Electronic Journal of Plant Breeding



Research Article

Parent progeny regression analysis in segregating generations of drought QTLs pyramided rice lines (*Oryza sativa* L.)

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Abstract

The present study was undertaken to estimate the effectiveness of selection for the yield and yield contributing traits in the BC_2F_3 and BC_2F_4 generations of drought QTL introgressed progenies of Improved White Ponni (IWP) x Apo. A positively skewed and negatively skewed platykurtic curve was observed in many of the traits in both generations indicating the influence of a large number of genes. Significant and positive intergenerational correlation and regression coefficient values were obtained for all the yield contributing characters indicating that selection can be done in these generations for isolating superior genotypes. Narrow sense heritability estimates obtained high values for the traits days to 50 per cent flowering, the number of productive tillers, filled grains per panicle and single plant yield indicating that selection will be effective for these traits in these early generations.

Key words: Drought, parent progeny, regression, skewness, kurtosis, intergenerational correlation, heritability

INTRODUCTION

majority of the world's food consumption is based on rice diet and its productivity is severely affected due to frequent droughts in recent years (Khan et al., 2021) which requires the development of drought tolerant varieties to secure food availability in the future. Drought is the main abiotic stress in rice crops (Rasheed et al., 2020). More regions are expected to become drought prone in the future in India and the percentage of drought risk areas in India, China and Japan are estimated to be above 55% (Guo et al., 2021). Marker assisted selection (MAS) is a quick, effective and economical approach to improve drought tolerance in rice. The availability of elite lines with heritable target traits and the assessment of the stability of the pyramided genes evaluated in field experiments provide a better avenue for drought tolerance breeding in rice (Rasheed et al., 2020). Drought tolerance, governed by many complex traits, is

linked to many undesirable traits like a late flowering, tallness, low tillers and reduced yield. For example, the drought QTL qDTY3.1 is known to affect the yield under non-stress conditions (Dixit et al., 2014). The high yielding ability under non-stress conditions is a desirable trait in drought tolerance because the plants with high yield and drought tolerance could produce relatively better yield under drought stress. Hence, selection for high yield in the earlier generations is necessary for achieving the target of yield improvement under drought tolerance. A high mean with a large amount of variation in the segregating generations is needed for the development of elite cultivars (Govintharaj et al., 2017). Hence, to know the association and heritability of the traits contributing to yield in the drought QTLs introgressed segregating population of rice, parent progeny regression analysis was carried out.

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MATERIALS AND METHODS

Improved White Ponni (IWP) is a medium duration, popular rice variety of Tamil Nadu due to its fine grains and good cooking quality but it is drought susceptible. APO is an upland rice variety identified to harbour the QTLs qDTY1.1, qDTY2.1, qDTY3.1, and was used as the donor for improving the drought tolerance of IWP. The QTLs viz., qDTY1.1, qDTY2.1, qDTY3.1 contribute for grain yield up to 58 per cent (Venuprasad et al., 2012), 16.3 per cent and 30.7 per cent, genetic variation, respectively (Venuprasad et al., 2009). In this study, foreground selection for all the three QTLs was done in a total of 195 progenies belonging to 65 families in the BC₂F₂ generation. Fifty one positive homozygous plants identified were forwarded to BC₂F₄ generation by selfing. Quantitative traits viz., days to 50 per cent flowering (DFF), plant height (PH), the number of productive tillers per plant (PT), the number of filled grains per panicle(FG), the number of chaffy grains per panicle(CG), panicle length(PL), grain yield(Yld) and thousand grain weight (TGW) were recorded on five plants and their average values were taken for analyses. Intergenerational correlation and parent progeny regression analyses were done using Origin software version 10. The mean values were used for calculating skewness and kurtosis using Microsoft excel and graphs using R software to understand gene interactions.

Narrow sense heritability (Smith and Kinman, 1965)

$$h^2 = \frac{byx}{2rxy} \times 100$$

byx= regression coefficient of BC_2F_4 progeny means on BC_2F_3 parental values for respective characters

rxy= Intergenerational correlation coefficient between the parent "x" and its offspring "y"

RESULTS AND DISCUSSION

Variation in the segregating generations provide opportunities for the selection of superior plants for the traits like earliness with high tillering ability and yield. A wide range of variation was expressed in the $\mathrm{BC}_2\mathrm{F}_3$ and $\mathrm{BC}_2\mathrm{F}_4$ generations. Mean and range values for the different traits were obtained for parents, $\mathrm{BC}_2\mathrm{F}_3$ (Table 1) and $\mathrm{BC}_2\mathrm{F}_4$ (Table 2) generations. Mean values for days to 50 per cent flowering in both generations were intermediate between the parents. Plant height recorded mean closer to the height to Apo parent, whereas for the trait productive tillers the mean values in $\mathrm{BC}_2\mathrm{F}_3$ and $\mathrm{BC}_2\mathrm{F}_4$ were nearer to the mean value of IWP parent. Mean values of both the generations for the number of filled and

chaffy grains per panicle, panicle length and thousand grain weight were intermediate between both parents while for the trait single plant yield the mean values in BC_2F_3 and BC_2F_4 were highly similar to the IWP parent.

Positive skewness was observed for the traits days to 50 per cent flowering (0.06) and single plant yield (1.09) in BC₂F₃ generation. In BC₂F₄ generation, the traits number of productive tillers (0.59) and single plant yield (0.53) were positively skewed. Similarly, negative skewness was observed for plant height (-0.56), the number of productive tillers (-0.32), number of filled grains per panicle (-0.21), panicle length (-0.27), thousand grain weight (-0.71) in the BC₂F₃ generation and the traits days to 50 per cent flowering (-0.08), plant height (-0.93), the number of filled grains per panicle (-0.31), panicle length (-0.08), thousand grain weight (-0.34) in the BC_2F_4 generation (**Table 3**). In the BC_2F_3 generation, platykurtic curve was observed for the traits days to 50 per cent flowering (kurtosis = 0.14), plant height (kurtosis = -0.14), thousand grain weight (kurtosis = 0.11) and single plant yield (kurtosis = 0.49) and leptokurtic curve was observed for the traits number of filled grains per panicle (kurtosis = -1.31) and panicle length (kurtosis = 1.71). Mesokurtic curve was observed for the number of productive tillers (kurtosis = -0.06) (Fig.1). Similarly, in the BC₂F₄ generation, the traits days to 50 per cent flowering (kurtosis = 0.10), plant height (kurtosis = 0.21), the number of productive tillers (kurtosis = -0.17), the number of filled grains per panicle (kurtosis = -0.76) and panicle length (kurtosis = -0.10), single plant yield (kutosis = 0.19) showed platykurtic curve while thousand grain weight showed leptokurtic curve (Fig.2).

Skewness and Kurtosis are used to analyse the variation in the segregating generations (Nadarajan et al., 2016). Skewness gives information about gene interaction. While skewness values greater than zero indicates the presence of complementary interactions, its value lesser than zero indicates duplicate interactions for the specific traits (Choo and Reinbergs, 1982). Leptokurtic and platykurtic curves indicate the influence of a relatively fewer and larger number of genes in controlling a trait, respectively (Aananthi, 2018). In the present study, a positively skewed and platykurtic curve was observed for days to 50 per cent flowering, chaffy grains per panicle and single plant yield in BC2F3 and for chaffy grains, productive tillers, single plant yield in BC₂F₄ generations. This suggests that these traits are governed by a large number of genes with dominance based gene interactions. Intense selection is needed for faster genetic gains in these traits. Similar findings were reported by Hosagoudar et al. (2018), Harijan et al. (2021) for days to flowering, the number of tillers, days to maturity and yield per plant. The negatively skewed platykurtic curve for the



Table 1. Per se performance of yield and yield contributing traits in the $\mathrm{BC_2F_3}$ progenies

