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Genetic variability, correlation and path coefficient studies for yield attributes in BYVMV resistant genotypes of okra

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Abstract

Thirty diverse okra genotypes were evaluated for 16 yield attributing traits during the *kharif* season 2013-14 in Randomized Block Design with 3 replications. The general mean of yield attributing traits data showed that there was considerable variation among the genotypes for most of the characters under study. High GCV, heritability and genetic advance was exhibited by per cent disease incidence, showing the high heritability. Similarly, days to Ist flowering, average fruit weight and yield also showed high heritability. Correlation studies at genotypic level showed the presence of negative and significant correlation of yield/plant with BYVMV disease after 30, 60 and 90 days of sowing (-0.53**, -0.82** and -0.69** respectively). However, yield was positively correlated with average fruit weight, fruit length, fruit diameter, fruits per plant and number of fruiting nodes. Path-coefficient analysis at genotypic level showed that internodal length, number of branches, number of fruiting nodes, fruit diameter and number of seeds/fruit had high direct effect on yield. While days to 50% flowering and plant height had negative direct effect on yield/plant. The residual effect was found very low (0.0243) indicating that most of the variability present in the genotypes was explained with traits under study.

Keywords: Okra, *Abelmoschus esculentus*, genetic variability, heritability, correlation, path-analysis

Introduction

Okra [*Abelmoschus esculentus* L. (Moench) 2n=2x=130], belongs to the Malvaceae family, is an important fruit vegetable grown throughout the India. India is the largest producer of okra with 6.35 mt production (72.9% of total world production) from 0.53 mha area (NHB 2014). Tender pods of okra are used as delicious vegetable and also processed as canned, dehydrated and frozen form. It is good source of protein, calcium, potassium and fibre. The yield contributing traits in okra have to be studied for developing most suitable ideotype having earliness, more number of nodes with short inter nodal length. The pod quality traits like pod colour, pod length, pod diameter, number of ridges per pod also determine the acceptability of the hybrids and varieties. Apart from these, the okra crop heavily suffers from Bhendi Yellow Vein Mosaic Virus (BYVMV) which is the most devastating biotic factor causing significant loss (Jose and Usha 2003, Sanwal *et al*. 2014). Any variety without BYVMV resistance/tolerance has limited scope. Hence, resistance to BYVMV has become an integral part of okra improvement programmes. At present, most of the released varieties of okra which were earlier developed against BYVMV resistance are no more fully resistant to BYVMV disease; therefore, identification of new sources of resistance is the need of hour. Yield is a complex trait influenced by various yield attributing traits and direct selection for yield is often misleading. So, knowledge about inter-relationship between pairs of the characters and with yield is essential to bring a rational improvement in the desirable traits. The knowledge of the nature of association between characters is of great asset to plant breeders to formulate any improvement programme. The improvement in any crop is proportional to the magnitude of its genetic variability present in the germplasm (Dhankhar and Dhankhar 2002). The magnitude and direction of association is measured by correlation coefficients. The path coefficient analysis measures the influence of one trait upon the set of other traits through standardized partial regression coefficient to increase the efficiency of selection. Genetic variability, heritability and genetic advance will provide information about heritable portion of variability which is likely to be achieved in the next generation. Keeping above in view, the present study was carried out to estimate genetic variability, genetic

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advance, characters association and direct and indirect effects on yield of okra.

Materials and methods

The present investigation was done at the Research Farm, Division of Vegetable Science, Indian Agricultural Research Institute, New Delhi during the *kharif* season of the year 2013-14. The experimental material consisted of 30 promising and diverse lines/varieties of okra collected from different institutes and universities of the country. The crop was raised following the standard cultivation practices. Sixteen yield attributing traits data were recorded as per DUS guidelines. Phenotypic and genotypic components of variance were estimated by using the formula given by Cochran and Cox (1957) followed by the expected genetic gain or advance for each character. Both genotypic and phenotypic correlation coefficients between two characters were determined by using the variance and covariance components as suggested by Al-Jibouri *et al.* (1958). Path coefficient analyzed by using correlation values of yield components on yield as suggested by Wright (1921) and illustrated by Dewey and Lu (1959).

