Interrelationship among elite germplasm of cucumber (*Cucumis sativus* L.) at genotypic and phenotypic level

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**ABSTRACT**

The experiment was conducted to work out variability, heritability, genetic advance and interrelationship using twelve genotypes of cucumber (*Cucumis sativus* L.). GCV and PCV were highest for number of fruits per vine; whereas lowest estimate was recorded for days to first harvesting and days to last harvesting. The high heritability showed by vine length and number of fruit per vine and as compare to other characters, whereas days to last harvesting, showed lower value of heritability. Genetic advance in percentage of mean was found highest for number of fruits per vine show that these characters are under the control of additive gene action and that environmental factors have a lesser influence on the expression of these traits, thus further development of these traits through direct selection. The path coefficient analysis revealed high and positive direct is possible effect on fruit weight and days to last harvesting. As a result, these traits turned out to be important components of fruit yield thus direct selection effective via these two traits.

**Key words:** Cucumber, GCV, PCV, Correlation, Heritability, Path, Genetic advance.

**Introduction**

Cucumber (*Cucumis sativus* L.) an important crop of cucurbitaceous family cultivated widely in the tropical and sub-tropical regions. After tomatoes, cabbage and onions, it is the fourth most valuable vegetable (Sandeep Kumar, *et al.*, 2013). Cucumber fruit is versatile and is used in salads, pickles, and desserts. Cucumber is useful in lowering high and low blood pressure because of its high potassium content 50-80 mg/100g (Kashif *et al.*, 2008). Cucumber pulp has 2.16 g carbohydrate dietary fibre (0.7g), total sugars (1.38g), glucose (0.63g), fructose (0.75g) and starch (0.08g) thereby considered an ideal digestive fruit with higher water content. (Department of agriculture, U.S. 2010). In addition, consumption of cucumber has additional health benefits, *i.e.* anticancer activity, skin diseases, high and low blood pressure treatment; bone health etc (Jony *et al.*, 2013).

The understanding of genetic architecture and direct and indirect selection parameters of agronomically important traits helps in deciding the type of variety to be developed and the breeding methodology to be followed in a particular growing situation. In this context to develop high yielding inbred line varieties, it is essential to screen germplasm lines for gene action, combining ability and nature and magnitude of heterosis for different characters (Shrivastav *et al.*, 2020).

The farmers are facing many problems while cul-
tivating cucumber. Farmer is not getting the improved varieties of cucumber cultivation. Therefore there is immense need to development of wider adaptive multiple resistance/tolerance as well as high yielding with quality are important (Shrivastav et al., 2022).

Materials and Methods

The present investigation was conducted during summer season of 2021 and 2022, at experimental farm, Department of Genetics and Plant Breeding, Lovely Professional University, Phagwara, Punjab (31°13' 26.4720” N and 75°46' 14.8728” E.) A diverse group of 12 genotypes of cucumber (Cucumis sativus L.) were used as experimental material. The selected genotypes exhibiting sufficient amount of variation was grown with respect to morphological and important economical traits. The experiments conducted three replications and in a randomised block design. The Five plant from each plot were randomly selected for recording the observations on the following traits days to first female flower (DFFF), days to first male flower (DFMF), node number at first female flower (NFFF), first fruit bearing node (FFBN), days to first harvest (DFH), fruit weight (g) (FW), fruit length (cm) (FL), fruit diameter (cm) (FD), internodal length (IL), vine length (VL), number of fruits per vine (NFPV), fruit yield per vine (FYPV) and days to last harvest (DLH). The recorded data were analyzed as suggested by Panse and Sukhatme (1985) for analysis of variance. The genotypic and phenotypic coefficient of variance was calculated as per the formula suggested by Burton and De Vane and Johnson et al., (1953) for heritability and genetic advance. The direct and indirect path were obtained according to the method given by Dewey and Lu et al., (1959). The statistical analysis of the data was carried out using R Studio software and Variability statistical package. The replicated mean values of data were subjected to analysis of variance.