1	Line number	Days to 50 per cent flowering	Plant height (cm)	Number of Productive tillers	Number of chaffy grains per panicle	Number of filled grains per panicle	Panicle length (cm)	1000 grain weight (g)	Single plant yield (g)
2 114.0 137.1 19.0 32.5 147.3 22.8 19.5 3 3 96.0 77.3 18.0 65.3 96.3 19.9 19.1 19.1 4 4 95.0 77.3 18.0 65.3 96.3 20.9 19.5 5 5 110.0 135.0 20.0 45.0 102.0 23.0 18.5 2 6 112.0 127.9 17.9 28.6 126.9 22.7 22.0 7 7 106.0 138.0 20.0 10.0 90.0 21.0 15.2 8 8 108.0 136.0 16.0 40.0 90.0 21.1 15.7 9 9 108.0 140.0 20.0 31.0 115.0 22.5 19.8 10 10 108.0 140.0 20.0 31.0 115.0 22.5 19.8 11 10 108.0 143.5 20.9 24.0 123.3 20.8 20.5 11 107.0 139.9 18.9 58.0 97.5 24.0 20.2 12 97.0 96.9 18.4 59.0 87.5 18.0 16.4 13 105.0 139.2 23.1 33.0 135.0 22.4 24.5 14 105.0 142.0 18.0 25.0 145.0 27.2 23.5 15. 15. 105.0 135.8 21.2 31.0 121.0 23.2 20.3 16. 109.0 140.0 27.0 80.0 95.0 22.0 14.8 17.9 96.0 142.3 22.5 34.5 145.5 20.9 21.7 18. 97.0 93.5 15.0 39.5 158.5 23.5 14.5 20.9 21.7 18. 97.0 93.5 15.0 39.5 158.5 23.5 14.5 22.9 21.7 18. 95.0 93.1 12.3 80.0 85.5 21.6 24.0 22.2 95.0 93.1 12.3 80.0 122.0 22.9 14.8 22.9 50.0 140.3 22.4 45.2 14. 22. 95.0 93.1 12.3 80.0 122.0 22.9 23.7 23.1 100.0 139.8 22.2 24.4 67.7 22.3 15.0 122.0 22.9 23.7 23.1 14.1 105.0 142.0 18.0 25.0 145.5 29.9 21.7 18.0 16.0 19.0 140.0 27.0 80.0 95.0 22.0 14.8 22.2 24.2 24. 24.5 24. 24. 24. 24. 24. 25. 25. 25. 25. 25. 25. 25. 25. 25. 25	1	115.0	115.0	23.0			21.0	18.5	43.2
3 96.0 77.7 20.0 41.3 85.0 19.9 19.1 19.5 5 110.0 135.0 20.0 45.0 102.0 23.0 18.5 6 112.0 127.9 17.9 28.6 126.9 22.7 22.0 2.7 7 106.0 138.0 20.0 10.0 90.0 21.0 15.2 8 108.0 136.0 16.0 40.0 90.0 21.1 15.7 9 108.0 140.0 20.0 31.0 115.0 22.5 19.8 10 10 108.0 143.5 20.9 24.0 123.3 20.8 20.5 11 10.7 0 139.9 18.9 58.0 97.5 24.0 20.2 12 97.0 96.9 18.4 59.0 87.5 18.0 16.4 13.1 105.0 139.2 23.1 33.0 135.0 22.4 24.5 14.1 105.0 142.0 18.0 25.0 145.0 27.2 23.5 15.1 105.0 139.2 23.1 33.0 135.0 22.4 24.5 15.1 105.0 135.8 21.2 31.0 121.0 23.2 20.3 16.0 19.9 14.0 27.0 80.0 95.0 22.0 14.8 17.9 95.0 91.3 14.1 30.0 85.5 216. 22.9 17.7 18.9 95.0 91.3 14.1 30.0 85.5 216. 22.5 14.5 19.9 95.0 91.3 14.1 30.0 85.5 216. 22.5 23.5 14.5 19.9 95.0 91.3 14.1 30.0 85.5 216. 22.9 23.7 22.9 23.7 22.9 22.9 14.0 12.3 22.0 22.9 14.8 12.2 13.0 10.7 0 136.8 20.9 20.0 162.0 23.5 19.4 12.2 22.9 50.0 93.1 12.3 63.0 122.0 22.9 23.7 23.1 12.3 63.0 122.0 22.9 23.7 23.1 12.3 63.0 122.0 22.9 23.7 23.1 12.3 63.0 122.0 22.9 23.7 23.1 12.3 63.0 122.0 22.9 23.7 23.1 12.3 63.0 122.0 22.9 23.7 23.1 12.3 63.0 122.0 22.9 23.7 23.1 12.3 63.0 122.0 22.9 23.7 23.1 12.3 63.0 122.0 22.9 23.7 23.1 12.3 63.0 122.0 22.9 23.7 23.1 12.3 63.0 122.0 22.9 23.7 23.1 12.3 63.0 122.0 22.9 23.7 23.1 12.3 63.0 122.0 22.9 23.7 23.7 23.1 12.3 63.0 122.0 22.9 23.7 23.1 12.3 63.0 122.0 22.9 23.7 23.1 12.3 63.0 122.0 22.9 23.7 23.7 23.1 12.3 63.0 122.0 22.9 23.7 23.1 12.3 63.0 122.0 22.9 23.7 23.7 23.1 12.3 63.0 122.0 22.9 23.7 23.7 23.1 12.3 63.0 122.0 22.9 23.7 23.7 23.1 12.3 63.0 122.0 22.9 23.7 23.7 23.1 12.3 63.0 122.0 22.9 23.7 23.7 23.1 12.3 63.0 122.0 22.9 23.7 23.7 23.1 12.3 63.0 122.0 22.9 23.7 23.7 23.1 12.3 63.0 122.0 22.9 23.7 23.7 23.1 12.3 63.0 122.0 22.9 23.7 23.7 23.1 12.3 63.0 122.0 22.9 23.7 23.7 23.1 12.3 63.0 122.0 22.9 23.7 23.7 23.1 12.3 63.0 122.0 22.9 23.7 23.7 23.1 12.0 12.0 12.0 12.0 12.0 12.0 12.0 12									37.0
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14 105.0 142.0 18.0 25.0 145.0 27.2 23.5 3.6 15 105.0 135.8 21.2 31.0 121.0 23.2 20.3 3.6 16 109.0 140.0 27.0 80.0 95.0 22.0 14.8 3.7 17 96.0 142.3 22.5 34.5 145.5 20.9 21.7 18 97.0 93.5 150.0 39.5 158.5 23.5 14.5 4.0 2.0 107.0 136.8 20.9 20.0 162.0 23.5 19.4 5.0 20.0 162.0 23.5 19.4 5.0 22.4 24.0 2.2 29.0 20.0 162.0 22.5 24.4 24.0 2.2 29.0 33.7 146.3 22.5 24.4 24.0 2.2 29.0 23.7 23.3 100.0 139.6 23.7 83.3 100.5 22.4 24.1 4.2 19.0 20.0 21.0 19.0 <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>44.8</td>									44.8
15									33.6
16 109.0 140.0 27.0 80.0 95.0 22.0 14.8 3.1 17 96.0 142.3 22.5 34.5 145.5 20.9 21.7 18 97.0 93.5 15.0 39.5 158.5 23.5 14.5 4 19 95.0 91.3 14.1 30.0 85.5 21.6 24.0 2 20 107.0 136.8 20.9 20.0 162.0 23.5 19.4 2 21 95.0 140.3 21.4 57.3 146.3 22.5 24.4 2 22 95.0 93.1 12.3 63.0 122.0 22.9 23.7 23 23 100.0 139.6 23.7 83.3 100.5 22.4 24.4 108.0 132.2 22.4 46.7 127.3 21.7 20.6 42.1 46.7 127.3 21.7 20.6 42.1 46.7 127.3 21.7 20.6 42.1 <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>31.3</td>									31.3
17 96.0 142.3 22.5 34.5 145.5 20.9 21.7 3.5 18 97.0 93.5 150.0 39.5 158.5 23.5 14.5 4 20 107.0 136.8 20.9 20.0 162.0 23.5 19.4 3 21 95.0 140.3 21.4 57.3 146.3 22.5 24.4 4 21 95.0 140.3 21.4 57.3 146.3 22.5 24.4 4 22 95.0 93.1 12.3 63.0 122.0 22.9 23.7 23 100.0 139.6 23.7 83.3 100.5 22.4 21.4 3 24 108.0 132.2 22.4 46.7 127.3 21.7 20.6 24 21.4 3 25 105.0 77.3 18.7 63.5 95.0 17.0 20.2 2 2 4 17.6 2 2 17.6									32.8
18 97.0 93.5 15.0 39.5 158.5 23.5 14.5 4.6 19 95.0 91.3 14.1 30.0 85.5 21.6 24.0 24.0 20 107.0 136.8 20.9 20.0 162.0 23.5 19.4 21 95.0 140.3 21.4 57.3 146.3 22.5 24.4 22 95.0 93.1 12.3 63.0 122.0 22.9 23.7 23 23 100.0 139.6 23.7 83.3 100.5 22.4 21.4 3.6 24 108.0 132.2 22.4 46.7 127.3 21.7 20.6 4 25 105.0 77.3 18.7 63.5 95.0 17.0 20.2 2 26 94.0 77.4 21.0 57.3 87.5 15.6 17.6 3 27 118.0 115.0 13.0 22.0 168.0 20.8 22.6 22.9 28 118.0 125.0 20.0 2									30.7
19									45.4
20 107.0 136.8 20.9 20.0 162.0 23.5 19.4 3.2 21 95.0 140.3 21.4 57.3 146.3 22.5 24.4 2 22 95.0 93.1 12.3 63.0 122.0 22.9 23.7 23 100.0 139.6 23.7 83.3 100.5 22.4 21.4 24 108.0 132.2 22.4 46.7 127.3 21.7 20.6 4 25 105.0 77.3 18.7 63.5 95.0 17.0 20.2 26 94.0 77.4 21.0 57.3 87.5 15.6 17.6 27 118.0 115.0 13.0 22.0 168.0 20.8 22.6 22.8 22.6 22.9 119.0 25.0 23.6 22.9 119.0 22.0 23.0 21.9 23.0 21.9 23.0 21.9 23.0 21.9 23.0 21.9 23.0 21.9 <									25.0
21 95.0 140.3 21.4 57.3 146.3 22.5 24.4 22 95.0 93.1 12.3 63.0 122.0 22.9 23.7 2 23 100.0 139.6 23.7 83.3 100.5 22.4 21.4 3 24 108.0 132.2 22.4 46.7 127.3 21.7 20.6 4 25 105.0 77.3 18.7 63.5 95.0 17.0 20.2 2 26 94.0 77.4 21.0 57.3 87.5 15.6 17.6 27 118.0 115.0 13.0 22.0 168.0 20.8 22.6 2 28 118.0 125.0 20.0 21.0 190.0 25.0 23.6 29 119.0 125.0 20.0 15.0 184.0 22.6 22.9 31 116.0 112.0 9.0 23.0 187.0 23.0 21.3 23.5 23.5 23.5									33.1
