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Research Article – Agriculture

Stability analysis of selected mutants of Indian indigo (*Indigofera tinctoria* L.)

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Abstract

Stability analysis was carried out with nine mutant genotypes and one local accession of neelamari (*Indigofera tinctoria* L.) under four environments to identify stable genotypes that could be cultivated uniformly under varied environmental conditions for yield and yield attributing traits aswell as for the indigotin content. Pooled analysis of variance for stability indicated that all the genotypes of neelamari were highly significant for all the characters indicated that materials selected possessed sufficient genetic variation for all the traits studied. Mean squares due to G x E interaction and E + (G x E) were found significant for someof the traits. Genotype x Environment (linear) were exhibited by all the genotypes for most of the characters. The mutants It-3 and It-6 were stable over all environments for the characters plant spread, dry weight of leaves and indigotin content. Mutant It-8 was stable over favourable environment for the characters plant height, plant spread, girth of stem, total fresh weight of plant, fresh weight of leaves and dry weight of leaves and It-10 was stable over unfavourable environment for plant spread, total fresh weight of the plant and dry weight of shoot.

Key words: Indian indigo, Neelamari, Indigofera tinctoria, Stability analysis, Eberhart and Russell

Introduction

Indian indigo *(Indigofera tinctoria* L.), commonly known as neelamari,belongs to the family Leguminoceae. It is widely used as a textile dye and a medicine for centuries in Southeast Asia and India. The dye present in the leaves of *Indigofera tinctoria* is indigotin which is a glycoside with a blue colour. It also contain so many other dyes like Indirubine, Indigorubine or red indigo, Indirenine, Indihumine or brown indigo.

Indigofera tinctoria is one of the important plants used in traditional medicine. The roots, stems and leaves are bitter, thermogenic, laxative, trichogenous, expectorant, antihelminthic. It is also used in naturopathy, splenomegaly, echolalia, cardiopathy, chronic bronchitis, asthama, ulcers, skin diseases, diuretic and are useful for promoting growth of hair (Amrithpal, 2006). It is one of the major ingredients of hair tonics. The leaf extract is used for the treatment of hydrophobia. An Infusion of root is given as an antidote in cases of poisoning by arsenic (Gauravet *et al.,* 2011).

Lack of improved varieties results in cultivation of local types with low yield and indigotin content. Therefore an experiment was conducted with an objective of inducing variability in this plant species through mutagenesis for improving the indigotin content and yield during 2007 to 2009 (Kumanan, 2009) in the College of Agriculture, Vellayani.

Promising mutants having high yield and indigotin content were identified on the basis of evaluation done in the Department of Plant Breeding and Genetics, College of Agriculture, Vellayani from 2010 to 2015. During 2015-2016 multilocation studies were done to study the stability of the promising mutants in yield and indigotin content over different locations in the south zone of Kerala.

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Materials and methods

Mutant seeds from Department of Plant Breeding and Genetics were used for the study. These seeds were raised in Randomized Block Design with ten treatments including one control(vellanikara local) and three replications in the farmer's field in Vellanad, Kalliyoor, Kayamkulam and Kottarakara during the year 2015-2016. Each genotype was sown with a spacing of 60 x 30 cm. All the recommended agronomic package of practices was followed for raising a healthy crop. The observations were recorded on five randomly selected plants in each replication for each genotype on 11 characters viz., plant height (cm), plant spread (cm), number of leaves per plant, girth of stem(cm),total fresh weight of plant, total dry weight of plant,fresh weight of leaves(g), dry weight of leaves(g), fresh weight of shoot (g), dry weight of shoot (g) and indigotin content. The observations were subjected to stability analysis using Eberhart and Russell model.

