77
Atlantic	46.66	1.733	0.57	260.10	4.054	6.60	109.46	-0.008	210.53
Shilbilati	31.33	0.558	15.23	246.07	4.119	368.30	107.2	1.611*	0.61
Cheroki	48.50	3.120	49.21	258.97	11.790	217.65	138.19	1.483	1060.64
Lalpakri	30.05	-1.627	10.06	89.72	-4.715*	0.56	92.98	0.983	93.95
Blondy	52.52	2.743	23.07	264.60	11.007*	0.19	58.15	1.023	75.93
Superior	45.19	2.063	2.43	204.02	-3.017	49.99	72.96	0.428	43.43
Pllude	31.65	-0.947	4.26	123.17	-4.539*	0.00	150.19	-0.216*	2.97
Fundy	46.62	0.333	29.22	212.00	-0.971*	0.08	134.81	2.164	1390.65
Yucon gold	37.81	0.935	5.21	177.34	4.004	963.45	126.48	1.848	125.61
GMO	40.15	1.642	4.70	220.19	5.822	54.12	114.07	1.409	92.91
TPS-67	45.76	1.658	15.75	253.98	0.754	2.35	112.22	1.353	512.22
Elvera	45.09	0.548	24.10	233.41	-0.410	61.38	125.56	2.176	539.74
Multa	36.57	-0.684	19.69	142.46	-2.744	227.64	122.78	2.191	1066.34
Shepody	45.17	1.808	3.59	262.30	3.313	194.22	95.56	0.547	168.45
TPS-7	34.43	0.136	15.72	403.20	-51.865*	995.35	90.33	1.219	86.18
All blue	30.05	0.396	33.68	127.53	-4.279	193.45	95.37	-0.246	291.55
Monona	44.69	0.968	10.90	198.53	1.084	50.77	110.00	0.412	87.06

Table Legend

\bar{X}	= mean
bi	= regression coefficient &
S ² di	= deviation from regression
PH	= plant height
NLPP	= number of leaves/plant
FWP	= fresh weight of plant
NTPP	= number tuber /plant
ATW	= average tuber weight and
TYP	= tuber yield /plant

Table 2. Cont'd (as right hand side columns)

Genotypes	NTPP			ATW			TYP		
	\bar{X}	bi	S ² di	\bar{X}	bi	S ² di	\bar{X}	bi	S ² di
Petronese	49.59	0.500	9.39	8.71	2.957	2.83	8.71	0.801	4075.99
Conestoga	46.53	1.031	5.87	7.11	1.217	0.29	7.11	1.017	1791.36
Granula	39.13	1.231	3.34	9.26	1.295	0.06	9.26	0.965	13.40
Raja	45.40	3.560	36.49	11.54	-0.196	0.35	11.54	0.258	486.82
Calwhite	40.04	0.564	34.37	10.10	0.722	0.07	11.01	0.749	1042.94
Hagrai	35.42	0.172	8.96	9.41	-1.846	1.92	9.41	0.635	84.42
Japanese red	43.97	0.369	28.56	11.56	2.043	0.04	11.56	1.470	419.83
Atlas	41.84	1.516	32.07	9.42	6.133*	0.10	9.42	0.533	24.32
TPS-573	42.62	0.603	4.87	15.19	2.141	0.01	15.20	1.743	981.17
Diamont	46.79	1.131	0.66	7.70	-2.766	1.78	7.70	1.264	3533.74
Banana	30.75	1.303	0.19	10.37	3.988	0.37	10.37	-0.054	68.78
Russet Burbank	35.41	2.063	2.39	11.66	1.949	2.31	11.66	0.245	1517.56
Green Mountain	43.78	0.573	48.24	13.06	-1.697	0.72	13.06	0.504	30.38
Atlantic	46.66	1.733	0.57	13.57	-1.956	8.51	13.57	0.349	178.12
Shilbilati	31.33	0.558	15.23	10.06	-1.619	2.78	10.06	0.824	356.45
Cheroki	48.50	3.120	349.21	7.91	1.924	0.65	7.91	0.893	1962.67
Lalpakri	30.05	-1.627	10.06	8.62	0.191	0.61	8.62	1.012	188.88
Blondy	52.52	2.743	123.07	9.82	0.426	0.76	9.82	0.304	172.45
Superior	45.19	2.063	2.43	10.06	1.104	0.09	10.06	1.614	301.20
Plelude	31.65	-0.947	4.26	9.42	0.062	0.20	9.42	2.992*	10.64
Fundy	46.62	0.333	29.22	12.44	0.382	1.47	12.44	2.381	2227.38
Yucon Gold	37.81	0.935	5.21	10.08	1.291	3.46	10.08	1.148*	0.84
GMO	40.15	1.642	4.70	9.06	-0.793	1.08	9.06	0.864	51.77
TPS-67	45.76	1.658	15.75	10.18	-0.681	0.21	10.18	0.645	1151.29
Elvera	45.09	0.548	24.10	10.92	3.193	0.19	10.92	2.193	2168.94
Multa	36.57	-0.684	19.69	9.17	3.678*	0.03	9.17	1.135	106.94
Shepody	45.17	1.808	3.59	8.20	2.088	4.14	8.20	2.296	709.77
TPS-7	34.43	0.136	15.72	7.60	4.158*	0.00	7.60	-0.428	2820.02
All blue	30.05	0.396	33.68	8.63	0.996	0.25	8.63	0.598	414.58
Monona	44.69	0.968	10.90		-0.383	5.75		2.050	541.19

Table Legend

\bar{X}	= mean
bi	= regression coefficient &
S ² di	= deviation from regression
PH	= plant height
NLPP	= number of leaves/plant
FWP	= fresh weight of plant
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