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Short Communication

Character association studies in bitter gourd (*Momordica charantia* L.)

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Bitter gourd is a most important cucurbitaceous crop grown throughout the country for its high nutritive and pharmacological value. Correlation studies between yield and its components and their relative contribution to yield will be of great value in evaluating and planning breeding programmes. Correlation coefficient analysis measures the mutual relationship between plant characters and determines the component characters on which selection can be based for improvement in yield. Path analysis facilitates the portioning of correlation coefficients into direct and indirect effect of various characters on yield or any other attributes. The present experiment was conducted during the summer season of 2010 at Vegetable Research Centre of G.B.P.U.A&T, Pantnagar, U.S. Nagar (Uttarakhand). The experimental material taken for the present study consisted of forty seven germplasm lines of *Momordica charantia* L. including 2 checks viz. Pant Karela-1 and Kalyanpur Sona. The experiment was laid out in an augmented randomized block design with five blocks each consisted of nine germplasm and two checks. The material was sown on 22nd march 2010. The spacing between the two rows was kept 2 m while between the plants it was 0.6 m. Initially seeds were sown in a pit and later on 2 plants per hill were maintained after thinning. In the experiment data were recorded on ten quantitative traits viz. days to first male flower, days to first female flower, number of nodes to first male flower, number of nodes to first female flowers, fruit weight (g), fruit diameter (cm), fruit length (cm), vine length (m), number of fruits per vine, yield per vine (kg). Correlation coefficient analysis measures the mutual relationship between plant characters and determines the component characters on which selection can be based on for improvement in the yield which are presented in Table 1. Single fruit weight showed highly significant and positive correlation with fruit length (0.648) and yield per vine (0.413) but positive and non-significant correlation with fruit diameter (0.103) and number of fruits per vine (0.006). Number of fruits had significant and positive correlation with yield per vine (0.852) but non-significant and positive correlation with vine length (0.042). Main vine length exhibited non-significant and negative correlation with almost all traits. Node no. to first female flower exhibited positive and highly significant correlation with days to anthesis of first female flower (0.519) and node number to first male flower (0.399). Node number to male showed highly significant and positive correlation with days to anthesis of first male flower (0.588), days to first female flower (0.339) and node number to first female flower (0.399). However, node number to first male flower showed negative and significant correlation with total yield (-0.379). Total yield showed highly significant and positive correlation with number of fruits per vine (0.853) and fruit weight (0.411) indicating any increase in the later two will increase the fruit yield. These traits also showed positive and high significant correlation with fruit yield per vine (0.910). Positive correlation of yield with fruit weight, number of fruits per vine and yield per vine has also been reported earlier by Bhave *et al.* (2003), Dey *et al.* (2005) and Kumar *et al*., (2013) and Sundaram, (2010). Yield showed negative and highly significant correlation with days to anthesis of first male flower which implies that selection of genotypes with lesser number of days to anthesis of first male flower are expected to yield better Kumar *et al*., (2013). Yield per vine showed highly significant and positive correlation with fruit weight, number of fruits per vine and total yield similar results were found by Parhi *et al.* (1995) and Sundaram, (2010) in the experiment. This indicates that selection for these traits would be effective to improve yield in bittergourd.

Path coefficient analysis developed by Wright (1921) proves helpful in partitioning the correlation coefficient

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Table 1: Path coefficient analysis showing direct (diagonal) and indirect (off diagonal) effects of different quantitative traits on fruit yield

Traits	Days to 1st male flower	Node number	Days to 1st female flower	Node number	Weight of 1 fruit (gm)	Diameter (cm)	Length (cm)	No. of fruit per vine	Yield per vine (kg)	Vine length (m)
Days to1st male flower	**- 0.142**	0.052	0.082	-0.031	-0.096	-0.011	0.002	-0.418	-0.016	0.003
Node number	-0.083	**0.088**	0.044	-0.045	-0.130	-0.025	0.005	-0.227	-0.010	0.005
Days to 1st female flower	-0.090	0.030	**0.130**	-0.059	-0.041	-0.010	0.000	-0.194	-0.006	0.008
Node number	-0.039	0.035	0.067	**-0.114**	-0.114	-0.017	0.012	-0.053	-0.006	0.007
Wt. of 1 fruit (gm)	0.035	-0.030	-0.013	0.033	**0.387**	0.006	-0.020	0.004	0.011	-0.004
Diameter (cm)	0.025	-0.033	-0.020	0.029	-0.039	**0.066**	0.004	0.115	-0.006	-0.012
Length (cm)	0.009	-0.016	0.001	0.045	0.250	-0.009	**-0.031**	-0.167	0.002	0.005
No. of fruit per plant	0.075	-0.025	-0.032	0.007	0.002	0.009	0.006	**0.782**	0.024	0.001
Yield of fruit per plant	0.081	-0.0337	-0.030	0.025	0.159	0.014	-0.002	0.667	**0.028**	0.001
Vine length (m)	-0.014	0.012	0.028	-0.021	-0.046	-0.021	-0.004	0.032	0.0001	**0.038**

