



Stability analysis of different biostimulant applications to flowering characters of rose (*Rosa hybrida*) cultivar First Red

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Received: 4 November 2010; Revised accepted: 12 September 2011

ABSTRACT

Stability parameters were estimated for four quantitative flowering characters of rose cultivar First Red under 22 biostimulant applications during two years and two seasons in each year, i.e. 2006–07 and 2007–08 by using Eberhart and Russel's model (1966). All analysis of variance showed that biostimulants had significant responses towards different environment changes. Significant biostimulant × Environment interactions were detected for all the four characters, i.e. number of flowering shoots/plant, flower bud length, days taken from bud appearance to harvesting of rose and flower size. Winter season were found to be suitable for days taken from bud appearance to harvesting of last flower and flower size as compared to summer season. Treatment 16 (i.e. 50% recommended dose of NPK+5% *Panchagavya* + 5% Manchurian mushroom tea) were found to be stable biostimulant for two characters, i.e. number of flowering shoot/plant and flower size.

Key words: Biostimulants, Rose, Seasons, Stability parameters

Rose (*Rosa hybrida* L.) is the top ranking cut flower of the world. It belongs to the family Rosaceae, originated in northern hemisphere. Its different types having beautiful flowers of exquisite shape, different sizes, forms, bewitching colours and most delightful fragrance has made it an important flower. The diverse climatic conditions prevailing in different regions of the country can be exploited for commercial cultivation of rose round the year (Singh 2002). Consequently, there is a great scope for production of high quality cut roses for export to the international markets, by which India can increase its foreign earning manifolds.

The cut flowers grown under open conditions are subjected to various abiotic and biotic stresses resulting in the inferior quality of cut flowers. Protected cultivation of rose has, therefore, been proposed as one of the essential inputs to boost floriculture in India by producing high quality cut flowers. Apart from other inputs, fertilization is one of the crucial aspects in increasing the flower yield of rose. Now-a-days, the application of nutrients through fertigation in rose is gaining popularity on account of higher cut flower

and better plant health (Srinivas 2005). After green revolution, there has been a tremendous increase in the use of chemical fertilizers and pesticides in agriculture, which has posed threats to ecology and environment. Therefore organic farming can be practised as an alternative to maintain the productivity, besides keeping the environment safe (Rawat 2002). Among organic farming components, biodynamic agriculture, *rishikheti*, *panchagavya*, *dasgavya* and homa farming have emerged in different parts of India (Palanikumar 2005). Spraying of Manchurian mushroom tea extract for improving yield and quality of cut flowers can also be utilized. These biostimulants have been found to stimulate various phenological variables in flower crops and have resulted in increase and/or earlier flowering as well as they improve the quality and yield.

Information about phenotypic stability is useful for the selection of biostimulants. Biostimulants × environments (B×E) interaction is a universal phenomenon when different biostimulants are evaluated across different seasons/years. Most agronomically and economically important flower traits of rose plant, such as number of flowering shoots/plant, flower bud length, days taken from bud appearance to harvesting of rose and flower size are quantitative in nature and routinely exhibit B×E interaction. There is a need for analyzing stability of biostimulants across environments. Thus, better understanding of the relative contribution of

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biostimulants, environments and their interaction as a source of variation could potentially help to identify biostimulants with more stable performance for different traits. Therefore, present study was carried out to identify the stable biostimulant(s) for diverse environmental conditions.

