# Seed Quality Attributes in Bitter Gourd (Momordica charantia L.)

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ABSTRACT Thirty-six genotypes (eight parental lines and 28 F<sub>1</sub> hybrids) of bitter gourd were subjected to seed quality assessment under laboratory conditions utilizing standard germination test. The genotypic differences were highly significant in both the seasons for number of seeds per fruit, seed yield/fruit and seed vigour index. The genotypic difference for seed germination was highly significant only in the rainy season experiment.

Keywords: Bittergourd, seed germination, vigour.

Among the cultivated cucurbits, bittergourd (Momordica charantia L., 2n=2x=22) is one of the most important vegetable crop grown throughout the country for its nutritive value and medicinal properties. Along with an optimum combination of desirable horticultural traits in a cultivar of bitter gourd, the evaluation of seed quality in terms of seed germination and vigour is equaly important as bittergourd having hard seed coat is known for poor seed germinability at low temperatures [1]. The seed germination and vigour are assessed to predict some aspects of potential and performance, crop yield and storability. Germination test is considered as the most important quality test in evaluating the planting value of a seed lot. The laboratory germination of seed lots has been shown to be indicative of their ability to emerge in the field in cases where the seed lot used differed markedly in their laboratory germination. It is perhaps not surprising that a seed lot having a laboratory germination of, for example 65 per cent emergence less well than one with a germination of 90 per cent [2]. There are also however many reports where seed lot having similar high laboratory germinations reveals large differences in their ability to emerge in the field [3, 4]. Thus, laboratory

germination is not indicative of field emergence potential. This led to the development of the concept of seed vigour, whereby seed lots with high laboratory germinations, which emerge poorly in the field, are referred to as low vigour lots, while high vigour lots emerge well. The present study was, therefore, undertaken to evaluate the seed quality of bitter gourd under laboratory conditions.

#### MATERIALS AND METHODS

The experimental materials consist of 36 genotypes including eight parental lines and twenty-eight F<sub>1</sub> hybrids. Number of seeds was counted in five random fruits and their weight was recorded in grams and mean seed weight and number of seeds per fruit was calculated.

Standard germination test was conducted as per the ISTA rules [5]. Three replication consist of hundred seeds each were kept between two layers of moist paper towels, which are then rolled carefully ensuring no excess pressure is placed on seeds, wrapped in a sheet of butter paper to reduce surface evaporation and placed in a germination chamber in a upright position at 25 °C temperature for 14 days. The germination per cent was calculated by mean of

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Table 1. Analysis of variance for various horticultural and seed quality traits in bitter gourd (rainy season, 2001 and summer season, 2002)

	Degree of freedom	Mean square								
Source of variation		Seeds per fruit		Seed yield/fruit (g)		Germination (%)		Vigour index		
		Rainy	Summer	Rainy	Summer	Rainy	Summer	Rainy	Summer	
Replication	2	11.67	23.59	0.31	1.11	77.57	145.95	24032.00	19142.20	
Genotype	35	148.98**	47.84**	3.89**	1.45**	14.08**	14.32	234901.9**	84413.70**	
Error	70	2.06	5.27	0.071	0.17	4.44	13.86	9799.77	10258.79	

<sup>\*</sup> and \*\* Significant at 0.05 and 0.01 level respectively

three replications. Seed vigour index was calculated by determining the germination percentage and seedling length (including root and shoot both) of the seed lot. While determining germination at the time of final count, the length of five random seedlings was also measured. Seed vigour was calculated by multiplying germination percentage and seedling length in cm. The seed lot showing the higher seed vigour index is considered to be more vigorous [6]. The statistical analysis was done according to randomized block design [7].

### RESULTS AND DISCUSSION

Analysis of variance for various seed quality traits for both the seasons is given in (Table 1). The genotypic differences were significant, consistently over both the seasons for number of seeds per fruit, seed yield/fruit (g), and seed vigour index. The genotypic difference for seed germination per cent was significant in rainy season experiment only.

