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# Genetic variability, correlation and path analysis studies in Jute (*Corchorus olitorius*) germplasm lines

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**Abstract**
Fifty two accessions of tossa jute germplasm were evaluated for variability. The highest heritability ($h^2$), genotypic coefficient of variation (GCV) and percent genetic advance over mean were observed for the traits green biomass and fibre weight per plant indicated preponderance of additive gene action. Green biomass weight per plant found to be highest (0.85) genotypic correlation with fibre yield per plant. The traits plant height, base diameter, green biomass weight, days to 50% flowering and fibre weight were found associated with each other. Path coefficient analysis showed that green biomass weight has direct effect on fibre yield per plant. The traits plant height, basal diameter and days to 50% flowering had also indirect effect via green biomass yield on fibre yield per plant. Thus, the result of this investigation suggested that green biomass weight, plant height, basal diameter and days to 50% flowering would be the selection parameters to produce jute varieties with acceptable yield.

**Keywords:** Heritability, genotypic coefficient of variation, genetic advance, direct effect, improvement, selection

## Introduction
Jute (*Corchorus sp.*) is grown as fibre crop during pre-kharif season and plays an important role in Indian economy. West Bengal alone contributes to 77% of the total Indian Jute Sinha *et al*. (2004) [34]. Jute is one of the most important bast fibre crop of the world being cultivated in Eastern India, Bangladesh, Nepal and some South East Asian countries, and is second only to cotton in terms of production and variety of uses (Islam *et al*., 2013) [15]. Entire life-cycle of jute from cultivation to usage disposal, it is friendly to the environment and produces no toxic material (Sarkar, 2008) [28]. Jute is still the leading cash crop and an important tradable and foreign exchange-earning (4.82%) commodity of Bangladesh. The jute fibre is used, as a raw material, for several products like hessians, sacs, and carpet backings. The two species of the genus *Corchorus*, which are cultivated as jute crop include *C. capsularis* (white jute) and *C. olitorius* (tossa jute), each with 2n = 14, are cultivated in our country, but *Corchorus olitorius* is predominantly grown by the farmers. Due to increase the environmental consciousness the demand of natural fibre increases rapidly through the world. To meet this increasing demand there is an urgent need to redesign the ongoing breeding strategies to improve both the yield and quality of jute. Information on the nature and magnitude of genetic variability for the desired characters in the base material and interrelationship among them is useful in breeding for high yield (Kumar *et al*., 2008) [19]. It is therefore, essential to understand the variability, path analysis for prediction of direct and indirect effect of characters on fibre yield in the available germplasm of jute. Increased pressure has been exerted on jute scientists to develop varieties with high yield potential and superior grade fibre that meet the demands of the textile industries. The use of plant genetic resources in breeding research is largely dependent on the available information of their genetic variability. The rates of genetic exploitation of the variation for production of improved cultivars and yield have not received sufficient attention. Rapid genetic improvement of crop depends on the availability of sufficient genetic diversity, which could be selected and combined in various forms to produce reasonable improvement (Denton and Nwangburuka, 2011; Wani *et al*. 2011) [9, 35]. Estimates of heritability values become more reliable and meaningful when combined with genetic advance (Denton and Nwangburuka, 2011) [9]. High heritability and genetic advance in a trait indicates the presence of additive genes in such trait and further suggest reliable crop improvement through selection of such a trait (Panse, 1957) [24]. In this study fifty two accessions of tossa jute (*Corchorus olitorius*) germplasm were used to find out the superior genotypes and presence of variability among them. This study also includes the correlation and path coefficient between yield and its

attributing traits and to find out the extent of direct and indirect effects of fibre yield components.

