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# Combining Ability Analysis for Yield and Its Component Traits in Wheat (*Titicum aestivum* L.) under Timely Sown Irrigated Condition

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**Abstract**

The present investigation entitled "Combining ability analysis for yield and its component traits in wheat (*Triticum aestivum* L.) under timely sown irrigated condition" was carried out during *Rabi* 2015-16 and 2016-17 at the All India Co-ordinated Wheat & Barley improvement project, B.T.C. College of Agriculture and Research Station, Bilaspur (C.G.). The experiment was conducted in Randomized Complete Block design involving ten lines, four testers and 40 $F_1$s hybrids of wheat with two replications for study of character associated with yield and yield contributing traits for combining ability analysis. Analysis of variance revealed that variance due to the line×tester was significant for almost all the characters studied.MP 1202, Chhattisgarh genhu 03 and HW 2045 are good general combiner for number of grains per spike. LOK 1 had highest GCA effect for 1000 seed weight and GW 322 is best combiner for seed yield per plant. Negative SCA for days to 50% flowering and maturity was recorded by GW 322×GW 2013–507 and Chattisgarh genhu 03×GW 2013–507 respectively. MP 1202×PBW 585 is the best specific combiner for 1000 seed weight. More than 70% of crosses show positive SCA effect for seed yield per plant. Hence these findings of general combiners and specific combiners will be useful for next breeding programme for increasing the seed yield per plant, number of grains per spike and 1000 seed weight.

***Keywords:*** Wheat, Combining ability, Line×Tester, timely sown irrigated condition

## 1. Introduction

Wheat (*Triticum aestivum* L.) is second important staple food crop in India next to rice. It is widely cultivated due to its remarkable adaptation to a wide range of environment. The bread wheat (Hexaploid 2n=42) and durum wheat (Tetraploid 2n=28) is mostly grown in the central zone. Chhattisgarh comes under the central zone along with MP, Gujarat and some part of Rajasthan. A large area of paddy cultivation is covered early and medium duration paddy varieties, which are harvested in the end of October or up to first fortnight of November followed by cultivation of wheat under irrigated areas. Soybean is also cultivated sizable area in Chhattisgarh which is harvested in the month of October make it possible to cultivated the wheat after soybean harvest under irrigated/ restricted irrigation condition. Sowing of wheat before 25th November is called timely sown wheat.

The line×tester analysis was used to estimate both general combining ability effects (G.C.A.) and specific combining ability ones (S.C.A.) for yield and its components and other important agronomic traits of wheat by authors. Raj and Kandalkar (2013), reported that many traits were under the control of both additive as well as non-additive inheritance. On the other hand, Barot *et al*., (2014) observed that the magnitude of general combining ability variances was higher than the specific combining ability variances for all the characters which indicated preponderance of additive gene action in the inheritance of these traits (Hassan, 2007). A present study was designed to find out good general combining lines, testers and crosses for various characters so that suitable crosses are marked in view of gene action for adopting proper selection method to develop productive wheat cultivars.

## 2. Materials and Methods

The present research was conducted in two season *rabi* 2015–17 at All India Co-ordinated Wheat & Barley Improvement Project at B.T.C. College of Agriculture and Research Station, Indira Gandhi Krishi Vishwavidyalaya, Bilaspur, Chhattisgarh, India. Chhattisgarh state is located between 17°14'N and 24°45'N latitudes and 73°30' E and 84°15' E longitudes. Bilaspur is lies at 22°07' N latitude and 82°13' E longitude with an altitude of 289.60 meters above mean sea level.