Result and discussion

The analysis of variance showed significant difference among the genotypes for all the characters under study in all the four locations. The pooled analysis of variance revealed that highly significant differences existed among the genotypes for all traits, which indicated the presence of wide genotypic variability among the genotypes involved in the study (Table. 1). This provides ample opportunity for selecting suitable genotypes with high mean value for all the traits of interest. The G x E interactions was significant for all characters andtherefore, further analysis was done for estimating the stability parameters. Estimation of environmental index for all characters in all the four locations revealed that out of the four locations Vellanad was the most favorable or suitable environment for the cultivation of neelamari and Kayamkulam was the least favourable location for the cultivation of neelamari.

Stability analysis by joint regression analysis revealed that the linear component of G x E interaction was highly significant for plant height (cm), no of leaves per plant, total fresh wt. (g), dry wt. of leaves (g) and indigotin content (%) indicating that genotypes had divergent linear response to the environmental changes for these characters. The G x E (linear) was not significant for remaining characters indicating that variation in the performance of genotypes was predictable. Similar response was also obtained by Toshniwal (1984) for plant height, pods per plant, grain per pod and test weight and Kakkani et al. (2014) for no of branches and days to 50% flowering in fenugreek.

According to Eberhart and Russell, the stability parameters for a stable genotype are high meanwith unit regression coefficient and a non-significant deviation from regression coefficient. For the characters plant height (μ=176.95, bi=1.04, s^2di=0.43), plant spread (μ=166.83, bi=1.01, S^2di=0.2), fresh(μ=275.66, bi=0.85, S^2di= -23.26) and dry weight of leaves (μ=98.90, bi=0.91, S2di= -0.65), fresh weight of shoot (μ=661, bi= -1.06, S2di=-7.10) and indigotin content (μ=3.63, bi=0.97, S2di=-0.001), mutant It-6 was stable over all environment having unit regression and non-significant deviation from regression. While the mutant It-3 showed stable performance over all the environments for the characters plant spread (μ=193.60, bi=1.02, s^2di=0.13), girth of stem (μ=7.84, bi=1.09, S^2di=0.06), total dry weight of plant, dry weight of leaves (μ=83.85, bi=1.06, S2di= -1.02), dry weight of shoot (μ=328.20, bi=-1.03, S2di=-1.14) and indigotin content (μ=4.15, bi=-0.96, S2di=-0.001). Varied response of genotypes with respect to stability parameters for plant height and number of leaves per plant has been reported by Manomohan *et al.* (2000) in ginger. So these two mutants showed stable performance for majority of characters and these were the stable mutants having high mean, unit regression coefficient and non-significant deviation from regression. Genotypes which had high mean, regression coefficient greater than one and a non-significant deviation from regression performed well under favorable environment. From the Table 5, it was clear that the mutant It-8 showed average or stable performance over favorable environment for majority of the characters. Mutant It-8 showed high mean, regression coefficient greater than one and a non-significant deviation for the characters plant height, plant spread, girth of stem, total fresh weight of plant, fresh weight of leaves and dry weight of leaves. Mutant It-4 showed stable performance over favourable environment for indigotin content.

Table 1. Analysis of variance (mean square) for mean data of different quantitative traits over four locations

Source of variation	df	Plant height (cm)	Plant spread (cm)	No. of leaves per plant	Girth of stem (cm)	Total fresh wt. (g)	Total dry wt. (g)	Fresh wt. of leaves (g)	Dry wt. of leaves (g)	Fresh wt. of shoot (g)	Dry wt. of shoot (g)	Indigotin content (%)
Genotype	9	2664**	2550**	46234**	1.28*	91065**	16169**	11461.90**	1591.83**	31249.97**	15098.66**	2.26**
Env. + (gen. * env.)	30	2.97	1.33	29.82	2.53**	195.66**	94.42	22.47	1.91	40.73	38.20	0.006**
Env. (Linear)	1	6.67	5.73*	36.49	61.72**	800.53**	189.59	10.36	8.68**	100.74	203.46*	0.07**
Genotype * env. (linear)	9	5.70**	1.09	50.12*	0.50	405.52**	54.08	28.14	3.04*	36.98	32.94	0.008**
Pooled deviation	20	1.56	1.22	20.35	0.48	70.98	107.81	20.52	1.06	39.42	32.30	0.002
Pooled error	80	3.48	0.63	26.83	0.24	76.60	31.35	42.94	2.87	38.48	26.78	0.002