## Materials and Methods

The experiment was conducted at the All India Network Project on Jute and Allied Fibres, Mahatma Phule Krishi Vidyapeeth, Rahuri during the Kharif 2018. Fifty two accessions of tossa jute (*Corchorus olitorius*) which collected from AINP jute and allied fibres via Central Research Institute for Jute and Allied Fibres (CRIJAF), Barrackpore, West Bengal, India along with two check variety JRO-524 and JRO-204 were taken for this study. The experiment was laid out in the Randomized Block Design (RBD) with three replications. Seeds were sown in single row of 6m long. Spacing was 30 cm between rows, 5-7cm between plants and 1 m between blocks. Standard production technology from Hand Book on Agricultural Technologies of Jute, Kenaf and Mesta crops (2008) [17] was adopted to raise a good crop under optimum management. The recommended agronomic practices were followed to obtain optimum fibre yield. Except days to 50% flowering, which was studied on plot basis, observations on other four quantitative characters namely plant height (cm), base diameter (cm), green weight (g/plant), days to 50% flowering and fibre weight (g/plant) were recorded from ten plants randomly selected from each genotype from each replication. The analysis of variance (ANOVA) for RBD was estimated according to Panse and Sukhtame (1989) [25]. The genotypic and phenotypic variances were calculated according to Johnson *et al*. (1955) [16] and Comstock and Robinson (1952) [5]. Genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were calculated by the method suggested by Singh and Chaudhary (1985) [31] whereas heritability in broad sense for yield and its components were worked out by using formula suggested by Hanson *et al*. (1956) [13]. Genetic advance (GA) was calculated by the method suggested by Johnson *et al*. (1955) [16]. Genotypic and phenotypic correlations were partitioned using the technique outlined by Dewey and Lu (1959) [10].

## Results and Discussion

The analysis of variance revealed highly significant differences among genotypes for all the characters indicating presence of considerable variability for the characters under study among the test genotypes (Table 1). This suggests that there was genetic diversity in these characters among the accessions studied and further suggests prospects for meaningful selection for Corchorus improvement. This agree with the reports of Dar and Sharma (2011) [7], who reported significant variation in quantitative characters in 60 tomatoes genotypes, Kitila *et al*. (2011) [18] reported significant variation in quantitative traits in coffee; Singh *et al*. (2011) reported significant variations quantitative characters in field pea, Nwangburuka *et al*. (2012) [23] reported significant variations in nine yield related characters in twenty-nine accessions of okra. Bhandari *et al.* (2017) [3] reported significant variations in ten yield related characters in 66 genotypes of tomato. Biswas *et al.* (2018) [4] reported significant variations in seven yield related traits in tossa jute. The mean performance of individual genotype is presented in Table 2. The different genetic parameters like range, mean, phenotypic variance, genotypic variance, phenotypic coefficient of variation, genotypic coefficient of variation, heritability, genetic advance and genetic advance as a percentage of mean for each character are presented in Table 03. The plant height at harvest (113 days) ranged from 190-285cm. The highest score of plant height was recorded in accession JRO-524 (285cm/plant) which was followed by accessions JRO-204 (283cm/plant), OIN-115 (280cm/plant), OIN-124 (275cm/plant) and OIN-110 (272cm/plant). Base diameter was ranged from 1.15 – 1.63cm. The highest score of base diameter was recorded in accession OIN-186 (1.63cm/plant) which was followed by accessions OIN-124 (1.62 cm/plant), OIN-87, OIN-109, JRO-524 (1.61 cm/plant), JRO-204 (1.59 cm/plant) and accession OIN-110, OIN-111, OIN-115 and OIN-122 (1.58 cm/plant). Green biomass was ranged from 61-260 g. The highest score for green biomass weight was recorded in accession JRO-524 (260 g/plant) which was followed by accessions JRO-204 (235 g/plant), OIN-124 (232g/plant) and OIN-86 OIN-110 (220 g/plant). Days to 50% flowering ranged from 44-70 days. The highest score for days to 50% flowering was recorded in accession JRO-524 (70 days) which was followed by accessions JRO-204 (68 days), OIN-105 (60 days), OIN-134 (58 days) and OIN-109, OIN-115 (54 days). Fibre weight was ranged from 3.73 – 13.76 g/plant. It was highest in accession JRO-524 (13.76 g/plant) which was followed by accessions JRO-204(13.54 g/plant), OIN-115 (12.75 g/plant), OIN-86 (11.59 g/plant accession OIN-110 (10.80 g/plant) and OIN-100 (10.0 g/plant). Based on major yield contributing characters six accessions, *viz*., JRO-524, JRO-204, OIN-115, OIN-86, OIN-110 and OIN-100 performed relatively better in most of the cases than the studied materials. Hence these accessions may be selected for further study in the next season.