Results and Discussion

The combined mean performance of 30 okra genotypes for yield attributing traits indicated that there were significant differences among the genotypes with respect to all the characters under study. Mean, range, Phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability (h^2**)**, genetic advance and genetic advance as per cent over mean of yield attributing traits and quality traits in 30 genotypes is presented in Table 1. Days to 1st flowering ranged from 35.33 to 41.33 days with earliest in genotype P-8. Plant height ranged from 51.67 to 86.67 cm. Four genotypes namely, DOV-11, DOV-66, DOV-24 and DOV-12 recorded no incidence of BYVMV after 30 days of sowing. The varieties namely, Arka Abhay and Arka Anamika recorded14.82 % and 37.26 % BYVMV infestation after 30 days of sowing respectively. After 90 days of sowing, the genotype DOV-12 recorded minimum incidence of BYVMV (3.0%) followed by DOV-66 (3.6%); while Pusa Sawani recorded maximum 94% incidence. It was also noticed that Arka Abhay and Arka Anamika recorded 85.18% and 85.29% BYVMV incidence, respectively after 90 days of sowing and were found susceptible to BYVMV under Delhi condition. However, newly developed genotype DOV-12 and DOV-66 recorded minimum disease incidence during whole growing period and found resistant to BYVMV even after 90 days of sowing. Inter-nodal length, a desirable traits from plant ideotype viewpoint, ranged from 4.33 to 8.67 cm. Fruit length ranged from 8.33 cm to 14.27 cm. Fruit yield (q/ha) ranged from 48 q/ha (Pusa Sawani) to 141.52 q/ha (DOV-66) with mean yield of 97.29 q/ha.

PCV was higher than the GCV in all the yield attributing traits under study (Table 1). The highest PCV and GCV were recorded BYVMV incidence at 30, 60 and 90 days i.e. 77.14 and 73.63%; 63.80% and 62.39%; 59.84% and 58.76%, respectively. Days to 1st flowering, plant height, per cent BYVMV incidence at 60 days and 90 days, no of fruits /plant and yield /plant recorded very less difference in PCV and GCV showing that variation in these traits were mainly due to genotype and these traits were less affected by environment. Heritability in broad sense varied from 25.50% for no of seeds/plant to 95.90% for yield /plant. High heritability estimates were also recorded in all the traits except, days to 50%

Table 1. Mean, range, PCV, GCV, heritability (h^2), genetic advance (GA) and genetic advance as per cent over mean of yield attributing traits of 30 genotypes of okra.

Sl. No.	Characters	Mean	Range		PCV	GCV	Heritability (%)	GA	GA as % mean
			Minimum	Maximum					
1.	Days to 1st flowering	37.51	35.33	41.33	3.70	3.33	80.90	2.31	6.16
2.	Days to 50% flowering	43.83	42.15	46.33	4.26	1.91	40.10	0.6	1.76
3.	Plant height (cm)	74.23	51.67	86.67	9.77	8.04	67.80	10.12	13.63
4.	Per cent BYVMV (30 DAS)	14.28	0.00	37.26	77.14	73.63	91.10	20.68	144.79
5.	Per cent BYVMV (60 DAS)	28.53	0.74	73.67	63.80	62.39	95.60	35.85	125.68
6.	Per cent BYVMV (90 DAS)	36.50	3.85	94.00	59.84	58.76	96.40	43.38	118.86
7.	Inter nodal length (cm)	6.19	4.33	8.67	18.94	16.06	71.90	1.74	28.11
8.	No of branches	5.06	3.33	7.67	23.06	20.34	77.80	1.87	36.99
9.	No of fruiting node	4.62	3.33	7.00	24.16	13.22	29.90	0.69	14.93
10.	Fruit diameter (mm)	17.74	15.00	19.64	7.28	7.02	92.90	2.47	13.92
11.	Fruit length (cm)	12.04	8.33	14.27	12.39	11.38	84.50	2.6	21.59
12.	Fruits/plant	12.31	7.33	15.33	18.16	17.43	92.20	4.24	34.44
13.	Average fruit weight (g)	12.70	10.17	15.33	7.97	6.36	63.60	1.33	10.47
14.	No of seeds per pod	50.68	42.00	57.33	10.90	5.51	25.50	2.91	5.74
15.	Yield/plant (g)	127.66	66.00	163.67	21.11	20.59	95.10	59.15	41.36
16.	Yield (q/ha)	97.29	48.00	141.52	26.45	25.90	95.90	33.29	52.24

flowering (40.10%) and plant height (67.80%), which showed moderate heritability, while no. of seeds per pod (25.50%) and no. of fruiting nodes (29.90%) recorded low heritability. This might attributed to the fact that parental genotypes might have possessed both additive and /or non-additive genes for their traits in different magnitudes. Thus, selection of these traits may not be that much effective, as these traits are more influenced by environment .These finding were also corroborated with the finding of Prakash and Pithaimuthu (2010) and Akotkar *et al*. (2010).

