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A correlation based response parameter proposed for varietal promotion/identification in coordinated varietal evaluation trials: A case study in bread wheat (*Triticum aestivum* L.)

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Abstract

A parameter based on correlation coefficient between deviations of yields of a variety from corresponding mean yields recorded at several locations, and the estimates of similar deviations for a check variety was used to estimate response of each of the 44 varieties included in National Initial Varietal Trial - Irrigated Timely Sown, Coordinated Trial of bread wheat planted in North Western Plains Zone and North Eastern Plains Zone during 1999-2000. Five well established standard check varieties were also included in the trial for comparison. The deviations in the yields of test entries from mean yield of all the test entries and the checks were computed for each location. The correlations between deviations of the yields of a variety and those of each of the checks were treated as measures of sensitivity or response. Significant positive correlation was taken as a measure of similarity between a variety and a check included in the pair while recommending variety for promotion or identification. This response estimate of a variety can be used as an additional parameter along with yield potential and other desirable characteristics conventionally used. Only thirteen test entries exhibited similarity in response with the five check varieties used. In the given example two varieties HD 2790 and WH 736 should have been promoted to the next trial of higher order on being statistically identical in sensitivity with standard check varieties HD 2329 and HP 1731, respectively. The variety HD 2790 was also statistically *at par* to the best check PBW 343 and superior to all other checks in yield (q/ha). Similarly variety WH 736 was significantly superior to all checks other than PBW 343 in yield. The five check varieties differed in sensitivity to varying agroecological conditions. The check variety HUW 206 exhibited most co-adaptive nature and had similarity with three test entries UP 2527, WH 738, RW 3542 and a filler entry in sensitivity towards different levels of agronomic management used at different locations.

Key words: Bread wheat, correlation coefficient, response parameter, All India Coordinated Trials, isoresponsive varieties

Introduction

Newly developed promising genotypes of crop plants are evaluated in Coordinated Yield Trials of different tiers (Initial Evaluation Trial, Advance Varietal Trial-1, Advance Varietal Trial-2 and so on) over locations at national level, constituted by concerned projects funded by Indian Council of Agriculture Research in order to know the actual potential of desired genotypes before these are released for commercial cultivation. In coordinated trials major emphasis is laid on yield and disease reactions. Some other characteristics, which are either, crop specific or based on consumers' demand (*e.g.*, protein content in wheat and malt in barley) are also considered. However, varietal sensitivity to varying environments, which is equally important, is not given due consideration. No efforts have been made to obtain direct estimate of sensitivity *in toto* of such varieties, although, varietal sensitivity is obtained and analyzed indirectly in terms of yield, disease reactions and other parameters. A need is felt to obtain the direct measure of sensitivity, which could provide composite effect of most of the factors influencing the yield over a series of locations.

In the present paper an effort has been made to provide a solution to the problem to some extent by comparing the deviations in yield of new varieties from the mean yield with similar deviations of standard checks (pair wise) at different locations. Yield data from an All India Coordinated Varietal Trial on wheat was used for the study.

Materials and methods

Forty-nine varieties of bread wheat (*Triticum aestivum*) including five check varieties (HD 2329, PBW 343, HUW 206, K 9107 and HP 1731) developed at State Agriculture Universities and Indian Council of Agriculture Research Institutes of India were evaluated in All India Coordinated trials. These varieties were planted in simple lattice with two replications in plot size as prescribed in National Initial Varietal Trial-IA-Timely Sown-National Zone Rabi during crop season 1999-2000. These trials were conducted at nine locations in North

Western Plains Zone and five locations in North Eastern Plains Zone. Yield potential of every locations was quantified by taking mean yield of all the 49 varieties grown at the corresponding locations. The ranks of these means were used as potentials of locations, similar to the ranks obtained in Eberhart and Russel [1] and Perkins and Jinks [2]. Correlations were computed between deviations of each with those of each check variety, obtained in a series of environments. Significant positive correlations between deviations in yields suggested similar response of the variety and the check following the method proposed by Singh [3]. Correlation coefficients were estimated following the method proposed by Hayes *et al.* [4].

Results and discussion

The detailed yield data obtained from the Coordinated Trial was given in the progress report 1999-2000 of Directorate of Wheat Research, Karnal. Correlation coefficients between each of the 44 test entries and each of the 5 standard check varieties for their deviations in yield (q/ha) from respective location means are pair-wise given in Table 1. Yield (q/ha) and yield ranks of all the varieties are also given in Table 1.