The PCV value was found slightly higher than the GCV value for all the characters. This may suggest that slight environmental effect on the phenotype of all the other characters. This report corresponds to the report of Denton and Nwangburuka (2011) [29], Nwangburuka *et al*. (2012) [23], Mohammed *et al*. (2012) [20], Yadav *et al*. (2011) [36] and Ayalneh *et al.* (2012) [1] who observed slight differences between PCV and GCV in characters studied in *Solanum anguivi*, okra, Ethiopian Duram wheat, Rice and in Tef, respectively.

The PCV ranged from (9.42) for days to 50% flowering to (35.61) for green weight (g)/plant. Similarly, GCV ranged from (9.14) for days to 50% flowering to (33.52) for green weight (g)/plant. The high PCV and GCV values recorded in green weight (g)/plant suggests that this character accounts for most of the variation recorded in *C. olitorius.* The phenotypic and genotypic variance was the highest in green weight (g)/plant (2594.57 and 2298.89) but the lowest in the basal diameter (cm) (0.0241 and 0.0238) and fibre weight (g)/plant (6.48 and 5.72), respectively. High genotypic variance facilitates selection for the improvement and widens the probability for heritability of traits from parents to offspring (Ayalneh *et al*. 2012) [1]. Broad-sense heritability estimates were high for all the charcaters. Dabholkar (1992) [6] categorized heritability estimates as low (5-10%), medium (11-30%) and high (>30%). Maximum estimates of broad-sense heritability was recorded in basal diameter (cm) (98.90) followed by days to 50% flowering (94.19), green weight (g)/plant (88.60), fibre yield (88.27) and plant height (88.17) This suggests the effect of additive genes in the inheritance of these characters. According to Ghandi *et al.* (1964) [11] and Ibrahim and Hussein (2006) [14], prediction of the response of an individual to selection are more reliable when GCV, estimates of broad-sense heritability and genetic advance is combined instead of relying on the estimates of broad-sense heritability estimates alone. When the GA is high the heritability is mainly due to additive gene effect (Percy and Turcotte, 1991) [26]. Hence in present investigation, selection based on characters such as green weight (g)/plant (33.52, 88.60 and 64.99) and fibre weight (g)/plant (33.60, 88.27 and 64.46) combining high GCV, heritability and GA, respectively are under additive gene effect and will be effective in accurate prediction of yield. This agree with the reports of Bello *et al*. (2006) [2] in Okra and Mohammed *et al*. (2012) [20] in their work with wheat; Yadav *et al.* (2011) [36] in their report on rice and Biswas *et al.* (2018) [4] in tossa jute. High heritability and genetic advance is an indication of how much selection to improve a character can be based of phenotypic performance (Johnson *et al*., 1955) [16].

Estimates of phenotypic and genotypic correlation coefficients between each pair of characters are given in Table 4. The results showed that the magnitude of genotypic correlation is higher than the phenotypic correlation indicating that elimination of environmental effects led to strengthen genetic association. The correlation analysis revealed that there was significant and positive association of green biomass weight, plant height, basal diameter and days to 50% flowering with fibre yield per plant The traits plant height, basal diameter, green weight, days to 50% flowering were also associated with each other both at genotypic and phenotypic level.. Similar result was obtained by Singh *et al*. (2013) [33], Nayak and Baisakh (2008) [22] and Mostofa *et al*. (2002) [21].

The results of path coefficient analysis are given in Table 5. Green weight (0.88) had highest positive direct effect (genotypic) on fibre yield per plant followed by days to 50% flowering (0.12) and plant height (0.04). This findings is in agreement with Senapati *et al*. (2006) [30]. Therefore direct selection based on these characters would be feasible. Base diameter per plant exhibited negative direct effects towards fibre yield, but its significant positive correlations with fibre yield per plant indicated that the indirect selection through green weight, plant height and days to 50% flowering could be made for high yielding jute genotypes as they having positive indirect effects. Similar findings were reported by Pervin *et al*. (2012) [27]. The residual effect (R) was 0.48, indicating there was also some other characters which although not studied but influenced the yield of fibre per plant. The green weight per plant of the present study had higher values of direct effects even than their respective correlation coefficients indicating their prime importance in fibre yield. Sawarkar *et al*. (2014) [29] also suggested that green weight per plant and plant height would be an important parameter in predicting fibre yield in jute. The traits plant height, basal diameter and days to 50% flowering had also indirect effect via green biomass yield on fibre yield per plant. Thus, the result of this investigation suggested that green biomass weight, plant height, basal diameter and days to 50% flowering would be the selection parameters to produce jute varieties with acceptable yield.