Similarly genetic advance per cent over mean was recorded maximum for per cent BYVMV incidence at 30 days (144.79) followed by per cent BYVMV incidence at 60 days (125.68) and 90 days (118.86). A joint consideration of GCV, broad sense heritability estimates and genetic advance revealed high value for per cent BYVMV incidence at 30, 60 90 days after sowing, whereas yield /plant had high heritability but moderate GCV and genetic advance. High heritability coupled with high genetic advance was recorded in per cent BYVMV incidence and yield/plant, demonstrated the preponderance of additive genes in controlling the expression of these characters and thus, providing better opportunity for effective and reliable selection for these characters. This was in accordance to our findings. Similarly, Yamuna *et al.,* (2013) observed high GCV and heritability for yield /plant and BYVMV incidence in okra. This was akin with our findings.

Phenotypic and Genotypic correlation coefficient are presented in Table 2 and 3 for yield attributing traits and quality traits respectively. Plant height (0.28), no. of fruiting nodes (0.32), fruit diameter (0.31), fruit length (0.34), no. of fruits/plant (0.16), average fruit weight (0.28), no. of seeds/pod (0.03) showed positive correlation with yield (q/ha) at genotypic level. However, fruit yield /plant (0.82**) was positively and highly significantly correlated with yield (q/ha). Per cent BYVMV incidence at 30 (-0.53**), 60 (-0.82**) and 90 days (-0.84**) shown highly significant but negative correlation with yield (q/ha) showing that the genotype with more infestation with BYVMV may give lower

Table 2: Phenotypic correlations among yield attributing traits in 30 genotypes of okra

Sl. No.	Traits	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	Days to 1st flowering	1.00	0.05	-0.14	0.14	0.07	0.14	0.28	0.27	0.04	0.21	-0.02	-0.15	-0.02	-0.08	-0.10	-0.04
2.	Days to 50% flowering		1.00	-0.01	0.06	0.22	0.20	0.14	0.31	-0.05	-0.21	-0.05	-0.07	-0.04	0.12	-0.31	-0.28
3.	Plant height (cm)			1.00	-0.07	-0.18	-0.32	-0.18	0.19	0.20	**0.42***	0.27	**0.41***	-0.14	0.02	0.27	0.22
4.	Per cent BYVMV (30 DAS)				1.00	**0.72****	**0.63****	0.15	-0.04	-0.15	0.01	0.13	0.28	-0.10	-0.02	-0.26	**-0.49****
5.	Per cent BYVMV (60 DAS)					1.00	**0.94****	0.18	-0.11	-0.10	-0.33	-0.22	0.21	-0.23	-0.14	**-0.61** **	**-0.80****
6.	Per cent BYVMV (90 DAS)						1.00	0.32	-0.12	-0.10	**-0.39***	-0.25	0.04	-0.30	-0.13	**-0.66****	**-0.82****
7.	Internodal length (cm)							1.00	0.17	-0.02	-0.03	0.22	-0.24	-0.18	-0.09	-0.28	-0.15
8.	No of branches								1.00	-0.04	0.05	0.14	-0.13	0.00	0.03	0.00	-0.03
9.	No of fruiting nodes									1.00	-0.10	0.03	0.06	-0.05	0.11	0.22	0.17
10.	Fruit diameter (mm)										1.00	0.25	0.06	0.06	-0.10	0.28	0.28
11.	Fruit length (cm)											1.00	0.10	-0.12	0.01	0.30	0.29
12.	Fruits/plant												1.00	0.11	0.01	0.23	0.14
13.	Average fruit weight (g)													1.00	0.09	0.19	0.19
14.	No of seeds /pod														1.00	0.18	0.03
15.	Yield /plant (g)															1.00	**0.79****
16	Yield (q/ha)																1.00

**Significant at 1% level of probability, * Significant at 5% level of probability

Table 3. Genotypic correlations among yield attributing traits in 30 genotypes of okra.