MATERIALS AND METHODS

The present study was carried out during 2006–07 and 2007–08 in rose plants of six year at experimental farm of Department of Floriculture and Landscaping, YS Parmar University of Horticulture and Forestry, Solan, Himachal Pradesh under naturally ventilated polyhouse. The experiment was laid out in completely randomised design with 22 treatments replicated thrice with five plants/replication. The treatment combination consisting of inorganic fertilizers and biostimulants namely Manchurian mushroom tea and *panchagavya*. The above biostimulants were applied as foliar spray through a hand sprayer on the leaves of rose plants till run off. The spray schedule started 15th days after pruning and repeated at fortnightly intervals till the flowering was over. Common basal dose consist of the use of CAN (100 g/m²), SSP (200 g/m²) and MOP (50 g/m²). For supplying 150 ppm N and 200 ppm K, different water soluble fertilizers used were Multi – k (N:P:K :: 13:0:45), calcium nitrate (15% N) and Urea (46% N). Out of 150 ppm of nitrogen, 90 ppm was applied as nitrate nitrogen (i e 444 mg of multi-K and 180 mg Ca (NO₃)₂/litre of water) and 60 ppm as ammonical nitrogen (i e 130 mg urea/litre of water).Multi-k used above for supplying N, also supplied 200 ppm of k. The 50% recommended basal dose of NPK and water soluble fertilizers was applied in every treatment except control.

Table 1 shows the experimental material comprising 22 biostimulant combinations applied to the rose cultivar First Red grown under four different environment, i e two years and two seasons in each year.

The stability analysis was carried out following the model proposed by Eberhart and Russel(1966).

RESULTS AND DISCUSSION

The results on mean performance of different biostimulants for different flowering traits are presented in Table 2 and revealed significant differences among the biostimulants (B), environments (E) and biostimulant × environments (B×E) interaction. Treatment 16 shows maximum number of flowering shoots/plant (12.25), flower bud length (2.90 cms), days taken for bud appearance to harvesting of rose flower (29.66 days) and flower size (10.54 cms) while treatment 1 had minimum values for all the studied traits. From the study of environment index (Table 2) indicated that winter season were the most favourable environment for flower size and days taken from bud appearance to harvesting of rose whereas summer season is suitable for number of flowering shoots/plant and flower bud length.

Table 1 Different treatment combinations of biostimulants

Treatment	Treatment combinations
1	Recommended dose of NPK
2	50 % Recommended dose of NPK + 2 % <i>panchagavya</i>
3	50 % Recommended dose of NPK + 3 % <i>panchagavya</i>
4	50 % Recommended dose of NPK + 5 % <i>panchagavya</i>
5	50 % Recommended dose of NPK + 2 % Manchurian mushroom tea
6	50 % Recommended dose of NPK + 3% Manchurian mushroom tea
7	50 % Recommended dose of NPK + 5 % Manchurian mushroom tea
8	50 % Recommended dose of NPK + 2 % <i>panchagavya</i> + 2 % Manchurian mushroom tea
9	50 % Recommended dose of NPK + 2 % <i>panchagavya</i> + 3 % Manchurian mushroom tea
10	50 % Recommended dose of NPK + 2 % <i>panchagavya</i> + 5 % Manchurian mushroom tea
11	50 % Recommended dose of NPK + 3% <i>panchagavya</i> + 2 % Manchurian mushroom tea
12	50 % Recommended dose of NPK + 3 % <i>panchagavya</i> + 3 % Manchurian mushroom tea
13	50 % Recommended dose of NPK + 3 % <i>panchagavya</i> + 5 % Manchurian mushroom tea
14	50 % Recommended dose of NPK + 5 % <i>panchagavya</i> + 2 % Manchurian mushroom tea
15	50 % Recommended dose of NPK + 5 % <i>panchagavya</i> + 3 % Manchurian mushroom tea
16	50 % Recommended dose of NPK + 5 % <i>panchagavya</i> + 5 % Manchurian mushroom tea
17	2 % <i>panchagavya</i>
18	3 % <i>panchagavya</i>
19	5 % <i>panchagavya</i>
20	2 % Manchurian mushroom tea
21	3 % Manchurian mushroom tea
22	5 % Manchurian mushroom tea

