A BIOMETRICAL APPROACH FOR SCREENING OF ELITE LINES THROUGH SEQUENTIAL ORDER OF FARMER'S PREFERENCE

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Abstract: The experiment was conducted at the National Wheat Research Programme, Bhairahawa, Nepal (NWRP) in an augmented experimental design-I with eighty three elite advance lines and two checks viz. RR 21 (standard check) and Triveni (popular check) of wheat during winter of 1995/96 to screen superior genotypes for grain yield and other desirable attributes. Selection was performed by generating culling level for farmers' preferred desirable characters in the sequential order. Based on this, sixteen elite lines were selected for yield trial in the next wheat growing season.

Key words: screening; elite lines; farmers; preference; sequential order; culling level.

Nepal's *Terai,* three sides bordering with India, belongs to the Gangatic Flood Plain and covers 23 per cent of the country's land area. Forty per cent of the *Terai* is under cultivation, which represents 42 per cent of Nepal's cultivated land. Wheat is the third staple food next to rice and maize. As per the estimates, it is evident that out of 611,309 ha under wheat cultivation, 44.71 per cent is grown under rainfed situation. The yield in this domain is as low as one ton per hectare. Since early 1980's, wheat consumption in Nepal is increasing at the rate of 1.7 per cent, however, the yield increment is only 1.6 per cent (CIMMYT, 1995). In *Terai* region of Nepal, the rainfall distribution during crop growing season is very low and erratic. Further, occasional strong, hot, dry westerly windstorms occur during the months of March - May (Hobbs *et al*., 1996). The maximum stress period coincides with tillering stage to maturity. Ultimately, the most crucial period of flowering and milking stage get drastically affected and thereby a great yield loss occurs in this domain (Sah, 1996).

An early maturing variety RR 21 (105 days) with a semidwarf plant stature (100 cm) and bold grain size having a test weight of 35 g per 1000 grains, however susceptible to various diseases is a poor grain yielder under rainfed situations. Another variety Triveni is presently popular under rainfed domain of *Terai* for its high yield potential, more number of grains per spike and lesser leaf blight incidence, however, less preferred as compared to RR 21 due to longer duration (115 days) and smaller in grain size, and is also getting degenerated due to fixation of alleles over time.

Under the prevailing farming systems in Nepal, people still largely depend on traditional methods of cultivation, *i.e.,* animals are used for the preparatory cultivation, sowing and threshing. Mechanical cultivation is still at an infancy stage. Farmers still prefer short duration varieties, with high grain as well as straw yields. The variety possessing smaller grain size is less preferred by consumers due to its poor flour quality and low market price. Keeping these socio"economical aspects in view, present study was initiated to screen advance lines which are significantly higher in grain yield with desirable traits over released varieties viz. Triveni and RR 21.

The objective of this study was to select superior genotypes with farmers' preferred traits like short duration, medium to tall plant type, bold grain type, appreciable number of grains per spike, high grain yield and resistant to leaf blight disease, so that the new variety will boost up the production and productivity of wheat grown under rainfed situations of Nepal *Terai* and help in improve livelihoods and contribute in poverty alleviation of the farmers.

MATERIALS AND METHODS

The experiment was conducted with a total of eighty three elite advance lines comprising forty lines developed at NWRP, Bhairahawa and forty three lines received from CIMMYT, Mexico during winter of 1995/96. Since the high number of test entries and meagre amount of seed available, the test entries were planted without replication while checks (RR 21 and Triveni) were replicated thrice by adopting the augmented experimental design-I (Federer, 1956; Federer and Ragavarao, 1975; and

