Analytical Study on Correlation and Path Coefficient for Various Agronomical Traits in Sorghum [Sorghum bicolor (L.) Moench] in Tarai Region of Uttarakhand, India

Priyamvada Chauhan and Pradeep Kumar Pandey

1Assistant Professor, Seed Science and Technology, Teerthanker Mahaveer University, Moradabad, U.P.-244001
2Assistant Professor, Genetics and Plant Breeding, G.B.P.U.A. & T., Pantnagar, 263 145, Uttarakhand, India
*Corresponding Author E-mail: priyam09chauhan@gmail.com
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ABSTRACT
Sorghum genotypes were evaluated for genetic variability and interrelationships of characters during Kharif 2013-14 and 2014-15. A significant genotypic variation for all the characters was observed among the accessions. All the characters showed higher phenotypic and genotypic coefficient of variation which indicates that the expression of characters in sorghum population is genetic and can be exploited in sorghum breeding programme. High heritability coupled with high genetic advance was observed for plant height, panicle weight, stover yield and grain yield per plant which indicates that these characters are controlled by additive gene action, so the phenotypic selection for these will be effective. Grain yield was positively correlated with all the characters indicating the effective selection for these characters can be done to improve grain yield. The path coefficient analysis showed a positive and significant correlation as well as high or moderate direct effects of stover yield, plant height, panicle weight, 1000 seed weight on grain yield per plant.

Keywords: Genotypes, Sorghum, Yield, Plant height

INTRODUCTION
Sorghum is an important multi-purpose drought tolerant crop which ranks fifth after wheat, rice, maize and pearl millet among cereals. To fulfill the demands of continuously increasing population, maximizing the yield either fodder or grain is main objective of crop breeding and improvement programmes. For this purpose, adequate exploitation of the available variability in population is view to identify and select the superior genotypes with desirable traits is most important and difficult task. Therefore, it is necessary to know the relative magnitudes of genetic and non-genetic variability exhibited by various traits with the use of suitable parameters like genotypic and phenotypic coefficient of variability (GCV and PCV), heritability (H) & genetic advance (GA).

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Estimates of correlation measure the level of dependence of various traits and out of these numerous correlation coefficients, it is often difficult to determine the actual mutual effects among selected traits (Ikanovic et al., 2011). The estimates of correlations alone either genotypic or phenotypic may be often misleading due to mutual cancellation of component traits. So, it is necessary to study path coefficient analysis, which measures the casual relationship with the degree of relationship among traits by partitioning the correlation coefficient in to direct and indirect effect of independent variables on dependent variable. (Mahajan et al., 2011). The present study was done to assess the genetic variability (PCV and GCV), heritability, genetic advance, correlation and path coefficient analysis for yield and its contributing attributes to provide necessary information that could be useful in various sorghum improvement programmes.

MATERIALS AND METHODS

The experiment was conducted at the Instructional Dairy Farm of the G.B. Pant University of Agriculture and Technology, Pantnagar (U.S. Nagar) India, during Kharif season in 2013-14 and 2014-2015. The experimental materials for the present study was consisted of involving five diverse CMS lines (female), eight pollinator (male) lines and forty F₁ crosses developed through line × tester mating design. The details of genotypes presented in Table 1.

For data collection, 10 competitive plants were randomly selected, from each treatment/genotype in each replication during both the years. All the selected plants were tagged and observations for all the characters were taken. The means of different characters for the purpose of statistical analysis were calculated on the basis of the individual data recorded for each character, in each replication separately, for each cross. Days to 50 % flowering were calculated by counting the number of days between planting when one half of the panicles in a plot reached the half bloom stage. The plant height was measured from ground level to the tip of the uppermost leaf of each plant. Leaf length was measured from base to tip and leaf width was recorded from middle of leaf. Stem diameter was taken from middle of stem with the help of electronic Vanier callipers. Number of nodes was counted from base to panicle initiation of stem. Panicle length was measured at maturity, from the bottom panicle node to the upper most floret or the tip, while panicle width was taken from middle of panicle and panicle weight was measured at maturity. Stover yield was taken by weighing and averaging the ten randomly selected plants just after harvest. Weight of one thousand random grains from total grain yield of tagged plants was recorded in grams and mean was worked out. Average weight of grains obtained from ten random plants after threshing and sun drying was recorded in grams.

Analysis of variance was done by the method given by Panse and Sukhatme (1978). Phenotypic and genotypic coefficient of variation (PCV and GCV), heritability, genetic advance, genotypic coefficient and path coefficient using standard method suggested by Allard (1960), Johnson et al. (1955) and Searle (1961), respectively.