Fourteen wheat genotypes including ten lines and four testers were crossed in a Line×Tester matting design and developed 40 $F_1$ hybrids during *rabi* 2015–16 (Table 1) The experiment was laid out with 40 hybrids and 14 parents in a randomized

Table 1: Details of parents used in study

| Sl. No. | Name of parent | Origin of Genotype | Releasing year |
|---|---|---|---|
| [A] Tester (Male parents) | | | |
| 1. | GW 2013-507 | SDAU, Vijaypur, Gujrat | - |
| 2. | DBW 14 | DWR, Karnal, Hariyana | 2002 |
| 3. | PBW 585 | PAU, Ludhiana, Panjab | - |
| 4. | WH 1021 | HAU, Hissar, Hariyana | - |
| [B] Line (Female parents) | | | |
| 1. | GW 322 | SDAU, Vijapur Gujrat | 2002 |
| 2. | GW 366 | JAU, Junagarh, Gujrat | 2007 |
| 3. | HI 1544 | ICAR-RS, Indore, (MP) | 2007 |
| 4. | GW 273 | SDAU, Vijapur, Gujrat | 1993 |
| 5. | MP 1202 | JNKVV, Powarkheda, (MP) | 2010 |
| 6. | CG 03 | IGKV, Bilaspur, (C.G.) | 2015 |
| 7. | DL 803-3 | IARI, New Delhi | 1995 |
| 8. | GW 391 | SDAU, Vijaypur, Gujrat | - |
| 9. | HW 2045 | IARI, RS, Wellington | - |
| 10. | LOK 1 | Lok Bharti, Sonasora, Gujrat | 1982 |

block design with two replication during *rabi* 2016–17. Five competitive plants were randomly selected to record the observation on ten characters *viz* (days to 50% flowering, days to maturity, plant hight (cm), number of tillers per plant, spike length (cm), number of spikelets per spike, number of grains per spike, harvest index (%), 1000 seed weigh (g), and seed yield per plant (g). The combining ability analysis was done as the procedure described by Kempthorne (1957).

## 3. Results and Discussion

### *3.1. Anlysis of variance for parents and hybrids:*

Variances were estimated for all the ten characters under study (Table 2 and Table 3) Variance due to line and tester, show significant for all the character except spike length as found by Grifing (1956). Variance due to line vs. tester show significant for all the character except days to maturity, number of tillers per plant, Harvest index (%) and 1000 seed weight, variance due to crosses show significant for all the ten character and variance due to parents *vs* crosses show significant for all the character except days to 50% flowering and number of spikelets per spike.

### *3.2. Analysis of variance for combining ability*

Analysis of variance for combining ability was estimated for all the traits as per procedure described by Kempthorne (1957). Variance due to females found highly significant for all the character under studied (Table 4 and Table 5). The variances due to males found highly significant for all traits

Table 2: Analysis of variance for parents and hybrids

| Source | d.f. | DF | DM | PH | NTP | SL |
|---|---|---|---|---|---|---|
| Replication | 1 | 9.48* | 4.44* | 0.81 | 10.07* | 1.42 |
| Parents | 13 | 16.26** | 7.35** | 24.52** | 9.92** | 1.44** |
| Females | 9 | 20.11** | 3.11** | 19.18** | 11.01** | 1.10 |
| Males | 3 | 9.66** | 2.33 | 46.03** | 9.96** | 1.43 |
| Female vs. males | 1 | 1.42 | 15.53** | 8.05* | 0.002 | 4.60** |
| Crosses | 39 | 17.01** | 13.37** | 83.48** | 17.24** | 1.89** |
| Parents vs crosses | 1 | 5.89 | 47.15** | 8.12* | 206.07* | 22.2** |
| Error | 53 | 1.76 | 1.06 | 1.91 | 1.87 | 0.55 |

DF: Days to 50% flowering (days); DM: Day to maturity (days); PH: Plant height (cm); NTP: No. of tillers plant$^{-1}$; SL: Spike length (cm); *Significant at *p*=0.05 level, **Significant at *p*=0.01 level