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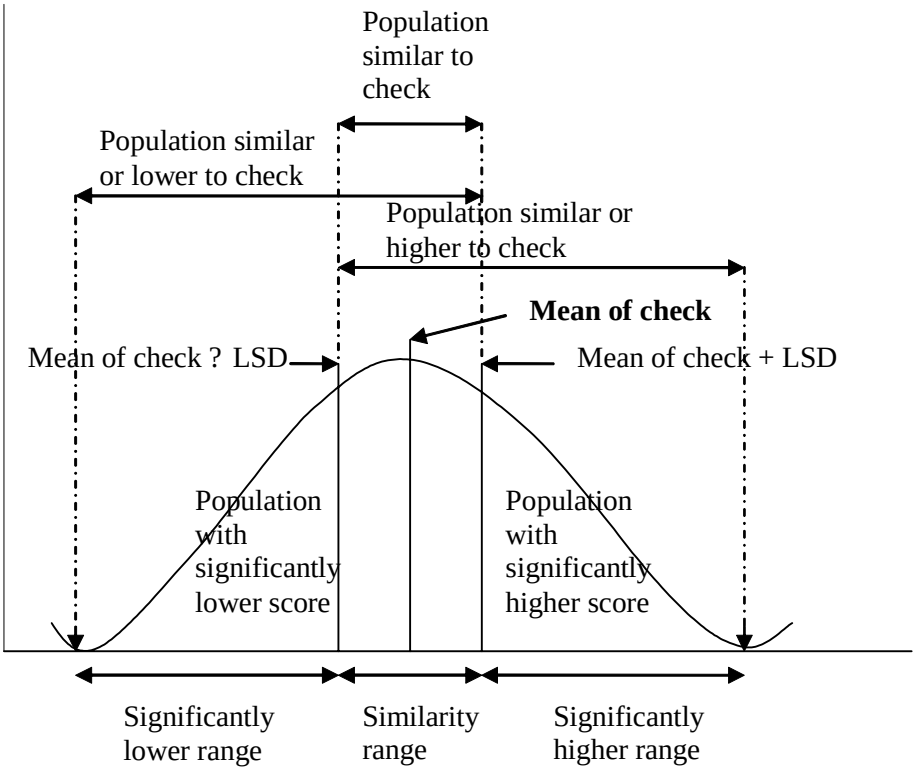

Peterson, 1994) to get a realistic statistical inference. Each entry was maintained with a plot size of 5 rows of 3 meters length with row spacing of 25 cm. The recommended dose of fertilizer at the rate of 60:30:20 kg N:P:K per ha was applied as basal and the experiment was planted on normal date of sowing *i.e.* 20th November 1995 at Rainfed Research Farm of NWRP, Bhairahawa, Nepal. All fertilizers were applied as basal since the rainfall is not assured.

The Research Farm of NWRP, Bhairahawa is situated at latitude - 27^{0}6"N, longitude - 89^{0}4"E and elevation"105m. More than 85 per cent of the annual rain of 1600 mm fell from middle of June to the end of September. November and December were the driest months. The rains during the crop season fell 20 mm which was also erratic. The maximum temperature ranged from 20 to 38^{0}C while the minimum from 4 to 20^{0}C. Mean temperature was lowest (15^{0}C) in January and highest (30^{0}C) in May. The soil type is clayey loam.

Based on several discussions made with farmers in the past and review of literatures (Sah, 1993; Hobbs *et al.,* 1996), the selected traits were decided. Accordingly, the observations were recorded on days to heading, days to grain filling, days to physiological maturity (crop duration in days), test weight of 1000 grains (g), grain yield (kg/ha) and leaf blight score in double digit (DD) on plot basis, while plant height (cm), and grains per spike were on 10 randomly selected plants per plot, and productive spikes per square meter averaged over two samples each of one square meter in each plot to get an appropriate estimate.

The data were subjected to statistical analysis for augmented experimental design I (Federer, 1956; Federer and Ragavarao, 1975; and Peterson, 1994) and the results are presented in Table 1 and Table 2. The selections were made on the basis of sequential order of farmer's preference for various characters: 1) grain yield, 2) plant height, 3) crop duration, 4) test weight, 5) leaf blight, 6) number of grains per spike, 7) per day yield, and 8) number of spikes per square meter and like wise rest of other traits. This sequential order of preference was decided according to the farmers' choice.

Practice of visual selection in screening nursery is beneficial for trait like grain colour, while for others, like grain size, quantitative measurement should be recorded. In the present study, culling level was fixed in desired direction (positive or negative) over and above the check varieties possessing the desirable attributes by adding or subtracting LSD computed at desired level of significance to select the elite entries multi-location yield trial sets based on the following procedure -

(i) When the lines to be selected should be better (positive direction) than the check, then the LSD value should be added to the mean of check and lines having higher

score than the culling level would be selected, as for example grain yield.

(ii) When the lines to be selected should be similar and/ or better (positive direction) than check, then the LSD value should be subtracted from the score of check and lines having higher score than the culling level would be selected as in the case of plant height.