Results and Discussion

Analysis of variance revealed significant variation for most of the traits except Internodal length (0.88), Node number of first female flowers (0.56) and Fruit diameter (0.52) traits under study (Table 1). The estimation of variability parameter i.e., Phenotypic (PCV) and Genotypic (GCV) coefficient of variation for yield and other characters are presented in (Table 2). Genotypic coefficient of variation and phenotypic coefficient of variation were highest for number of fruit per vine (34.73 and 34.79, respectively) whereas lowest estimate of GCV and PCV was recorded for Days to first harvesting (0.89 and 1.17, respectively) and Days to last harvesting. For several features in cucumber, the coefficients of genotypic and phenotypic variability were moderate to high, according to Rastogi and Arya (1990), Kumar et al., (2008), and Mehdi and Khan (2009).

Variation at the phenotypic level involves a mix of genetic and environmental diversity, which makes selection difficult. As a result, the most important characteristics are genetic variability, specifi-

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Character</th>
<th>Replications</th>
<th>Source of Variance</th>
<th>Error</th>
</tr>
</thead>
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<td>Genotypes</td>
<td>163.64**</td>
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<tr>
<td>2</td>
<td>Days to first male flower</td>
<td>0.814</td>
<td>Genotypes</td>
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<td>Node number at first female flower</td>
<td>0.005</td>
<td>Genotypes</td>
<td>0.56</td>
</tr>
<tr>
<td>4</td>
<td>First fruit bearing node</td>
<td>0.017</td>
<td>Genotypes</td>
<td>2.34*</td>
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<td>5</td>
<td>Days to first harvest</td>
<td>0.097</td>
<td>Genotypes</td>
<td>4.61**</td>
</tr>
<tr>
<td>6</td>
<td>Fruit weight (g)</td>
<td>16.15**</td>
<td>Genotypes</td>
<td>2299.01**</td>
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<tr>
<td>7</td>
<td>Fruit length (cm)</td>
<td>0.015</td>
<td>Genotypes</td>
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<td>Fruit diameter (cm)</td>
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<td>Genotypes</td>
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<td>Internodal length</td>
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<td>Genotypes</td>
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<td>Vine length</td>
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<tr>
<td>12</td>
<td>Fruit yield per vain</td>
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<td>Genotypes</td>
<td>3189.99**</td>
</tr>
<tr>
<td>13</td>
<td>Days to last harvest</td>
<td>19.43**</td>
<td>Genotypes</td>
<td>12.37**</td>
</tr>
</tbody>
</table>
cally additive genetic variability, which a breeder is most interested in range, mean, coefficient of variation, and heritability analysis for selection of elite genotypes. This also indicates the role of the environment in causing the variance. Phenotypic variation is composed of genotypic and environmental variability, there by not to be considered as a tool for effective selection result, since it has been influenced by environmental factors. For a plant breeder, genetic diversity, (additive genetic), is important because it indicates positive genetic gain through selection.

The estimation of heritability and genetic advance as a percentage of mean is given in (Table 2). The range of heritability for all characters varied from 99.75% to 57.66%. Vine length (99.75%) showed highest percentage of heritability as compare to other characters followed by number of fruit per vine (99.69%), days to first female flower (99.44%) and characters, mainly, days to first male flower (99.42%), fruit yield per vine (97.04%), fruit diameter (95.57%), fruit weight (95.21%), first fruit bearing node (93.36%), fruit length (92.68%) and internodal length (92.42%), showed moderate value of heritability. Characters, namely, node number at first female flower (72.22%), days to last harvesting (64.34%) and days to first harvesting (57.66%), showed lower value of heritability.

Genetic progress refers to the improvement in a population’s genetic makeup that can be achieved through character selection. It is determined by the heritability of phenotypic variation and the selection differential of the breeder. Genetic progress is influenced by the amount of genetic variability, the size of the masking effect of genetic expression (environmental influence) and the strength of selection.

