Correlation and Path Analysis of the Yield Contributing Characters of Different Ash Gourd [(Benincasa hispida (Thunb.) Cogn.] Germplasm

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ABSTRACT

The objectives of the present study were to evaluate the associations between yield and yield contributing traits and identify the direct and indirect effects of component traits on fruit yield of ash gourd to enable selection of promising lines. Observations were recorded for two seasons (rainy seasons of 2015 and 2016) on 18 ash gourd genotypes (local landraces and released varieties). Correlation coefficients indicated that yield per vine had significant and positive association with number of branches per vine (0.318, 0.137), number of female flowers per vine (0.078, 0.565), sex ratio (0.579, 0.322), fruit length (0.604, 0.463), fruit diameter (0.743, 0.565), average fruit weight (0.830, 0.758), number of seeds per fruit (0.387, 0.286), weight of seeds per fruit (0.635, 0.478) and vine length (0.395, 0.340). Negative associations were noticed with node to 1st female flower (-0.279, -0.280) and days to 1st fruit setting (-0.465, -0.189). Number of fruits per vine (0.108) was positively associated with yield per vine at phenotypic level only. Path coefficient analysis revealed that number of female flowers per vine (6.221), vine length (5.727), fruit diameter (5.201), fruit length (0.647), days to 1st fruit setting (3.455), number of branches per vine (1.300) and weight of seeds per fruit (0.892) directly contributed to the yield of ash gourd.

Keywords: Ash gourd, Benincasa, Correlation, Drought tolerant, Path coefficient.

INTRODUCTION

Ash gourd [Benincasa hispida Thunb. Cogn.] is an important vegetable mainly valued for its long storage life and good scope for value addition. The fruits are consumed as baked, fried, boiled, pickled, candied/preserved (Robinson & Decker-Walters, 1997). World famous confectionery locally known as Petha is prepared using ripe flesh of ash gourd in sugar syrup.

Ash gourd is also valued for its medicinal attributes especially in Ayurveda for the cure of peptic ulcer and the fruit juice is used for treating a range of ailments including insanity and epilepsy. It can also prevent kidney damage (Pandey, 2008). The methanolic extract of the fruit is reported to possess anti-ulcer (Grover et al., 2001), anti-inflammatory (Chandrababu & Umamaheshwari, 2002), antihistaminic and antidepressant activities (Kumar & Ramu, 2002). Fruits of Benincasa hispida are used in folk medicine for treatment of nervousness and debility (Nadhiya et al., 2014). Its fruits contain a relatively high level of K and low Na and from the index of nutritional value, it has been adjudged as a quality vegetable (Pandey, 2008).

Ash gourd crop has also been found to be drought (Pagare et al., 2011) and salt tolerant (Chauhan, 2010). Drought (dehydration) tolerant plants are able to withstand dehydration due to osmotic adjustment (Morgan, 1984). Due to limited availability of arable land and high market demand for off-season vegetables, cucurbits (plants in the family Cucurbitaceae) are continuously cultivated under unfavorable conditions in some countries. These conditions include environments that are too cold, wet, or dry, or are cool low-light winter greenhouses (Pandey et al., 2015). Fruits of Benincasa hispida are used in folk medicine for treatment of nervousness and debility (Nadhiya et al., 2014).

Although ash gourd is becoming a crop of industrial importance, relatively less attention has been paid towards the varietal improvement of existing strains available in different parts of India. There is an imperative need to select an ideal plant type having maximum desirable traits to meet the growing demand.

Yield is a complex and polygenically controlled character and is highly influenced by environmental factors. The analysis of various yield contributing traits and their interrelationships can be of immense help for a need based crop improvement programme, especially in selecting desirable genotypes for high yield. A study of correlation between yield and its components and their relative contribution to yield have a great importance in planning effective breeding programmes and selection of suitable plant types. Correlation also provides information on the nature and extent of relationship between all pairs of characters.

When more characters are included in a correlation study, the indirect associations become complex. Path coefficient analysis is an important tool for the better understanding of the crop inheritance in respect of yield. It provides an effective means of partitioning the correlation coefficients into direct and indirect effects of the component characters on yield. Selection on the basis of direct and indirect effects is much more effective and useful than selection for yield per se. Considering the above factors, the present study was undertaken to improve fruit yield of ash gourd using correlation and path analysis in respect of yield and yield contributing traits of 18 ash gourd genotypes (local landraces and released varieties).