Table 3: Analysis of variance for parents and hybrids

| Source | d.f. | Number of spikelets spike$^{-1}$ | No. of grains spike$^{-1}$ | Harvest index (%) | 1000 seed weight (g) | Seed yield per plant (g) |
|---|---|---|---|---|---|---|
| Replication | 1 | 0.31 | 115.66** | 30.66** | 152.61 | 79.39** |
| Parents | 13 | 6.65** | 102.13** | 8.90** | 11.78** | 92.17** |
| Females | 9 | 5.43** | 91.47** | 9.49** | 13.74** | 95.89** |
| Males | 3 | 9.67** | 148.93** | 8.83* | 9.82* | 73.65** |
| Female vs. males | 1 | 8.54** | 57.68** | 3.80 | 0.029 | 114.25** |
| Crosses | 39 | 5.92** | 207.61** | 12.97** | 27.01** | 104.05** |
| Parents vs crosses | 1 | 0.37 | 1972.86** | 244.99** | 373.26** | 166.56** |
| Error | 53 | 0.71 | 6.53 | 3.01 | 3.22 | 4.22 |

*Significant at p=0.05 level, **Significant at p=0.01 level

Table 4: Analysis of variance for combing ability

| Source | d.f. | DF | DM | PH | NTP | SL |
|---|---|---|---|---|---|---|
| Replication | 1 | 1.25 | 2.10 | 0.60 | 0.75 | 1.42 |
| Females | 9 | 21.86** | 37.53** | 201.56** | 30.83** | 3.69** |
| Males | 3 | 56.68** | 15.28** | 41.15** | 17.46** | 3.07** |
| Female vs. Male | 27 | 10.98** | 4.98** | 48.83** | 12.6** | 1.16* |
| Error | 39 | 1.40 | 0.83 | 1.97 | 1.77 | 0.54 |

*Significant at $p$=0.05 level, **Significant at $p$=0.01 level

except harvest index (%) and variance due to female vs. male found highly significant for all the traits. Similar results also reported by Joshi et al., (2003), Joshi et al., (2004) and Singh et al., (2004).

*3.3. General combining ability effect of parents*

HI 1544, HW 2045, GW 2013-507 were the parents which could reduce the days to flowering and maturity on the basis of the GCA effects (Table 6).The crosses between these parents through early flowering and maturity segregates in $F_2$ generation. DL 803-3 and GW 366 were good general combiners for number of tillers per plant (Kulshreshtha and Singh, 2011); however GW 391 and GW 273 were better

Table 5: Analysis of variance for combing ability

| Source | d.f. | No. of spikelets spike$^{-1}$ | No. of grains spike$^{-1}$ | Harvest index (%) | 1000 seed weight (g) | Seed yield plant$^{-1}$ (g) |
|---|---|---|---|---|---|---|
| Replication | 1 | 0.73 | 116.60** | 67.52** | 142.45** | 86.12** |
| Females | 9 | 17.44** | 572.69** | 38.92** | 60.62** | 239.52** |
| Males | 3 | 5.57** | 65.21** | 5.87 | 14.04* | 97.11** |
| Female vs Male | 27 | 2.12** | 101.93** | 5.10* | 17.24** | 59.66** |
| Error | 39 | 0.65 | 6.33 | 2.41 | 3.70 | 4.97 |

*Significant at p=0.05 level, **Significant at p=0.01 level

combiner for spikelets per spike. MP 1202, Chhattisgarh gehu 03 and HW 2045 were good general combiner for number of grains per spike. LOK 1 had highest GCA effect for 1000 seed weight and GW 322 is best combiner for seed yield per plant. Similar result was also reported by Dhadhal and Dobariya (2006).

*3.4. Specific combining ability effect of hybrids:*

Negative SCA for days to 50% flowering and maturity was recorded by GW 322×GW 2013-507 and Chhattisgarh gehu 03×GW 2013-507 respectively. (Table 6) Ten hybrids expressed positive SCA for tillers per plant and HW 2045×GW 2013-507 had the highest SCA effect. Only four hybrids