22 95.0 93.1 12.3 63.0 122.0 22.9 23.7 23 23 100.0 139.6 23.7 83.3 100.5 22.4 21.4 3 24 108.0 132.2 22.4 46.7 127.3 21.7 20.6 4 25 105.0 77.3 18.7 63.5 95.0 17.0 20.2 2 26 94.0 77.4 21.0 57.3 87.5 15.6 17.6 2 27 118.0 115.0 13.0 22.0 168.0 20.8 22.6 2 28 118.0 125.0 20.0 21.0 190.0 25.0 23.6 2									22.1
23 100.0 139.6 23.7 83.3 100.5 22.4 21.4 32.4 24 108.0 132.2 22.4 46.7 127.3 21.7 20.6 42.2 46.7 127.3 21.7 20.6 42.2 46.7 127.3 21.7 20.6 42.2 46.7 127.3 21.7 20.6 42.2 46.7 127.3 21.7 20.6 42.2 46.7 127.3 11.7 20.6 42.2 46.7 42.2 46.7 42.2 46.7 42.2 46.7 42.2 46.7 42.2 46.7 42.2 46.7 42.2 46.7 42.2 46.7 42.2 46.2									27.3
24 108.0 132.2 22.4 46.7 127.3 21.7 20.6 42.5 25 105.0 77.3 18.7 63.5 95.0 117.0 20.2 22.6 26 94.0 77.4 21.0 57.3 87.5 15.6 17.6 22.9 23.6 29.0 1190.0 25.0 23.6 29.0 1190.0 25.0 23.6 29.0 187.0 23.0 21.9 23.0 21.9 23.0 21.9 23.0 21.9 23.0 21.0 29.0 23.0 122.0 22.3 23.5 32.5 33.1 116.0 115.0 27.8 37.0 166.3 25.1 21.3 33.1 33.1 105.0 108.0 29.1									30.4
25 105.0 77.3 18.7 63.5 95.0 17.0 20.2 22.2 26 94.0 77.4 21.0 57.3 87.5 15.6 17.6 27 118.0 115.0 13.0 22.0 168.0 20.8 22.6 2 28 118.0 125.0 20.0 21.0 190.0 25.0 23.6 2 29 119.0 125.0 28.0 29.0 187.0 23.0 21.9 30 120.0 125.0 20.0 15.0 184.0 22.6 22.9 31 116.0 112.0 9.0 23.0 122.0 22.3 23.5 32 108.0 115.0 27.6 48.0 167.0 19.0 23.0 24.3 34 108.0 108.0 29.1 30.0 186.3 23.0 24.3 3 35 106.0 115.0 28.9 33.0 128.0 24.0 24.1									41.9
26 94.0 77.4 21.0 57.3 87.5 15.6 17.6 27 118.0 115.0 13.0 22.0 168.0 20.8 22.6 2 28 118.0 125.0 20.0 21.0 190.0 25.0 23.6 2 29 119.0 125.0 28.0 29.0 187.0 23.0 21.9 30 120.0 125.0 20.0 15.0 184.0 22.6 22.9 31 116.0 112.0 9.0 23.0 122.0 22.3 23.5 32 108.0 115.0 27.8 37.0 166.3 25.1 21.3 23.0 34 108.0 108.0 29.1 30.0 186.3 23.0 24.3 21.3 35 106.0 115.0 28.9 33.0 128.0 24.0 24.1 23.0 36 105.0 110.0 25.2 35.0 157.2 21.6 22.2									26.4
27 118.0 115.0 13.0 22.0 168.0 20.8 22.6 28 28 118.0 125.0 20.0 21.0 190.0 25.0 23.6 23.6 23.6 23.6 29.0 187.0 23.0 21.9 23.6 29.0 187.0 23.0 21.9 23.0 21.9 23.0 21.9 23.0 21.9 23.0 21.9 23.0 22.6 22.9 23.1 21.0 21.0 29.0 15.0 184.0 22.6 22.9 23.1 23.0 21.2 22.3 23.5 32.5 32.0 122.0 22.3 23.5 32.5 32.0 128.0 24.0 24.1 21.3 23.0 23.0 24.3 24.3 23.0 23.0 24.3 23.0 24.3 24.3 23.0 24.3 24.3 23.0 24.3 24.3 23.0 24.3 24.3 24.3 23.0 18.0 24.0 24.1 24.0 24.1 24.0 <									15.1
28 118.0 125.0 20.0 21.0 190.0 25.0 23.6 29 119.0 125.0 28.0 29.0 187.0 23.0 21.9 30 120.0 125.0 20.0 15.0 184.0 22.6 22.9 31 116.0 112.0 9.0 23.0 122.0 22.3 23.5 32 108.0 115.0 27.8 37.0 166.3 25.1 21.3 2 33 105.0 105.0 27.6 48.0 167.0 19.0 23.0 2 34 108.0 108.0 29.1 30.0 186.3 23.0 24.3 2 35 106.0 115.0 28.9 33.0 128.0 24.0 24.1 2 36 105.0 110.0 25.2 35.0 157.2 21.6 22.2 2 37 107.0 116.0 26.5 31.0 151.7 19.0 23.9 2									24.0
29 119.0 125.0 28.0 29.0 187.0 23.0 21.9 30 120.0 125.0 20.0 15.0 184.0 22.6 22.9 31 116.0 112.0 9.0 23.0 122.0 22.3 23.5 32 108.0 115.0 27.8 37.0 166.3 25.1 21.3 2 33 105.0 105.0 27.6 48.0 167.0 19.0 23.0 2 34 108.0 108.0 29.1 30.0 186.3 23.0 24.3 2 35 106.0 115.0 28.9 33.0 128.0 24.0 24.1 2 36 105.0 110.0 25.2 35.0 157.2 21.6 22.2 2 37 107.0 116.0 26.5 31.0 151.7 19.0 23.9 38 108.0 114.0 23.5 23.0 178.0 29.0 21.3 2 39 105.0 108.0 22.5 25.0 176.3									19.5
30									14.9
31 116.0 112.0 9.0 23.0 122.0 22.3 23.5 32 108.0 115.0 27.8 37.0 166.3 25.1 21.3 2 33 105.0 105.0 27.6 48.0 167.0 19.0 23.0 2 34 108.0 108.0 29.1 30.0 186.3 23.0 24.3 2 35 106.0 115.0 28.9 33.0 128.0 24.0 24.1 2 36 105.0 110.0 25.2 35.0 157.2 21.6 22.2 2 37 107.0 116.0 26.5 31.0 151.7 19.0 23.9 2 38 108.0 114.0 23.5 23.0 178.0 29.0 21.3 2 40 105.0 108.0 22.5 25.0 176.3 21.0 19.5 41 105.0 126.0 25.0 10.0 110.0 22.1 22.0 42 105.0 117.0 20.0 12.0 <									18.8
32									18.1
33 105.0 105.0 27.6 48.0 167.0 19.0 23.0 24.3 34 108.0 108.0 29.1 30.0 186.3 23.0 24.3 24.3 35 106.0 115.0 28.9 33.0 128.0 24.0 24.1 22.3 36 105.0 110.0 25.2 35.0 157.2 21.6 22.2 23.7 37 107.0 116.0 26.5 31.0 151.7 19.0 23.9 23.9 38 108.0 114.0 23.5 23.0 178.0 29.0 21.3 23.9 40 105.0 108.0 22.5 25.0 176.3 21.0 19.5 40 105.0 122.0 20.0 12.0 143.0 24.5 23.8 41 105.0 126.0 25.0 10.0 110.0 22.1 22.0 42 105.0 117.0 20.0 12.0 114.0 22.3 18.6 43 106.0 115.0 24.0 37.0									21.6
34 108.0 108.0 29.1 30.0 186.3 23.0 24.3 24.3 35 106.0 115.0 28.9 33.0 128.0 24.0 24.1 24.3 36 105.0 110.0 25.2 35.0 157.2 21.6 22.2 22.2 37 107.0 116.0 26.5 31.0 151.7 19.0 23.9 2 38 108.0 114.0 23.5 23.0 178.0 29.0 21.3 2 39 105.0 108.0 22.5 25.0 176.3 21.0 19.5 40 105.0 122.0 20.0 12.0 143.0 24.5 23.8 41 105.0 126.0 25.0 10.0 110.0 22.1 22.0 42 105.0 117.0 20.0 12.0 114.0 22.3 18.6 43 106.0 115.0 24.0 37.0 175.0 25.8 19.8 2 44 105.0 108.0 24.0 31.0 162.									22.7
35 106.0 115.0 28.9 33.0 128.0 24.0 24.1 24.3 36 105.0 110.0 25.2 35.0 157.2 21.6 22.2 2 37 107.0 116.0 26.5 31.0 151.7 19.0 23.9 2 38 108.0 114.0 23.5 23.0 178.0 29.0 21.3 2 39 105.0 108.0 22.5 25.0 176.3 21.0 19.5 40 105.0 122.0 20.0 12.0 143.0 24.5 23.8 41 105.0 126.0 25.0 10.0 110.0 22.1 22.0 42 105.0 117.0 20.0 12.0 114.0 22.3 18.6 43 106.0 115.0 24.0 37.0 175.0 25.8 19.8 2 44 105.0 108.0 24.0 31.0 162.0 25.2 20.5 2 45 105.0 110.0 30.5 34.0 173.2									21.6
36 105.0 110.0 25.2 35.0 157.2 21.6 22.2 2 37 107.0 116.0 26.5 31.0 151.7 19.0 23.9 2 38 108.0 114.0 23.5 23.0 178.0 29.0 21.3 2 39 105.0 108.0 22.5 25.0 176.3 21.0 19.5 40 105.0 122.0 20.0 12.0 143.0 24.5 23.8 41 105.0 126.0 25.0 10.0 110.0 22.1 22.0 42 105.0 117.0 20.0 12.0 114.0 22.3 18.6 43 106.0 115.0 24.0 37.0 175.0 25.8 19.8 2 44 105.0 108.0 24.0 37.0 175.0 25.8 19.8 2 45 105.0 110.0 30.5 34.0 173.2 22.7 22.3 2 46 108.0 110.0 28.0 17.0 166.2									20.4
37 107.0 116.0 26.5 31.0 151.7 19.0 23.9 23.9 38 108.0 114.0 23.5 23.0 178.0 29.0 21.3 2 39 105.0 108.0 22.5 25.0 176.3 21.0 19.5 2 40 105.0 122.0 20.0 12.0 143.0 24.5 23.8 2 41 105.0 126.0 25.0 10.0 110.0 22.1 22.0 2 42 105.0 117.0 20.0 12.0 114.0 22.3 18.6 2 43 106.0 115.0 24.0 37.0 175.0 25.8 19.8 2 44 105.0 108.0 24.0 31.0 162.0 25.2 20.5 2 45 105.0 110.0 30.5 34.0 173.2 22.7 22.3 2 46 108.0 110.0 28.0 17.0 166.2 22.0 23.4 2 47 106.0 109									22.0
