# INTERACTION BETWEEN GENOTYPE AND ENVIRONMENT SHOWN BY SOME QUANTITATIVE CHARACTERS IN LENTIL (*Lens culinaris* Medic.)

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**Key words:** *Lens culinaris*,Lentil, Barimasur, Genotype, Environment, Effect, Path, Correlation, Irrigation and Stability

## Abstract

The influence of four levels of environments viz. $E_1$ (no irrigation), $E_2$ (irrigation at first flowering stage), $E_3$ (irrigation at poding stage) and $E_4$ (irrigation both the flowering and poding stages) on yield and yield contributing characters of six lentil genotypes viz. $G_1$ (Barimasur-1), $G_2$ (Barimasur-2), $G_3$ (Barimasur-3), $G_4$ (Barimasur-4), $G_5$ (Barimasur-5) and $G_6$ (Barimasur-6) exhibited distinct variation in respect of all the characters under investigation in the field condition. The environment-4 plants produced the maximum grain yield (2181 kg /ha). Barimasur-6 gave the highest grain yield (2276 kg /ha) and Barimasur-1 had the lowest grain yield (1795 kg /ha). Barimasur-6 along with double irrigation produced maximum grain yield (2308 kg /ha). Correlation studies revealed that grain yield was positively related with different yield components. Branch number per plant showed strong positive correlation with most of the characters. Path coefficient analysis revealed that plant area per plant showed the highest and plant height showed the lowest positive direct effect on grain yield. Stability parameters studies revealed that Barimasur-6 showed the highest grand mean performance, regression value nearly one ($b_i$=1.00) and stability value nearly zero ($\overline{S}^2_{di}$=0) most of the characters. So, Barimasur-6 is the suitable genotype for cultivation in the northern region of Bangladesh.

## Introduction

Pulses, called the "protein particles" are the important source of protein nutrition for the people of Bangladesh (Mian,1976). Lentil (*Lens culinaris* Medic.) is one of the most important nutritious food of the modern human civilization. Protein is the basis of life. It is the main component of different organ of human body. For balanced diet optimum content is very much essential in people daily food with other components (Afzal *et al.*,2003). Lentil contains adequate quantity of protein. It is nutritionally superior to most other food in many ways in value. It compares very well in nutrition value with fish and meat. So, in pulse particularly lentil is called the meat of poor in this country (Afzal *et al*., 2003). Among the pulse crops lentil is the first ranks in respect of production and area of Bangladesh (Afzal *et al*.,1999). In Bangladesh, the demands for lentil are increasing day by day, where the area under lentil cultivation is not increasing rather it is reducing. As a result, Bangladesh has to import lentil from other countries to meet its demand. Present consumption is about 1.00 million tons against the production of about 0.54 million tons and every year import is about o.44 million tons (Bakr *et al*., 2007). Lack of use of modern genotypes and optimum environment may be a major constraint of maximum harvest. Lentil genotypes vary in their nature of grain with wide range of production of yield parameters and yield. Hence, an investigation was undertaken with four levels of environment (treatment) along with six genotypes to find out a suitable environment combination in respect of growth and yield of lentil grown in the Rajshahi region of Bangladesh.

## Materials and Methods

The experiment was carried out at the Botanical research field of Rajshahi University, during the period from November 2009 to February 2010 and November 2010 to February 2011 for production of grain. The global position site (GPS) of the experimental area is $24^0 17^/$- $24^0$ $31^/$ N latitude and

$88^0 28^/$- $88^0 43^/$ E longitude with a height of 20 meter above the sea level (Anisuzzaman, 2003). The pH of soil 8.12 with organic mater content of 2.56% (Islam *et al*., 2002). There were four levels of irrigations, $E_1$(no irrigation), $E_2$ (irrigation at first flowering stage), $E_3$ (irrigation at poding stage) and $E_4$ (irrigation both the flowering and poding stages) and six genotypes, $G_1$(Barimasur-1) $G_2$ (Barimasur-2), $G_3$ (Barimasur-3), $G_4$ (Barimasur-4), $G_5$ (Barimasur-5) and $G_6$ (Barimasur-6). The experiment was arranged in split plot design with four environments (treatment). Each treatment was divided into three replications and each replication was divided into six sub plot or split plots. The size of each plot was (8.7×1.5) 13.05 $m^2$. The field was prepared in due time. Fertilizer was applied at the rate of per hectare 45 kg urea, 85 kg TSP and 35 kg MP at the final land preparation (Afzal *et al*., 2003). Intercultural operations like gap filling, weeding, thinning, plant protection etc. were done as and when required. Three plants were selected randomly for each genotype in such a way that the marginal effect was avoided and the data was recorded on plant height , branch number per plant, plant area per plant, days to 50% flower, days to maturity, pod number per plant, seed number per plant,1000 seed weight, total dry matter and grain yield per hectare. Data regarding various parameters under were statistically analyzed. The significance difference among the means was determined the DMRT (Gomez and Gomez, 1984)