(iii) When the lines to be selected should be similar and/ or better (earlier than check will be in negative direction) than check, then the LSD value should be added to the score of check and lines having lower score than the culling level should be selected as for example days to maturity.

(iv) When the lines to be selected should be always better (less disease score will be in negative direction) than check, the LSD value should be subtracted from the score of check and lines having lower score than the culling level should be selected as in the case of disease score.

Based on the above theory, culling levels were generated for various characters in the sequential order of farmer's preference as the selected varieties:

I. must be at par to the grain yield of the best check, as Triveni + $LSD_{(0.05)}$: this is the farmer's first preference. Therefore, the selected genotypes must yield more than the sum of the yield of the best check and LSD value.

II. should be similar to or taller than the plant height of popular check, as Triveni " $LSD_{(0.05)}$ value: this is the farmer's second preference. Since the plant height of the popular check variety is preferred, the plant height of the selected line should exceed the estimates of culling level.

III. should be similar to or earlier than the crop duration of popular check, as Triveni + $LSD_{(0.05)}$ value

IV. should be similar to or higher than the test weight of popular check, as Triveni " $LSD_{(0.05)}$ value

V. should be similar to or lower than the leaf blight score of best check, as Triveni + $LSD_{(0.05)}$ value

VI. should be similar to or more than the number of grains per spike of popular check, as Triveni " $LSD_{(0.05)-}$ value

VII. should be more than the grain yield per day of popular check, as Triveni + $LSD_{(0.05)}$, and

VIII. should be similar to or more than the number of spikes per square meter of best check, as RR 21 " $LSD_{(0.05)}$ value

RESULTS AND DISCUSSION

The data on yield and ancillary traits with their means and coefficents are presented in Table 1. A very high range for grain yield from 1120 to 3040 kg/ha was recorded among the test entries. The entries were found significantly different for all characters studied (Table 2). This indicates the presence of high variability and therefore, selection of better entries over checks will be effective.

Based on the sequential order of farmer's preference and culling level, 40.96 per cent of the total test entries were selected as superior grain yielder than the popular variety Triveni. All of these selected genotypes were also found at par to the culling level for the plant height. Range of crop duration was small (105 to 118 days) and hence none of the new genotypes were found earlier to the standard check RR 21. However, in third round of selection, 34.94 per cent were found to be similar and or earlier in maturity to the popular check variety Triveni.

There was very high range of variation (22.60 to 46.65 g) for 1000 grain weight indicating a high chance of getting better genotypes over checks. Therefore, in the fourth round, 31.33 per cent were selected as being similar to and or having higher test grain weight than the popular check variety Triveni. In the fifth round of selection for leaf blight disease score, 25.30 per cent were selected as similar to or having less score than Triveni.

In the sixth round of selection for number of grains per spike, only 19.28 percent entries showed similarity and or superiority over variety Triveni. In the seventh step, all these 19.28 per cent entries also showed superiority over the variety Triveni for grain yield per day.

These selected materials were studied carefully for rest of the characters namely number of spikes per square meter, days to grain filling and days to heading and were found desirable compared to checks, and were selected. Therefore, further selection was stopped here. These sixteen selected cultures, which were found superior/or at par to the checks for all desirable traits are presented in Table 1. These lines were hence selected for further evaluation in multi-location advance yield trial in next wheat growing season.

Presence of check(s) guided to which direction selection should be oriented for a specific character. Estimate of least significant difference test (LSD) or critical difference test (CD) helped to know the similarity or dissimilarity between any two treatments or treatment and check means.

Table 1: Yield and ancillary characters of bread wheat elite lines and checks tested in augmented design-I at NWRP, Bhairahawa, Nepal[*]