Sl. No.	Traits	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	Days to 1st flowering	1.00	0.05	-0.13	0.16	0.09	0.16	0.26	0.29	0.00	0.26	-0.04	-0.14	-0.05	-0.30	-0.12	-0.05
2.	Days to 50% flowering		1.00	-0.16	0.24	0.37*	0.43*	0.45**	0.55**	0.10	-0.45**	-0.29	-0.02	-0.36*	-0.15	-0.54**	-0.48**
3.	Plant height (cm)			1.00	-0.07	-0.21	-0.39*	-0.32	0.26	0.25	0.49**	0.32	0.50 **	-0.14	-0.29	0.34	0.28
4.	Per cent BYVMV (30 DAS)				1.00	0.78 **	0.68**	0.17	-0.08	-0.32	0.01	0.17	0.30	-0.16	-0.10	-0.28	-0.53**
5.	Per cent BYVMV (60 DAS)					1.00	0.94**	0.22	-0.13	-0.21	-0.34	-0.26	0.23	-0.30	-0.20	-0.63**	-0.82**
6.	Per cent BYVMV (90 DAS)						1.00	0.38*	-0.13	-0.17	-0.40*	-0.28	0.04	-0.38*	-0.19	-0.69**	-0.84**
7.	Inter nodal length (cm)							1.00	0.23	-0.26	-0.07	0.26	-0.25	-0.26	-0.28	-0.37*	-0.18
8.	No of branches								1.00	-0.04	0.06	0.22	-0.12	-0.02	0.07	0.02	-0.02
9.	No of fruiting node									1.00	-0.25	-0.11	0.14	-0.04	-0.18	0.43*	0.32
10.	Fruit diameter (mm)										1.00	0.27	0.06	0.15	-0.31	0.30	0.31
11.	Fruit length (cm)											1.00	0.11	-0.11	-0.09	0.34	0.34
12.	Fruits/plant												1.00	0.17	0.09	0.25	0.16
13.	Average fruit weight (g)													1.00	0.33	0.25	0.28
14.	No of seeds per pod														1.00	0.45 **	0.03
15.	Yield /plant (g)															1.00	0.82**
16	Yield (q/ha)																1.00

**Significant at 1% level of probability * Significant at 5% level of probability

Table 4. Genotypic path-coefficient analysis showing direct (diagonal) and indirect (Off –diagonal) effects of yield attributing traits on yield per plant of okra

Sl. No.	Traits	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	®with yield / plant
1	Days to 1st flowering	-0.25	-0.02	0.08	0.00	0.19	-0.26	0.10	0.10	0.00	0.25	0.00	0.02	0.02	-0.30	-0.04	-0.12
2	Days to 50% flowering	-0.01	-0.43*	0.09	0.00	0.85	-0.70	0.17	0.20	0.11	-0.44	0.00	0.00	0.16	-0.15	-0.39	-0.54
3	Plant height (cm)	0.03	0.07	-0.57**	0.00	-0.47	0.64	-0.12	0.09	0.27	0.47	0.00	-0.08	0.06	-0.29	0.22	0.34
4	Per cent BYVMV (30 DAS)	-0.04	-0.10	0.04	-0.02	1.76	-1.11	0.07	-0.03	-0.35	0.01	0.00	-0.05	0.07	-0.10	-0.43	-0.28
5	Per cent BYVMV (60 DAS)	-0.02	-0.16	0.12	-0.01	2.27**	-1.55	0.08	-0.05	-0.23	-0.33	0.00	-0.04	0.14	-0.20	-0.66	-0.63
6	Per cent BYVMV (90 DAS)	-0.04	-0.19	0.22	-0.01	2.14	-1.64**	0.14	-0.05	-0.18	-0.39	0.00	-0.01	0.17	-0.19	-0.67	-0.69
7	Inter nodal length (cm)	-0.06	-0.19	0.18	0.00	0.51	-0.63	0.38*	0.08	-0.29	-0.07	0.00	0.04	0.12	-0.28	-0.15	-0.37
8	No of branches	-0.07	-0.24	-0.15	0.00	-0.29	0.21	0.09	0.36*	-0.05	0.06	0.00	0.02	0.01	0.08	-0.02	0.02
9	No of fruiting node	0.00	-0.04	-0.14	0.01	-0.48	0.27	-0.10	-0.02	1.10**	-0.24	0.00	-0.02	0.02	-0.18	0.25	0.43
10	Fruit diameter (mm)	-0.06	0.19	-0.28	0.00	-0.76	0.66	-0.03	0.02	-0.28	0.97**	0.00	-0.01	-0.07	-0.32	0.25	0.30
11	Fruit length (cm)	0.01	0.13	-0.18	0.00	-0.59	0.45	0.10	0.08	-0.12	0.26	-0.01	-0.02	0.05	-0.09	0.27	0.34
12	Fruits/plant	0.03	0.01	-0.28	-0.01	0.51	-0.07	-0.10	-0.04	0.15	0.05	0.00	-0.16	-0.08	0.09	0.12	0.25
13	Average fruit weight (g)	0.01	0.16	0.08	0.00	-0.69	0.61	-0.10	-0.01	-0.05	0.15	0.00	-0.03	-0.45**	0.33	0.22	0.25
14	No of seeds per pod	0.08	0.07	0.16	0.00	-0.45	0.31	-0.11	0.03	-0.20	-0.30	0.00	-0.01	-0.15	1.01**	0.02	0.46
15	Yield /plant (g)	0.01	0.21	-0.16	0.01	-1.87	1.37	-0.07	-0.01	0.35	0.30	0.00	-0.02	-0.12	0.03	0.80**	0.82