Mean values for various seed quality traits measured on parental lines and the F, generation are summarized in (Table 2). The cv values were below 25 per cent for all the characters studied. This indicated that the precision of the experiment was within the accepted normal limit of coefficient of variation. The genotype PBIG 90 x PBIG 4 had the highest number of seeds per fruit (40) in rainy season followed by PBIG 2 x PBIG 3 and PBIG 2 x Kalyanpur Baramasi (35 each) and PBIG 86 x PBIG 3 (32). During summer season the highest seed producer was PBIG 4 x PBIG 56 (32) followed by PBIG 4 x PBIG 3 (29), PBIG4 x Kalyanpur Baramasi (28) and PBIG 2 x PBIG 3 and PBIG 2 x PBIG 56 (26 each). For weight of seed per fruit, the genotype PBIG 90 x PBIG 4 (6.6 g) recorded as the highest in rainy season, followed by PBIG 2 x PBIG 3 (6.4 g), PBIG 2 x Kalyanpur Baramasi (5.3 g) and PBIG 2 x PBIG 4 (5.0 g). During summer season PBIG 4 x PBIG 56 (6.0 g) had the highest seed weight, followed by PBIG 2 x PBIG 3 (5.2 g), PBIG 56 x Kalyanpur Baramasi (4.9 g) and PBIG 86 x PBIG 3 (4.8 g). Seed germination ranged from 87 per cent (Kalyanpur Baramasi) to 97 per cent (Kalyanpur sona, PBIG 4, PBIG 3, PBIG 56, Kalyanpur Sona x PBIG 90, Kalyanpur Sona x PBIG 4, Kalyanpur Sona x PBIG 3, Kalyanpur Sona x PBIG 56, PBIG 86 x Kalyanpur Baramasi, PBIG 2 x PBIG 4, PBIG 2 x PBIG 3, PBIG 2 x PBIG 56, PBIG 90 x PBIG 4, PBIG 90 x Kalyanpur Baramasi, PBIG 4 x PBIG 56 and PBIG 4 x Kalyanpur Baramasi) in the rainy season experiment. However in summer season the range was 88 per cent to 98 per cent. The highest value for seed germination 98 per cent was recorded from the genotype PBIG 86 and PBIG 56. The lowest seed germination was recorded from Kalyanpur Sona x PBIG 56, it was 88 per cent. On an average from both season experiment the highest seed germination was recorded from PBIG 56 (97 %), and the lowest seed germination from the genotype Kalyanpur Baramasi (89 %). On the average value for both season germination per cent indicated that the parents have better germination than their crosses.

The highest seed vigour index in rainy season and summer season was in Kalyanpur Sona (2281) PBIG 2 x Kalyanpur Baramasi (1966). The lowest seed vigour (1147) was recorded in genotype PBIG 90 x PBIG 3 respectively during rainy season and in summer season, the lowest seed vigour index (1211) was recorded in PBIG 86 x PBIG 2. On an average of both season, the highest seed vigour index (1872) was recorded in PBIG 56 and the lowest seed vigour index (1238) was recorded in PBIG 86 x PBIG 3. These results are also indicated that the parents have higher seed vigour index than their hybrids.