## Declaration

The authors declare no conflict of interest.

## Acknowledgment

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**Table 1:** Results of analysis of variance (ANOVA) for Jute traits

| Source of variation | DF | Mean sum of squares | | | | |
|---|---|---|---|---|---|---|
| | | Plant height (cm) | Basal diameter (cm) | Green biomass plant$^{-1}$ (g) | Days for 50% flowering | Fibre yield plant$^{-1}$(g) |
| Replication | 2 | 278.56 | 0.001 | 244.55 | 73.90 | 0.55 |
| Treatments | 51 | 2097.69** | 0.072** | 7192.37** | 66.91** | 17.93** |
| Errors | 102 | 89.77 | 0.0003 | 295.68 | 1.35 | 0.76 |

**Table 2:** Mean performance of fibre yield and yield contributing characters

| Sr. No. | Genotypes | Plant height (cm) | Basal diameter (cm) | Green biomass plant$^{-1}$ (g) | Days for 50% flowering | Fibre yield plant$^{-1}$(g) |
|---|---|---|---|---|---|---|
| 1. | OIN 86 | 269 | 1.63 | 220 | 51 | 11.59 |
| 2. | OIN 87 | 268 | 1.61 | 204 | 51 | 8.40 |
| 3. | OIN 88 | 249 | 1.44 | 144 | 53 | 6.39 |
| 4. | OIN 89 | 200 | 1.21 | 86 | 46 | 4.08 |
| 5. | OIN 90 | 243 | 1.36 | 145 | 45 | 5.79 |
| 6. | OIN 91 | 234 | 1.28 | 120 | 44 | 6.40 |
| 7. | OIN 92 | 190 | 1.17 | 61 | 50 | 6.91 |
| 8. | OIN 93 | 226 | 1.24 | 112 | 50 | 6.01 |
| 9. | OIN 94 | 194 | 1.21 | 88 | 51 | 7.21 |
| 10. | OIN 95 | 203 | 1.15 | 73 | 52 | 3.63 |
| 11. | OIN 96 | 200 | 1.17 | 79 | 49 | 3.73 |
| 12. | OIN 97 | 210 | 1.18 | 84 | 50 | 7.80 |
| 13. | OIN 98 | 210 | 1.22 | 104 | 52 | 5.62 |
| 14. | OIN 99 | 209 | 1.18 | 84 | 53 | 4.82 |
| 15. | OIN 100 | 252 | 1.56 | 192 | 53 | 10.00 |
| 16. | OIN 101 | 218 | 1.27 | 136 | 45 | 8.00 |
| 17. | OIN 102 | 196 | 1.22 | 88 | 45 | 4.80 |
| 18. | OIN 103 | 209 | 1.30 | 108 | 52 | 5.22 |
| 19. | OIN 104 | 266 | 1.55 | 194 | 52 | 9.32 |
| 20. | OIN 105 | 218 | 1.24 | 104 | 60 | 5.22 |
| 21. | OIN 106 | 206 | 1.24 | 92 | 48 | 3.77 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 22. | OIN 107 | 227 | 1.31 | 136 | 50 | 6.41 |
| 23. | OIN 108 | 219 | 1.29 | 124 | 50 | 5.60 |
| 24. | OIN 109 | 268 | 1.61 | 144 | 54 | 6.61 |
| 25. | OIN 110 | 272 | 1.58 | 220 | 53 | 10.80 |
| 26. | OIN 111 | 267 | 1.58 | 202 | 51 | 9.60 |
| 27. | OIN 112 | 220 | 1.31 | 108 | 45 | 9.02 |
| 28. | OIN 113 | 240 | 1.42 | 132 | 50 | 6.42 |
| 29. | OIN 114 | 242 | 1.54 | 164 | 50 | 6.97 |
| 30. | OIN 115 | 280 | 1.58 | 215 | 54 | 12.75 |
| 31. | OIN 116 | 264 | 1.55 | 192 | 51 | 8.41 |
| 32. | OIN 117 | 221 | 1.37 | 140 | 50 | 5.81 |
| 33. | OIN 118 | 208 | 1.21 | 84 | 47 | 3.62 |
| 34. | OIN 119 | 235 | 1.25 | 136 | 45 | 6.41 |
| 35. | OIN 120 | 266 | 1.50 | 184 | 49 | 9.99 |
| 36. | OIN 121 | 252 | 1.39 | 176 | 51 | 8.01 |
| 37. | OIN 122 | 266 | 1.58 | 205 | 51 | 9.29 |
| 38. | OIN 123 | 223 | 1.25 | 114 | 51 | 6.50 |
| 39. | OIN 124 | 275 | 1.62 | 232 | 53 | 9.28 |
| 40. | OIN 125 | 210 | 1.31 | 113 | 51 | 4.83 |
| 41. | OIN 126 | 225 | 1.31 | 128 | 50 | 5.20 |
| 42. | OIN 127 | 228 | 1.34 | 136 | 52 | 5.45 |
| 43. | OIN 128 | 244 | 1.36 | 140 | 50 | 6.40 |
| 44. | OIN 129 | 261 | 1.55 | 184 | 53 | 8.41 |
| 45. | OIN 130 | 240 | 1.40 | 156 | 52 | 8.00 |
| 46. | OIN 131 | 230 | 1.39 | 144 | 50 | 6.39 |
| 47. | OIN 132 | 245 | 1.42 | 165 | 50 | 7.62 |
| 48. | OIN 133 | 235 | 1.30 | 136 | 51 | 6.81 |
| 49. | OIN 134 | 230 | 1.28 | 128 | 58 | 6.01 |
| 50. | OIN 135 | 207 | 1.18 | 86 | 48 | 4.88 |
| 51. | JRO 524© | 285 | 1.61 | 260 | 70 | 13.76 |
| 52. | JRO 204© | 283 | 1.59 | 235 | 68 | 13.54 |
| | Mean | 235 | 1.37 | 143 | 51 | 7.18 |
| | S.E. + at 5% | 5.47 | 0.009 | 9.94 | 0.67 | 0.50 |
| | C.D. + at 5% | 15.35 | 0.026 | 27.87 | 1.88 | 1.41 |
| | C.V. | 4.03 | 1.18 | 12.03 | 2.27 | 12.14 |