38 108.0 114.0 23.5 23.0 178.0 29.0 21.3 24.3 39 105.0 108.0 22.5 25.0 176.3 21.0 19.5 24.0 40 105.0 122.0 20.0 12.0 143.0 24.5 23.8 23.8 41 105.0 126.0 25.0 10.0 110.0 22.1 22.0 22.0 42 105.0 117.0 20.0 12.0 114.0 22.3 18.6 24.0 43 106.0 115.0 24.0 37.0 175.0 25.8 19.8 22.0 44 105.0 108.0 24.0 31.0 162.0 25.2 20.5 22.0 45 105.0 110.0 30.5 34.0 173.2 22.7 22.3 22.4 46 108.0 110.0 28.0 17.0 166.2 22.0 23.4 21.0 47 106.0 109.0 17.0 32.0 164.0 23.4 21.0 24.3 48 <									22.1
39 105.0 108.0 22.5 25.0 176.3 21.0 19.5 24.0 19.5 24.0 19.5 24.0 24.0 143.0 24.5 23.8 23.8 24.1 105.0 126.0 25.0 10.0 110.0 22.1 22.0 22.0 24.0 24.0 110.0 22.1 22.0 22.0 24.0 24.0 24.0 24.0 24.0 24.0 25.2 20.5 19.8 24.0 25.0 25.8 19.8 22.0 25.8 19.8 24.0 25.0 25.0 175.0 25.8 19.8 22.0 25.8 19.8 22.0 25.8 19.8 22.0 25.8 19.8 22.0 25.8 19.8 22.0 25.8 19.8 22.0 25.8 19.8 22.0 25.2 20.5 22.0 25.8 19.8 22.0 25.2 20.5 22.0 25.2 20.5 22.0 25.2 20.5 22.3 24.0 25.2 20.5 22.3 24.3 22.0 25.4 22.0 25.4 22.0 25.4 24.0 <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>21.5</td>									21.5
40 105.0 122.0 20.0 12.0 143.0 24.5 23.8 41 105.0 126.0 25.0 10.0 110.0 22.1 22.0 42 105.0 117.0 20.0 12.0 114.0 22.3 18.6 43 106.0 115.0 24.0 37.0 175.0 25.8 19.8 2 44 105.0 108.0 24.0 31.0 162.0 25.2 20.5 2 45 105.0 110.0 30.5 34.0 173.2 22.7 22.3 2 46 108.0 110.0 28.0 17.0 166.2 22.0 23.4 2 47 106.0 109.0 17.0 32.0 164.0 23.4 21.0 2 48 105.0 119.0 28.0 22.0 158.9 24.3 20.1 2 49 107.0 109.0 28.6 25.0 146.6 23.8 19.8 2 50 105.0 108.0 25.5 12.0									18.6
41 105.0 126.0 25.0 10.0 110.0 22.1 22.0 22.0 22.0 22.0 22.0 22.0 22.0 22.0 22.0 22.0 22.0 22.0 22.0 22.0 23.0 18.6 22.0 22.0 25.8 19.8 22.0 25.8 19.8 22.0 25.0 25.0 20.5 22.0 25.2 20.5 22.0 24.0 31.0 162.0 25.2 20.5 22.0 24.0 31.0 162.0 25.2 20.5 22.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 25.0 25.2 20.5 22.0 25.2 20.5 22.0 24.0									15.9
42 105.0 117.0 20.0 12.0 114.0 22.3 18.6 43 43 106.0 115.0 24.0 37.0 175.0 25.8 19.8 2 44 105.0 108.0 24.0 31.0 162.0 25.2 20.5 2 45 105.0 110.0 30.5 34.0 173.2 22.7 22.3 2 46 108.0 110.0 28.0 17.0 166.2 22.0 23.4 2 47 106.0 109.0 17.0 32.0 164.0 23.4 21.0 2 48 105.0 119.0 28.0 22.0 158.9 24.3 20.1 2 49 107.0 109.0 28.6 25.0 146.6 23.8 19.8 2 50 105.0 108.0 25.5 12.0 180.0 25.1 20.7 2 51 105.0 116.0 25.2 13.0 173.0 24.3 21.6 2 Mean 105.92									19.3
43 106.0 115.0 24.0 37.0 175.0 25.8 19.8 24.4 44 105.0 108.0 24.0 31.0 162.0 25.2 20.5 24.6 45 105.0 110.0 30.5 34.0 173.2 22.7 22.3 22.3 46 108.0 110.0 28.0 17.0 166.2 22.0 23.4 21.0 47 106.0 109.0 17.0 32.0 164.0 23.4 21.0 22.0 48 105.0 119.0 28.0 22.0 158.9 24.3 20.1 22.0 49 107.0 109.0 28.6 25.0 146.6 23.8 19.8 22.0 50 105.0 108.0 25.5 12.0 180.0 25.1 20.7 23.4 51 105.0 116.0 25.2 13.0 173.0 24.3 21.6 23.8 Mean 105.92 117.79 21.77 35.64 139.11 22.45 20.85 2 Range <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>19.6</td>									19.6
44 105.0 108.0 24.0 31.0 162.0 25.2 20.5 2 45 105.0 110.0 30.5 34.0 173.2 22.7 22.3 2 46 108.0 110.0 28.0 17.0 166.2 22.0 23.4 2 47 106.0 109.0 17.0 32.0 164.0 23.4 21.0 2 48 105.0 119.0 28.0 22.0 158.9 24.3 20.1 2 49 107.0 109.0 28.6 25.0 146.6 23.8 19.8 2 50 105.0 108.0 25.5 12.0 180.0 25.1 20.7 2 51 105.0 116.0 25.2 13.0 173.0 24.3 21.6 2 Mean 105.92 117.79 21.77 35.64 139.11 22.45 20.85 2 Range 94-120 77.3-143.5 9-30.5 10-90 85-190 15.5-29 14.5-24.5 14.									23.5
45 105.0 110.0 30.5 34.0 173.2 22.7 22.3 2 46 108.0 110.0 28.0 17.0 166.2 22.0 23.4 2 47 106.0 109.0 17.0 32.0 164.0 23.4 21.0 2 48 105.0 119.0 28.0 22.0 158.9 24.3 20.1 2 49 107.0 109.0 28.6 25.0 146.6 23.8 19.8 2 50 105.0 108.0 25.5 12.0 180.0 25.1 20.7 2 51 105.0 116.0 25.2 13.0 173.0 24.3 21.6 2 Mean 105.92 117.79 21.77 35.64 139.11 22.45 20.85 2 Range 94-120 77.3-143.5 9 -30.5 10 -90 85-190 15.5 -29 14.5-24.5 14.									21.3
46 108.0 110.0 28.0 17.0 166.2 22.0 23.4 24.4 47 106.0 109.0 17.0 32.0 164.0 23.4 21.0 23.4 48 105.0 119.0 28.0 22.0 158.9 24.3 20.1 23.4 49 107.0 109.0 28.6 25.0 146.6 23.8 19.8 23.8 50 105.0 108.0 25.5 12.0 180.0 25.1 20.7 25.1 51 105.0 116.0 25.2 13.0 173.0 24.3 21.6 23.8 Mean 105.92 117.79 21.77 35.64 139.11 22.45 20.85 22.0 Range 94-120 77.3-143.5 9-30.5 10-90 85-190 15.5-29 14.5-24.5 14.5									22.5
47 106.0 109.0 17.0 32.0 164.0 23.4 21.0 24.8 48 105.0 119.0 28.0 22.0 158.9 24.3 20.1 22.0 49 107.0 109.0 28.6 25.0 146.6 23.8 19.8 22.0 50 105.0 108.0 25.5 12.0 180.0 25.1 20.7 25.1 51 105.0 116.0 25.2 13.0 173.0 24.3 21.6 22.0 Mean 105.92 117.79 21.77 35.64 139.11 22.45 20.85 22.0 Range 94-120 77.3-143.5 9-30.5 10-90 85-190 15.5-29 14.5-24.5 14.									22.5
48 105.0 119.0 28.0 22.0 158.9 24.3 20.1 24.3 49 107.0 109.0 28.6 25.0 146.6 23.8 19.8 25.0 50 105.0 108.0 25.5 12.0 180.0 25.1 20.7 25.1 51 105.0 116.0 25.2 13.0 173.0 24.3 21.6 25.2 Mean 105.92 117.79 21.77 35.64 139.11 22.45 20.85 22.45 Range 94-120 77.3-143.5 9-30.5 10-90 85-190 15.5-29 14.5-24.5 14.5									20.4
49 107.0 109.0 28.6 25.0 146.6 23.8 19.8 2 50 105.0 108.0 25.5 12.0 180.0 25.1 20.7 2 51 105.0 116.0 25.2 13.0 173.0 24.3 21.6 2 Mean 105.92 117.79 21.77 35.64 139.11 22.45 20.85 2 Range 94-120 77.3-143.5 9-30.5 10-90 85-190 15.5-29 14.5-24.5 14.									20.4
50 105.0 108.0 25.5 12.0 180.0 25.1 20.7 2 51 105.0 116.0 25.2 13.0 173.0 24.3 21.6 2 Mean 105.92 117.79 21.77 35.64 139.11 22.45 20.85 2 Range 94-120 77.3-143.5 9-30.5 10-90 85-190 15.5-29 14.5-24.5 14.									22.5
51 105.0 116.0 25.2 13.0 173.0 24.3 21.6 2 Mean 105.92 117.79 21.77 35.64 139.11 22.45 20.85 2 Range 94-120 77.3-143.5 9-30.5 10-90 85-190 15.5-29 14.5-24.5 14.									20.4
Mean 105.92 117.79 21.77 35.64 139.11 22.45 20.85 2 Range 94-120 77.3-143.5 9-30.5 10-90 85-190 15.5-29 14.5-24.5 14.									21.1
Range 94-120 77.3-143.5 9-30.5 10-90 85-190 15.5-29 14.5-24.5 14.									25.51
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IVVF 124 147.2 32.1 32.7 277.9 23.2 16.2 2	_								
									25.2 18.6