Table 6: GCA and SCA effects

| Sl. No. | Lines/Testers/ Crosses | Days to 50% flowering (days) | Days to maturity (days) | Plant height (cm) | No. of tillers plant$^{-1}$ | Spike length (cm) | No. of spikelets spike$^{-1}$ | No. of grains spike$^{-1}$ | Harvest index (%) | 1000 seed weight (g) | Seed yield plant$^{-1}$ (g) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lines | | | | | | | | | | | |
| 1. | GW 322 | -0.45 | -2.31** | 3.96** | -1.31** | -0.61 | 0.30 | 1.38** | -1.53** | -2.77** | 7.30** |
| 2. | GW 366 | -0.45 | 1.94C** | -3.30** | 1.88** | -1.08** | -0.97* | -5.61** | 1.74** | -1.95** | 4.92** |
| 3. | HI 1544 | -2.70** | -2.94** | -4.54** | -2.13** | -0.36 | -1.01** | -8.07** | 2.13** | 0.41 | -4.95** |
| 4. | GW 273 | -0.32 | -2.69** | 6.94** | -2.40** | 0.72* | 1.08** | -5.45** | -1.70** | -1.57** | -8.97** |
| 5. | MP 1202 | 2.05** | 1.19** | 1.84** | -2.00** | 1.02** | 0.91* | 11.34** | -2.26** | 0.40 | 4.58** |
| 6. | CG 03 | 2.80** | 2.94** | -5.59** | -0.46 | -0.20 | -0.64 | 6.91** | 2.14** | 0.53 | 0.68 |
| 7. | DL 803-3(K) | 1.18** | 0.94* | 4.61** | 3.42** | -0.59 | 0.66 | 3.49** | -2.30** | -2.02** | -2.67** |
| 8. | GW 391 | 0.43 | -1.19** | 2.60** | 0.62 | 0.65 | 2.78** | 5.81** | -0.98** | -1.85** | 0.96* |
| 9. | HW 2045 | -1.32** | 2.31** | -8.14** | 0.97* | 0.30 | -0.51 | 6.26** | 3.75** | 2.53** | -6.22** |
| 10. | LOK 1 | -1.20** | -0.19 | 1.61** | 1.40** | 0.15 | -2.60** | -15.97** | -0.98** | 6.30** | 4.35** |
| Testers | | | | | | | | | | | |
| 1. | GW 2013-507 | -1.88** | -1.06** | 1.00** | 0.95** | -0.40* | -0.34 | -2.19** | -0.53* | 0.85** | -1.00** |

Continue...