Genetic advance as percentage of mean was found highest for number of fruits per vine (71.45%) followed by fruit length (15.77%). Characters namely, vine length (22.47), days to first female flower (20.84), internodal length (20.19), fruit yield per vine (19.99), first fruit bearing node (17.34), fruit weight (16.82), fruit diameter (15.83) and days to first male flower (15.62) showed moderate value of genetic advance and node number of first female flower (7.47), days to last harvesting (2.21) and days to first harvesting (1.39) were recorded for low value of genetic advance as percentage of mean. The phenotypic coefficient of variation (PCV) was higher.

<table>
<thead>
<tr>
<th>Sr.No.</th>
<th>Character</th>
<th>$\sigma^2_g$</th>
<th>$\sigma^2_p$</th>
<th>GCV (%)</th>
<th>PCV (%)</th>
<th>$h^2_{obs}$ (%)</th>
<th>GA</th>
<th>GA (%)</th>
</tr>
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<td>27.27</td>
<td>10.14</td>
<td>10.17</td>
<td>99.44</td>
<td>10.69</td>
<td>20.84</td>
</tr>
<tr>
<td>2</td>
<td>Days to first male flower</td>
<td>16.39</td>
<td>16.49</td>
<td>7.60</td>
<td>7.62</td>
<td>99.42</td>
<td>8.31</td>
<td>15.62</td>
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<td>Node number at first female flower</td>
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<td>0.09</td>
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<td>5.02</td>
<td>72.22</td>
<td>0.45</td>
<td>7.47</td>
</tr>
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<td>4</td>
<td>First fruit bearing node</td>
<td>0.36</td>
<td>0.39</td>
<td>8.71</td>
<td>9.01</td>
<td>93.36</td>
<td>1.20</td>
<td>17.34</td>
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<td>Days to first harvest</td>
<td>0.44</td>
<td>0.77</td>
<td>0.89</td>
<td>1.17</td>
<td>57.66</td>
<td>1.04</td>
<td>1.39</td>
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<td>Fruit weight (g)</td>
<td>364.80</td>
<td>383.16</td>
<td>8.37</td>
<td>8.57</td>
<td>95.21</td>
<td>38.39</td>
<td>16.82</td>
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<td>7</td>
<td>Fruit length (cm)</td>
<td>0.95</td>
<td>1.02</td>
<td>7.95</td>
<td>8.26</td>
<td>92.68</td>
<td>1.93</td>
<td>15.77</td>
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<td>Fruit diameter (cm)</td>
<td>0.08</td>
<td>0.08</td>
<td>7.85</td>
<td>8.03</td>
<td>95.67</td>
<td>58.39</td>
<td>15.83</td>
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<td>Internodal length</td>
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<td>0.14</td>
<td>10.19</td>
<td>10.60</td>
<td>92.42</td>
<td>0.73</td>
<td>20.19</td>
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<td>54.99</td>
<td>10.92</td>
<td>10.93</td>
<td>99.75</td>
<td>15.23</td>
<td>22.47</td>
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<td>Number of fruits per vine</td>
<td>9.28</td>
<td>9.31</td>
<td>34.73</td>
<td>34.79</td>
<td>99.69</td>
<td>6.26</td>
<td>71.45</td>
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<td>12</td>
<td>Fruit yield per vine</td>
<td>515.93</td>
<td>531.66</td>
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<td>10.00</td>
<td>97.04</td>
<td>46.09</td>
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<td>Days to last harvest</td>
<td>1.32</td>
<td>2.06</td>
<td>1.34</td>
<td>1.67</td>
<td>64.34</td>
<td>1.90</td>
<td>2.21</td>
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</table>

Table 2. Estimation of coefficient of variation and genetic parameters in cucumber 2021-2022

Fig. 1. Diagram for Phenotypic Path coefficient analysis
than genotypic coefficient of variation (GCV) and the difference between PCV and GCV was narrow for most of the characters showing less influence of the environment in the expression of such like traits. Since it is a measure of success in segregating genotypes via selection, knowing about genetic parameter would be helpful in improving the performance of a breeding system Saikumar P. et al., (2020).