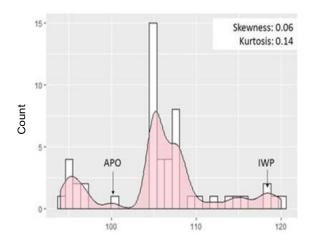
Table 2. Per se performance of the yield and yield contributing traits in the BC_2F_4 progenies

2 113. 3 97.4 4 98.6 5 108 6 104 7 105 8 106 9 105 10 105 11 105 12 105 13 105 14 102 15 104 16 108 17 97.1 18 97.1 19 94.1 20 108 21 98.1 22 96.2 23 102 24 106 25 106 26 98.2 27 115. 28 116. 29 115. 30 116. 31 115. 32 109 33 108 34 108 35 110. 36 104 37 107 38 107 38 107 39 108 40 107 41 106 42 108 43 103 44 105 45 104 46 109 47 105 48 106	s to 50 ercent wering	ent height (cm)	Number of Productive tillers	Number of chaffy grains per panicle	Number of filled grains per panicle	Panicle length (cm)	1000 grain weight (g)	Single plant yield (g)
3 97.4 4 98.6 5 108 6 104 7 105 8 106 9 105 10 105 11 105 12 105 13 105 14 102 15 104 16 108 17 97.1 18 97.1 19 94.1 20 108 21 98.1 22 96.23 102 24 106 25 106 26 98.2 27 115.28 116.29 115.30 116.31 115.32 109 33 108 34 108 35 110.36 104 37 107 38 107 38 107 39 108 40 107 41 106 42 108 43 103 44 105 45 104 46 109 47 105 48 106	14.00	.00 97.64	20.20	58.00	177.40	26.87	16.9	48.50
4 98.4 5 108 6 104 7 105 8 106 9 105 10 105 11 105 12 105 13 105 14 102 15 104 16 108 17 97.4 18 97.4 19 94.4 20 108 21 98.4 22 96.23 102 24 106 25 106 26 98.2 27 115.28 116.29 115.30 116.31 115.32 109 33 108 34 108 35 110.36 104 37 107 38 107 38 107 39 108 40 107 41 106 42 108 43 103 44 105 45 104 46 109 47 105 48 106	13.00	.00 95.20	17.30	48.00	134.40	23.80	20.5	36.83
5 108 6 104 7 105 8 106 9 105 10 105 11 105 12 105 13 105 14 102 15 104 16 108 17 97.1 18 97.1 19 94.1 20 108 21 98.1 22 96.2 23 102 24 106 25 106 26 98.2 27 115.3 30 116.31 31 115.32 30 116.31 31 115.32 32 109 33 108 34 108 35 110.36 36 104 37 107 38 107 39 108 40 107	7.00	00 86.35	17.13	29.00	86.70	22.45	20.1	19.08
6 104 7 105 8 106 9 105 10 105 11 105 12 105 13 105 14 102 15 104 16 108 17 97.1 18 97.1 19 94.1 20 108 21 98.1 22 96.23 102 24 106 25 106 26 98.2 27 115.28 116.29 115.30 116.31 115.32 109 33 108 34 108 35 110.36 104 37 107 38 107 38 107 39 108 40 107 41 106 42 108 43 103 44 105 45 104 46 109 47 105 48 106	8.00	00 79.24	17.50	38.00	100.20	21.90	20.8	21.81
7 105 8 106 9 105 10 105 11 105 12 105 13 105 14 102 15 104 16 108 17 97.1 18 97.1 19 94.1 20 108 21 98.1 22 96.23 102 24 106 25 106 26 98.2 27 115.28 116.29 115.30 116.31 115.32 109 33 108 34 108 35 110.36 104 37 107 38 107 38 107 39 108 40 107 41 106 42 108 43 103 44 105 45 104 46 109 47 105 48 106	08.80	.00 88.00	20.00	58.00	114.50	22.45	19.5	20.00
8 106 9 105 10 105 11 105 12 105 13 105 14 102 15 104 16 108 17 97.1 18 97.1 19 94.1 20 108 21 98.1 22 96.2 23 102 24 106 25 106 26 98.1 27 115.2 30 116.31 31 115.32 30 116.31 31 115.32 30 108.31 34 108.31 35 110.33 36 104.37 37 107.38 38 107.38 39 108.40 40 107.41 41 106.42 43 103.44 44 105.45 45 </td <td>04.00</td> <td>.00 105.25</td> <td>21.25</td> <td>49.00</td> <td>137.90</td> <td>24.64</td> <td>19.5</td> <td>22.13</td>	04.00	.00 105.25	21.25	49.00	137.90	24.64	19.5	22.13
9 105 10 105 11 105 11 105 12 105 13 105 14 102 15 104 16 108 17 97.1 18 97.1 19 94.1 20 108 21 98.1 22 96.1 23 102 24 106 25 106 26 98.1 27 115.28 116.29 115.30 116.31 115.32 109 33 108 34 108 35 110.36 104 37 107 38 107 38 107 39 108 40 107 41 106 42 108 43 103 44 105 45 104 46 109 47 105 48 106	05.00	.00 102.90	15.60	59.00	125.90	25.68	20.1	30.05
10 105 11 105 12 105 13 105 14 102 15 104 16 108 17 97.1 19 94.1 20 108 21 98.1 22 96.23 23 102 24 106 25 106 26 98.2 27 115.30 30 116.31 31 115.32 30 116.31 31 115.32 30 108.31 34 108.35 35 110.36 36 104.37 37 107.38 38 107.38 39 108.40 40 107.41 41 106.42 43 103.44 44 105.45 45 104.46 46 109.47 47 105.48	06.00	.00 108.46	15.24	29.00	162.18	22.45	21.1	33.57
11 105 12 105 13 105 14 102 15 104 16 108 17 97.1 18 97.1 19 94.1 20 108 21 98.1 22 96.2 23 102 24 106 25 106 26 98.2 27 115.3 30 116.31 31 115.32 30 116.31 31 115.32 30 108.31 34 108.35 35 110.36 36 104.37 37 107.38 38 107.38 39 108.40 40 107.41 41 106.42 43 103.44 44 105.45 45 104.46 46 109.47 47 105.48 <	05.00	.00 109.28	16.00	42.00	146.50	25.60	19.6	18.98
12	05.00	.00 105.15	17.20	46.00	100.70	23.87	20.5	35.01
13 105 14 102 15 104 16 108 17 97.1 18 97.1 19 94.1 20 108 21 98.1 22 96.2 23 102 24 106 25 106 26 98.2 27 115.3 30 116.31 31 115.32 32 109 33 108 34 108 35 110.3 36 104 37 107 38 107 39 108 40 107 41 106 42 108 43 103 44 105 45 104 46 109 47 105 48 106	05.00	.00 106.16	13.24	63.00	150.24	20.78	19.6	18.09
14 102 15 104 16 108 17 97.1 18 97.1 19 94.1 20 108 21 98.1 22 96.2 23 102 24 106 25 106 26 98.1 27 115.3 30 116.31 31 115.32 32 109 33 108 34 108 35 110.36 36 104 37 107 38 107 39 108 40 107 41 106 42 108 43 103 44 105 45 104 46 109 47 105 48 106	05.00	.00 71.64	20.70	46.00	114.90	18.29	18.9	24.26
15	05.00	.00 110.00	18.00	24.00	161.00	22.50	23.4	38.00
16 108 17 97.4 18 97.4 19 94.4 20 108 21 98.4 22 96.4 23 102 24 106 25 106 26 98.4 27 115. 30 116. 31 115. 32 109 33 108 34 108 35 110. 36 104 37 107 38 107 39 108 40 107 41 106 42 108 43 103 44 105 45 104 46 109 47 105 48 106	02.00	.00 98.28	16.50	41.00	133.80	23.19	22.9	28.00
17 97.4 18 97.4 19 94.1 20 108 21 98.1 22 96.1 23 102 24 106 25 106 26 98.1 27 115.2 30 116.31 31 115.32 32 109 33 108 34 108 35 110.3 36 104 37 107 38 107 39 108 40 107 41 106 42 108 43 103 44 105 45 104 46 109 47 105 48 106	04.00	.00 98.27	17.50	42.00	134.90	24.65	21.6	28.00