Sl. No.	Entry No.	LINES / CROSSES / CHECKS	Days to heading	Days to grain filling	Days to physiological maturity	Plant height (cm)	Spikes per square meter	Grain per spike	Test grain weight (gm)	Grain Yield (kg/ha)	Grain Yield kg/ha/day	Leaf blight (DD)	Leaf rust (score)
Selected lines:													
1	4	BL 1667	65	42	107	83.7	401	39.6	33.70	2528	23.63	73	30SMS
2	7	BL 1673	75	36	111	102.0	242	46.8	34.25	2496	22.49	63	R
3	14	BL 1691	66	41	107	86.5	282	35.6	45.30	2660	24.86	73	R
4	16	BL 1695	65	42	107	93.0	285	43.4	36.05	2520	23.55	75	R
5	21	BL 1706	64	43	107	94.5	262	40.6	42.95	2400	22.43	75	10SMS
6	23	BL 1709	72	37	109	98.0	296	47.0	36.40	2624	24.07	63	R
7	30	BL 1724	72	38	110	85.7	300	43.0	33.40	3040	27.64	75	R
8	34	BL 1731	68	42	110	111.0	307	40.6	32.50	2368	21.53	83	R
9	35	BL 1732	76	35	111	111.2	270	40.0	33.35	2240	20.18	73	R
10	43	CETTIA	68	41	109	89.5	364	48.0	29.45	2752	25.25	85	R
11	45	PIK/OPATA	78	35	113	99.7	267	47.0	31.20	2432	21.52	63	R
12	50	ND/VG9144//KAL/BB/3/YACO/4/CHIL	73	38	111	93.2	240	35.6	32.85	2368	21.33	85	R
13	71	CHIL/BUC	71	40	111	97.0	241	43.6	34.10	2640	23.78	83	R
14	72	GIM/LIRA	72	39	111	88.2	300	40.2	29.90	2560	23.06	82	R
15	74	SERI//HUI/TUB/3/TRAP#1	76	37	113	99.2	349	59.2	34.10	3040	26.90	73	R
16	78	TIA.2	73	38	111	88.7	359	43.8	30.95	2720	24.50	73	5MRMS
Discarded lines:													
17	1	BL 1660	76	34	110	96.7	300	12.0	43.35	1472	13.38	84	R
18	2	BL 1661	69	38	107	91.5	287	32.0	31.80	2240	20.93	82	R
19	3	BL 1663	64	41	105	84.7	278	26.6	35.55	1920	18.29	85	R
20	5	BL 1669	73	37	110	92.0	383	46.6	26.80	2416	21.96	86	R
21	6	BL 1670	72	37	109	89.0	243	41.4	39.45	1792	16.44	82	R
22	8	BL 1674	68	41	109	89.0	293	36.8	28.85	1696	15.56	82	R
23	9	BL 1677	64	43	107	90.0	362	34.4	31.35	2016	18.84	87	R
24	10	BL 1680	69	40	109	91.5	330	30.0	39.90	2016	18.50	75	R
25	11	BL 1684	67	40	107	91.7	311	22.6	38.45	1920	17.94	85	R
26	12	BL 1685	67	41	108	94.7	306	31.6	38.55	2380	22.04	85	R
27	13	BL 1689	73	38	111	87.5	308	30.4	33.95	2860	25.77	83	R
28	15	BL 1693	64	43	107	91.5	228	27.4	37.30	2600	24.30	83	R
29	17	BL 1697	66	41	107	101.7	214	48.0	40.65	2000	18.69	73	R
30	18	BL 1702	67	40	107	84.7	305	33.0	34.25	2100	19.63	85	R

