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Evaluation of Potato Genotypes for Yield Characters in Late Autumn Season

Prabhjot Kaur, V K Vashist* and Ajay Kumar**

Department of Vegetable Science
Punjab Agricultural University, Ludhiana-140 001(Punjab)

ABSTRACT

Evaluation of ten potato genotypes for yield characters in late autumn season was undertaken under different environments viz., E_1-haulm cutting 80 days after planting, E_2-haulm cutting 100 days after planting and E_3-haulm cutting 120 days after planting to assess their suitability for processing purpose. The characters recorded were days to emergence, number of shoots/plant, foliage weight/plant (g), number of tubers/plant, tuber weight (g), tuber length (cm), tuber yield/plant (g), total tuber yield (q/ha). The environmental components were highly significant for all the traits except days to emergence, number of shoots/plant and tuber weight. Genotypes x environment interaction was significant for number of shoots/plant, foliage weight/plant, tuber weight, tuber yield/plant, total tuber yield, Among the three environments, 120 days crop duration (E_3) yielded the highest total tuber yield (q/ha) followed by environment E_2 (100 days crop duration) and E_1 (80 days crop duration). For total and processing grade yield, cvs Kufri Chipsona-1, Kufri Chipsona-2 and Kufri Ashoka were found with the highest yield in the environment E_1. However, in environment E_2, for total tuber yield, cvs Kufri Badshah, Kufri Bahar, Kufri Chipsona-1, Kufri Chipsona-2 and Kufri Ashoka performed significantly better than mean and cvs Kufri Badshah, Kufri Bahar, Kufri Lauvkar, Kufri Chipsona-1 and Kufri Chipsona-2 had yielded better than mean value for processing grade yield.

Key Words: Potato, genotypes, yield, genotypes, genotypes x environments.

INTRODUCTION

Potato (*Solanum tuberosum* L.) being a highly productive crop can play a significant role in ensuring food security because it produces more dry matter per unit area and time than the major cereal crops. It can supplement the food requirement of developing countries with its high food yield per hectare, well balanced proteins and high level of vitamins B and C. The present study was undertaken to evaluate the performance of potato genotypes for their yield attributes in the late autumn season.

MATERIALS AND METHODS

The experimental material comprised ten genetically diverse potato genotypes viz., Kufri Badshah, Kufri Anand, Kufri Chandramukhi, Kufri Bahar, Kufri Lauvkar, Kufri Chipsona-1, Kufri Chipsona-2, Kufri Ashoka, Kufri Jawahar and Russet Nor x 97-ES-33 obtained from Central Potato Research Institute (CPRI), Shimla and multiplied at Vegetable Research Farm of the Department of Vegetable Science. Ten cultivars were evaluated at Vegetable Research Farm, in Randomized Block Design (RBD) with three replications. Each plot measuring 3.2 m x 1.2 m had 16 plants in each row. The seed sized tubers were planted at row to row and plant to plant spacing of 60 cm and 20 cm, respectively. The crop was planted at 2nd fortnight of Nov., 2005 and there were three such experiments for different crop duration periods viz., 80, 100 and 120 days. The crop duration periods are symbolized below:

Environment-I (E_1) – Haulm cutting 80 days after planting (DAP),Environment-II (E_2) – Haulm cutting 100 DAP and Environment-III (E_3) – Haulm cutting 120 DAP.

Each experiment was harvested after 10-15 days after haulm cutting. The crop was raised by following the package of practices recommended by Punjab Agricultural University, Ludhiana. The

*Corresponding Author's Email:vashistvk@pau.edu ; ajayk@pau.edu

characters studied and method of recording observations were days to emergence, number of shoots / plant, number of tubers/plant, tuber weight (g), foliage weight/plant (g),tuber length (cm), tuber yield/plant (g), total tuber yield (q/ha). For analysis of variance over environments, the genotypes were assessed for their stability of performance over environments as suggested by Eberhart and Russell (1966).

RESULTS AND DISCUSSION

The mean squares for different sources of variation for different traits viz., days to emergence, number of shoots/plant, foliage weight/plant (g), number of tubers/plant, tuber weight (g), tuber length (cm), tuber yield/plant (g), total tuber yield (q/ha) among the cultivars under investigation indicated that sufficient variability was present among the genotypes for these characters. The significance of environment component for all the traits indicated the presence of wide variation among environments. The environment component was highly significant for all the traits except days to emergence, number of shoots/plant and tuber weight (g). Genotypes x environments interaction was significant for number of shoots/plant, foliage weight/plant (g), tuber weight (g), tuber yield/plant (g), total tuber yield (q/ha).