Table 2. Mean performance and stability parameters for yield and its component traits

Genotype	Plant height (cm)			Plant spread (cm)			No. of leaves per plant			Girth of stem(cm)		
	Mean	bi	s^2di	Mean	bi	s^2di	Mean	bi	s^2di	Mean	bi	s^2di
It-1	184.32	-0.55	-2.50	143.41	-1.41	0.29	1120.59	3.57	-24.71	7.42	0.88	0.36
It-2	154.51	-1.56	-2.89	135.55	2.48	-0.13	1269.12	-1.08	13.22	7.65	1.44	-0.18
It-3	201.76	6.72	-3.26	193.60	1.02	0.13	1310.00	5.32	-26.44	7.84	1.09	0.06
It-4	155.86	1.09	0.45-	126.18	1.92	0.63	1241.54	3.48	36.37	7.21	0.80	0.90
It-5	176.04	1.98	-2.13	185.87	2.48	-0.07	1147.92	-0.64	-17.70	7.45	0.86	-0.07
It-6	176.95	1.04	0.43	166.83	1.01	0.20	1328.46	3.71	-5.10	7.32	1.31	0.22
It-8	214.65	5.19	-1.56	196.76	2.17	1.08	1475.66	-5.13	-21.44	8.67	1.21	0.35
It-9	184.66	1.16	-2.83	185.38	-0.66	1.14	1351.44	4.97	-23.27	6.80	0.65	-0.05
It-10	138.61	-1.48	-1.78	165.00	0.44	1.06	1261.95	-3.67	0.53	7.34	1.13	1.08
Vellanikara local (control)	136.53	-2.05	-1.53	150.27	-0.17	0.54	1168.41	-0.52	3.82	6.44	0.58	-0.23
Grand mean	172.39			164.89			1267.51			7.41		

Table 3. Mean performance and stability parameters for yield and its component traits

Genotype	Total fresh weight of the plant (g)			Total dry weight of the plant (g)			Fresh wt. of leaves(g)		
	Mean	bi	s^2di	Mean	bi	s^2di	Mean	bi	s^2di
It-1	845.63	0.37	-53.43	480.36	1.40	-6.86	237.08	-1.09	24.14
It-2	678.37	0.82	-34.76	379.67	2.20	-8.20	242.08	1.90	-38.22
It-3	780.88	0.11	50.51	456.88	1.08	405.65	149.58	7.42	-31.56
It-4	631.31	0.74	-46.48	361.98	3.43	34.90	241.66	-8.35	-9.98
It-5	822.46	-0.98	-35.59	338.01	-0.07	33.32	146.25	3.29	-39.19
It-6	654.99	1.62	-71.36	330.40	-0.48	47.91	275.66	0.85	-23.26
It-8	1076.5	6.94	107.21	478.88	-0.74	108.83	281.66	-5.46	-30.65
It-9	964.80	-1.07	86.38	352.68	1.06	175.68	159.16	4.55	-41.19
It-10	866.81	0.43	-35.13	342.60	-1.09	-2.18	177.50	7.77	-36.74
Vellanikara local (control)	838.67	0.98	-24.06	316.20	0.61	-24.46	262.50	-0.80	2.55
Grand mean	816.04			383.76			217.31		

Table 4. Mean performance and stability parameters for yield and its component traits