Sl. No.	Entry No.	LINES / CROSSES / CHECKS	Days to heading	Days to grain filling	Days to physiological maturity	Plant height (cm)	Spikes per square meter	Grain per spike	Test grain weight (gm)	Grain Yield (kg/ha)	Grain Yield kg/ha/day	Leaf blight (DD)	Leaf rust (score)
31	19	BL 1703	72	37	109	101.2	289	37.0	37.05	2000	18.35	86	R
32	20	BL 1704	63	42	105	83.2	287	35.4	41.05	2080	19.81	83	R
33	22	BL 1707	64	42	106	74.0	242	28.2	37.20	1440	13.58	85	R
34	24	BL 1710	81	34	115	100.0	333	42.2	30.95	2112	18.37	73	R
35	25	BL 1713	72	40	112	107.7	323	28.4	43.20	1600	14.29	85	R
36	26	BL 1715	76	37	113	97.5	298	30.8	40.65	1920	16.99	75	R
37	27	BL 1717	84	31	115	97.0	284	40.4	31.50	1440	12.52	63	R
38	28	BL 1718	71	38	109	105.2	230	36.2	36.60	1904	17.47	86	R
39	29	BL 1721	72	39	111	88.7	254	6.4	46.65	1216	10.95	55	R
40	31	BL 1727	76	37	113	87.7	284	34.2	37.20	2144	18.97	63	R
41	32	BL 1728	67	41	108	81.3	236	32.2	43.25	1456	13.48	62	R
42	33	BL 1729	68	41	109	94.7	261	38.6	45.00	2368	21.72	86	R
43	36	BL 1734	81	34	115	100.2	288	43.2	34.40	2208	19.20	65	R
44	37	BL 1736	75	37	112	83.0	295	48.0	29.85	1312	11.71	73	R
45	38	BL 1737	92	26	118	90.0	321	39.6	27.20	1664	14.10	62	R
46	39	BL 1741	91	26	117	116.2	281	25.2	31.95	1120	9.57	65	R
47	40	BL 1742	91	26	117	121.2	303	23.0	34.00	1136	9.71	65	R
48	41	MON/IMU//ALD/PVN	72	39	111	84.7	296	37.6	36.65	1936	17.44	86	R
49	42	PSN/BOW//SERI	81	34	115	89.7	361	38.6	23.85	1824	15.86	73	R
50	44	CHIL/ALD//PVN	85	32	117	102.0	294	40.8	35.55	2448	20.92	73	R
51	46	K 9348	76	35	111	89.7	211	39.0	37.30	1888	17.01	75	R
52	47	K 9351	77	37	114	106.7	353	28.2	43.25	2528	22.18	73	R
53	48	URES/TRT	79	35	114	92.2	323	33.0	25.85	2272	19.93	63	R
54	49	ATTILA	84	32	116	86.0	325	37.8	25.05	2160	18.62	55	R
55	51	ND/VG9144//KAL/BB/3/YACO/4/CHIL	76	35	111	86.0	223	40.0	25.70	1472	13.26	86	R
56	52	IRENA	72	39	111	90.7	294	46.0	31.20	2240	20.18	86	R
57	53	CETTIA	68	41	109	88.5	302	48.8	31.75	2240	20.55	87	R
58	54	CETTIA	69	40	109	89.5	224	44.2	29.95	1920	17.61	88	R
59	55	CETTIA	72	36	108	82.5	360	48.6	24.20	2176	20.15	87	R
60	56	CETTIA	69	40	109	84.7	251	56.8	27.90	1952	17.91	83	R
61	57	CETTIA	69	40	109	85.0	244	32.8	30.95	2016	18.50	86	R
62	58	TURACO/CHIIL	76	33	109	86.7	312	44.8	25.75	2288	20.99	75	R