**MATERIALS AND METHODS**

The field experiments were carried out during the rainy seasons of 2015 and 2016, at All India Coordinated Research Project on Vegetable Crops, Odisha University of Agriculture and Technology, Bhubaneswar, Odisha, India. The experiment comprised of 18 genotypes of ash gourd viz., BAGS-1, BAGS-2, BAGS-3, BAGS-4, BAGS-5, BAGS-6, BAGS-7, BAGS-8, BAGS-9, BAGS-10, BAGS-11 (local landraces), Kashi Dhawal, Kashi Ujwal, Kashi Surbhi, Pusa Ujwal, Pusa Urmii, Pusa Sabji Petha and Pusa Shreyali. The experiment was laid out in the Randomized Block Design with three replications.
Each genotype was sown in hills, in each plot measuring 3mx3m and accommodating 5 plants /hill. All the recommended cultural practices were adopted to raise a healthy crop. Observations were recorded on 13 quantitative traits of 5 random plants of each genotype per plot. Data were recorded with respect to the characters viz., number of branches per plant, node to 1st female flower, number of female flowers /plant, sex ratio, days to 1st fruit setting, number of fruits/plant, fruit length (cm), fruit diameter (cm), average fruit weight (g), number of seeds /fruit, weight of seeds/fruit (g), vine length(cm) and yield per plant (g). The data were subjected to statistical and biometrical analysis according to the methods suggested by Singh and Chaudhary (1985). Correlation and path coefficient analyses were worked out according to the methods described by Johnson et al. (1955) and Dewey & Lu (1959) respectively.

RESULTS AND DISCUSSION
Genotypic and phenotypic correlations between yield per vine and its components
The genotypic and phenotypic associations with yield per vine and interrelationships of different traits are presented in table 1. In general, the genotypic correlation values were numerically higher than phenotypic values. Yield per vine was positively correlated with number of branches per vine (0.318, 0.137), number of female flowers per plant (0.078, 0.154 ), sex ratio( 0.579, 0.322), fruit length (0.604, 0.463), fruit diameter (0.743, 0.565), average fruit weight (0.830, 0.758), number of seeds per fruit (0.387,0.286), weight of seeds per fruit (0.635, 0.478) and vine length (0.395, 0.340) while it recorded negative association at both levels for days to 1st fruit setting and node to 1st female flower while for number of fruits per vine it was at genotypic level alone.

The present study revealed that the traits viz., number of branches per plant, number of female flowers per vine, sex ratio, fruit length, fruit diameter, average fruit weight, number of seeds per fruit, weight of seeds per fruit and vine length exhibited high positive association with fruit yield at genotypic and phenotypic levels respectively.

Weight of seeds/fruit showed significant positive associations with sex ratio and days to 1st fruit setting (at genotypic level) and with fruit length, fruit diameter, average fruit weight and number of seeds/fruit at both the levels. Number of seeds/fruit had significant positive associations with days to 1st fruit setting and average fruit weight (at genotypic level) and with fruit length and fruit diameter at both the levels. Average fruit weight exhibited significant positive correlation with sex ratio (at genotypic level) and with fruit length and fruit diameter at both the levels. Sex ratio showed significant positive association with fruit length, fruit diameter and fruits/vine at genotypic level. Fruit length and diameter had significant positive association at both levels. Number of female flowers/vine showed significant positive association with sex ratio at genotypic level.

Node to 1st female flower exhibited significant negative correlation with sex ratio, number of fruits/ vine and average fruit weight at genotypic level. Again, number of fruits/vine had significant negative association with fruit length and vine length at genotypic level.

Cause and effect relationships: Upon the assessment of apparent relationships between yield and yield components, it was felt necessary to partition the direct and indirect effects of each character on yield to understand the association more realistically. In order to fulfill the requirement, path coefficient analysis was undertaken and the direct and indirect effects of different characters on yield per vine in ash gourd are presented in Table 2.

Direct effects: Number of female flowers per plant (6.221), vine length (5.727), fruit
diameter (5.201), days to 1st fruit setting (3.455), number of branches/plant(1.300), weight of seeds per fruit (0.892) and fruit length (0.647) exhibited positive direct effects on yield, whereas negative direct effects were observed for number of seeds per fruit (-6.249), node to 1st female flower (-4.580), number of fruits per plant (-3.422), average fruit weight (-3.530) and sex ratio (-1.797).