Genotypes and environments exhibited significant variation which indicated the presence of variability among genotypes as well as environments as also reported by Sharma *et al* (2001) and Sharma *et al* (2003) for tuber yield and marketable yield, respectively. Similar studies were also reported by Kumar and Kang (2001).

The phenotypic stability of genotypes was measured by three parameters i.e. mean performance over environments ($\overline{Xi}$), the linear regression (bi) and deviation from regression (S^2di). A variety is considered to be stable over different environments if it has higher mean value (above average performance), unit regression coefficient (bi=1) and the lowest non-significant deviation from regression ($S^2di=0$) (Eberhart and Russell, 1966). The cv. Russet Nor x 97-ES-33 had taken significantly less number of days to emergence among all the cultivars in environment E_1. However, in environments, E_2 and E_3 cvs Kufri Chipsona-2, Kufri Ashoka and Russet Nor x 97-ES-33 had taken significantly less number of days to emerge than the mean value. (Table 1). For pooled analysis, the cv. Russet Nor x 97-ES-33 had taken significantly less number of days for emergence (23.5) than the pooled mean. The cvs Kufri Anand and Kufri Chipsona-1 had taken more number of days to emergence and had regression coefficient less than one (0.57 and 0.38, respectively) and non-significant deviation from regression, indicating their unsuitability under diverse environments. The cvs Kufri

Table 1. Mean ($\overline{Xi}$), regression coefficient (bi) and deviation from regression (S^2di) for days to emergence in potato during autumn season.

Sr. No.	Genotypes	E_1	E_2	E_3	Overall mean ($\overline{Xi}$)	bi	S^2di
1.	Kufri Badshah	29.33	29.33	24.67	27.78	2.80	3.21**
2.	Kufri Anand	30.00	31.33	30.33	30.56	0.57	0.50
3.	Kufri Chandramukhi	26.67	28.33	29.33	28.11	-0.64	3.04**
4.	Kufri Bahar	27.67	28.67	27.00	27.78	0.98	0.03
5.	Kufri Lauvkar	30.33	30.67	26.67	29.22	2.39	1.60
6.	Kufri Chipsona-1	30.33	31.33	30.67	30.78	0.38	0.31
7.	Kufri Chipsona-2	27.00	27.33	25.33	26.56	1.19	0.25
8.	Kufri Ashoka	30.00	27.00	24.67	27.22	1.47	11.18**
9.	Kufri Jawahar	32.67	35.33	36.33	34.78	-0.66	6.55**
10.	Russet Nor x 97-ES-33	22.67	25.33	22.67	23.56	1.54	1.33
	Mean	28.67	29.46	27.77	28.63		
	CD (5%)	2.14	1.84	1.71	2.48	SE of bi = 1.39	
	CV	4.37	3.74	3.48			

*Significant at 5%,**Significant at 1%

Chipsona-2 and Russet Nor x 97-ES-33 had regression coefficient more than one (1.19 and 1.54, respectively) and non-significant deviation from regression, indicating suitability of these cultivars for growing under favorable environments. Only cv. Kufri Bahar had mean equal to pooled mean, regression coefficient equal to unity (0.98) and non-significant deviation from regression, thereby exhibiting its stability over all the environments.

The cvs Kufri Anand, Kufri Chipsona-1 and Russet Nor x 97-ES-33 had significantly higher value for number of shoots/plant than the mean value in E_1. However, cvs Kufri Badshah and Kufri Chipsona-2 had significantly more number of shoots than the mean under E_2. In E_3, cvs Kufri Anand, Kufri Bahar, Kufri Chipsona-2 and Kufri Ashoka had significantly higher number of shoots than the mean value (Table 2). In case of pooled analysis, none of the cultivars had significantly high overall mean for number of shoots/plant than the pooled mean. The cv. Kufri Chipsona-2 had the highest overall mean for number of shoots/ plant (5.04) followed by Kufri Anand (5.00), Kufri Ashoka (4.94) and Russet Nor x 97-ES-33 (4.67). The cv. Kufri Ashoka had higher mean number of shoots per plant, regression coefficient more than one (1.86) and non-significant deviation from regression, thereby indicating below average stability and suggesting their suitability for favourable conditions.