RESULTS AND DISCUSSION

A significant difference among all genotypes was reported by analysis of variance for all the characters which indicates sufficient variability and large scope for the selection of desirable genotypes for higher yield from material evaluated. The similar results were also earlier reported by scientists in fodder sorghum (Jadhav et al., 2011 & Jain & Patel, 2012). Highest range was recorded for stover yield (251.75-1012.75) followed by plant height (168.04-345.58), panicle weight (53.50-208.41), grain yield (31.33-127.43), leaf length (52.8-85.5), 1000 seed weight (16.02-37.51), days to 50% flowering (62.67-82.50), number of nodes per plant (26.45-45.58), number of nodes per plant (26.45-45.58), panicle length (22.86-34.00), stem diameter (11.73-17.95), panicle width (5.25-10.52) and leaf width (6.57-11.08) (Table2). In present investigation, the phenotypic coefficient of variation (PCV) was recorded higher than the
corresponding genotypic coefficient of variation (GCV) for all the characters indicating the influence of environmental factors. The highest PCV and GCV were recorded for grain yield (40.89 and 31.25, respectively) followed by panicle weight (38.89 and 31.13, respectively), stover yield (34.19 and 29.88, respectively), plant height (18.33 and 15.37, respectively). The highest PCV and GCV were recorded for grain yield (40.89 and 31.25, respectively) followed by panicle weight (38.89 and 31.13, respectively), stover yield (34.19 and 29.88, respectively), plant height (18.33 and 15.37, respectively), 1000 seed weight (15.15 and 15.02, respectively), panicle width (12.33 and 12.63, respectively), number of nodes per plant (13.37 and 12.63, respectively), stem diameter (12.18 and 11.65, respectively), leaf width (12.18 and 12.18, respectively), leaf length (11.65 and 11.65, respectively), panicle length (12.18 and 12.18, respectively) and days to 50% flowering (7.45 and 6.76, respectively) (Table 2). High magnitude of GCV and PCV indicated that there is a greater scope for selection of superior genotypes for these attributes. The same findings were confirmed by Khandelwal et al. 2015.

On the basis of GCV and PCV, the accuracy in determining the genetically heritable portion may be affected. In this direction, heritability along with coefficient of variation gives more accurate information. Burton (1952) also suggested that heritability along with GCV gives better information for the selection of superior genotypes. Highest values for heterosis were recorded in 1000 seed weight (0.98) and the lowest estimates were reported for panicle length (0.33). Most of the characters showed high magnitudes of heritability which indicates the genotypic control for these characters as reported by Jain et al. (2010). High heritability in association with high genetic advance was observed stover yield (0.76 and 345.32, respectively), plant height (0.70 and 70.74, respectively), panicle weight (0.64 and 57.61, respectively) and grain yield (0.58 and 35.83, respectively) which indicates that these characters are associated with additive gene action and therefore, phenotypic selection for these characters will be more effective (Table 3). High heritability and high genetic advance also has been reported by Jain et al. (2010) and Jadhav et al. (2011).
These results indicate that selection of these traits may be helpful to increase the yield in sorghum improvement programme (Table and fig.). Similar kinds of findings are reported by Kumar and Singh (2012) and Mahendra et al. (2016).

Table 1: Parentage, origin/source and important characteristic features of parental lines used for the study

| Name of the Parental line | Parentage | Origin/Source | Tillering/ Non-Tillering |
|---------------------------|-----------|---------------|--------------------------|
| Male sterile lines        |           |               |                          |
| ICSA 467                  | -         | ICRISAT       | Non-tillering            |
| ICSA 469                  | [(ICSB 37 x ICSV 702 x PS 19349B]3-3-4-2 | ICRISAT | Non-tillering |
| ICSA 276                  | (ICSB 101 x TRL 74/C 57 x PM17467B]2-5-1-3-3 | ICRISAT | Non-tillering |
| 11A2                      | Non-milo  | DSR, Hyderabad| Non-tillering            |
| MR 750A2                  | Non-milo  | DSR, Hyderabad| Non-tillering            |
| Pollinator lines          |           |               |                          |
| Pant Chari 5              | CS 3541 x IS 6953 | Pantnagar | Non-tillering |
| UPC 2                     | VIDISHA 60-1x ISC 953 | Pantnagar | Non-tillering |
| CSV15                     | SPV 475 x SPV 462 | DSR, Hyderabad | Non-tillering |
| CS3541                    | IS 3575 x IS341 | DSR, Hyderabad | Non-tillering |
| RS 29                     | IS 108 x SPV 126 | DSR, Hyderabad | Non-tillering |
| M 35-1                    | Selection from Maldandi landraces | Mahol | Non-tillering |
| JJ1041                    | -         | Indore        | Non-tillering            |
| SPV1616                   | -         | DSR, Hyderabad | Non-tillering |

