Path Matrix Analysis of Cane Yield and Their Component Traits in Spring Planting of Sugarcane under Waterlogging Condition

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ABSTRACT

A study was conducted with sixteen genotypes received from Sugarcane Research Institute, D.R.P.C.A.U., Pusa, Samastipur, Bihar. The experiment was conducted in Randomized Block Design with three replications during spring season 2016 in paddy block, to evaluate the midlate sugarcane clones for waterlogging tolerance. Observations on a total of twenty-five quantitative and qualitative characters were recorded. The result of present study clearly indicated that highest positive direct effect on cane yield was exerted by pol percent at 12 months stage, sugar yield, brix percentage at 10 months stage, single cane weight and purity percentage at 10 months stage at phenotypic level, hence these traits can be used for clonal selection programme on sugarcane for sub-tropical regions.

Key words: Sugarcane, Phenotypic level, Genotypes, Yield

INTRODUCTION

Sugarcane crop occupies in several parts of India (Assam, Bihar, and West Bengal, eastern Uttar Pradesh, Coastal region of Andhra Pradesh, Tamil Nadu, Kerala and Karnataka) are exposed to stagnant water for two to three months during monsoon season. The short fall in yield potential is mainly due to various biotic and abiotic stresses in Bihar in which waterlogging is the main factor because in Bihar about 35-40 per cent of sugarcane remains waterlogged during monsoon season which coincides with the grand growth period of the crop.

Yield in sugarcane is dependent on a number of factors. Agronomist and breeders have adopted yield component studies through correlation and path coefficient analysis, as a crop improvement strategy. The concept of correlation is used to explore and reveal the relationship between yield and its components. It has also proved valuable in determining the association of quantitative attributes with yield for selecting characters that influence the yield, but the correlation values decide only the nature and degree of association existing between pairs of characters. The economic character like yield is dependent on several mutually associated component characters and hence change in any one of the component is likely to affect the whole network of cause and effect.

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This in turn might affect the true association of component characters both in magnitude and direction and tend to vitiate the association of yield with its attributes. Hence, it has to be analyzed through path analysis, where the two types of action namely direct effect of component characters on the yield and the indirect effects through other component characters on the yield are obtained which cannot be ascertained through correlation studies. Path co-efficient is the standardized partial regression coefficient of correlation, which splits correlation co-efficient into direct and indirect effects of component characters on complex dependent character like yield.

The present investigation was taken up to study direct and indirect inter-relationships among cane yield and their component traits of the spring-planted sugarcane in waterlogged environments.

MATERIAL AND METHODS

Climate
The experimental plot was well leveled but remain waterlogged during May to September 2016 due to low land. The average depth of water varied from 30 to 90 cm and 130 cm for 15 days during September, 2016. The month wise temperature, relative humidity and rainfall data has been provided at Fig: 1

Treatments and experimental design
The sixteen sugarcane clones viz. CoP 09437, CoP 11439, CoP 11440, CoP 12438, CoP 12439, CoP 13438, CoP 13439, CoP 14438, CoP 14439, CoP 15439, CoP 15440, CoP 15441, BO 155 and CoP 2061 were evaluated along with two standard check BO91 and BO154. The trial was laid out in randomized block design with three replications. Equal number of three budded set of each clones was planted.

Data collected and analysis
Data were collected for yield attributing traits viz. germination percentage at 45 DAP (Days After Planting), number of shoots at 120 DAP, (000/ha), plant height at 150, 240, 360 days (cm), number of fully emerged leaves at 30 days and 60 days after waterlogging, leaf area index before waterlogging, at 30 and 60 days after waterlogging, number of nodes with aerial roots, cane diameter at harvest (cm), number of shoots at 240 DAP (000/ha), number of millable canes at harvest (000/ha), single cane weight (Kg), cane yield (t/ ha) and sugar yield (CCS t/ha) at harvest and juice quality traits viz. brix, Pol and Purity at 10 &12 months stage (%), CCS % at 10 and 12 months stage. Chemical analyses of sugarcane juice for brix (%), pol (%), purity (%) and CCS (%) were done.

Path coefficient analysis
Path coefficient was obtained according to the procedure suggested by Deway and Lu 1 and the direct and indirect effects are rated as follows by Lenka and Mishra.

RESULTS AND DISCUSSION
In the present investigation, twenty-five associated characters were subjected separately to path analysis for partitioning the correlation values into direct and indirect effects through alternative path ways and results are discussed below.