Genotype	Dry wt. of leaves(g)			Fresh wt. of shoot(g)			Dry wt. of shoot(g)			Indigotin content (%)		
	Mean	bi	s^2di	Mean	bi	s^2di	Mean	bi	s^2di	Mean	bi	s^2di
It-1	77.07	0.04	-2.02	659.75	-0.37	28.83	352.90	2.79	-19.58	3.14	0.83	-0.001
It-2	67.27	0.46	0.78	562.16	0.77	35.53	282.84	2.29	3.16	3.47	0.53	-0.001
It-3	83.85	1.06	-1.02	727.91	-0.29	-18.44	328.20	-1.03	1.14	4.15	-0.96	-0.001
It-4	77.33	-1.12	-2.65	661.25	0.84	-23.38	258.96	1.85	-10.69	4.16	2.73	0.001
It-5	62.42	-0.07	-2.84	552.08	2.18	-33.68	262.91	1.63	-16.88	3.48	-0.34	-0.001
It-6	98.90	0.91	-0.65	661.00	-1.06	-7.10	269.92	1.57	8.08	3.63	0.97	-0.001
It-8	122.35	4.85	-2.51	845.50	0.28	-2.40	417.54	0.82	1.05	4.45	2.01	0.005*
It-9	87.07	-1.07	-1.90	716.91	1.07	73.75	321.27	0.45	72.35*	4.27	1.00	-0.001
It-10	65.57	0.32	-2.63	646.94	0.64	-11.04	371.91	-0.57	-22.58	3.72	1.51	0.006*
Vellanikara local (control)	54.06	2.91	-2.63	579.00	3.92	-32.70	214.36	0.37	-2.34	1.89	0.59	0.002
Grand mean	79.59			661.15			308.08			3.59		

Table 5. Comparison of mutants on the basis of mean performance and stability parameters

S. No.	Character	Stable	Favourable environment	Poor environment
1	Plant height (cm)	It-6(176.95)	It-3(201.76),It-5(176.04), It-8(214.65), It-9(184.66)	It-1(184.32)
2	Plant spread (cm)	It-3(193.6), It-6(166.83)	It-5(185.87), It-8(196.76)	It-9(185.38),It-10(165)
3	No. of leaves per plant	It-2(1269.12)	It-3(1310),It-6(1328.46),	
4	Girth of stem (cm)	It-1(7.42), It-3(7.84), It-5 (7.45)	It-2(7.65), It-8(8.67)	
5	Total fresh wt.(g)	It-5(822.46),Vellanikara local(838.67), It-9(964.8)	It-8(1076.5)	It-1(845.63), It-10(866.81)
6	Total dry wt.(g)	It-3(456.88)	It-1(480.36)	It-8(478.88)
7	Fresh wt. of leaves(g)	It-1(237.08),It-6(275.66), Vellaniakara local(262.5)	It-2(242.08), It-4(241.66), It-8(281.66)	
8	Dry wt. of leaves(g)	It-3(83.85), It-6(98.90), It-9(87.07)	It-8(122.35)	
9	Fresh wt. of shoot(g)	It-9(716.91) ,It-4 (661.25),It-6(662.00)		It-3(727.91), It-8(845.5)
10	Dry wt. of shoot(g)	It-3(328.20), It-8(417.54)	It-1(352.9)	It-10(371.91)
11	Indigotin content (%)	It-3(4.15), It-6(3.63), It-9(4.27)	It-4(4.16)	

These findings were agreement with those of Lee (2006) in fenugreek, Panwar *et al.* (2011), Sangwan *et al.* (2013) in awagandha and Rajendra *et al.* (2015) in *Ocimum*. Mutants which had high mean, regression coefficient less than one and a non-significant deviation from regression will perform or give stable performance in unfavourable environment. Table 5 showed that the mutant It-10 showed stable performance over unfavourable or poor environment for the characters plant spread, total fresh weight of the plant and dry weight of shoot. So from this study it revealed that mutant It-3 and It-6 were suitable for all environments and mutant It-8 was suitable for favourable environment and mutant It-10 was suitable for unfavourable environment. The present study showed that mutant populations show not only increased yield, but also has greater stability in yield across environments. The stable mutants identified in this study can be further promoted to farm trials before releasing them as varieties.

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