18 97.4 19 94.1 20 108 21 98.1 22 96.1 23 102 24 106 25 106 26 98.1 27 115.2 30 116.31 31 115.32 32 109 33 108 34 108 35 110.36 36 104 37 107 38 107 39 108 40 107 41 106 42 108 43 103 44 105 45 104 46 109 47 105 48 106	08.80	.00 61.67	16.67	52.00	94.00	21.58	15.40	30.00
19 94.1 20 108 21 98.1 22 96.1 23 102 24 106 25 106 26 98.1 27 115. 28 116. 29 115. 30 116. 31 115. 32 109 33 108 34 108 35 110. 36 104 37 107 38 107 39 108 40 107 41 106 42 108 43 103 44 105 45 104 46 109 47 105 48 106	7.00	00 63.25	22.00	54.00	136.50	20.50	20.50	24.25
20 108 21 98.1 22 96.1 23 102 24 106 25 106 26 98.1 27 115. 28 116. 29 115. 30 116. 31 115. 32 109 33 108 34 108 35 110. 36 104 37 107 38 107 39 108 40 107 41 106 42 108 43 103 44 105 45 104 46 109 47 105 48 106	7.00	00 79.27	14.90	42.00	149.00	24.50	19.6	31.00
21 98.4 22 96.4 23 102 24 106 25 106 26 98.4 27 115. 28 116. 29 115. 30 116. 31 115. 32 109 33 108 34 108 35 110. 36 104 37 107 38 107 39 108 40 107 41 106 42 108 43 103 44 105 45 104 46 109 47 105 48 106	4.00		17.70	45.00	100.00	20.46	22.6	17.70
22 96.4 23 102 24 106 25 106 26 98.4 27 115. 28 116. 29 115. 30 116. 31 115. 32 109 33 108 34 108 35 110. 36 104 37 107 38 107 39 108 40 107 41 106 42 108 43 103 44 105 45 104 46 109 47 105 48 106	08.80		14.10	22.00	108.00	22.60	18.6	26.40
23 102 24 106 25 106 26 98. 27 115. 28 116. 29 115. 30 116. 31 115. 32 109 33 108 34 108 35 110. 36 104 37 107 38 107 39 108 40 107 41 106 42 108 43 103 44 105 45 104 46 109 47 105 48 106	8.00		16.90	63.00	136.00	23.48	25.4	17.56
24 106 25 106 26 98.4 27 115. 28 116. 29 115. 30 116. 31 115. 32 109 33 108 34 108 35 110. 36 104 37 107 38 107 39 108 40 107 41 106 42 108 43 103 44 105 45 104 46 109 47 105 48 106	6.00	00 81.29	11.90	28.00	118.00	26.40	24.6	11.90
25 106 26 98.4 27 115. 28 116. 29 115. 30 116. 31 115. 32 109 33 108 34 108 35 110. 36 104 37 107 38 107 39 108 40 107 41 106 42 108 43 103 44 105 45 104 46 109 47 105 48 106	02.00	.00 90.89	18.89	52.00	102.00	23.34	20.6	34.51
26 98.4 27 115. 28 116. 29 115. 30 116. 31 115. 32 109 33 108 34 108 35 110. 36 104 37 107 38 107 39 108 40 107 41 106 42 108 43 103 44 105 45 104 46 109 47 105 48 106	06.00	.00 88.50	16.00	38.00	105.00	23.40	19.6	31.00
27 115. 28 116. 29 115. 30 116. 31 115. 32 109 33 108 34 108 35 110. 36 104 37 107 38 107 39 108 40 107 41 106 42 108 43 103 44 105 45 104 46 109 47 105 48 106	06.00	.00 73.64	16.80	76.00	106.00	19.70	21.5	16.80
28 116. 29 115. 30 116. 31 115. 32 109 33 108 34 108 35 110. 36 104 37 107 38 107 39 108 40 107 41 106 42 108 43 103 44 105 45 104 46 109 47 105 48 106	8.00	00 65.25	20.70	60.00	79.00	19.45	15.6	20.70
29 115. 30 116. 31 115. 32 109 33 108 34 108 35 110. 36 104 37 107 38 107 39 108 40 107 41 106 42 108 43 103 44 105 45 104 46 109 47 105 48 106	15.00	.00 89.50	9.00	19.00	176.80	23.40	19.4	14.50
30 116 31 115 32 109 33 108 34 108 35 110 36 104 37 107 38 107 39 108 40 107 41 106 42 108 43 103 44 105 45 104 46 109 47 105 48 106	16.00		11.67	18.00	134.90	21.70	21.2	14.07
31 115. 32 109 33 108 34 108 35 110. 36 104 37 107 38 107 39 108 40 107 41 106 42 108 43 103 44 105 45 104 46 109 47 105 48 106	15.00		16.00	24.00	167.50	22.80	19.8	16.75
32 109 33 108 34 108 35 110. 36 104 37 107 38 107 39 108 40 107 41 106 42 108 43 103 44 105 45 104 46 109 47 105 48 106	16.00		18.00	19.00	182.60	26.00	22.1	17.30
33 108 34 108 35 110 36 104 37 107 38 107 39 108 40 107 41 106 42 108 43 103 44 105 45 104 46 109 47 105 48 106	15.00		14.50	29.00	145.20	22.60	21.6	21.00
34 108 35 110. 36 104 37 107 38 107 39 108 40 107 41 106 42 108 43 103 44 105 45 104 46 109 47 105 48 106	09.00		24.00	19.00	146.30	25.46	20.50	28.57
35 110. 36 104 37 107 38 107 39 108 40 107 41 106 42 108 43 103 44 105 45 104 46 109 47 105 48 106	08.80		18.00	20.00	158.90	21.67	22.40	32.25
36 104 37 107 38 107 39 108 40 107 41 106 42 108 43 103 44 105 45 104 46 109 47 105 48 106	08.80		24.00	21.67	167.60	23.54	21.40	21.67
37 107 38 107 39 108 40 107 41 106 42 108 43 103 44 105 45 104 46 109 47 105 48 106	10.00		19.00	20.67	105.60	24.60	20.40	25.33
38 107 39 108 40 107 41 106 42 108 43 103 44 105 45 104 46 109 47 105 48 106	04.00		28.00	16.00	135.40	20.57	22.50	41.84
39 108 40 107 41 106 42 108 43 103 44 105 45 104 46 109 47 105 48 106	07.00		32.00	16.89	164.90	20.54	20.80	20.97
40 107 41 106 42 108 43 103 44 105 45 104 46 109 47 105 48 106	07.00		19.00	15.25	154.90	22.45	23.50	26.50
41 106 42 108 43 103 44 105 45 104 46 109 47 105 48 106	08.80		21.00	13.25	167.70	21.85	23.50	25.00
42 108 43 103 44 105 45 104 46 109 47 105 48 106	07.00		12.00	4.00	136.00	22.30	20.50	37.10
43 103 44 105 45 104 46 109 47 105 48 106	06.00		14.00	15.00	172.00	22.80	21.60	46.30
44 105 45 104 46 109 47 105 48 106	08.80		16.00	18.00	188.00	24.00	21.50	25.50
45 104 46 109 47 105 48 106	03.00		30.00	16.00	167.90	21.24	19.50	31.20
46 109 47 105 48 106	05.00		29.00	14.33	147.10	24.69	21.30	33.21
47 105 48 106	04.00		27.00	18.24	152.70	22.45	19.80	32.80
48 106	09.00		22.00	16.45	147.05	22.65	19.30	30.70
	05.00		29.00	17.67	149.10	22.49	20.60	25.90
40 400	06.00		27.00	18.33	137.50	23.54	23.40	24.80
	08.80		24.00	16.36	134.90	21.87	22.90	27.94
	05.00		25.00	17.60	176.80	25.45	21.90	32.35
	05.00		26.00	15.00	167.90	24.67	24.40	24.36
	05.78		19.32	32.21	139.22	22.94	20.88	26.71
	4-116		9-32	4-76	79-188	18.2-26.8	15.4-25.4	11.9-48.5
IWP 12 Apo 98	125	25 128.1 90.5	25.4 16.9	35.1 68.2	209.7 134.8	22.9 26.3	15.8 21.9	27.9 20.2