Present investigation, genotypic and phenotypic path matrix (Tables 1 and 2) indicated that, highest positive direct effect on cane yield was exerted by pol percent at 12 months stage, sugar yield, brix percentage at 10 months stage, single cane weight and purity percentage at 10 months stage at phenotypic level. In the other words these characters were directly responsible for higher cane yield. Although, at phenotypic level, CCS percentage at 12 months stage, brix percentage at 12 months stage, pol percentage at 10 months stage and number of fully emerged leaves at 60 days after waterlogging showed negative direct effect on cane yield and their indirect effect via each other was also negative. At genotypic level, brix percentage at 12 months stage recorded highest direct positive effect on cane yield followed by CCS percentage at 12 months stage, CCS percentage at 10 months stage, sugar yield, leaf area index at 30 days after waterlogging, purity percentage at 12 months stage and single cane weight. Other characters like pol percentage at 12 months stage, pol percentage at 10 months stage, brix percentage at 10 months stage, plant height at 360 DAP, purity percentage at 10 months
stage and leaf area index before waterlogging at genotypic level recorded negative direct effect. Tena et al.\textsuperscript{4} observed that highest positive direct effect of number of millable cane number on cane yield followed by single cane weight and pol percentage. Masti\textsuperscript{3} found that genotypic path coefficient of stalk diameter, stalk number had positive direct effect on cane yield. These finding are in agreement with chaudhary and Joshi\textsuperscript{2}, Smiullah et al.\textsuperscript{6}, Seeja and Sreekumar\textsuperscript{5}, Das et al. and Sanghera et al.\textsuperscript{5}. Singh et al.\textsuperscript{7} also found that number of millable canes, single cane weight and stalk diameter reflected highly positive direct effect on ratoon yield at genotypic level, whereas stalk length showed negative direct but highly positive indirect effect via pol percent in juice and single cane weight. Patel et al.\textsuperscript{8} found that high positive direct of CCS on cane yield and suggested that for improving cane yield in sugarcane more emphasis should be given to single cane weight, number of millable cane per ha and commercial cane sugar (\text{t/ha}). Kumar and Singh\textsuperscript{9} observed that single cane weight, cane diameter and number of shoots were important characters contributing towards cane yield, these characters should be given due consideration for selection of high yielding sugarcane varieties.

The characters sugar yield, single cane weight, number of millable cane at harvest, cane diameter at harvest and leaf area index at 30 days after waterlogging showed positive direct effect on cane yield both at genotypic and phenotypic levels, therefore these traits may be considered as important characters contributing towards cane yield under waterlogging. On account of genetic coefficient of variation, heritability estimates, genetic advance, as percent of mean as well as positive direct effect or indirect effect through other characters, sugar yield, single cane weight, number of millable cane at harvest, cane diameter at harvest and leaf area index at 30 days after waterlogging can also be considered as the component characters of cane yield.

**Residual effect**

The lower value of residual effect in case of both genotypic as well as phenotypic path coefficient indicates that the all important characters were studied.

### Table 1: Genotypic path coefficient of twenty-five traits of sugarcane clones under waterlogging condition

| Traits                      | X1 | X2 | X3 | X4 | X5 | X6 | X7 | X8 | X9 | X10 | X11 | X12 | X13 | X14 | X15 | X16 | X17 | X18 | X19 | X20 | X21 | X22 | X23 | X24 | X25 |
|-----------------------------|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|                             | 0.003 | 0.006 | 0.005 | 0.001 | 0.000 | 0.003 | 0.000 | 0.003 | 0.001 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
|                             | 0.019 | 0.020 | 0.018 | 0.013 | 0.005 | 0.004 | 0.001 | 0.002 | 0.004 | 0.002 | 0.001 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
|                             | 0.012 | 0.016 | 0.021 | 0.034 | 0.034 | 0.034 | 0.034 | 0.034 | 0.034 | 0.034 | 0.034 | 0.034 | 0.034 | 0.034 | 0.034 | 0.034 | 0.034 | 0.034 | 0.034 | 0.034 | 0.034 | 0.034 | 0.034 | 0.034 | 0.034 | 0.034 |
|                             | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 |
|                             | 0.007 | 0.006 | 0.004 | 0.002 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