KS. V. PBIG 56         Rainy         Summer         Average         Rain	Summer 3.3 4.1 3.6 2.7 2.7 3.3 3.3 3.7 3.8 3.8 3.8 4.5 3.8 3.8 4.5 4.5 4.7 4.7 4.8	Rainy         Summer           97         95           95         98           95         93           97         93           97         93           97         93           97         93           97         93           97         93           97         93           97         93           97         93           95         93           95         93           95         93           95         93	30	Summer 1377 1468 1634 1596 1611 1591 1677 1692 1692 1692 1350 1350 1400 1683	Average 1829 1637 1587 1587 1644 1693 1872 1416 1544 1452 1518 1832 1518 1632 1748 1748 1748 1748
KS.         19         24         21         25         3.3         2.9           PBIG 86         24         30         27         3.5         4.1         3.8           PBIG 2         15         20         17         26         3.4         1.3           PBIG 3         16         22         19         26         3.7         3.4           PBIG 3         21         20         27         4.0         2.7         3.4           PBIG 3         21         20         20         4.0         3.7         3.8           R.S. x PBIG 36         16         26         21         2.9         4.5         3.7           K.S. x PBIG 36         16         26         21         2.9         4.5         3.7           K.S. x PBIG 36         16         26         21         2.9         4.5         3.7           K.S. x PBIG 36         16         26         21         2.9         4.5         3.7           K.S. x PBIG 36         16         26         21         2.9         4.4         3.3         3.4           K.S. x PBIG 2         18         22         21         2.9         4.4         3.3	6. 4 6. 6. 6. 6. 6. 6. 6. 6. 6. 6. 6. 6. 6.	NG 55 (5.0 g). During summer, seesan PR SIG 55 (5.0 g) had the highest seed weeps to PRIG 2 x PRIG 3 (5.2 g). PRIG 36 x 155		1377 1468 1634 1596 1611 1591 1677 1692 1692 1692 1350 1350 1400 1400 1683	1829 1637 1587 1587 1644 1693 1872 1416 1544 1452 1518 1832 1518 1748 1748 1748 1748
PBIC 86  PBIC 86  PBIC 86  PBIC 87  PBIC 90  PBI	1. 4. 6. 6. 6. 6. 6. 6. 6. 6. 6. 6. 6. 6. 6.				1637 1587 1587 1644 1693 1872 1416 1544 1452 1518 1832 1832 1748 1748 1748
PBIG 2 PBIG 3 PBIG 4 PBIG 4 PBIG 5 PB	6. 2. 2. 2. 2. 2. 4. 2. 2. 2. 2. 4. 4. 2. 2. 2. 2. 2. 4. 4. 2. 2. 2. 2. 2. 4. 4. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2.				1587 1587 1644 1693 1872 1416 1544 1452 1518 1832 1368 1748 1778 1272
PBIG 90 PBIG 90 PBIG 90 PBIG 64 PBIG 64 PBIG 64 PBIG 75 PBIG 75 PBIG 56 PBIG 75 PBIG 75 PBIG 86 PBIG 8	7. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8.				1587 1644 1693 1872 1416 1544 1452 1518 1832 1368 1748 1748 1773
PBIG 4         15         21         18         22         33         2.8           PBIG 3         16         22         19         26         3.7         3.2           PBIG 3         16         22         19         26         3.7         3.8         3.5           K.B.         21         20         21         20         4.0         3.8         3.9           K.S. X PBIG 2         14         22         18         2.1         3.4         2.8         3.9           K.S. X PBIG 2         14         22         18         2.1         3.4         2.8         3.4           K.S. X PBIG 3         23         22         18         2.1         3.4         2.8         3.4           K.S. X PBIG 3         25         22         18         2.4         4.4         3.3         3.4         2.8         3.4           K.S. X PBIG 3         25         22         18         2.4         4.4         3.3         3.4         2.8         3.4         2.8         3.4         2.8         3.4         2.8         3.4         2.8         3.4         2.8         3.4         2.8         3.4         3.2         3.4	6. 6. 6. 6. 6. 6. 6. 6. 6. 6. 6. 6. 6. 6				1644 1693 1872 1416 1544 1452 1518 1832 1368 1748 1748 1773