| Sl. No. | Lines/Testers/ Crosses | Days to 50% flowering (days) | Days to maturity (days) | Plant height (cm) | No. of tillers plant$^{-1}$ | Spike length (cm) | No. of spikelets spike$^{-1}$ | No. of grains spike$^{-1}$ | Harvest index (%) | 1000 seed weight (g) | Seed yield plant$^{-1}$ (g) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2. | DBW 14 | -0.82** | -0.36 | -1.08** | 0.55* | -0.23 | -0.18 | 0.34 | 0.38 | 0.34 | -0.68** |
| 3. | PBW 585 | 1.93** | 0.64** | -1.38** | -0.40* | 0.47* | 0.79* | -0.35 | 0.54* | -0.07 | -1.58** |
| 4. | WH 1021 | 0.78** | 0.79** | 1.46** | -1.11** | 0.16 | -0.26 | 2.18** | -0.40* | -1.12** | 3.26** |
| Crosses | | | | | | | | | | | |
| 1. | GW 322×GW 2013-507 | -4.50** | 0.06 | -1.90** | -2.44** | 0.15 | 1.34* | -2.63** | -0.19 | 0.16 | -6.09** |
| 2. | GW 322×DBW 14 | -0.05 | 0.36 | 0.28 | 0.96 | -0.22 | 0.98 | 7.54** | 0.73 | -2.00** | -6.18** |
| 3. | GW 322×PBW 585 | 3.71** | -0.14 | -4.47** | -0.04 | -0.47 | -1.44* | 0.28 | -2.28** | 0.31 | 4.07** |
| 4. | GW 322×WH 1021 | 0.85 | -0.29 | 6.09** | 1.53* | 0.54 | -0.89 | -5.20** | 1.74** | 1.53* | 8.20** |
| 5. | GW 366×GW 2013-507 | 0.50 | 1.31* | 0.36 | 3.42** | 0.86 | 1.42* | 16.01** | 0.08 | 1.60* | 5.83** |
| 6. | GW 366×DBW 14 | -0.05 | -2.89** | 4.49** | -1.73** | -0.15 | -1.19* | -2.47** | -039* | -1.17 | 1.60** |
| 7. | GW 366×PBW 585 | -0.30 | 0.11 | 4.39** | 0.27 | 0.19 | -0.11 | -5.33** | -2.12** | -0.01 | -2.04** |
| 8. | GW 366×WH 1021 | -0.15 | 1.46* | -9.24** | -1.96** | -0.90 | -0.12 | -8.21` | 2.43** | -0.43 | -5.38** |
| 9. | HI 1544×GW 2013-507 | -2.25** | -0.31 | -0.75 | -0.27 | 0.15 | -0.29 | -0.13 | -0.34 | -3.32** | 2.56** |
| 10. | HI 1544×DBW 14 | 1.20* | -0.01 | -3.52** | -0.72 | 0.13 | 0.45 | -0.36 | 1.66* | 0.74 | 1.73** |
| 11. | HI 1544×PBW 585 | -1.05 | -1.01 | 3.38** | 0.23 | -0.17 | -0.82 | 4.93** | 0.16 | 2.22** | -0.35 |
| 12. | HI 1544×WH 1021 | 2.10** | 1.34* | 0.89 | 0.75 | -0.11 | 0.67 | -4.45** | -1.47* | 0.35 | -3.93** |
| 13. | GW 273×GW 2013-507 | 0.88 | -0.06 | 0.38 | -0.90 | 0.46 | -0.43 | -0.05 | -2.42** | -3.09** | -0.09 |
| 14. | GW 273 X DBW 14 | 3.32** | 2.74** | 1.95** | -2.15** | -0.45 | 0.56 | -0.33 | 0.14 | 1.79** | -2.82** |
| 15. | GW 273×PBW 585 | -1.43* | -2.26** | -0.65 | 2.00** | -0.81 | 0.64 | 0.46 | 0.42* | -0.27 | 4.34** |
| 16. | GW 273× WH 1021 | -2.78** | -0.41 | -1.68** | 1.06 | 0.80 | -0.77 | -0.07 | 1.86** | 1.58* | -1.43* |
| 17. | MP 1202× GW 2013-507 | 2.00** | -0.44 | 0.28 | 1.75** | -0.04 | -1.22* | -10.89** | 0.64 | -0.26 | 0.62 |
| 18. | MP1202× DBW 14 | -3.55** | -1.14 | 1.35** | 2.70** | -0.80 | -0.63 | -11.42** | 0.25 | -3.14** | 1.34 |
| 19. | MP1202×PBW 585 | 0.70 | 1.36* | -1.10 | -1.75** | 0.29 | 0.40 | 5.82** | 1.76** | 7.18** | 3.41** |

Continue...