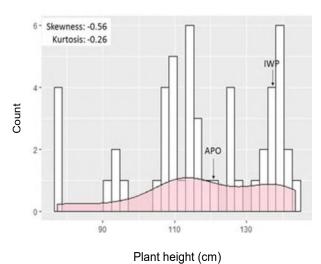


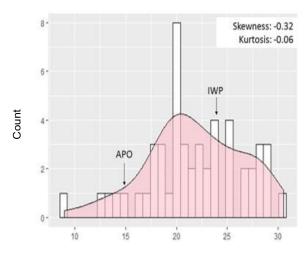
Table 3. Skewness and Kurtosis values for the quantitative traits in $\mathrm{BC_2F_3}$ and $\mathrm{BC_2F_4}$ progenies

Traits	ВС	₂ F ₃	BC ₂ F ₄	
	Skewness	Kurtosis	Skewness	Kurtosis
Days to 50 per cent flowering	0.06	0.14	-0.08	0.10
Plant height	-0.56	-0.26	-0.93	0.21
Number of productive tillers	-0.32	-0.06	0.59	-0.17
Number of chaffy grains per panicle	1.05	0.79	0.62	-0.79
Number of filled grains per panicle	-0.21	-1.31	-0.31	-0.76
Panicle length	-0.27	1.71	-0.08	-0.10
Thousand grain weight	-0.71	0.11	-0.34	1.08
Single plant yield	1.09	0.49	0.53	0.19

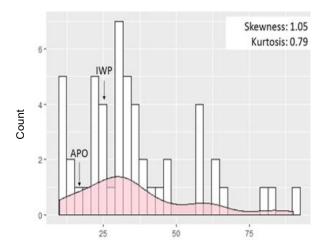


Days to 50 per cent flowering





Number of productive tillers



Number of chaffy grains per panicle

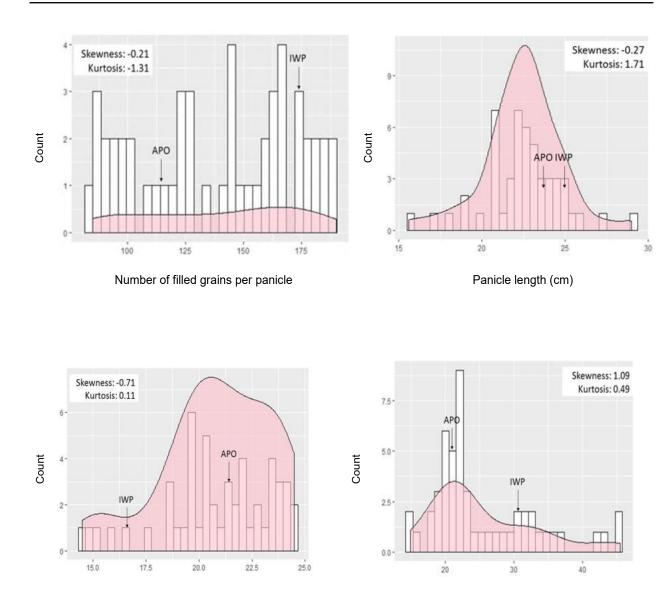


Fig. 1. Frequency distribution patterns of different traits in the BC,F, generation

traits plant height and thousand grain weight in the BC_2F_3 generation and plant height, filled grains per panicle, panicle length in BC_2F_4 generation indicated that these traits are under the control of many genes with duplicate gene action. Mild selection will help in achieving faster genetic gain in these traits.

Thousand grain weight (g)

The parent progeny regression analysis was estimated using the mean values of BC_2F_4 individuals on BC_2F_3 for all the traits (**Fig. 3**). The results showed a strong association between the traits in BC_2F_3 and BC_2F_4 generations. Regression coefficients were highly significant (p<0.01)

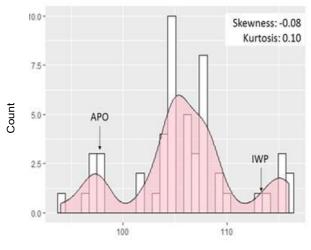
for the traits days to 50 per cent flowering, the number of productive tillers, the number of chaffy grains per panicle, the number of filled grains per panicle, panicle length, thousand grain weight and single plant yield. The maximum regression coefficient was obtained for days to 50 per cent flowering (1.12) followed by the number of productive tillers (0.60), filled grains per panicle (0.52) and single plant yield (0.43) indicating that selection is effective for these traits in these early generations for obtaining high yield along with earliness (**Table 4**). Similar results were obtained for single plant yield by Anilkumar *et al.* (2011), for days to 50 per cent

Single plant yield (g)

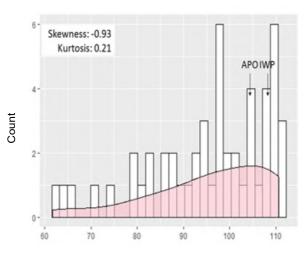


Table 4. Intergenerational correlation and regression values for the quantitative traits

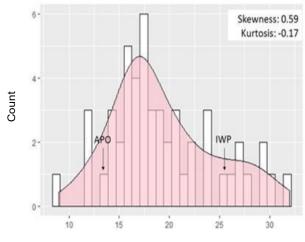
Traits	Correlation coefficient (r)	Regression coefficient (b)	Heritability h² (%)
Days to 50 per cent flowering	0.92**	1.12**	60.9
Plant height	0.30*	0.21*	35.0
Number of productive tillers	0.55**	0.60**	54.5
Number of chaffy grains per panicle	0.60**	0.56**	46.7
Number of filled grains per panicle	0.63**	0.52**	41.3
Panicle length	0.41**	0.32**	39.0
Thousand grain weight	0.51**	0.40**	39.2
Single plant yield	0.41**	0.43**	52.4



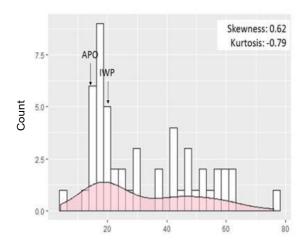
Days to 50 per cent flowering



Plant height (cm)



Number of productive tillers



Number of chaffy grains per panicle

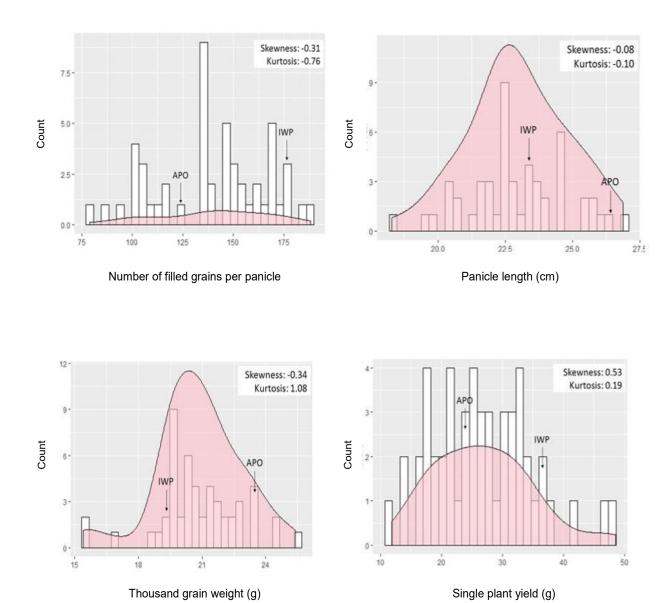


Fig. 2. Frequency distribution patterns of different traits in the BC₂F₄ generation

flowering, plant height and the number of productive tillers by Kavithamani *et al.* (2013) and for panicle length by Lalitha *et al.* (2018). Higher values of regression indicate greater genetic influence and less environmental effects (Palanisamy *et al.*, 2018). Real heritability should be known for the improvement of a trait (Dubey *et al.*, 2019). Regression estimates in this study indicated less environmental influence on these traits and selection based on their phenotypes in these generations is heritable. Parent-progeny regression method is used to know the narrow-sense heritability of the traits which is due to the additive genetic variance (Rani *et al.*, 2021).