PBIG 3         16         22         19         26         3.7         3.2           RES. X PBIG 56         21         20         21         3.1         3.8         3.5           K.S. X PBIG 56         16         26         21         2.9         4.5         3.5         3.5           K.S. X PBIG 2         14         22         18         2.1         3.4         2.8         3.9           K.S. X PBIG 4         14         18         16         2.8         3.1         3.9           K.S. X PBIG 4         14         18         16         2.8         3.1         3.9           K.S. X PBIG 5         15         2.2         18         2.4         4.4         3.3         3.0           K.S. X PBIG 5         15         2.2         18         2.4         4.4         3.3         3.0           K.S. X PBIG 5         15         2.2         18         2.4         4.4         3.3         3.0           K.S. X PBIG 5         15          2.2         18         2.4         4.4         3.3         3.0           K.S. X PBIG 5         15         2.2         18         2.4         4.4         3.3         3.1	7. 8. 8. 4. 8. 8. 8. 8. 8. 4. 8. 4. 8. 4. 8. 8. 8. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.				1693 1872 1416 1544 1452 1518 1832 1368 1748 1573
REBG 56         21         20         21         3.8         3.5           K.B.         21         20         20         4.0         3.8         3.5           K.S. x PBIG 86         16         26         21         2.9         4.5         3.7           K.S. x PBIG 2         14         22         18         21         2.9         4.5         3.7           K.S. x PBIG 3         23         21         22         3.0         3.8         3.4           K.S. x PBIG 40         14         18         16         2.8         3.1         3.0           K.S. x PBIG 5         15         22         18         2.4         4.4         3.3         3.4           K.S. x PBIG 5         15         22         18         2.1         3.7         2.9           K.S. x PBIG 5         15         22         18         2.4         4.4         3.3         3.0           K.S. x PBIG 5         15         22         18         2.4         4.4         3.3         3.0           K.S. x PBIG 5         15         22         18         2.1         2.1         3.2         3.1           K.S. x K.B.         22         2	8. 8. 4. 8. 8. 8. 8. 8. 7. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8.				1872 1416 1544 1452 1518 1832 1368 1748 1573 1272
K.B.         21         20         40         3.8         3.9           K.S. X PBIG 86         16         26         21         2.9         4.5         3.7           K.S. X PBIG 2         14         22         18         2.1         2.9         4.5         3.7           K.S. X PBIG 4         14         18         16         2.8         3.1         3.0           K.S. X PBIG 5         15         22         18         2.4         4.4         3.3         3.0           K.S. X PBIG 56         15         22         18         2.4         4.4         3.3         3.0           K.S. X K.B.         22         18         2.4         4.4         3.3         3.0           K.S. X K.B.         22         18         2.4         4.4         3.3         3.0           K.S. X K.B.         22         18         2.4         4.4         2.8         3.1           K.S. X K.B.         22         22         24         4.5         4.7         3.8           PBIG 8 x PBIG 5         13         22         24         4.3         4.5         4.2           PBIG 8 x PBIG 5         13         23         24	8. 4. 8. 8. 8. 8. 8. 4. 8. 4. 8. 8. 4. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8.				1416 1544 1452 1518 1832 1368 1748 1573 1272
K.S. X PBIG 86         16         26         21         2.9         4.5         3.7           K.S. X PBIG 2         14         22         18         2.1         3.4         2.8           K.S. X PBIG 4         14         18         16         2.8         3.1         3.9           K.S. X PBIG 4         14         18         16         2.8         3.1         3.9           K.S. X PBIG 5         15         2.9         18         2.1         3.7         2.9           K.S. X PBIG 5         15         2.9         18         2.1         3.9         3.9           K.S. X KB.         15         2.9         4.4         3.3         3.9         4.5           K.S. X KB.         15         2.9         4.5         4.2         3.9         4.5           PBIG 86 X PBIG 5         14         2.2         18         2.1         3.2         2.9         4.7         3.8           PBIG 86 X PBIG 4         18         2.5         2.4         4.3         4.5         4.2         3.8         3.2           PBIG 86 X PBIG 3         2.3         2.3         2.4         4.3         4.5         4.2         3.8         4.2         <	7. 4. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8.				1544 1452 1518 1832 1368 1748 1573 1272