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<th>Traits</th>
<th>X1</th>
<th>X2</th>
<th>X3</th>
<th>X4</th>
<th>X5</th>
<th>X6</th>
<th>X7</th>
<th>X8</th>
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<th>X10</th>
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<tr>
<td>Number of Shoots at 120 DAP</td>
<td>0.473</td>
<td>0.005</td>
<td>0.014</td>
<td>0.014</td>
<td>0.001</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
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<tr>
<td>Germination Percentage at 45 DAP</td>
<td>0.286</td>
<td>0.076</td>
<td>0.019</td>
<td>0.014</td>
<td>0.001</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
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<tr>
<td>CCS % at 10 Months Stage</td>
<td>0.234</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Purity % at 10 Months Stage</td>
<td>0.611</td>
<td>0.004</td>
<td>0.003</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cane yield (t/ha)</td>
<td>0.129</td>
<td>0.007</td>
<td>0.003</td>
<td>0.002</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
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<td>-</td>
</tr>
<tr>
<td>Number of Millable Canes at Harvest (000/ha)</td>
<td>1.167</td>
<td>0.100</td>
<td>0.098</td>
<td>0.098</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
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<tr>
<td>Pol % at 10 Months Stage</td>
<td>0.257</td>
<td>0.006</td>
<td>0.003</td>
<td>0.001</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
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<tr>
<td>Leaf Area Index Before Waterlogging</td>
<td>0.145</td>
<td>0.014</td>
<td>0.017</td>
<td>0.048</td>
<td>0.001</td>
<td>0.000</td>
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<td>CCS % at 12 Months Stage</td>
<td>0.950</td>
<td>0.025</td>
<td>0.369</td>
<td>0.234</td>
<td>0.006</td>
<td>0.000</td>
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<tr>
<td>Purity % at 12 Months Stage</td>
<td>0.521</td>
<td>0.006</td>
<td>0.002</td>
<td>0.002</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
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</tr>
<tr>
<td>Number of Nodes with Aerial Roots</td>
<td>0.865</td>
<td>0.030</td>
<td>0.019</td>
<td>0.012</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
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<tr>
<td>Brix % at 12 Months Stage</td>
<td>0.184</td>
<td>0.003</td>
<td>0.002</td>
<td>0.002</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
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</tr>
<tr>
<td>Number of Fully Emerged Leaves at 60 Days After Waterlogging</td>
<td>0.087</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cane Diameter at Harvest (cm)</td>
<td>0.358</td>
<td>0.012</td>
<td>0.000</td>
<td>0.012</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CCS % at 10 Months Stage</td>
<td>0.139</td>
<td>0.004</td>
<td>0.001</td>
<td>0.001</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
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</tbody>
</table>

**Table 2: Phenotypic path coefficient of twenty-five traits of sugarcane clones under waterlogging condition**

**X13**: Number of Nodes with Aerial Roots
**X14**: Plant Height at 150 DAP (cm)
**X15**: Plant Height at 240 DAP (cm)
**X16**: Plant Height at 360 DAP (cm)
**X17**: Single Cane Weight (kg)
**X18**: Cane Diameter at Harvest (cm)
**X19**: Leaf Area Index Before Waterlogging
**X20**: Leaf Area Index at 30 Days After Waterlogging
**X21**: Leaf Area Index at 60 Days After Waterlogging
**X22**: Number of Fully Emerged Leaves at 30 Days After Waterlogging
**X23**: Number of Fully Emerged Leaves at 60 Days After Waterlogging
**X24**: CCS % at 10 Months Stage
**X25**: CCS % at 12 Months Stage

**RESIDUAL EFFECT = 0.016**
CONCLUSIONS
Path coefficient analysis of cane yield with its component characters revealed highest positive direct effect on cane yield was exerted by pol percent at 12 months stage, sugar yield, brix percentage at 10 months stage, single cane weight and purity percentage at 10 months stage at phenotypic level whereas, CCS percentage at 12 months stage, brix percentage at 12 months stage, pol percentage at 10 months stage and number of fully emerged leaves at 60 days after waterlogging showed negative direct effect on cane yield. At genotypic level, brix percentage at 12 months stage recorded highest direct positive effect on cane yield followed by CCS percentage at 12 months stage, CCS percentage at 10 months stage, sugar yield, leaf area index at 30 days after waterlogging, purity percentage at 12 months stage and single cane weight. The characters sugar yield, single cane weight, number of millable cane at harvest, cane diameter at harvest and leaf area index at 30 days after waterlogging showed positive direct effect on cane yield both at genotypic and phenotypic levels.

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