In the environment E_1, cvs Kufri Badshah, Kufri Anand, Kufri Chipsona-1 and Kufri Jawahar had significantly higher foliage weight than the mean value. The cvs Kufri Badshah, Kufri Anand, Kufri Ashoka and Kufri Jawahar had significantly more foliage weight than the mean value in E_2. In E_3, cvs Kufri Badshah, Kufri Anand and Kufri Bahar had significantly more foliage weight than the mean value. The foliage weight of different cvs in various environments does not show consistency due to the differential reaction of cvs to frost injury in the first fortnight of January. However, in E_3 environment, there was recorded reduction in weight of foliage due to the incidence of late blight disease at the time of crop maturity in the month of March (Table 3). For pooled analysis, only the cv. Kufri Badshah had significantly higher overall mean (242.80 g) than the pooled mean. None of the cvs had significantly higher overall mean than pooled mean, regression coefficient close to one along with non-significant deviation from regression, indicating that none of the cultivars had average stability for this character.

None of the cultivars had significantly more number of tubers/ plant than the mean value in all the three environments (Table 4).In pooled analysis of data, it was found that three cvs Kufri Chipsona-1, Kufri Anand and Kufri Badshah had significantly higher number of tubers per plant than pooled mean. Kufri Chipsona-1 had the

Table 2.Mean ($\overline{Xi}$), regression coefficient (bi) and deviation from regression (S^2di) for number of shoots/plant in potato during autumn season.

Sr. No.	Genotypes	E_1	E_2	E_3	Overall mean ($\overline{Xi}$)	bi	S^2di
1.	Kufri Badshah	3.87	4.67	4.00	4.18	-1.10	0.11*
2.	Kufri Anand	5.47	4.07	5.47	5.00	2.27	0.23**
3.	Kufri Chandramukhi	4.80	3.53	3.73	4.02	0.50	0.88**
4.	Kufri Bahar	3.33	3.27	5.27	3.96	2.93	0.79**
5.	Kufri Lauvkar	4.80	4.20	4.27	4.42	0.20	0.21**
6.	Kufri Chipsona-1	4.93	3.87	4.33	4.38	0.86	0.42**
7.	Kufri Chipsona-2	3.67	5.53	5.93	5.04	0.28	2.91**
8.	Kufri Ashoka	4.80	4.40	5.63	4.94	1.86	0.07
9.	Kufri Jawahar	4.13	3.47	4.13	3.91	1.08	0.05
10.	Russet Nor x 97-ES-33	5.07	4.13	4.80	4.67	1.13	0.20**
	Mean	4.49	4.11	4.76	4.45		
	CD (5%)	0.43	0.46	0.39	1.13	SE of bi = 1.67	
	CV	5.66	6.12	5.21			

*Significant at 5%,**Significant at 1

Table 3. Mean ($\overline{Xi}$), regression coefficient (bi) and deviation from regression (S^2di) for foliage weight/plant (g) in potato during autumn season.

Sr. No.	Genotypes	E_1	E_2	E_3	Overall mean ($\overline{Xi}$)	bi	S^2di
1.	Kufri Badshah	163.93	310.20	254.27	242.80	1.72	4559.39**
2.	Kufri Anand	125.33	183.33	151.07	153.24	0.78	393.42**
3.	Kufri Chandramukhi	50.73	64.60	47.73	54.36	0.27	2.42
4.	Kufri Bahar	107.07	153.87	151.33	137.42	0.40	1035.25**
5.	Kufri Lauvkar	72.27	70.47	71.13	71.29	-0.02	0.72
6.	Kufri Chipsona-1	155.47	158.47	104.53	139.49	0.54	1220.37**
7.	Kufri Chipsona-2	101.53	173.80	60.40	111.91	1.67	657.81**
8.	Kufri Ashoka	85.80	193.20	72.47	117.16	2.02	27.36
9.	Kufri Jawahar	140.80	183.73	81.53	135.36	1.32	1536.74**
10.	Russet Nor x 97-ES-33	81.27	143.47	60.33	95.02	1.30	146.88**
	Mean	108.42	163.51	105.47	125.80		
	CD (5%)	14.24	11.37	8.15	45.96	SE of bi = 0.67	
	CV	6.60	5.27	3.78			