Sensitivity of a variety comprises influence of varying effects of several biotic and abiotic factors observed in phenotypic expressions over a series of locations or environments. Generally it is conceived in terms of yield *i.e.*, how the productivity of a variety is influenced over the range of locations. It is expressed as the sum effects of counteractions of several yield-influencing factors predominant at a location. Several mathematical devices are available for assessing different aspects of the complexities of varietal response. However, no perfect measure of response could be available so far. A generalized assessment of similarity or dissimilarity in response of two varieties could also be obtained by estimating correlation between actual yield of both the varieties at respective locations. In this case, it is assumed that both the varieties of the pair with significant positive correlation for their yield at different locations, give similar response to all the factors influencing the yield at respective location. In the present communication a simple correlation based method is given to visualize varietal response. Correlation coefficients are estimated between a newly developed variety under trial and a well-established check variety for their deviations in yield from respective location mean. Location mean was measured by taking simple arithmetic mean of yields of all the varieties under testing in order to quantify the potential of the location. Location potential could also be measured in terms of absolute yield values on the basis of other observations. The mean yield as location potential (q/ha) is used for estimation of correlation coefficient between deviations from mean, which is considered as a measure of response. A generalized assessment of similarity or dissimilarity in response could also be obtained by estimating correlation between actual yield of both the varieties at respective locations. It was assumed that both the varieties of the pair with significant positive correlation for their yield at different locations are expected to be equally responding to all the factors influencing the yield at respective locations. When deviations in yield of both the varieties of the pair from respective location means are used for estimating correlations, a more precise measurement of similarity/dissimilarity in response between both the varieties of the pair could be obtained, specifically both in rich (above average yield potential) and poor (below average yield potential) environments. In the given example of wheat varieties, 13 significant positive correlations out of the 230 correlations examined were detected (negative correlations were not of interest in the present context therefore, significance of the negative correlation is not indicated in the Table 1). For example HD 2790 and HD 2791 two newly developed varieties had significant positive correlation with the check 2329 indicating that both these newly developed test entries expressed similarity in response with the well established old variety HD 2329. Therefore, on being *at par* or acceptable in yield and other characteristics both these genotypes could be recommended for further trial in the areas suitable for cultivation of HD 2329. All the three genotypes were developed at Indian Agriculture Research Institute, New Delhi. These genotypes perhaps shared the common gene pool and therefore, expressed similar response pattern over a diversified range of agroecological conditions in the country. Three test entries UP 2527, WH 738, RW 3542 and one filler entry used in the trial were similar in response to the check variety HUW 206. Similarly, HUW 536, HD 2795, CBW 12 and the check variety K 9107 were also all alike in response pattern. Likewise, other pairs of varieties with significant positive correlations could be explained for response patterns but only those varieties, which are good in yield will have commercial utility and, therefore, could be acceptable to the farmers. None of the five check varieties had significant positive correlation with any other check. On the other hand none of the variety had significant positive correlation with more than one check. The reason for this might be that the checks belonged to different gene pools and, therefore, they expressed entirely diversified sensitivity to environmental variations.

The correlation coefficient as above provides additional information about commercial value for a variety. It could be possible to develop a sensitivity map of the varieties in the country while the genotypes

Table 1. Means and rank of 49 varieties (including checks) and correlation coefficients between 44 test entries and 5 standard check varieties for their deviations of yield from respective site mean