**Table 3:** Range, variability, heritability and other genetic parameters

| Characters | Mean | Range | GV | PV | GCV | PCV | $H^2$ | GA | %GA |
|---|---|---|---|---|---|---|---|---|---|
| Plant height (cm) | 235.0 | 190-285 | 669.31 | 759.08 | 10.99 | 11.71 | 88.17 | 50.04 | 21.26 |
| Basal diameter (cm) | 1.37 | 1.15-1.63 | 0.0238 | 0.0241 | 11.24 | 11.30 | 98.90 | 0.32 | 23.02 |
| Green biomass plant$^{-1}$ (g) | 143.0 | 61-260 | 2298.89 | 2594.57 | 33.52 | 35.61 | 88.60 | 92.97 | 64.99 |
| Days for 50% flowering | 51.0 | 44-70 | 21.85 | 23.20 | 9.14 | 9.42 | 94.19 | 9.34 | 18.29 |
| Fibre yield plant$^{-1}$(g) | 7.18 | 3.73-13.76 | 5.72 | 6.48 | 33.30 | 35.45 | 88.27 | 4.63 | 64.46 |

GV-Genotypic Variance, PV- Phenotypic Variance, GCV- Genotypic Coefficient of Variation, PCV- Phenotypic Coefficient of Variation, $H^2$-Heritability, GA- Genetic Advance, % GA- Genetic Advance over Percentage of Mean.

**Table 4:** Phenotypic (P) and Genotypic (G) correlation coefficient among different yield component

| Characters | Correlation coefficient | Basal diameter (cm) | Green biomass plant$^{-1}$ (g) | Days for 50% flowering | Fibre yield plant$^{-1}$(g) |
|---|---|---|---|---|---|
| Plant height (cm) | P | 0.89** | 0.91** | 0.44** | 0.77** |
| | G | 0.96** | 0.97** | 0.48** | 0.83** |
| Basal diameter (cm) | P | | 0.90** | 0.40** | 0.75** |
| | G | | 0.95** | 0.42** | 0.79** |
| Green biomass plant$^{-1}$ (g) | P | | | 0.47** | 0.87** |
| | G | | | 0.49** | 0.85** |
| Days for 50% flowering | P | | | | 0.49** |
| | G | | | | 0.52** |

*, ** significant at 5% and 1% respectively.