Correlation studies

The phenotypic correlation values were higher than genotypic correlation values in most of cases effect of environment is added for development of traits. The character, number of fruit per vine ($r_g =0.6957$, $r_p =0.6972$) exhibited highly significant and positive genotypic as well as phenotypic correlation as well as phenotypic correlation (Table 3) with days to first female flower and days to first male flower. The character, number of fruit per vine exhibited highly significant and negative genotypic as well as phenotypic correlation (Table 3) with days to first male flower and days to first female flower.

The yield components showed various types of association each other. As a result, it was found that under normal sowing conditions, days to first female flower, days to first male flower, node number at first female flower, first fruit bearing node, days to first harvesting, fruit weight, fruit length, fruit diameter, internodal length, vine length, number of fruit per vine, fruit yield per vine and days to last harvesting were the most important traits and may contribute considerably towards fruit yield per vine. The interaction of yield components would improve in increasing yield levels; accordingly, more emphasis needs to be placed on these components while selecting better cucum-

<table>
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<th>Character</th>
<th>DFFF</th>
<th>DFMF</th>
<th>NFFF</th>
<th>FFBN</th>
<th>DFH</th>
<th>FW</th>
<th>FL</th>
<th>FD</th>
<th>IL</th>
<th>VL</th>
<th>NFPV</th>
<th>DLH</th>
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<td>0.3580**</td>
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<td>0.0041</td>
<td></td>
<td></td>
<td>0.0107</td>
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<tr>
<td>2. DFMF</td>
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<td></td>
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<td>-0.2120**</td>
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<td>-0.2521**</td>
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<td>0.3536**</td>
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<tr>
<td>5. DFH</td>
<td></td>
<td></td>
<td>0.3583**</td>
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<td>0.2824**</td>
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<td>6. FW</td>
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<td>-0.3077**</td>
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<td>8. FD</td>
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<td>9. IL</td>
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<td>0.2225**</td>
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<td>0.1560**</td>
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<td>0.1820**</td>
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<td>10. VL</td>
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<td>11. NFPV</td>
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</table>
Path Coefficient Analysis

The path coefficient analysis indicated high and positive direct effect on fruit weight (0.7978) and days to last harvesting (0.9219). Thus, these characters turned out to be major components of fruit yield thus direct selection effective via these two traits. The trait number of fruit per vine exhibited positive and high indirect effect via Fruit length (0.3594) so indirect selection revered via above mention traits. According to Hasan et al., (2015) there was positive and significant association of Fruit weight and days to last harvesting. Ahirwar et al., (2017) observed high positive direct effect of fruit weight and days to last harvesting of cucumber which showed the importance of fruit weight for figuring the yield in cucumber.

Conclusion

From the results, it can be concluded that substantial amount of genetic variations for yield and its components traits studied material. The genotypes had a high genotypic and phenotypic coefficient of variation, heritability and a high value of genetic advance for the number of fruit per vine, vine length, days to first female flower, and days to last harvesting. It indicating that these traits are under the control of additive gene action and that environmental factors have a less influence on the expression of these traits, with the possibility of further

Table 4. Phenotypic path coefficient analysis showing direct (diagonal and bold) and indirect effects of various characters in cucumber.

<table>
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<td>0.0227</td>
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<td>0.0870</td>
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development of these traits through direct selection.

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Authors’ Contributions

Prasad D. Khedkar and Harmeet Singh Janeja had conceptualized the idea, worked and prepared the data, and results along with the draft manuscript and have edited final draft manuscript. All authored have written, reviewed, and edited the manuscript.

Conflicts of Interest

The authors report no financial or any other conflicts of interest in this work

References