S. No.	Varieties	Mean yield (q/ha)	Mean yield rank	Correlation of varieties with checks				
				HD 2329	PBW 343	HUW 206	K 9107	HP 1731
	1	2	3	4	5	6	7	8
1.	HD 2789	53.4	18	0.29	-0.18	-0.12	-0.13	-0.32
2.	HD 2790	56.9	04	0.55*	-0.42	0.01	0.32	0.34
3.	HD 2791	51.5	26	0.57*	0.06	-0.44	-0.06	0.34
4.	HD 2792	54.1	15	0.05	0.22	-0.41	-0.03	-0.35
5.	HD 2793	47.8	41	0.23	-0.37	-0.10	0.06	0.07
6.	UP 2526	53.9	16	-0.43	0.14	0.05	0.02	-0.51
7.	UP 2527	46.3	44	0.17	-0.18	0.65*	-0.02	-0.25
8.	UP 2528	51.8	25	0.09	0.23	-0.48	-0.35	-0.17
9.	UP 2529	50.5	29	0.35	-0.67	0.16	0.17	0.31
10.	UP 2530	54.7	12	-0.27	-0.32	-0.26	-0.16	0.42
11.	PBW 489	56.9	04	-0.45	0.40	0.13	0.32	-0.38
12.	PBW 490	55.7	07	-0.35	0.21	-0.15	0.01	-0.12
13.	PBW 491	55.3	10	0.44	0.24	-0.16	0.14	-0.02
14.	PBW 492	57.0	02	-0.05	-0.14	-0.10	-0.25	0.41
15.	PBW 493	54.5	19	-0.56	0.32	-0.34	-0.42	-0.32
16.	Raj 4015	48.5	38	0.21	0.10	-0.05	-0.46	-0.30
17.	Raj 4016	51.5	26	-0.54	-0.13	0.01	0.01	0.10
18.	Raj 4017	49.6	35	0.17	-0.51	0.01	-0.40	-0.23
19.	Raj 4018	53.2	19	-0.28	-0.13	-0.43	-0.09	-0.33
20.	Raj 4019	49.7	34	0.15	-0.48	-0.17	0.00	0.12
21.	WH 736	57.0	02	-0.36	-0.13	-0.20	-0.25	0.68*
22.	WH 737	49.6	35	-0.13	-0.27	-0.33	-0.24	-0.11
23.	WH 738	52.3	23	-0.24	-0.06	0.63*	0.06	-0.33
24.	WH 739	55.7	07	-0.03	0.05	0.06	-0.33	0.24
25.	WH 740	55.7	07	0.34	-0.37	0.38	0.43	-0.41
26.	HUW 536	54.5	13	0.10	-0.02	0.03	0.61*	-0.09
27.	HUW 537	52.5	21	-0.14	0.21	-0.72	-0.34	0.12
28.	NW 2020	48.8	37	-0.17	0.37	-0.07	-0.23	0.13
29.	NW 2026	55.0	11	-0.15	-0.17	0.28	0.11	-0.10
30.	RSP 304	52.1	24	-0.19	0.68**	-0.25	0.06	0.13
31.	RSP 401	51.3	28	0.38	-0.02	-0.10	-0.35	-0.13
32.	K 9901	48.0	40	0.13	0.37	0.09	0.48	-0.15
33.	K 9902	53.5	17	0.33	-0.21	-0.16	-0.16	0.77**
34.	HD 2794	52.4	22	0.27	0.37	-0.60	-0.45	-0.25
35.	HD 2795	50.1	31	-0.24	0.32	0.49	0.62*	-0.21
36.	CBW 11	52.9	20	-0.06	0.56*	-0.53	-0.14	0.08
37.	CBW 12	56.1	06	-0.22	0.27	0.37	0.67*	-0.41
38.	Filler	43.6	47	-0.16	-0.55	0.56*	0.28	-0.01
39.	RW 3542	50.0	32	-0.06	-0.21	0.58*	-0.05	-0.05
40.	HW 3029	44.2	46	-0.45	0.07	-0.14	-0.23	-0.18
41.	TL 2921	45.1	45	-0.43	-0.23	-0.34	-0.78	0.20
42.	TL 2922	47.7	45	0.24	-0.23	-0.23	0.04	0.39
43.	DT 127	41.3	48	-0.06	0.14	0.12	-0.41	0.02
44.	DT 128	41.2	49	-0.20	0.11	0.30	-0.64	-0.06
45.	HD 2329	50.2	30	-	-0.19	-0.02	0.26	-0.08
46.	PBW 343	58.7	01	-	-	-0.17	0.04	-0.20
47.	HUW 206	47.0	43	-	-	-	0.37	0.13
48.	K 9107	48.2	39	-	-	-	-	-0.10
49.	HP 1731	49.8	33	-	-	-	-	-

S.E. of mean –0.83, CD 5% –2.3

*,**, Significant at 5% and 1% levels of probability (only significance of positive correlation is marked).

are being evaluated in All India Coordinated system. Such information should be considered in addition to yield, disease reaction and other parameters already used for promotion/identification of the varieties. Therefore, correlation coefficient estimated as above will help the coordinator to recommend a variety for cultivation in the area where the concerned check variety is suitable for cultivation. The varieties released using such information will last longer in cultivation. In the present example the best check variety PBW 343 outyielded all the test entries. However, two test entries HD 2790 and WH 736 were statistically at par in yield potential with this check, HD 2790 being identical in sensitivity with HD 2329 & WH 736 being identical in sensitivity with HP 1731 both these checks being old, well established and having broader adaptation base. Therefore, both these entries, which were rejected, should have been considered for promotion to the next step (Advance Varietal Trial) of evaluation in All India Coordinated trials. In addition to yield and other important characters used conventionally, sensitivity parameter and sensitivity maps of varieties must be published at the time of its release for commercial cultivation.

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