**Indirect effects:** Sex ratio and number of fruits per plant exerted high positive indirect effects through number of female flowers per plant. Days to 1st fruit setting had high positive indirect effect through sex ratio. Sex ratio, fruit length, average fruit weight, number of seeds/fruit and weight of seeds per fruit exerted high positive indirect effects through fruit diameter. Number of fruits/vine, number of seeds/fruit and weight of seeds/fruit had good indirect positive effect through days to 1st fruit setting. Number of branches/vine and node to 1st female flower had good indirect positive effect through vine length. Sex ratio, number of fruits/vine and average fruit weight exerted good indirect positive effect through node to 1st female flower.

Positive correlations of fruit length with fruit diameter, average fruit weight and yield were in agreement with the findings of Singh et al. (1987) in parwal and Prasad and Singh (1992) in cucumber. Sex ratio exhibited positive correlation with fruit yield. Similar finding was reported in cucumber by Prasunna and Rao (1989).

The present investigation revealed that fruit diameter was positively correlated with average fruit weight and yield. Salk (1982) working on melons also reported strong positive correlation between fruit diameter and average fruit weight. Parkash et al. (2000) in ash gourd and Bhave et al. (2003) in bitter gourd confirmed the association of fruit diameter with yield.

The traits viz., number of branches per plant, number of female flowers per vine, sex ratio, fruit length, fruit diameter, average fruit weight, number of seeds per fruit, weight of seeds per fruit and vine length exhibited high positive association with fruit yield at genotypic and phenotypic levels. Hence, during selection, care should be taken to give more emphasis on these traits for realizing the highest fruit yield. Such positive association was quoted by several researchers (Yadav et al., 2007; Resmi & Sreelathakumary, 2012; Dewan et al., 2014).

The negative correlation between fruits per plant and yield was supported by the findings of Priya (2001) in watermelon and Lovely (2001) in ash gourd. Fruits per vine also had negative correlation with average fruit weight. This gives a clear indication that increase in number of fruits per vine would affect the fruit yield. Similar results had been reported by Salk (1982) in melons as well as Resmi and Sreelathakumary (2012) in ash gourd.

In the present study, high direct contribution of number of female flowers per plant to yield is in conformity with the findings of Hawlader et al. (1999).Days to 1st fruit setting exerted high positive direct effect on fruit yield which corroborates the observation of Narayan (1996).Negative correlation of fruits per plant with yield was due to high negative indirect effect through fruit length, while in node to first female flower, negative correlation was through high negative indirect effects of sex ratio, fruits/vine and average fruit weight. This is in conformity with the findings of Rakhi (2001) in melon and Pandey et al. (2003) in snap melon.
Table 1: Genotypic and phenotypic correlation co-efficients ($r_g$ and $r_p$) between all pairs of 13 characters of genotypes of Ash Gourd