K.S. x PBIG 2         14         22         18         2.1         3.4         2.8           K.S. x PBIG 90         23         21         22         3.0         3.8         3.4           K.S. x PBIG 90         23         21         22         3.0         3.8         3.4           K.S. x PBIG 5         15         18         24         4.4         3.3         3.9           K.S. x PBIG 56         15         18         2.1         3.7         2.9           K.S. x K.B.         22         15         18         3.4         2.8         3.1           PBIG 86 x PBIG 5         22         24         3.9         4.7         3.8         3.1           PBIG 86 x PBIG 5         14         22         18         2.9         4.7         3.8         3.1           PBIG 86 x PBIG 5         13         25         22         26         3.6         4.7         3.8         4.8           PBIG 86 x PBIG 5         13         25         22         26         3.8         4.8         4.8         4.8         4.8         4.8         4.8         4.8         4.8         4.8         4.8         4.8         4.8         4.8         4.8 </td <td>6. 6. 6. 6. 6. 4. 6. 4. 6. 7. 8. 6. 7. 8. 8. 7. 8. 8.</td> <td></td> <td>(6)</td> <td></td> <td>1452 1518 1832 1368 1748 1573 1272</td>	6. 6. 6. 6. 6. 4. 6. 4. 6. 7. 8. 6. 7. 8. 8. 7. 8. 8.		(6)		1452 1518 1832 1368 1748 1573 1272
K.S. x PBIG 90         23         21         22         3.0         3.8         3.4           K.S. x PBIG 4         14         18         16         2.8         3.1         3.0           K.S. x PBIG 4         14         18         16         2.8         3.1         3.9           K.S. x PBIG 5         15         22         18         2.1         3.7         2.9           K.S. x K.B.         22         15         18         3.4         2.8         3.1           PBIG 86 x PBIG 5         23         25         24         4.7         3.8         4.2           PBIG 86 x PBIG 5         13         25         25         26         3.6         3.8         3.2           PBIG 86 x PBIG 5         13         25         22         26         3.6         4.7         3.8           PBIG 86 x PBIG 5         13         25         22         4.8         4.8         4.8           PBIG 86 x PBIG 5         13         23         24         4.3         4.3         4.2           PBIG 86 x PBIG 5         13         23         24         4.3         4.3         4.3           PBIG 86 x PBIG 5         25         23	8. E. E. E. C. 4. 4. E. 4. E. 7. 8. 8. E. F. 8. 8.				1518 1832 1368 1748 1573 1272
K.S. x PBIG 4         14         18         16         2.8         3.1         3.0           K.S. x PBIG 5         15         22         18         24         4.4         3.3         3.9           K.S. x PBIG 56         15         22         18         2.1         3.7         2.9           K.S. x K.B.         22         15         18         2.4         3.9         4.5         2.9           PBIG 86 x PBIG 2         23         25         24         3.9         4.5         4.2           PBIG 86 x PBIG 3         32         25         24         3.9         4.7         3.8           PBIG 86 x PBIG 3         32         23         2.6         4.8         4.8         4.8           PBIG 86 x PBIG 3         32         23         24         4.3         4.8         4.8           PBIG 86 x PBIG 3         30         22         26         4.8         4.8         4.8           PBIG 86 x PBIG 56         13         23         24         4.3         4.3         4.3           PBIG 2 x PBIG 56         26         26         26         40         40         4.2           PBIG 2 x PBIG 56         26         26 <td>6. 6. 6. 4. 4. 6. 4. 6. 7. 6. 8. 6. 7. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8.</td> <td></td> <td></td> <td></td> <td>1832 1368 1748 1573 1272</td>	6. 6. 6. 4. 4. 6. 4. 6. 7. 6. 8. 6. 7. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8.				1832 1368 1748 1573 1272
K.S. x PBIG 3         29         18         24         4.4         3.3         3.9           K.S. x PBIG 56         15         15         18         2.1         3.7         2.9           K.S. x K.B.         22         15         18         2.1         3.7         2.9           K.S. x K.B.         22         15         18         2.9         4.7         2.9           PBIG 86 x PBIG 20         14         22         18         2.9         4.7         3.8           PBIG 86 x PBIG 4         18         25         2.6         3.9         4.7         3.8           PBIG 86 x PBIG 56         13         23         2.6         4.8         4.8         4.8           PBIG 86 x PBIG 56         13         23         2.6         4.3         4.3         4.3         4.3           PBIG 86 x PBIG 56         13         23         24         4.3<	E. E. S. 4. 4. 7. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8.				1368 1748 1573 1272