**Significant at 1% level of probability * Significant at 5% level of probability; Residual effect =0.0243

Table 5: Phenotypic path-coefficient analysis showing direct (diagonal) and indirect (Off –diagonal) effects of yield attributing traits on yield per plant of okra.

Sl No.	Traits	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	® with yield /plant
1	Days to 1st flowering	-0.081	-0.005	-0.001	0.017	-0.002	0.025	-0.055	0.030	0.004	0.019	-0.002	0.001	-0.001	-0.013	-0.034	-0.098
2	Days to 50% flowering	-0.004	-0.101	0.000	0.007	-0.006	0.038	-0.028	0.035	-0.004	-0.018	-0.004	0.000	-0.002	0.020	-0.238	-0.305
3	Plant height (cm)	0.011	0.001	0.005	-0.009	0.005	-0.059	0.036	0.021	0.019	0.037	0.023	-0.002	-0.006	0.002	0.182	0.266
4	Per cent BYVMV (30 DAS)	-0.011	-0.006	0.000	0.122	-0.020	0.117	-0.030	-0.004	-0.015	0.001	0.011	-0.001	-0.005	-0.003	-0.415	-0.259
5	Per cent BYVMV (60 DAS)	-0.006	-0.022	-0.001	0.088	-0.028	0.173	-0.035	-0.013	-0.010	-0.029	-0.019	-0.001	-0.010	-0.022	-0.675	-0.610
6	Per cent BYVMV (90 DAS)	-0.011	-0.020	-0.002	0.077	-0.026	0.185	-0.064	-0.013	-0.010	-0.034	-0.022	0.000	-0.014	-0.021	-0.687	-0.662
7	Inter nodal length (cm)	-0.022	-0.014	-0.001	0.018	-0.005	0.059	-0.201	0.020	-0.002	-0.003	0.019	0.001	-0.008	-0.014	-0.128	-0.281
8	No of branches	-0.021	-0.031	0.001	-0.005	0.003	-0.022	-0.035	0.114	-0.004	0.004	0.012	0.001	0.000	0.005	-0.026	-0.004
9	No of fruiting node	-0.003	0.005	0.001	-0.019	0.003	-0.019	0.004	-0.005	0.096	-0.009	0.002	0.000	-0.002	0.018	0.145	0.217
10	Fruit diameter (mm)	-0.017	0.021	0.002	0.001	0.009	-0.072	0.006	0.005	-0.010	0.088	0.021	0.000	0.003	-0.017	0.239	0.279
11	Fruit length (cm)	0.002	0.005	0.001	0.016	0.006	-0.046	-0.045	0.016	0.003	0.022	0.086	0.000	-0.005	0.001	0.242	0.304
12	Fruits/plant	0.013	0.007	0.002	0.034	-0.006	0.008	0.048	-0.015	0.006	0.005	0.008	-0.004	0.005	0.001	0.121	0.233
13	Average fruit weight (g)	0.002	0.004	-0.001	-0.012	0.006	-0.055	0.035	0.000	-0.005	0.005	-0.010	0.000	0.046	0.015	0.157	0.187
14	No of seeds per pod	0.007	-0.012	0.000	-0.003	0.004	-0.024	0.018	0.004	0.010	-0.009	0.001	0.000	0.004	0.163	0.021	0.184
15	Yield /plant (g)	0.003	0.029	0.001	-0.060	0.022	-0.151	0.031	-0.003	0.016	0.025	0.025	-0.001	0.009	0.004	0.716	0.791