*Significant at 5%,**Significant at 1%

highest number of tubers/plant (11.81) followed by Kufri Anand (11.46) and Kufri Badshah (11.27). The cvs Kufri Badshah had higher mean than the pooled mean, regression coefficient more than one (2.05) and non-significant deviation from regression, thereby indicating their suitability for growing under favourable environments. Contrarily, the cv. Kufri Chipsona-1 had higher mean value than the pooled mean value, regression coefficient less than one (0.09) and significant deviation from regression, again showing its suitability for growing under favourable environments. However, cv. Kufri Anand had significantly more number of tubers per plant than pooled mean, regression coefficient equal to one and non-significant deviation from regression, thereby exhibiting its stability over all the environments. The results of this study are contrary to those of Manivel *et al* (2003) who recorded maximum number of tubers (7.4) in case of cv. Kufri Chipsona-2 in the hills of Himachal Pradesh (Kufri).

In case of E_1, only cv. Kufri Chandramukhi had significantly better tuber weight than the mean value. However, cvs Kufri Bahar, Kufri Lauvkar and Kufri Chipsona-2 had significantly more average tuber weight than the mean value in E_2,

Table 4.Mean ($\overline{Xi}$), regression coefficient (bi) and deviation from regression (S^2di) for number of tubers/plants in potato during autumn season.

Sr. No.	Genotypes	E_1	E_2	E_3	Overall mean ($\overline{Xi}$)	bi	S^2di
1.	Kufri Badshah	9.20	12.10	12.50	11.27	2.05	0.24
2.	Kufri Anand	10.50	11.67	12.20	11.46	1.01	0.00
3.	Kufri Chandramukhi	6.20	6.60	8.40	7.07	1.15	0.80
4.	Kufri Bahar	7.20	8.50	8.30	8.00	0.73	0.18
5.	Kufri Lauvkar	7.40	7.50	7.60	7.50	0.11	0.00
6.	Kufri Chipsona-1	11.40	12.90	11.13	11.81	0.09	1.80**
7.	Kufri Chipsona-2	7.60	9.50	11.90	10.00	1.76	1.22*
8.	Kufri Ashoka	7.00	10.20	7.10	8.10	0.52	6.23**
9.	Kufri Jawahar	9.93	8.80	11.30	10.01	0.51	2.75**
10.	Russet Nor x 97-ES-33	7.70	9.00	11.50	9.40	2.07	1.13*
	Mean	8.51	9.68	10.19	9.46		
	CD (5%)	4.72	3.95	4.16	1.78	SE of bi = 0.98	
	CV	3.53	5.66	6.64			

*Significant at 5%,**Significant at 1%

whereas in case of E_3, the cvs Kufri Badshah, Kufri Anand and Kufri Ashoka had significantly more tuber weight than the mean value (Table 5). Tuber weight was comparatively low in all the environments due to frost injury to the crop at tuber development stage. None of the cultivars had significantly better overall mean than the pooled mean in pooled analysis.

However, the cv. Kufri Badshah had mean tuber weight equal to overall mean, regression coefficient more than one (1.52), and highly significant deviation from regression, indicating that their performance could not be predicted under unfavorable environments.

In E_1, cvs Kufri Badshah, Kufri Chipsona-1, Kufri Chipsona-2 and Kufri Ashoka had significantly larger tuber length than mean value. The cvs Kufri Badshah and Kufri Ashoka produced longer tubers than mean value of cvs in the environment E_2. In case of E_3, only cv. Kufri Ashoka yielded longer tubers than mean length (Table 6). From the analysis of pooled data, it was inferred that the cvs Kufri Badshah and Kufri Ashoka had more tuber length than pooled mean. The cv. Kufri Badshah had more tuber length (5.65 cm) followed by Kufri Ashoka (5.74 cm). The cvs Kufri Badshah had longer tuber length than pooled mean, regression coefficient more than one (2.41) and non significant deviation from regression indicating its suitability under favourable environments. Only the cv. Kufri Ashoka had shown maximum stability due to its higher tuber length (5.74) than pooled mean, regression coefficient near to one (0.93) and non-significant deviation from regression.