K.S. X PBIG 56         15         22         18         2.1         3.7         2.9           K.S. X.K.B.         22         15         18         3.4         2.8         3.1           PBIG 86 X PBIG 2         23         25         24         3.9         4.5         4.2           PBIG 86 X PBIG 4         18         25         26         3.8         3.2         4.7         3.8           PBIG 86 X PBIG 4         18         25         22         26         3.8         3.2         3.2           PBIG 86 X PBIG 5         13         23         23         27         4.8         4.8         4.8           PBIG 86 X PBIG 5         13         23         24         4.3         4.8         4.8         4.8           PBIG 86 X PBIG 56         13         23         24         4.3         4.3         4.3         4.8	7. 8. 4. 4. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8.				1748 1573 1272 1470
K.S. X.K.B.         22         15         18         3.4         2.8         3.1           PBIG 86 X PBIG 2         23         25         24         3.9         4.5         4.2           PBIG 86 X PBIG 20         14         22         18         2.9         4.7         3.8           PBIG 86 X PBIG 4         18         25         22         2.6         3.8         3.2           PBIG 86 X PBIG 5         13         23         23         24         4.8         4.8         4.8           PBIG 86 X PBIG 5         13         23         24         4.3         4.8         4.8         4.8           PBIG 86 X R.B.         25         23         24         4.3         4.3         4.3         4.3         4.3           PBIG 86 X R.B.         25         23         24         4.3         4.4         4.2         5.8         4.0         4.4         4.2         5.8         4.2	5, 4, 4, 6, 4, 80, 70, 70, 80, 80				1573
PBIG 86 X PBIG 2 23 25 24 3.9 4.5 4.2 PBIG 86 X PBIG 90 14 22 18 2.9 4.7 3.8 PBIG 86 X PBIG 4 18 25 22 2.6 3.8 3.2 PBIG 86 X PBIG 4 18 25 22 2.6 3.8 3.2 PBIG 86 X PBIG 3 32 23 24 4.8 4.8 4.8 4.8 PBIG 2 X PBIG 56 13 23 24 4.3 4.3 4.3 4.3 PBIG 2 X PBIG 2 X PBIG 5 26 26 5.0 4.0 4.6 PBIG 2 X PBIG 5 26 26 26 5.0 4.0 4.4 4.2 PBIG 2 X PBIG 4 40 19 22 26 5.3 3.1 4.2 PBIG 90 X PBIG 3 24 24 24 3.3 3.6 PBIG 90 X PBIG 5 2 2 2 2 2 3.3 3.1 4.2 PBIG 90 X PBIG 5 2 2 2 2 2 3.3 3.1 4.4 3.8 PBIG 4 X PBIG 5 2 2 2 2 2 3.3 3.4 4.4 3.8 PBIG 4 X PBIG 5 2 2 2 2 3.3 3.4 4.4 3.8 PBIG 4 X PBIG 5 2 2 2 2 3.3 3.4 4.4 3.8 PBIG 4 X PBIG 5 2 2 2 2 3.3 3.4 4.4 3.8 PBIG 4 X PBIG 5 2 2 2 3.3 3.4 4.4 3.3 3.4 PBIG 3 X PBIG 5 6 2 2 2 2 3.3 3.4 4.4 3.3 3.4 PBIG 3 X PBIG 5 6 19 18 19 3.4 4.2 3.3 3.4 PBIG 3 X PBIG 5 6 19 18 19 3.4 3.3 3.4 PBIG 3 X PBIG 5 6 19 18 19 3.4 3.3 3.4 PBIG 3 X PBIG 5 6 19 18 19 3.4 3.3 3.4 PBIG 3 X PBIG 5 6 19 18 19 3.4 3.3 3.4 PBIG 3 X PBIG 5 6 19 18 19 3.4 3.3 3.4 PBIG 3 X PBIG 5 6 19 18 19 3.4 3.3 3.4 PBIG 3 X PBIG 5 6 19 18 19 3.4 3.3 3.4 PBIG 3 X PBIG 5 6 19 18 19 3.4 3.3 3.4 PBIG 3 X PBIG 5 6 19 18 19 3.4 3.3 3.4 PBIG 3 X PBIG 5 6 19 18 19 3.4 3.3 3.4 PBIG 3 X PBIG 5 6 19 18 19 3.4 3.3 3.4 PBIG 3 X PBIG 5 6 19 19 19 19 19 19 19 19 19 19 19 19 19	4, 4, 6, 4, 7, 80 80				1272
PBIG 86 X PBIG 90 14 22 18 2.9 4.7 3.8 PBIG 86 X PBIG 4 18 25 22 2.6 3.8 3.2 3.2 PBIG 86 X PBIG 4 18 25 22 2.6 3.8 3.2 3.2 PBIG 86 X PBIG 5 13 23 18 1.7 3.2 2.5 PBIG 86 X R.B. 25 23 24 4.3 4.3 4.3 4.3 PBIG 2 X PBIG 4 30 22 2.6 5.0 4.0 4.0 4.5 PBIG 2 X PBIG 2 X PBIG 5 26 2.6 5.0 4.0 4.4 4.2 PBIG 2 X PBIG 5 2.6 2.6 5.0 4.0 4.4 4.2 PBIG 2 X PBIG 5 2.6 2.6 2.6 5.0 4.0 4.4 4.2 PBIG 90 X PBIG 4 40 19 27 5.3 3.1 4.2 PBIG 90 X PBIG 5 2.5 2.1 2.2 2.8 3.3 3.1 4.2 PBIG 90 X PBIG 5 2.5 2.1 2.3 3.5 3.8 3.1 PBIG 90 X PBIG 5 2.5 2.1 2.3 3.5 3.8 3.1 PBIG 4 X PBIG 5 2.6 2.6 2.6 3.3 3.5 PBIG 4 2.4 19 2.2 4.4 3.8 PBIG 4 X PBIG 5 2.6 2.6 2.6 3.3 3.3 3.4 PBIG 4 X PBIG 5 2.6 3.2 2.9 3.8 6.0 4.9 PBIG 5 2.6 2.6 2.6 3.3 3.3 3.4 PBIG 3 X PBIG 5 2.6 3.2 2.9 3.8 PBIG 3 X PBIG 5 2.0 3.3 3.4 4.4 3.3 3.4 PBIG 3 X PBIG 5 2.0 3.0 3.4 3.4 3.3 3.4 PBIG 3 X PBIG 5 2.0 3.0 3.4 3.4 3.3 3.4 PBIG 3 X PBIG 5 2.0 3.0 3.4 3.4 3.3 3.4 PBIG 3 X PBIG 5 2.0 3.0 3.4 3.4 3.3 3.4 PBIG 3 X PBIG 5 2.0 3.0 3.0 3.4 3.3 3.4 3.4 3.5 PBIG 3 X PBIG 5 2.0 3.0 3.0 3.0 3.0 3.0 3.0 3.0 3.0 3.0 3	7.4. E. 8.4.				1470