<table>
<thead>
<tr>
<th>Character</th>
<th>Number of branches/vine</th>
<th>Node to 1st female flower</th>
<th>Number of flowers/vine</th>
<th>Sex ratio</th>
<th>Days to 1st fruit setting</th>
<th>Number of fruits/flower</th>
<th>Fruit length (cm)</th>
<th>Fruit diameter (cm)</th>
<th>Average fruit weight (g)</th>
<th>Number of seeds/fruit</th>
<th>Weight of seeds/fruit (g)</th>
<th>Vine length (cm)</th>
<th>Yield/vine (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of branches/vine</td>
<td>G 1.000</td>
<td>-0.185</td>
<td>-0.246</td>
<td>0.439</td>
<td>0.194</td>
<td>-0.821</td>
<td>-0.437</td>
<td>-0.022</td>
<td>-0.059</td>
<td>-0.168</td>
<td>-0.018</td>
<td>0.436</td>
<td>0.318</td>
</tr>
<tr>
<td>Node to 1st female flower</td>
<td>G</td>
<td>1.000</td>
<td>0.140</td>
<td>0.175</td>
<td>0.048</td>
<td>-0.114</td>
<td>0.344</td>
<td>-0.161</td>
<td>-0.085</td>
<td>-0.089</td>
<td>-0.029</td>
<td>0.399</td>
<td>0.137</td>
</tr>
<tr>
<td>Number of flowers/vine</td>
<td>G</td>
<td>1.000</td>
<td>0.116</td>
<td>-0.625**</td>
<td>-0.042</td>
<td>-0.340</td>
<td>-0.238</td>
<td>-0.418</td>
<td>-0.531*</td>
<td>-0.113</td>
<td>-0.295</td>
<td>0.429</td>
<td>0.279</td>
</tr>
<tr>
<td>Number of fruit setting</td>
<td>G</td>
<td>1.000</td>
<td>-0.221</td>
<td>0.109</td>
<td>-0.002</td>
<td>-0.104</td>
<td>-0.223</td>
<td>-0.261</td>
<td>-0.338</td>
<td>-0.026</td>
<td>-0.170</td>
<td>-0.026</td>
<td>0.280</td>
</tr>
<tr>
<td>Number of seeds/fruit</td>
<td>G</td>
<td>1.000</td>
<td>0.094***</td>
<td>-0.054</td>
<td>0.609***</td>
<td>0.074</td>
<td>0.233</td>
<td>0.152</td>
<td>0.025</td>
<td>0.053</td>
<td>-0.305</td>
<td>0.078</td>
<td></td>
</tr>
<tr>
<td>Sex ratio</td>
<td>G</td>
<td>1.000</td>
<td>0.051</td>
<td>-0.082</td>
<td>-0.000</td>
<td>0.125</td>
<td>0.358</td>
<td>0.236</td>
<td>-0.000</td>
<td>0.114</td>
<td>-0.218</td>
<td>0.154</td>
<td></td>
</tr>
<tr>
<td>Number of fruits/fruit</td>
<td>G</td>
<td>1.000</td>
<td>0.544**</td>
<td>0.708**</td>
<td>0.940**</td>
<td>0.499*</td>
<td>0.845**</td>
<td>0.182</td>
<td>0.786**</td>
<td>0.164</td>
<td>0.579*</td>
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</tr>
<tr>
<td>Days to 1st fruit setting</td>
<td>G</td>
<td>1.000</td>
<td>-0.084</td>
<td>-0.027</td>
<td>0.255</td>
<td>0.231</td>
<td>0.235</td>
<td>0.113</td>
<td>0.169</td>
<td>-0.047</td>
<td>0.322</td>
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</tr>
<tr>
<td>Fruit length (cm)</td>
<td>G</td>
<td>1.000</td>
<td>0.773***</td>
<td>0.329</td>
<td>0.143</td>
<td>-0.192</td>
<td>0.623**</td>
<td>0.635**</td>
<td>-0.589*</td>
<td>0.465</td>
<td></td>
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</tr>
<tr>
<td>Fruit diameter (cm)</td>
<td>G</td>
<td>1.000</td>
<td>0.824**</td>
<td>0.730**</td>
<td>0.808**</td>
<td>0.024</td>
<td>0.743**</td>
<td></td>
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<tr>
<td>Average fruit weight (g)</td>
<td>G</td>
<td>1.000</td>
<td>-0.469*</td>
<td>0.804**</td>
<td>0.312</td>
<td>0.830**</td>
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</tr>
<tr>
<td>Number of seeds/fruit</td>
<td>G</td>
<td>1.000</td>
<td>0.375</td>
<td>0.585*</td>
<td>0.203</td>
<td>0.758**</td>
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</tr>
<tr>
<td>Weight of seeds/fruit (g)</td>
<td>G</td>
<td>1.000</td>
<td>0.498**</td>
<td>0.100</td>
<td>0.387</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Vine length (cm)</td>
<td>G</td>
<td>1.000</td>
<td>0.839*</td>
<td>0.059</td>
<td>0.286</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yield/ Vine (g)</td>
<td>G</td>
<td>1.000</td>
<td>0.149</td>
<td>0.635***</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Table 2: Estimates of direct (diagonal) and indirect effects of component characters on fruit yield of genotypes in Ash Gourd