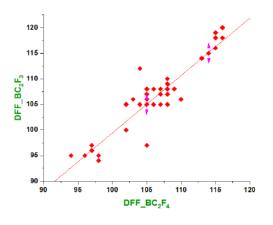
Correlation coefficients were highly significant for the traits days to 50 per cent flowering, the number of productive tillers, the number of chaffy grains per panicle, the number of filled grains per panicle, panicle length, thousand grain weight and single plant yield and significant for the trait plant height. Intergenerational correlation studies help to understand the extent to which the genetic potential of the trait will be transferred to further generations (Kumar et al., 2020; Rani et al., 2021). In the present study, intergenerational correlation coefficient was maximum for days to 50 per cent flowering (0.92) followed by The number of filled grains per panicle (0.63), the number of

productive tillers (0.55), thousand grain weight (0.51) and single plant yield (0.41) showing that these traits have high heritability. Similar positive and significant results for plant height, the number of filled grains per panicle, hundred grain weight and panicle length were obtained by Savitha *et al.* (2015).

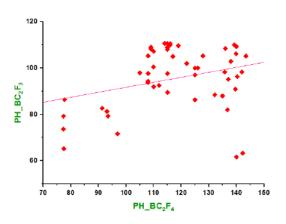
Narrow sense heritability estimated based on parent progeny regression method revealed high heritability for the trait days to 50 per cent flowering (60.9%), the number of productive tillers (54.5%), single plant yield (52.4%), the number of chaffy grains per panicle (46.7%), the number of filled grains per panicle (41.3%), thousand grain weight (39.2%), panicle length (39%)

and plant height (35%). Similar results were obtained by Kavithamani *et al.* (2013).

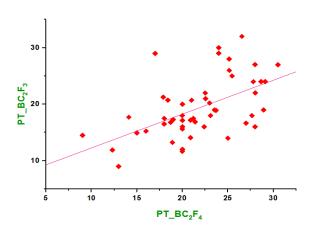
Drought tolerant upland cultivars are generally low tillering and low yielding with bold grains. These donors are crossed with the locally adapted cultivars for improving their drought tolerance. Hence, the developed segregating generations need to be carefully evaluated for improved tolerance for drought without compensating for the high yielding ability of the varieties. In the present study, high values of heritability, correlation and regression coefficients for the traits flowering, number of productive tillers, grain yield indicate that these traits can be used for the selection of elite genotypes in early generations.



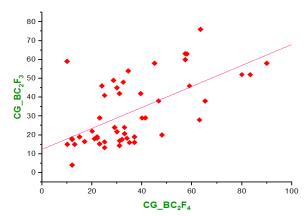
Days to 50 per cent flowering



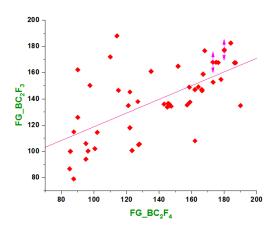
Plant height (cm)

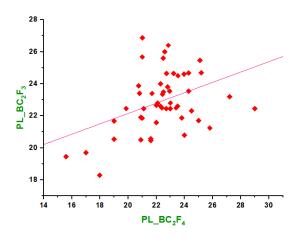


Number of productive tillers



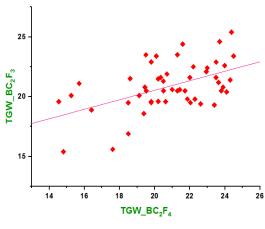
Number of chaffy grains per panicle



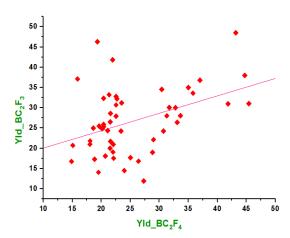


Number of filled grains per panicle

Panicle length (cm)



Thousand grain weight (g)



Single plant yield (g)

Fig. 3. Parent offspring regression for the quantitative traits

REFERENCES

Aananthi, N. 2018. Inter generation trait association and regression analysis in F2 and F3 generations of rice. *Int.J.Curr.Microbiol.App.Sci.*, **7**(8): 3651-3662. [Cross Ref]

Anilkumar, C. V. and Ramalingam, J. 2011. Parent progeny regression analysis in F₂ and F₃ generations of rice. *Electronic Journal of Plant Breeding*, **2**(4): 520-522.

Choo, T.M. and Reinbergs, E. 1982. Analysis of skewness and kurtosis for detecting gene interaction in a double haploid population. *Crop Science.*, **22**: 231-235. [Cross Ref]

Dixit, S., Singh, A., Cruz, M. T. S., Maturan, P. T., Amante, M. and Kumar, A. 2014. Multiple major QTL lead to stable yield performance of rice cultivars across varying drought intensities. *Bmc Genetics*, **15**(1): 1-13. [Cross Ref]

- Dubey, S. and Rangaiah, S. 2019. Broad sense and narrow sense heritability in F₄ and F₅ generations of finger millet, *Eleusine coracana* (L.) Gaertn.. *Electronic Journal of Plant Breeding*, **10**(1): 66-75. [Cross Ref]
- Govintharaj, P., Tannidi, S., Swaminathan, M. and Sabariappan, R. 2017. Effectiveness of selection, parent-offspring correlation and regression in bacterial blight resistance genes introgressed rice segregating population. *Ciência Rural*, **47**. [Cross Ref]
- Guo, H., Wang, R., Garfin, G. M., Zhang, A. and Lin, D. 2021. Rice drought risk assessment under climate change: Based on physical vulnerability a quantitative assessment method. Science of the Total Environment, 751, 141481. [Cross Ref]
- Harijan, Y., Katral, A., Mahadevaiah, C., Biradar, H., Hadimani, J. and Hittalmani, S. 2021. Genetic analysis of reciprocal differences for yield and yield attributing traits in segregating populations of rice (Oryza sativa L.). Journal of Pharmacognosy and Phytochemistry, 10(2): 614-621.
- Hosagoudar, G. N. and Shashidhar, H. E. 2018. Studies on variability and frequency distribution of yield and yield related traits in F2 population of rice (*Oryza sativa* L.). http://www. ijcmas. com, **7**(09). [Cross Ref]
- Kavithamani, D., Robin, S., Manonmani, S. and Mohanasundaram, K. 2013. Character association and parent progeny regression studies for yield in the segregating generations of TGMS rice lines. Oryza, 50(1): 45-51.
- Khan, M. I. R., Palakolanu, S. R., Chopra, P., Rajurkar, A. B., Gupta, R., Iqbal, N. and Maheshwari, C. 2021. Improving drought tolerance in rice: Ensuring food security through multi-dimensional approaches. *Physiologia Plantarum*, **172**(2): 645-668. [Cross Ref]
- Kumar, S. V., Kumar, M., Singh, V., Sheokand, R. N. and Kumar, P. 2020. Regression analysis and inter generation trait association in F3 and F4 generation of wheat. *Electronic Journal of Plant Breeding*, 11(01): 45-53. [Cross Ref]
- Lalitha, R., Anand, G. and Arunachalam, P. 2018. Parent progeny regression analysis on yield & yield component characters in advanced breeding lines in rice (*Oryza sativa* L.). Green Farming, 9(4): 615-617
- Nadarajan, N., Manivannan N. and Gunasekaran, M. 2016. Quantitative genetics and biometrical techniques in plant breeding. Kalyani Publishers, Ludhiana.

- Palanisamy, S. 2018. Genetic analysis of biofortification of micronutrient breeding in rice (*Oryza sativa* L.). *Rice Crop: Current Developments*, 17. [Cross Ref]
- Rani, R., Singh, V. and Punia, M. 2021. Intergeneration correlation and parent-offspring regression in rust resistance derived F. *Indian Journal of Agricultural* Sciences, 91(5): 683-8.
- Rasheed, A., Hassan, M. U., Aamer, M., Batool, M., Sheng, F. A. N. G., Ziming, W. U. and Huijie, L. I. 2020. A critical review on the improvement of drought stress tolerance in rice (*Oryza sativa* L.). *Notulae Botanicae Horti Agrobotanici Cluj-Napoca*, **48**(4): 1756-1788. [Cross Ref]
- Savitha, P. and Kumari, R. U. 2015. Studies on skewness, kurtosis and parent progeny regression for yield and its related traits in segregating generations of rice. *ORYZA-An International Journal on Rice*, **52**(2): 80-86.
- Smith, J. D. and Kinman, M. L. 1965. The use of parent offspring regression as an estimate of heritability. *Crop Sci.*, **5**: 595-596. [Cross Ref]
- Venuprasad, R., Dalid, C.O., Del Valle, M., Zhao, D., Espiritu, M., Cruz, M.S., Amante, M., Kumar, A. and Atlin, G.N. 2009. Identification and characterization of large-effect quantitative trait loci for grain yield under lowland drought stress in rice using bulk-segregant analysis. *Theoretical and Applied Genetics*, **120**(1): 177-190. [Cross Ref]
- Venuprasad, R., Bool, M. E., Quiatchon, L., Cruz, M. S., Amante, M. and Atlin, G. N. 2012. A large-effect QTL for rice grain yield under upland drought stress on chromosome 1. *Molecular Breeding*, **30**(1): 535-547. [Cross Ref]