Table 2: Genetic parameters of variability for grain yield per plant and other traits

| SR.NO. | TOPIC                     | RANGE       | MEAN     | GCV(%) | PCV(%) | HERITABILITY (%) | GENETIC ADVANCED | EXPECTED MEAN IN NEXT GENERATION |
|--------|---------------------------|-------------|----------|--------|--------|------------------|------------------|----------------------------------|
| 1      | DAYS TO 50% FLOWERING    | 62.67-82.50 | 70.03    | 6.76   | 7.45   | 0.82             | 8.84             | 78.88                            |
| 2      | PLANT HEIGHT              | 168.04-345.58 | 266.17  | 15.37  | 18.33  | 0.7              | 70.74            | 336.92                           |
| 3      | LEAF LENGTH               | 52.8-85.5   | 65.71    | 7.72   | 11.65  | 0.43             | 6.92             | 72.64                            |
| 4      | LEAF WIDTH                | 6.57-11.08  | 8.89     | 8.42   | 12.18  | 0.47             | 1.06             | 9.96                             |
| 5      | STEM DIAMETER             | 11.73-17.95 | 12.08    | 8.54   | 12.63  | 0.45             | 0.24             | 2.33                             |
| 6      | NO. OF NODES PER PLANT    | 26.45-45.58 | 30.57    | 14.39  | 15.37  | 0.44             | 1.78             | 16.17                            |
| 7      | PANICLE LENGTH            | 22.86-34.00 | 27.31    | 7.05   | 12.18  | 0.33             | 2.29             | 29.81                            |
| 8      | PANICLE WIDTH             | 3.25-10.52  | 7.16     | 14.85  | 23.09  | 0.41             | 1.41             | 8.58                             |
| 9      | PANICLE WEIGHT            | 53.50-208.41 | 112.25  | 31.13  | 38.89  | 0.64             | 57.61            | 169.87                           |
| 10     | STOVER YIELD              | 251.75-1012.75 | 641.98  | 29.88  | 34.19  | 0.76             | 345.32           | 987.31                           |
| 11     | 1000 SEEDS WEIGHT         | 16.02-37.51 | 28.69    | 15.02  | 15.15  | 0.98             | 8.8              | 37.51                            |
| 12     | GRAIN YIELD               | 31.33-127.43 | 72.85    | 31.25  | 40.89  | 0.58             | 35.83            | 108.69                           |
### Table 3: Phenotypic and Genotypic correlation between different quantitative traits in sorghum

| Days to 50% flowering | Plant height | Leaf length | Leaf width | Stem diameter | No. of nodes per plant | Panicle length | Panicle width | Panicle weight | Stover yield | 1000 seed weight |
|-----------------------|--------------|-------------|------------|---------------|------------------------|----------------|--------------|----------------|--------------|------------------|
| G                     | 1.0000       | 0.2483      | 0.0189     | 0.0872        | -0.0344               | 0.1072         | 0.0581       | 0.1969         | 0.1899       | 0.0037           |
| F                     | 1.0000       | 0.1900      | 0.0123     | 0.0630        | -0.0173               | 0.0579         | 0.0349       | 0.1175         | 0.1290       | 0.0230           |

### Table 4: Genotypic and Phenotypic path analysis for direct (diagonal) and indirect (off diagonal) effects of grain yield per plant

| Days to 50% flowering | Plant height | Leaf length | Leaf width | Stem diameter | No. of nodes per plant | Panicle length | Panicle width | Panicle weight | Stover yield | 1000 seed weight |
|-----------------------|--------------|-------------|------------|---------------|------------------------|----------------|--------------|----------------|--------------|------------------|
| G                     | 1.0000       | 0.2483      | 0.0189     | 0.0872        | -0.0344               | 0.1072         | 0.0581       | 0.1969         | 0.1899       | 0.0037           |
| F                     | 1.0000       | 0.1900      | 0.0123     | 0.0630        | -0.0173               | 0.0579         | 0.0349       | 0.1175         | 0.1290       | 0.0230           |

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