| Sl. No. | Lines/Testers/ Crosses | Days to 50% flowering (days) | Days to maturity (days) | Plant height (cm) | No. of tillers plant$^{-1}$ | Spike length (cm) | No. of spikelets spike$^{-1}$ | No. of grains spike$^{-1}$ | Harvest index (%) | 1000 seed weight (g) | Seed yield plant$^{-1}$ (g) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 20. | MP1202×WH 1021 | 0.85 | 0.21 | -0.53 | -2.68** | 0.55 | 1.45* | 16.49** | -2.65** | -3.78** | -5.38** |
| 21. | CG 03×GW 2013-507 | -1.75** | -3.69** | -0.85 | -0.34 | 0.29 | 1.23* | -2.26** | -1.89** | 5.63** | 1.43* |
| 22. | CG 03×DBW 14 | -1.80** | 0.61 | 0.98 | 0.41 | -0.18 | 0.62 | -2.79** | -0.14 | -3.36** | -0.30 |
| 23. | CG03×PBW 585 | 2.95** | 2.61** | -7.62** | -0.99 | -0.53 | -0.90 | -3.60** | 2.04** | -4.73** | -0.40 |
| 24. | CG 03×WH 1021 | 0.60 | 0.46 | 7.49** | 0.93 | 0.43 | -0.95 | 8.66** | -0.01 | 2.46** | -0.73 |
| 25. | DL803-3(K)× GW 2013-507 | 2.38** | 0.31 | 7.60** | -3.17** | 0.12 | -1.17 | -0.04 | -0.55 | -0.57 | -4.05** |
| 26. | DL803-3(K)× DBW 14 | -0.18 | -0.89 | -1.22* | 1.73** | 0.31 | 0.57 | -3.07** | -0.79 | 0.48 | 2.45** |
| 27. | DL803-3(K)×PBW 585 | -1.43* | -0.39 | 5.43** | 2.63** | 0.25 | -0.40 | 1.32* | 0.99 | -1.03 | 1.98** |
| 28. | DL803-3(K)× WH 1021 | -0.78 | 0.96 | -11.81** | -1.20* | -0.69 | 1.00 | 1.79** | 0.34 | 1.11 | -0.38 |
| 29. | GW 391× GW 2013-507 | -0.88 | 0.94 | -3.93** | -0.82 | -1.46* | -0.38 | -6.16** | 1.84** | -0.17 | -2.23** |
| 30. | GW 391× DBW 14 | 0.57 | -0.26 | 1.79** | -0.37 | 0.37 | -0.14 | 5.81** | -0.91 | 2.56** | 4.60** |
| 31. | GW 391× PBW 585 | 1.32* | 0.24 | -0.46 | -0.02 | 0.97 | 0.79 | -0.50 | -0.08 | -3.07** | -14.36** |
| 32. | GW 391×WH 1021 | -1.03 | -0.91 | 2.61** | 1.20* | 0.13 | -0.27 | 0.86 | -0.85 | 0.68 | 11.99** |
| 33. | HW2045× GW 2013-507 | 3.38** | 0.94 | -1.10 | 6.68** | 0.14 | 0.51 | 3.54** | 2.03** | 1.11 | 1.49* |
| 34. | HW2045× DBW 14 | 0.82 | -0.26 | -2.52** | -2.07** | 1.12** | -1.45* | 5.91** | -0.35 | 0.70 | 3.05** |
| 35. | HW2045× PBW 585 | -1.93** | -0.26 | 3.18** | -2.02** | 0.52 | 1.08 | -5.25** | -1.61* | -1.02 | -1.00 |
| 36. | HW2045× WH 1021 | -2.28** | -0.41 | 0.44 | -2.60** | -1.77** | -0.13 | -4.18** | -0.08 | -0.79 | -3.54** |
| 37. | LOK 1×GW 2013-50733.49 | 0.25 | 0.94 | -0.10 | -3.90** | -0.66 | -1.01 | 2.62** | 0.81 | -1.11 | 0.54 |
| 38. | LOK 1×DBW 14 | -0.30 | 1.74** | -3.57** | 1.25* | -0.13 | 0.23 | 1.19* | -0.21 | 3.40** | -5.47** |
| 39. | LOK 1×PBW 585 | -2.55** | -0.26 | -2.07** | -0.30 | -0.23 | 0.76 | 1.8** | 0.71 | 0.42 | 4.35** |
| 40. | LOK 1×WH 1021 | 2.60** | -2.41** | 5.74** | 2.96** | 1.03 | 0.01 | -5.70** | -1.31* | -2.71** | 0.58 |

*Significant at p=0.05 level, **Significant at p=0.01 level

showed positive significant SCA effect for spiklets per spike in lower magnitude. High magnitude of SCA effect was recorded in cross MP 1202×WH 1021 for number of grains per spike. MP 1202×PBW 585 was the best specific combiner for 1000 seed weight. More than 70% of crosses showed positive SCA effect for seed yield per plant (Singh et al., 2012).

## 4. Conclusion

Out of the 10 parents none were found good combiner for the character studied. Different parents were good combiner for the different character. None of the tester was good general combiner than the lines.None of the crosses exhibit significant SCA effect for all the character studied. Specific crosses were specific combiner for different traits, tester GW 2013-507 exhibit high SCA effects when the crosses with different parents for some of crosses studied.

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