In case of E_1, cvs Kufri Anand, Kufri Chandramukhi, Kufri Chipsona-1 and Kufri Chipsona-2 were found to have significantly more tuber yield / plant than the mean value. However, cvs Kufri Badshah, Kufri Bahar, Kufri Lauvkar, Kufri Chipsona-1, Kufri Chipsona-2 and Kufri Ashoka had significantly higher tuber yield per plant than the mean value. The cvs Kufri Badshah, Kufri Anand, Kufri Chipsona-1, Kufri Chipsona-2 and Kufri Ashoka significantly out yielded the other cultivars in E_3 (Table 7). The pooled data analysis depicted that only cv. Kufri Badshah had significantly higher overall mean tuber yield/plant (364.11 g) than the pooled mean. The tuber yield has been recorded low in case of E_1 due to too low temperature (4.4°C) in the crop season which affects photosynthesis, translocation of photosynthates, tuber development along with low temperature injury at vegetative stage. However, in case of E_2, the crop had relatively recovered from above malady due to prolonged crop duration (100 days) enabling most of Though the cv. Kufri Badshah had high mean yield, regression coefficient more than one (2.32) and highly significant deviation from the regression, indicating that their performance could not be predicted under different environmental

Table 5. Mean ($\overline{Xi}$), regression coefficient (bi) and deviation from regression (S^2di) for tuber weight (g) in potato during autumn season.

Sr. No.	Genotypes	E_1	E_2	E_3	Overall mean ($\overline{Xi}$)	bi	S^2di
1.	Kufri Badshah	19.82	33.04	41.53	31.46	1.52	143.55**
2.	Kufri Anand	21.03	26.91	30.25	26.06	0.67	24.79**
3.	Kufri Chandramukhi	36.07	20.37	17.96	24.80	-1.77	63.47**
4.	Kufri Bahar	25.37	43.53	28.44	32.45	1.96	28.80**
5.	Kufri Lauvkar	24.55	44.90	23.11	30.85	2.18	100.02**
6.	Kufri Chipsona-1	21.11	36.19	28.58	26.63	1.01	4.65
7.	Kufri Chipsona-2	26.69	41.46	25.60	31.25	1.58	53.21**
8.	Kufri Ashoka	25.94	33.22	43.60	34.25	0.86	126.58**
9.	Kufri Jawahar	18.92	28.77	26.65	24.78	1.09	4.15
10.	Russet Nor x 97-ES-33	16.04	24.26	18.23	19.51	0.89	3.15
	Mean	23.55	32.67	25.39	28.20		
	CD (5%)	4.72	3.95	4.16	11.03	SE of bi = 1.15	
	CV	9.79	8.19	8.59			

*Significant at 5%, **Significant at 1%

Table 6. Mean ($\overline{Xi}$), regression coefficient (bi) and deviation from regression (S^2di) for tuber length (cm) in potato during autumn season.

Sr. No.	Genotypes	E_1	E_2	E_3	Overall mean ($\overline{Xi}$)	bi	S^2di
1.	Kufri Badshah	5.17	6.35	5.43	5.65	2.41	0.04
2.	Kufri Anand	5.03	5.82	5.32	5.39	1.47	0.05
3.	Kufri Chandramukhi	4.17	4.69	4.43	4.43	-0.54	0.52**
4.	Kufri Bahar	5.16	5.63	4.89	5.23	1.41	0.03
5.	Kufri Lauvkar	4.35	5.05	4.57	4.65	1.35	0.03
6.	Kufri Chipsona-1	5.36	5.57	5.25	5.39	0.63	0.01
7.	Kufri Chipsona-2	5.19	5.30	5.22	5.24	-0.44	0.16**
8.	Kufri Ashoka	5.55	6.01	5.65	5.74	0.93	0.01
9.	Kufri Jawahar	4.59	5.54	5.05	5.06	1.63	0.11*
10.	Russet Nor x 97-ES-33	4.10	4.88	4.63	4.54	1.16	0.15**
	Mean	4.87	5.48	5.04	5.13		
	CD (5%)	0.31	0.41	0.47	0.49	SE of bi = 0.93	
	CV	3.50	4.61	5.34			

*Significant at 5%,**Significant at 1%

conditions. The cv Kufri Ashoka had tuber yield (275.78 g) equal to pooled mean, regression coefficient near to one (1.32) and non-significant deviation from regression, thereby showing that it is relatively stable cultivar.