Environment-wise analysis revealed that significant differences exists among biostimulants under each environment for all the four characters studied, i e number of flowering shoots per plant, flower bud length, days taken from bud appearance to harvesting of rose and flower size .The combined analysis of variance (Table 3) indicated significant differences among biostimulants(B), environment(E) and biostimulants × Environment(B×E) interaction for all the traits. These results suggested that biostimulants did not respond similarly to different environments. On the basis of pooled analysis of variance, biostimulants were highly significant which indicated variability for number of flowering shoots/plant, flower bud length,days taken from bud appearance to harvesting of rose and flower size. Higher magnitude of mean sum of square due to environment (linear) as compared to B×E (linear) indicated that the regression of the environment on performance for various characters accounted for the major part of the total variation for all characters (Rai *et al.* 1989).The

Table 2 Effect of biostimulants on different characters of rose cv First Red

Treatment	Number of flowering shoots/ plant						Flower bud length (cm)						Days taken from bud appearance to harvesting of rose						Flower size (cm)						
	2006		2007		Mean		2006		2007		Mean		2006		2007		Mean		2006		2007		Mean		
	S	W	S	W	Mean	S	W	S	W	Mean	S	W	S	W	Mean	S	W	S	W	Mean	S	W	S	W	Mean
1	10.29	7.52	10.38	7.96	9.04	2.56	2.52	2.61	2.52	2.55	18.2	28.2	18.07	26.3	22.69	9.23	9.22	9.10	9.12	9.17	9.23	9.22	9.10	9.12	9.17
2	10.73	8.63	11.35	8.72	9.86	2.63	2.58	2.65	2.62	2.62	18.8	28.68	19.52	28.67	23.92	9.17	9.26	9.25	9.16	9.21	9.17	9.26	9.25	9.16	9.21
3	11.24	8.77	11.72	8.75	10.12	2.73	2.61	2.71	2.62	2.67	19.2	29.2	20.73	30.73	24.97	9.05	9.16	9.01	9.19	9.10	9.05	9.16	9.01	9.19	9.10
4	11.93	8.95	11.95	8.99	10.46	2.71	2.72	2.79	2.65	2.72	23.8	33.8	22.89	33.17	28.42	9.35	9.85	9.32	9.80	9.58	9.35	9.85	9.32	9.80	9.58
5	11.95	8.56	12.13	8.69	10.33	2.64	2.62	2.75	2.76	2.69	19.5	29.5	18.83	28.18	24.00	9.26	9.56	9.26	9.52	9.40	9.26	9.56	9.26	9.52	9.40
6	12.07	8.78	12.59	8.88	10.58	2.7	2.69	2.78	2.75	2.73	17.68	27.68	19.97	29.62	23.74	9.45	9.68	9.42	9.61	9.54	9.45	9.68	9.42	9.61	9.54
7	12.22	9.55	12.76	9.63	11.04	2.81	2.75	2.92	2.77	2.81	15.89	25.89	19.66	29.39	22.71	9.82	10.15	9.81	10.10	9.97	9.82	10.15	9.81	10.10	9.97
8	11.84	8.15	12.07	8.29	10.09	2.62	2.6	2.72	2.72	2.67	17.91	29.58	18.32	28.36	23.54	9.56	9.89	9.52	9.82	9.70	9.56	9.89	9.52	9.82	9.70
9	12.66	8.49	12.91	8.62	10.67	2.66	2.65	2.76	2.74	2.7	18.54	28.54	18.3	28.45	23.46	9.62	9.98	9.61	9.90	9.78	9.62	9.98	9.61	9.90	9.78
10	12.95	8.72	13.32	8.87	10.97	2.71	2.71	2.78	2.75	2.74	17.16	27.16	15.09	27.39	21.7	9.88	10.21	9.85	10.23	10.04	9.88	10.21	9.85	10.23	10.04
11	12.95	8.6	13.38	8.75	10.92	2.69	2.66	2.82	2.81	2.75	17.69	27.69	17.85	28.17	22.85	9.80	10.19	9.78	10.17	9.99	9.80	10.19	9.78	10.17	9.99
12	13.26	8.92	13.66	8.97	11.2	2.7	2.68	2.86	2.83	2.77	17.52	27.52	17.98	28.23	22.81	9.91	10.28	9.89	10.21	10.07	9.91	10.28	9.89	10.21	10.07
13	13.56	9.07	13.75	9.13	11.38	2.74	2.72	2.95	2.83	2.81	18.93	28.93	17.6	27.52	23.25	9.97	10.53	9.96	10.52	10.25	9.97	10.53	9.96	10.52	10.25
14	13.39	9.11	13.72	9.77	11.5	2.69	2.65	2.87	2.82	2.76	22.2	32.2	17.52	28.32	25.06	9.37	9.85	9.32	9.81	9.59	9.37	9.85	9.32	9.81	9.59
15	13.85	9.62	13.77	10.12	11.84	2.75	2.73	2.94	2.84	2.82	20.69	30.6	16.93	28.69	24.23	9.78	10.16	9.76	10.07	9.94	9.78	10.16	9.76	10.07	9.94
16	13.92	10.39	14.02	10.66	12.25	2.77	2.81	3.1	2.92	2.90	17.58	27.68	15.32	29.66	22.56	10.22	10.19	10.20	10.77	10.54	10.22	10.19	10.20	10.77	10.54
17	10.52	9.03	10.92	9.13	9.9	2.59	2.52	2.74	2.6	2.61	18.63	28.63	18.52	27.19	23.24	9.10	9.18	9.07	9.01	9.09	9.10	9.18	9.07	9.01	9.09
18	10.67	9.22	11.32	9.33	10.14	2.76	2.72	2.71	2.66	2.71	20.01	30.01	18.31	27.53	23.97	9.27	9.36	9.26	9.22	9.28	9.27	9.36	9.26	9.22	9.28
19	10.68	9.35	11.73	9.56	10.33	2.83	2.79	2.68	2.68	2.75	21.25	31.25	18.17	28.32	24.75	9.32	9.15	9.30	9.20	9.24	9.32	9.15	9.30	9.20	9.24
20	10.57	8.71	10.98	8.78	9.76	2.71	2.69	2.7	2.65	2.69	19.51	29.51	17.32	28.3	23.66	9.17	9.28	9.15	9.23	9.21	9.17	9.28	9.15	9.23	9.21
21	10.82	9.07	11.25	9.14	10.07	2.73	2.71	2.7	2.67	2.70	21.09	31.09	17.16	27.91	24.31	9.26	9.30	9.24	9.52	9.33	9.26	9.30	9.24	9.52	9.33
22	10.73	9.14	11.25	9.26	10.1	2.8	2.77	2.72	2.69	2.75	21.92	31.92	17.01	27.55	24.6	9.68	10.05	9.65	9.81	9.80	9.68	10.05	9.65	9.81	9.80
Mean	11.95	8.93	12.32	9.09		2.71	2.68	2.78	2.72	2.72	19.26	29.33	18.23	28.53		9.51	9.78	9.49	9.73		9.51	9.78	9.49	9.73	
E.I	1.38	-1.64	1.75	-1.48		-0.01	-0.04	0.06	-0.00		-4.58	5.49	-5.61	4.69		-0.11	0.13	-0.13	0.11		-0.11	0.13	-0.13	0.11	