PBIG 86 X PBIG 4 18 25 22 2.6 3.8 3.2 PBIG 86 X PBIG 3 3.2 2.3 4.8 4.8 4.8 PBIG 86 X PBIG 56 13 2.3 18 1.7 3.2 2.5 PBIG 86 X K.B. 25 2.3 2.4 4.3 4.3 4.3 PBIG 86 X K.B. 25 2.3 2.4 4.3 4.3 4.3 4.3 PBIG 2 X PBIG 4 30 2.2 2.6 5.0 4.0 4.0 4.5 PBIG 2 X PBIG 5 26 2.6 2.6 2.6 4.0 4.0 4.4 4.2 PBIG 2 X PBIG 5 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	3.8				TTTT
PBIG 86 x PBIG 3         32         23         27         4.8         4.8         4.8           PBIG 86 x PBIG 56         13         23         17         3.2         2.5           PBIG 86 x K.B.         25         23         24         4.3         4.3         4.3           PBIG 2 x PBIG 50         20         15         18         3.3         3.6         3.5           PBIG 2 x PBIG 4         30         22         26         5.0         4.0         4.5           PBIG 2 x PBIG 5         26         26         26         4.0         4.4         4.5           PBIG 2 x PBIG 5         26         26         4.0         4.4         4.2           PBIG 2 x PBIG 5         26         26         4.0         4.4         4.2           PBIG 2 x FBIG 5         26         26         4.0         4.4         4.2           PBIG 90 x PBIG 5         25         21         2.2         3.3         3.6           PBIG 90 x PBIG 56         25         21         2.2         4.4         3.3           PBIG 4 x PBIG 56         25         21         2.2         4.4         3.3           PBIG 4 x PBIG 56         26         26<	4.8	95 93			1514
PBIG 86 X PBIG 56 13 23 18 1.7 3.2 2.5  PBIG 86 X K.B. 25 23 24 4.3 4.3 4.3 4.3  PBIG 2 X PBIG 4 30 22 26 5.0 4.0 4.0 4.5  PBIG 2 X PBIG 4 30 22 26 5.0 4.0 4.4 4.2  PBIG 2 X PBIG 56 26 26 26 4.0 4.4 4.2  PBIG 2 X PBIG 5 26 26 26 4.0 4.4 4.2  PBIG 90 X PBIG 3 14 22 18 2.8 4.3 3.6  PBIG 90 X PBIG 5 25 21 23 3.5 3.8  PBIG 90 X PBIG 5 25 21 23 3.5 3.8  PBIG 90 X PBIG 5 25 21 23 3.5 3.8  PBIG 4 X PBIG 5 26 26 27 3.1 4.4 3.8  PBIG 4 X PBIG 5 26 26 27 3.1 4.4 3.8  PBIG 4 X PBIG 5 26 26 27 3.1 4.4 3.8  PBIG 4 X PBIG 5 26 32 29 3.8 6.0 4.9  PBIG 5 X PBIG 5 26 26 32 29 3.8 6.0 4.9  PBIG 3 X PBIG 5 26 28 24 3.4 4.3 3.8  PBIG 3 X PBIG 5 26 28 24 3.4 4.3 3.8  PBIG 3 X PBIG 5 26 26 3.2 29 3.8 6.0 4.9  PBIG 3 X PBIG 5 26 26 3.2 29 3.8 6.0 4.9  PBIG 3 X PBIG 5 26 3.3 2.4 3.8 3.1  PBIG 3 X PBIG 5 3 2 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3		95 95	95 1194		1238
PBIG 86 X K.B.         25         23         24         4.3         4.3         4.3         4.3         4.3         4.3         4.3         4.3         PBIG 2 X PBIG 90         20         15         18         3.3         3.6         3.5         3.5         9.5         3.6         4.0         4.5         4.3         4.5         4.5         4.5         4.5         4.5         4.5         4.5         4.5         4.5         4.5         4.5         4.5         5.8         4.5         5.6         5.0         4.0         4.4         4.2         4.2         5.0         9.0         6.6         5.0         4.0         4.2         5.0         9.0         6.6         3.3         5.0         9.0         9.0         6.6         3.3         5.0         9.0         9.0         9.0         6.6         3.3         5.0         9.0	3.2 2.	95 93	94 1406	1430	1418
PBIG 2 X PBIG 90 20 15 18 3.3 3.6 3.5 PBIG 2 X PBIG 4 30 22 26 5.0 4.0 4.5 PBIG 2 X PBIG 3 35 26 30 6.4 5.2 5.8 PBIG 2 X PBIG 5 6 26 26 4.0 4.4 4.2 PBIG 2 X K.B. 35 19 27 5.3 3.1 4.2 PBIG 90 X PBIG 90 X PBIG 5 25 21 23 3.5 5.0 PBIG 90 X PBIG 5 25 21 23 3.5 3.8 3.7 PBIG 90 X PBIG 5 25 21 23 3.5 3.8 3.7 PBIG 90 X K.B. 14 24 19 2.2 4.4 3.8 PBIG 4 X PBIG 5 26 32 29 27 3.1 4.4 3.8 PBIG 4 X PBIG 5 26 32 29 3.8 6.0 4.9 PBIG 3 X PBIG 5 6 19 18 19 3.4 4.2 3.3 PBIG 3 X K.B. 13 25 19 2.4 3.8 3.1 PBIG 3 X K.B. 13 25 19 2.4 3.8 3.1 PBIG 3 X K.B. 13 25 19 2.4 3.8 3.1 PBIG 3 X K.B. 13 25 19 2.4 3.8 3.1 PBIG 3 X K.B. 14 3.8 3.1 PBIG 3 X K.B. 15 15 15 15 15 15 15 15 15 15 15 15 15		97 93	95 1472		1435
PBIG 2 X PBIG 4         30         22         26         5.0         4.0         4.5           PBIG 2 X PBIG 3         35         26         30         6.4         5.2         5.8           PBIG 2 X PBIG 5         26         26         26         4.0         4.4         4.2           PBIG 2 X R.B.         35         19         27         5.3         3.1         4.2           PBIG 90 X PBIG 4         40         19         30         6.6         3.3         5.0           PBIG 90 X PBIG 5         25         21         28         4.3         3.6           PBIG 90 X PBIG 5         25         21         28         4.3         3.6           PBIG 90 X PBIG 56         25         21         23         3.5         3.8         3.7           PBIG 90 X PBIG 56         26         25         21         22         4.4         3.3           PBIG 4 X PBIG 3         24         29         3.8         6.0         4.9           PBIG 4 X K.B.         19         3.4         3.3         3.4           PBIG 3 X F.B.         19         3.4         3.3         3.4           PBIG 3 X K.B.         19         2.4		95 95	95 1149		1240