Sl. No.	Entry No.	LINES / CROSSES / CHECKS	Days to heading	Days to grain filling	Days to physiological maturity	Plant height (cm)	Spikes per square meter	Grain per spike	Test grain weight (gm)	Grain Yield (kg/ha)	Grain Yield kg/ha/day	Leaf blight (DD)	Leaf rust (score)
63	59	BAU/PRL	72	37	109	82.0	343	39.0	25.80	1824	16.73	65	R
64	60	GAA/BOW	82	33	115	89.7	247	42.0	32.75	1760	15.30	63	R
65	61	BAU/SERI	80	33	113	86.2	321	38.0	35.70	2272	20.11	86	R
66	62	TOB//HD 832/BB/3/MON/4/BUC	71	39	110	90.5	250	45.0	33.80	2080	18.91	86	R
67	63	CHIL/BUC	70	39	109	90.0	207	39.2	34.65	2144	19.67	85	R
68	64	CHIL/BUC	69	41	110	89.5	229	41.2	36.80	2256	20.51	87	R
69	65	CHIL/BUC	71	38	109	82.5	266	40.2	25.35	1248	11.45	88	R
70	66	CHIL/BUC	70	39	109	85.2	178	40.4	31.05	1600	14.68	75	R
71	67	GZ 156/NAC//PSN/URES/3/OPATA	76	34	110	87.0	319	43.2	23.95	2128	19.35	65	R
72	68	BJY/COC//PRL/BOW	81	32	113	97.5	274	48.6	30.00	2176	19.26	63	R
73	69	CHIL/WUH 3	72	41	113	92.0	237	32.2	30.40	1760	15.58	55	30SMS
74	70	MRL/BUC//BUC	72	39	111	85.2	267	36.0	30.60	2144	19.32	86	R
75	73	VORONA/BAU//BAU	85	33	118	91.7	374	29.0	29.70	2272	19.25	65	R
76	75	SARA//JUP/BJY/3/KAUZ	81	33	114	87.2	292	49.2	22.60	1760	15.44	63	R
77	76	URES/JUN//KAUZ	86	29	115	93.0	356	43.8	27.90	2560	22.26	65	R
78	77	TIA.1	78	34	112	80.2	363	46.8	23.75	2000	17.86	62	R
79	79	RL 6010/4*INIA 66//3*GEN	89	29	118	80.2	306	31.6	26.25	1312	11.12	52	R
80	80	RL 6010/6*YR//3*SERI	81	34	115	84.7	315	36.6	30.90	2272	19.76	62	R
81	81	IAN 7/CHIL	88	30	118	88.2	236	31.4	31.85	1600	13.56	52	R
82	82	LIRA/SHA 5	89	29	118	88.5	259	33.0	29.10	1600	13.56	52	R
83	83	LIRA/SHA 5	88	30	118	89.7	305	39.2	29.55	1760	14.92	63	R
		Mean over lines	74.27	36.86	111.1	92.0	289.6	38.1	33.20	2070.2	18.66	74.72	
		Range of variation among lines											
		Minimum	63	26	105	74.0	178.0	6.4	22.60	1120	9.57	52	
		Maximum	92	43	118	123.8	401.0	59.2	46.65	3040	27.64	88	
		Checks:											
84	84	RR 21 (Standard check)	65	36	102	93.8	335	30.0	38.00	1632	16.05	86	R
85	85	TRIVENI (Popular check)	71	40	111	83.0	283	39.8	33.12	1903	17.15	83	R
		Mean over checks	68.33	38.00	106.3	88.4	308.9	34.9	35.55	1767.3	16.59	84.5	
		Experimental mean	73.87	36.94	110.8	91.8	290.9	37.8	33.36	2049	18.52	75.38	
		Coefficient of Variation (%)	1.24	1.56	0.73	1.97	3.27	3.40	3.46	3.51	3.67	0.77	

*All tasted genotypes (selected and discarded) have been included in the above table to demonstrate the sequential order of selection procedure in augmented design I.

Table 2: Analysis of variance of various characters

Source	Mean sum of squares for respective characters									
	Days to heading	Days to grain filling	Days to physiological maturity	Plant height (cm)	Spikes per square meter	Grains per spike	Test grain weight (gm)	Grain Yield (kg/ha)	Grain Yield kg/ha/day	Leaf blight (DD)
Entries	55.17**	17.52**	14.46**	80.69**	2122.95**	73.22**	31.84**	191094.31**	16.22**	118.93**
Lines	53.45**	17.65**	11.64**	79.62**	2101.38**	72.58**	31.80**	188150.36**	16.30**	115.20**
Checks	54.00**	16.67**	130.67**	176.04**	3937.31**	144.06**	35.77**	110432.67**	1.81ns	8.17*
Lines vs Checks	197.69**	7.17**	129.57**	73.84**	2077.19**	54.46**	31.11**	513159.59**	24.04**	534.90**
Least significant difference at 5% level of significance between means of										
Lines	3.59	2.27	3.18	7.09	37.37	5.06	4.53	282.44	2.67	2.28
Checks	2.07	1.31	1.84	4.10	21.58	2.92	2.62	163.07	1.54	1.31
Lines vs Checks	2.93	1.85	2.60	5.79	30.52	4.13	3.70	230.61	2.18	1.86
Order of selection preference	**X**	**IX**	**III**	**II**	**VIII**	**VI**	**IV**	**I**	**VII**	**V**
Culling level	74.59	42.27	114.18	75.91	297.63	34.74	28.59	2185.44	19.82	85.28

Application of this type of study will be rewarding to the breeding programme in selection of genotypes for farmer's preferred traits. The methodology of this study can also be adopted for selecting superior lines tested across the diverse agro environments.

ACKNOWLEDGEMENTS

The author is thankful to the Wheat Co-ordinator, NWRP, Bhairahawa and the Director, Regional Agricultural Research Station, Bhairahawa for providing necessary facilities to carry out the investigation, and to CIMMYT for providing technical inputs.

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