S, Summer; W, winter; E.I, environment indices

CD 0.28 0.12 0.10 0.08 0.03 0.07 0.06 0.04 1.35 1.80 0.22 0.63 0.21 0.25 0.23 0.12

Season 0.03 0.01 0.06 0.25 0.06

Biostimulants 0.07 0.02 0.60 0.13 0.13

Biostimulants × season 0.14 0.04 1.19 0.26 0.26

Table 3 Pooled analysis of variance (mean squares) for different traits in rose

Source of variation	Mean sum of squares				
	df	Number of flowering shoots/plant	Flower bud length (cm)	Days taken from bud appearance to harvesting of rose	Flower size (cm)
Biostimulants (B)	21	2.29*	0.023*	7.114*	0.612*
Environment (E)	3	72.09*	0.045*	766.946*	0.422*
Biostimulants × environment (B×E)	63	0.37*	0.003*	1.64*6	0.0154*
E+ (BXE)	66	3.63*	0.005*	36.436*	0.033*
E (linear)	1	216.27*	0.136**	2300.840*	1.266*
B×E linear	3	1.05*	0.006*	0.519	0.032*
Pooled deviation	62	0.03*	0.002*	2.214*	0.006*
Pooled error	169	0.008*	0.0005*	0.5504	0.0017
Overall environment		7,16	9	15,19	16,22
Rich environment		12,13,14,15	7,11,12,14,16	21,22	7,8,9,10,11,12,13,15
Average environment		None	6,10	2,3	None
Poor environment		5,8	5,8,17	8,10,16,20	5,14