PBIG 2 X PBIG 3 35 26 30 6.4 5.2 5.8 PBIG 2 X K.B. 26 26 4.0 4.0 4.4 4.2 PBIG 2 X K.B. 35 19 27 5.3 3.1 4.2 PBIG 90 X PBIG 4 40 19 30 6.6 3.3 5.0 PBIG 90 X PBIG 5 25 21 23 3.5 3.8 3.7 PBIG 90 X PBIG 5 25 21 23 3.5 3.8 3.7 PBIG 90 X K.B. 14 24 19 2.2 4.4 3.3 PBIG 4 X PBIG 3 24 29 27 3.1 4.4 3.8 PBIG 4 X FBIG 5 26 32 29 3.8 6.0 4.9 PBIG 5 26 28 24 3.4 4.2 3.8 PBIG 5 26 28 24 3.4 4.2 3.8 PBIG 5 26 28 24 3.4 4.2 3.8 PBIG 5 20 28 24 3.4 4.2 3.8 PBIG 3 X K.B. 13 25 19 2.4 3.8 3.1 PBIG 3 X K.B. 13 25 19 2.4 3.8 3.1		06 26	94 1608	1386	1497
PBIG 2 X PBIG 56 26 26 4.0 4.4 4.2 PBIG 2 X K.B. 35 19 27 5.3 3.1 4.2 PBIG 90 X PBIG 4 19 22 18 2.8 4.3 5.0 PBIG 90 X PBIG 56 25 21 23 3.5 3.6 PBIG 90 X K.B. 14 24 19 2.2 4.4 3.3 PBIG 4 X PBIG 3 24 29 27 3.1 4.4 3.8 PBIG 4 X PBIG 56 26 32 29 3.8 6.0 4.9 PBIG 4 X K.B. 20 28 24 3.4 4.2 3.8 PBIG 3 X K.B. 13 25 19 2.4 3.8 3.1	5.2	06 26	94 2076		1731
PBIG 2 X K.B. 35 19 27 5.3 3.1 4.2 PBIG 90 X PBIG 40 19 30 6.6 3.3 5.0 PBIG 90 X PBIG 3 14 22 18 2.8 4.3 3.6 PBIG 90 X PBIG 56 25 21 23 3.5 3.8 3.7 PBIG 90 X K.B. 14 24 19 2.2 4.4 3.3 PBIG 4 X PBIG 3 24 29 27 3.1 4.4 3.8 PBIG 4 X PBIG 56 26 32 29 3.8 6.0 4.9 PBIG 4 X K.B. 20 28 24 3.4 4.2 3.8 PBIG 3 X PBIG 56 19 18 19 3.4 3.3 3.4 PBIG 3 X K.B. 13 25 19 2.4 3.8 3.1	4.4	97 93	95 1452	1378	1415
PBIG 90 X PBIG 4         40         19         30         6.6         3.3         5.0           PBIG 90 X PBIG 3         25         21         23         3.5         3.8         4.3         3.6           PBIG 90 X PBIG 56         25         21         23         3.5         3.8         3.7           PBIG 90 X PBIG 56         25         21         23         3.5         3.8         3.7           PBIG 90 X PBIG 56         26         27         3.1         4.4         3.3           PBIG 4 X PBIG 56         26         32         29         3.8         6.0         4.9           PBIG 4 X FBIG 56         26         28         24         3.4         4.2         3.8           PBIG 3 X FBIG 56         19         18         19         3.4         4.2         3.8           PBIG 3 X K.B.         13         25         19         2.4         3.8         3.1           PBIG 3 X K.B.         13         25         19         4.0         4.9         4.5		95 95	95 1738		1852
PBIG 90 X PBIG 3 14 22 18 2.8 4.3 3.6 PBIG 90 X PBIG 56 25 21 23 3.5 3.8 3.7 PBIG 90 X K.B. 14 24 19 2.2 4.4 3.3 PBIG 4 X PBIG 5 26 26 29 27 3.1 4.4 3.8 PBIG 4 X FBIG 5 26 26 32 29 3.8 6.0 4.9 PBIG 4 X K.B. 20 28 24 3.4 4.2 3.8 PBIG 3 X FBIG 5 6 19 18 19 3.4 3.3 3.4 PBIG 3 X K.B. 13 25 19 2.4 3.8 3.1	3.3	06 26	94 1745		1818
PBIG 90 X PBIG 56 25 21 23 3.5 3.8 3.7 PBIG 90 X K.B. 14 24 19 2.2 4.4 3.3 PBIG 4 X PBIG 3 24 29 27 3.1 4.4 3.8 PBIG 4 X PBIG 56 26 32 29 3.8 6.0 4.9 PBIG 4 X K.B. 20 28 24 3.4 4.2 3.8 PBIG 3 X PBIG 56 19 18 19 3.4 3.3 3.4 PBIG 3 X K.B. 13 25 19 2.4 3.8 3.1 PBIG 3 X K.B. 13 25 19 2.4 3.8 3.1	4.3	92 93	92 1147	1350	1249
PBIG 90 X K.B. 14 24 19 2.2 4.4 3.3 PBIG 4 X PBIG 3 24 29 27 3.1 4.4 3.8 PBIG 4 X PBIG 56 26 32 29 3.8 6.0 4.9 PBIG 4 X K.B. 20 28 24 3.4 4.2 3.8 PBIG 3 X PBIG 56 19 18 19 3.4 3.3 3.4 PBIG 3 X K.B. 13 25 19 2.4 3.8 3.1	3.8		94 1586		1499
PBIG 4 X PBIG 56 26 29 27 3.1 4.4 3.8 PBIG 4 X PBIG 56 26 32 29 3.8 6.0 4.9 PBIG 4 X K.B. 20 28 24 3.4 4.2 3.8 PBIG 3 X PBIG 56 19 18 19 3.4 3.3 3.4 PBIG 3 X K.B. 13 25 19 2.4 3.8 3.1	4.4				1663
PBIG 4 X PBIG 56 26 32 29 3.8 6.0 4.9 PBIG 4 X K.B. 20 28 24 3.4 4.2 3.8 PBIG 3 X PBIG 56 19 18 19 3.4 3.3 3.4 PBIG 3 X K.B. 13 25 19 2.4 3.8 3.1	4.4		94 1326		1468
PBIG 4 X K.B. 20 28 24 3.4 4.2 3.8 PBIG 3 X PBIG 56 19 18 19 3.4 3.3 3.4 PBIG 3 X K.B. 13 25 19 2.4 3.8 3.1	0.9	97 93	95 1413		1317
PBIG 3 X PBIG 56 19 18 19 3.4 3.3 3.4 PBIG 3 X K.B. 13 25 19 2.4 3.8 3.1	4.2	97 93	95 1608		1600
PBIG 3 X K.B. 13 25 19 2.4 3.8 3.1	3.3	95 93	94 1653		1576
10 10 40 45	3.8	92 90	91 1572	1440	1506
17 4.0	4.9 4.5	92 95	94 1776		1670
2.34 3.74 0.43		3.43 6.06	161.21	_	
CV (%) 6.66 10.33 7.73 10.73 2.21		2.21 4.02	6.18	6.75	

K.S. = Kalyanpur Sona; K.B. = Kalyanpur Barai

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