**Table 5:** Path coefficient (Genotypic) analysis showing direct (Bold) and indirect effects of component traits in jute

| Characters | Plant height (cm) | Basal diameter (cm) | Green weight plant$^{-1}$ (g) | Days for 50% flowering | Correlation with fibre yield |
|---|---|---|---|---|---|
| Plant height (cm) | 0.04 | -0.14 | 0.87 | 0.06 | 0.83** |
| Basal diameter (cm) | 0.04 | -0.14 | 0.85 | 0.05 | 0.79** |
| Green weight plant$^{-1}$ (g) | 0.04 | -0.14 | 0.88 | 0.06 | 0.85** |
| Days for 50% flowering | 0.02 | -0.06 | 0.44 | 0.12 | 0.52** |

Residual effect = 0.50

**Table 6:** Path coefficient (Phenotypic) analysis showing direct (Bold) and indirect effects of component traits in jute.

| Characters | Plant height (cm) | Basal diameter (cm) | Green weight (qt./ha) | Days for 50% flowering | Correlation with fibre yield |
|---|---|---|---|---|---|
| Plant height (cm) | **0.007** | -0.13 | 0.86 | 0.05 | 0.77** |
| Basal diameter (cm) | 0.006 | **-0.15** | 0.85 | 0.04 | 0.74** |
| Green weight (qt./ha) | 0.006 | -0.14 | **0.95** | 0.05 | 0.86** |
| Days for 50% flowering | 0.002 | -0.06 | 0.44 | **0.10** | 0.49** |

Residual effect = 0.48

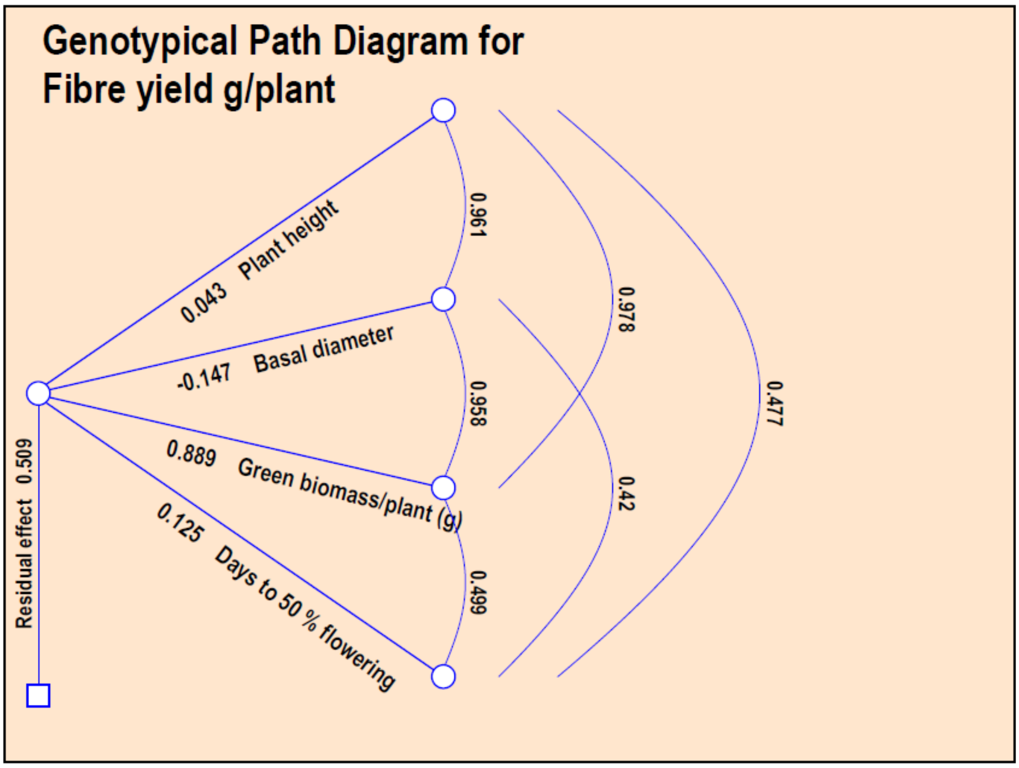


**Fig 1:** Genotypical path Diagram for Fiber yield g/plant


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