linear component of B×E interaction was found to be significant for number of flowering shoots per plant, flower bud length and flower size making the prediction of these traits possible. Significance of pooled deviation for the biostimulants was an indication of differential responses of biostimulants to different environments and deviation from linear regression also contributed substantially towards the difference in stability of biostimulants.

Stability parameters

Primary requisite for sustainable crop production is the requirement of a biostimulants with high yield and stable performance over different environments. The stability parameters are presented in Table 4. The stable biostimulant were categorized by regression coefficient (b_i) equal or close to one, mean square deviation (s^2_{di}) equal or close to 0 and having high mean performance.

Number of flower shoots/plant

Treatment 7 and 16 were found to be stable biostimulants as having $b_i=1$, $P_i > 0$ and s^2_{di} small. Treatment 12,13,14 and 15 had more days to bud formation and high responsiveness ($b_i > 1$) to change of environment. None of the biostimulants were poor sensitivity to change of environment ($b_i < 1$) for Number of flower shoots/plant.

Flower bud length

It is evident from Table 4 that treatment 9 having regression coefficient ($b_i = 1$), higher stem length and non – significant deviation from regression are the stable biostimulants. Treatment 7,11,12,14 and 16 had $b_i > 1$, $P_i > 1$ and non significant s^2_{di} which means these biostimulants were suitable under most favourable environment, i.e summer season.

Days taken for bud appearance to harvesting of rose

Treatment 16 and 22 has more days taken for bud appearance to harvesting of rose, $b_i=1$ and s^2_{di} small, hence these biostimulants responds consistently well to the varying environment conditions. Treatment 7,8,9,10,11,12,13 and 15 had $b_i < 1$ these biostimulants are least sensitive to environmental conditions.

Flower size

Treatment number 7,8,9,10,11,12,13,14,15 and 22 recorded $b_i = 1$, higher flower size and small s^2_{di} value were found to be stable biostimulants. On the other hand, treatment 16 manifested very high $b_i > 1$, $P_i > 1$ and s^2_{di} . It follows that treatment 16 is very sensitive to the environment and if input is no limitation biostimulant 16 can yield maximum number of flowers.

An examination of three stability parameters (P_i , b_i and s^2_{di}) some of the biostimulants have been identified to suit with stability of performance under favourable and non-favourable environment in respect of flower size and related traits (Table 5). In the present study the stable biostimulants could be used to develop more flower size and related characters of rose flower. It is clear that biostimulant 16 (50% recommended dose of NPK + 5% *panchagavya* + 5% Manchurian mushroom tea) was stable biostimulant for the characters number of flowering shoots/plant and flower size as compared to other biostimulants. Biostimulant 6 and 10 for flower bud length were best suited for poor environment.

Charles *et al.* (2002) performed a long-term study on pearl millet to test integrated use of millet crop residues retained on farm field after harvest and stability analysis indicated that crop residue + fertilizer treatment perform consistently in all the years. Roy and Parthasarathy (2003) identified stable cultivars for high and low phosphorus