Residual factor = 0.092

Table 2. Direct (diagonal) and indirect (off diagonal) effect of different correlated characters on total yield in bitter gourd.

Characters	Node number male flower	Days to female flower	Node number female flower	Fruit weight	Fruit diameter	Fruit Length	No. of fruits/ vine	Yield/ vine	Vine length	Total yield
Days to male flower	0.588**	0.634**	0.275	-0.249	-0.177	-0.068	-0.534**	-0.574**	0.104	-0.575*
Node no. 1st male flower		0.339*	0.339**	-0.338*	-0.379*	-0.182	-0.290	-0.380*	0.144	-0.379*
Days to female flower			0.519**	-0.106	-0.158	0.012	-0.249	-0.235	0.217	-0.234
Node no. 1st female flower				-0.295*	-0.258	-0.392**	-0.068	-0.222	0.190	-0.222
Fruit weight					0.103	0.648**	0.006	0.413**	-0.119	0.411**
Fruit diameter						-0.149	0.147	0.220	-0.319*	0.221
Fruit Length							-0.214	0.092	0.139	0.090
No. of fruits/vine								0.852**	0.042	0.853**
Yield/vine									0.005	0.910**
Vine length										0.004

*significant at 5% **significant at 1%

into direct and indirect effects which are given in Table 2. Path coefficient analysis revealed that number of fruits per plant exerted high order of positive direct effect (0.782) towards yield followed by single fruit weight (0.387), days to first female flower (0.130), number of node to first male flower (0.088), fruit diameter (0.066), vine length (0.038) and yield per plant (0.028). However, fruit length (-0.031), node number to first female flower (-0.114) and days to first male flower anthesis (-0.142) exerted negative direct effect towards yield. Number of fruit per vine exerted positive indirect effects on yield via days to first male flower (0.075), yield per vine (0.024), fruit diameter (0.009), node number to first female flower (0.007), fruit length (0.006), single fruit weight (0.002) and vine length (0.001). Negative indirect effects were exerted on yield via days to first female flower (-0.032) and node number to first male flower (-0.025). Similar results which showed positive direct effect on yield via yield per vine, number of fruit per vine, fruit weight, days to first female flower and vine length were also reported by Sundaram, (2010) and Yadav *et al*, (2013). Similar results were found earlier by Dey *et al*., (2005) and Bhave *et al*., (2003) also. In the investigation the contribution of residual factor (0.0921) was found to be low, which indicated that the component traits choosen in the study are adequate to explain yield. Based on the present investigation yield per vine and fruit weight have been identified as most important traits since both of them exhibited highly significant and positive direct effect on yield. Therefore, the characters like yield per vine, no. of fruit per vine and fruit weight showing positive direct effects on fruit yield should be preferred while making selection for improvement of fruit yield and more emphasis should be given to the traits with greater magnitude of positive direct effect than those with small magnitude.

As conclusive results characters showing highly significant and positive correlation with total yield were fruit weight (0.41), no. of fruits per vine (0.85) and yield per vine (0.91). Path coefficient analysis revealed that number of fruits per vine (0.782), fruit weight (0.387), days to anthesis of first female flower (0.130), fruit diameter (0.066), yield per vine (0.028) and vine length (0.038) exhibited positive and direct effects on yield. However, fruit length (-0.031), node number to female flower (-0.114), and days to first male flower anthesis (-0.142) exerted negative direct effects on yield. Fruit weight (0.41) and number of fruits per vine (0.85) exhibited significant positive correlation and both of them had either direct or indirect effect on yield per vine which emerged as an important component contributing fruit

yield and selection programme primarily based on these traits may result in the development of high yielding genotypes.

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