**Significant at 1% level of probability * Significant at 5% level of probability; Residual effect=0.03791

yield. Inter-nodal length which is also an important traits was significantly but negatively correlated (-0.18) with yield/plant (g). Plant height showed highly significant and positive correlation with fruit diameter (0.49**), no. of fruits /plant (0.50**), however, significantly negatively correlated with per cent BYVMV incidence at 90 days after sowing (-0.39*) (Table 3). BYVMV incidence at 90 days interval showed significant and positive correlation with inter nodal length (0.38*), but negative with fruit diameter (-0.40*), while with yield/ plant (g) and yield (q/ha) showed highly significant and negative correlation (-0.69** and -0.84**, respectively). Similar trends were also found at phenotypic level (Table 2).

Path-coefficient at phenotypic (Table 4) and genotypic level (Table 5) for yield attributing traits showed that plant height had positive indirect effect via no. of fruiting nodes, disease incidence, fruit diameter, average fruit weight, no. of branches, days to first flowering, days to 50% flowering and yield/plant which showed that it will increase total yield (q/ha) via these characters. However, no of fruiting nodes had positive and high direct effect (1.10**) on yield (q/ha). A critical perusal of path-coefficient analysis revealed that days to 50 % flowering (-0.43*) is directly but inversely affecting the yield (q/ha), while plant height (-0.57**), per cent BYVMV incidence after 90 days of sowing (-1.64**) and average fruit weight (-0.45**) showed highly significant indirect effect on yield (q/ha). The residual effect was found very low (0.0243) indicating that most of the variability present in the genotypes was explained with traits under study. Similarly trends were also recorded at phenotypic level but having very low value (Table 5).

Plant breeders also argue that selection for yield components is more effective than yield *per se*. Therefore, for improving the yield of okra, breeder should aim for selecting genotypes with shorter days to first and 50% flowering, low incidence of BYVMV, shorter inter-nodal length, more no. of fruits/plant, and higher fruit length, diameter and fruit weight.

सारांश

खरीफ सीजन 2013–14 के दौरान तीन बार प्रति कृति के साथ यादृच्छिक प्रखंड आकार विधि में 16 उपज तथा उपज घटकों वाले गुणों के लिए तीस विविध प्रकार के भिन्डी प्रजातियों का मूल्यांकन किया गया था। उपज की विशेषता वाले गुणों का सामान्य अर्थ यह दर्शाता है कि अध्ययन के तहत अधिकांश घटकों के लिए प्रजातियों में काफी अंतर था। बाहय स्वरूप विभिन्नता गुणाक, अनुवांशिक विभिन्नता गुणांक से ज्यादा था। अनुवांशिक विविधता गुणांक का अधिकतम आंकन प्रतिशत रोग 30, 60 एवं 90 दिनों के बुआई के बाद की घटनाओं में पाया गया। अनुवांशिक अस्तर पर सहसंबंध अध्ययन ने 30, 60 और 90 दिनों की बुवाई के बाद उपज/पौधे के साथ भिन्डी येलो वैन विषाणु रोग के साथ नकारात्मक सहसंबंध को दिखाया क्रमशः –0–53, 082 और 0–69 जबकि अधिकतम वंशागतित्व औसत फलों का वजन और उपज के लिए अंकित किया गया। अधिकतम वंशागतित्व के साथ उच्च अनुवांशिक उन्नयन प्रतिशत माध्यम आकलन पौध लम्बाई के लिए अधिक था। हालांकि उपज सकारात्मक रूप से फली/पौध, पौध लम्बाइ, फलियों की संख्या/पौध, बीजों की संख्या/फली, फली लम्बाई व प्रत्येक फली के वजन सम्बंधित था है। मार्ग गुणाक विश्लेषण से स्पष्ट होता है कि एकल फली भार व फलियों की संख्या/पौध, शाखाओं की संख्या फल व्यास और बीज की संख्या प्रति फल के प्रति पायी गयी। जबकि 50 प्रतिशत फूलों के उगने में लगे दिनों और पौधों की लम्बाई को पौधों के उपज पर नकारात्मक प्रभाव पड़ता है। अवशिष्ट प्रभाव बहुत कम (0–0243) दर्शाता है कि प्रजाति में मौजूद अधिकांश विभिन्ता को अध्ययन के तहत लक्षणों के साथ है।

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