Table 4 Stability parameters of biostimulants applied to rose crops

Treatment	Number of flowering shoots/plant			Flower bud length (cm)			Days taken from bud appearance to harvesting of rose			Flower size (cm)		
	b_i	P_i	σ^2_{di}	b_i	P_i	σ^2_{di}	b_i	P_i	σ^2_{di}	b_i	P_i	σ^2_{di}
1	0.830	-1.532	0.026	0.8	-0.17	0	0.896	-1.145	-0.044	0.067	-0.451	0.005
2	0.764	-0.712	0.021	0.57	-0.107	0	0.923	0.08	0.286	0.004	-0.409	0.002
3	0.873	-0.449	0.005	0.686	-0.055	0.004	0.96	1.128	2.379	0.604	-0.516	-0.001
4	0.944	-0.114	0.023	0.738	-0.005	0.003	0.994	4.578	-0.54	2.049	-0.039	-0.002
5	1.089	-0.237	0.005	1.243	-0.03	0.003	0.951	0.165	-0.449	1.17	-0.219	-0.001
6	1.122	0.011	-0.003	0.874	0.008	0	0.938	-0.1	3.945	0.891	-0.079	-0.001
7	0.932	0.471	0.003	1.55	0.09	0.001	0.929	-1.13	9.616	1.298	0.351	-0.002
8	1.192	-0.482	0.004	1.144	-0.057	0.002	1.06	-0.295	0.049	1.329	0.079	-0.001
9	1.349	0.101	0.01	1.073	0.02	0.001	0.983	-0.38	-0.278	1.366	0.159	-0.001
10	1.387	0.396	-0.001	0.701	0.015	0	1.095	-2.137	-0.022	1.475	0.424	-0.001
11	1.435	0.351	-0.004	1.518	0.023	0.002	0.987	-0.987	0.204	1.626	0.366	-0.002
12	1.442	0.633	0.005	1.746	0.045	0.002	0.981	-1.025	0.557	1.449	0.454	-0.001
13	1.451	0.808	0.03	2.253	0.088	0	0.982	-0.592	-0.427	2.328	0.626	-0.001
14	1.319	0.928	0.047	2.094	0.035	0.002	1.051	1.223	5.042	2.03	-0.031	-0.002
15	1.254	1.271	0.087	2.052	0.093	0	1.081	0.39	1.491	1.453	0.324	-0.001
16	1.098	1.678	0.017	3.018	0.178	0.004	1.194	-1.277	1.872	1.026	0.728	0.088
17	0.529	-0.669	0.002	2.022	-0.11	0	0.915	-0.595	-0.252	0.081	-0.529	0.006
18	0.559	-0.434	0.041	-0.202	-0.01	0.002	0.954	0.128	0.321	0.133	-0.341	0.003
19	0.577	-0.239	0.172	-1.205	0.023	0.004	1.008	0.91	1.638	-0.566	-0.376	-0.001
20	0.653	-0.809	-0.001	0.051	-0.035	0.001	1.037	-0.177	-0.196	0.408	-0.411	-0.001
21	0.622	-0.499	0.002	-0.15	-0.02	0	1.042	0.475	2.896	0.625	-0.289	0.012
22	0.579	-0.474	0.016	-0.576	0.023	0.002	1.041	0.763	6.317	1.153	0.179	0.01

conditions in a field trials with six Frenchbean (*Phaseolus vulgaris*) at five phosphorus levels (0, 20, 60, 90 and 120 kg/ha). Dapaah *et al.* (2005) conducted a field experiment study to determine the effects of supplementing inorganic fertilizers with poultry manure on yield stability. Ottai *et al.* (2006) analyzed stability parameters for five quantitative characters of three Rossel cultivars under seven nitrogen fertilizer treatments in two seasons. Selection index showed that chicken manure, followed by ammonium sulphate were the stable fertilizers. Raiger *et al.* (2009) studied the stability for seed yield and quality traits in Kalingada (*Citrullus lanatus*) and found that two genotypes were stable among eleven environments. Arya and Yadav (2009) evaluated pearl millet under four environment for stability parameters, viz regression coefficient, deviation from linearity and mean performance Gupta *et al.* (2010) studied that winter seasons were more suitable for flower size and vase life as compared to summer season. Arya and Yadav (2009) evaluated pearl millet under four environment for stability parameters, viz regression coefficient, deviation from linearity and mean performance.

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