The cvs Kufri Chipsona-1, Kufri Chipsona-2 and Kufri Ashoka had significantly better tuber yield than the mean value in E_1. However in case of E_2, the cvs Kufri Badshah, Kufri Bahar, Kufri Chipsona-1, Kufri Chipsona-2 and Kufri Ashoka performed better due to the recovery of crop from frost injury as compared to that in environment-I. In case of E_3, cvs Kufri Jawahar, Kufri Badshah, Kufri Bahar, Kufri Chipsona-1, Kufri Chipsona-2 and Kufri Ashoka produced significantly higher total yield than mean value (Table 8). Yield in case of environment E_1, was comparatively less due to unfavourable agroclimatic conditions during vegetative growth, tuber formation and tuber development stages. the cvs to perform better than the mean. In case of pooled analysis, cvs Kufri Badshah, Kufri Chipsona-1 and Kufri Chipsona-2 were found to produce significantly more total yield than pooled mean. The cv. Kufri Badshah had higher tuber yield than mean value, regression coefficient more than one (2.47) and

Table 7.Mean ($\overline{Xi}$), regression coefficient (bi) and deviation from regression (S^2di) for tuber yield/plant (g) in potato during autumn season.

Sr. No.	Genotypes	E_1	E_2	E_3	Overall mean ($\overline{Xi}$)	bi	S^2di
1.	Kufri Badshah	177.80	396.87	517.67	364.11	2.32	16438.23**
2.	Kufri Anand	214.73	313.67	368.67	299.02	1.05	3392.63**
3.	Kufri Chandramukhi	222.80	134.40	150.60	169.92	-0.75	2.33
4.	Kufri Bahar	182.00	368.87	237.20	262.69	1.29	5195.47**
5.	Kufri Lauvkar	180.40	336.47	175.33	230.73	0.93	9951.19**
6.	Kufri Chipsona-1	239.27	384.93	318.27	314.16	1.11	805.49**
7.	Kufri Chipsona-2	229.13	390.33	304.20	307.89	1.19	1677.75**
8.	Kufri Ashoka	181.40	338.47	307.47	275.78	1.32	1.02
9.	Kufri Jawahar	188.00	251.00	298.47	245.82	0.71	2181.83**
10.	Russet Nor x 97-ES-33	123.27	217.47	209.13	183.29	0.82	72.82
	Mean	193.88	313.25	288.70	265.28		
	CD (5%)	9.79	18.86	12.31	93.58	SE of bi = 0.71	
	CV	2.15	4.15	2.71			

*Significant at 5%,**Significant at 1%

Table 8. Mean ($\bar{X}i$), regression coefficient (bi) and deviation from regression (S^2di) for total tuber yield (q/ha) in potato during autumn season.

Sr. No.	Genotypes	E_1	E_2	E_3	Overall mean ($\bar{X}i$)	bi	S^2di
1.	Kufri Badshah	195.67	363.43	435.00	331.47	2.47	1267.52**
2.	Kufri Anand	185.43	292.77	321.27	266.67	1.46	126.16*
3.	Kufri Chandramukhi	162.13	103.13	151.03	138.77	-0.37	1316.41**
4.	Kufri Bahar	191.53	327.67	306.47	275.22	1.46	578.90**
5.	Kufri Lauvkar	169.30	285.80	225.73	226.94	0.97	2361.23**
6.	Kufri Chipsona-1	272.97	333.03	322.17	309.39	0.64	135.17*
7.	Kufri Chipsona-2	260.83	334.07	334.27	309.72	0.87	26.96
8.	Kufri Ashoka	232.33	329.03	312.63	291.63	1.03	347.90**
9.	Kufri Jawahar	177.63	294.47	318.67	263.59	1.54	58.83
10.	Russet Nor x 97-ES-33	199.17	179.33	203.13	193.88	-0.07	300.64**
	Mean	204.72	284.29	293.09	260.70		
	CD (5%)	14.41	22.45	13.12	37.91	SE of bi = 0.37	
	CV	3.22	5.02	2.94			

*Significant at 5%,**Significant at 1%

significant deviation from regression which indicated that this cv. was not stable in different environments. The cv. Kufri Chipsona-2 had significantly higher total tuber yield (309.72 q/ha) than pooled mean (260.70 q/ha), regression coefficient near to one and non-significant deviation from regression, thereby exhibiting its suitability under relatively wide range of environments. The cv. Kufri Chipsona-2 gave higher tuber yield in north-western plains at Jalandhar (Punjab) and Modipuram (U.P.) (Marwaha *et al* 2005, Pandey *et al* 2002). Manivel *et al* (2003) also recorded the highest yield in case of cv. Kufri Chipsona-2 (239.2 q/ha) in north-western hills.

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