<table>
<thead>
<tr>
<th>Character</th>
<th>Number of branches/vine</th>
<th>Node to 1st female flower</th>
<th>Number of flowers/vine</th>
<th>Sex ratio</th>
<th>Days to 1st fruit setting</th>
<th>Number of fruits/flower</th>
<th>Fruit length (cm)</th>
<th>Fruit diameter (cm)</th>
<th>Average fruit weight (g)</th>
<th>Number of seeds/fruit</th>
<th>Weight of seeds/fruit (g)</th>
<th>Vine length (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of branches/vine</td>
<td>1.300</td>
<td>0.849</td>
<td>-1.530</td>
<td>-0.789</td>
<td>-0.671</td>
<td>-2.126</td>
<td>-0.283</td>
<td>-0.116</td>
<td>0.207</td>
<td>1.052</td>
<td>-0.069</td>
<td>2.495</td>
</tr>
<tr>
<td>Node to 1st female flower</td>
<td>-0.241</td>
<td>-4.580</td>
<td>-0.722</td>
<td>1.117</td>
<td>-0.146</td>
<td>1.848</td>
<td>-0.154</td>
<td>-2.176</td>
<td>1.874</td>
<td>0.708</td>
<td>-0.263</td>
<td>2.457</td>
</tr>
<tr>
<td>Number of flowers/vine</td>
<td>-0.320</td>
<td>0.532</td>
<td>6.221</td>
<td>-2.953</td>
<td>-0.186</td>
<td>-2.083</td>
<td>0.048</td>
<td>1.213</td>
<td>-0.537</td>
<td>-0.156</td>
<td>0.047</td>
<td>-1.747</td>
</tr>
<tr>
<td>Sex ratio</td>
<td>0.571</td>
<td>2.847</td>
<td>8.216</td>
<td>-1.797</td>
<td>7.814</td>
<td>-5.357</td>
<td>0.608</td>
<td>9.484</td>
<td>-6.488</td>
<td>-1.135</td>
<td>0.701</td>
<td>0.942</td>
</tr>
<tr>
<td>Days to 1st fruit setting</td>
<td>-0.253</td>
<td>0.193</td>
<td>-0.335</td>
<td>4.063</td>
<td>3.455</td>
<td>-2.509</td>
<td>0.213</td>
<td>0.743</td>
<td>0.677</td>
<td>-3.904</td>
<td>0.566</td>
<td>-3.376</td>
</tr>
<tr>
<td>Number of fruits/flower</td>
<td>0.808</td>
<td>2.473</td>
<td>3.787</td>
<td>-2.918</td>
<td>2.533</td>
<td>-3.422</td>
<td>-0.337</td>
<td>-1.549</td>
<td>0.499</td>
<td>0.757</td>
<td>-0.153</td>
<td>-2.875</td>
</tr>
<tr>
<td>Fruit length(cm)</td>
<td>-0.568</td>
<td>1.091</td>
<td>0.462</td>
<td>-1.689</td>
<td>1.138</td>
<td>1.779</td>
<td>0.647</td>
<td>4.345</td>
<td>-3.224</td>
<td>-3.627</td>
<td>0.694</td>
<td>-0.444</td>
</tr>
<tr>
<td>Fruit diameter(cm)</td>
<td>-0.029</td>
<td>1.916</td>
<td>1.451</td>
<td>-2.276</td>
<td>0.494</td>
<td>1.019</td>
<td>0.541</td>
<td>5.201</td>
<td>-2.972</td>
<td>-4.562</td>
<td>0.729</td>
<td>0.241</td>
</tr>
<tr>
<td>Average fruit weight (g)</td>
<td>-0.076</td>
<td>2.432</td>
<td>0.947</td>
<td>-3.303</td>
<td>-0.663</td>
<td>0.484</td>
<td>0.591</td>
<td>4.379</td>
<td>-3.530</td>
<td>-2.933</td>
<td>0.717</td>
<td>1.784</td>
</tr>
<tr>
<td>Number of seeds/fruit</td>
<td>-0.219</td>
<td>0.519</td>
<td>0.155</td>
<td>-0.326</td>
<td>2.159</td>
<td>0.415</td>
<td>0.376</td>
<td>3.797</td>
<td>-1.657</td>
<td>-6.249</td>
<td>0.845</td>
<td>0.572</td>
</tr>
<tr>
<td>Weight of seeds/fruit(g)</td>
<td>-0.101</td>
<td>1.352</td>
<td>0.329</td>
<td>-1.413</td>
<td>2.194</td>
<td>0.586</td>
<td>0.504</td>
<td>4.202</td>
<td>-2.840</td>
<td>-5.925</td>
<td>0.892</td>
<td>0.855</td>
</tr>
<tr>
<td>Vine length(cm)</td>
<td>0.566</td>
<td>-1.963</td>
<td>-1.897</td>
<td>-0.295</td>
<td>-2.037</td>
<td>1.117</td>
<td>-0.050</td>
<td>0.219</td>
<td>-1.100</td>
<td>-0.624</td>
<td>0.133</td>
<td>5.727</td>
</tr>
</tbody>
</table>

CONCLUSION

It may be concluded that the traits number of female flowers per plant, vine length, fruit length, number of branches/plant, weight of seeds per fruit and fruit length of ash gourd may be relied upon for selecting high yielding genotypes of the crop. Node to 1st female flower is a dependable character for selecting early fruiting lines of ash gourd.

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