**Results and Discussion**

Effect of genotypes: Significant genotypic variation was observed (**Table 1 & 2**) in all the characters, Barimasur-6 ($G_6$) showed the maximum branch number per plant, pod number per plant, seed number per plant and grain yield per hectare. The lowest plant area per plant, pod number per plant, seed number per plant and grain yield per hectare were recorded from Barimasur-1($G_1$). The genotype Barimasur-1 accumulated maximum plant height and Barimasur-6 accumulated minimum. The lowest total dry matter and 1000 seed weight were obtained from Barimasur-2, but the highest total dry matter was found in Barimasur-5 and 1000 seed weight was observed in Barimasur-3. Different genotypic effect obtained in the present study were similar in lentil by Rasul (1988), Azad (1991), Khatun (1997) and Islam *et al*. (2002), in chickpea by Deb (2002), in barley by Anisuzzaman (2003) and in onion by Islam *et al*.(2007).

Effect of environments: Different levels of irrigation influence growth, yield and yield components of lentil (**Table 1 & 2**). The highest plant height, branch number per plant, pod number per plant, seed number per plant, 1000 seed weight, total dry matter and grain yield per hectare were found in environment-4 ($E_4$) plants. The lowest plant height, branch number per plant, plant area per plant, pod number per plant, seed number per plant, total dry matter and grain yield per hectare were recorded in environment-1 ($E_1$) plants. Environment-3 plants showed the highest plant area per plant and the lowest 1000 seed weight. Afzal *et al*. (2003) recorded that growth and yield of lentil positively influence by applying different irrigation levels. These results are in agreement with findings in lentil by Rasul (1988), Azad (1991), Khatun (1997) and Islam *et al*.(2002), in chickpea by Hauqe (1989) and Deb (2002) and in barley by Anisuzzaman (2003).

**Table 1:** Mean values of yield and its components of six lentil genotypes at final harvest as influenced by soil moisture for experiment 2009 – 2010.

| Genotype (G) | PH (cm) | BNPP | PAPP (cm) | Days to 50% F | DM | PNPP | SNPP | 1000 S.W.g | TDM (g) | Yield kg/ha$^{-1}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| Barimasur 1 ($G_1$) | 44.14 | 77.50 | 486.87 | 65.25 | 107.00 | 261.67 | 491.25 | 15.56 | 33.83 | 1885.17 |
| Barimasur 2 ($G_2$) | 39.97 | 76.92 | 515.12 | 65.01 | 107.00 | 264.33 | 502.33 | 12.64 | 33.74 | 1980.50 |
| Barimasur 3 ($G_3$) | 39.08 | 74.58 | 498.25 | 65.00 | 107.08 | 275.83 | 525.17 | 23.59 | 33.76 | 1986.00 |
| Barimasur 4 ($G_4$) | 39.98 | 78.42 | 658.26 | 67.75 | 111.75 | 278.33 | 537.92 | 20.25 | 34.16 | 2069.83 |
| Barimasur 5 ($G_5$) | 38.68 | 84.00 | 622.32 | 68.17 | 111.83 | 295.17 | 554.58 | 19.19 | 34.69 | 2176.42 |
| Barimasur 6 ($G_6$) | 38.07 | 84.67 | 636.89 | 64.67 | 107.00 | 303.08 | 576.92 | 19.66 | 34.64 | 2265.83 |
| LSD 5% | 1.83 | 3.78 | 60.96 | 0.91 | 0.54 | 34.83 | 59.71 | 0.35 | 0.69 | 21.93 |
| Environment (E) | | | | | | | | | | |
| Environment 1($E_1$) | 35.42 | 64.61 | 401.98 | 67.06 | 107.78 | 245.17 | 456.94 | 18.48 | 33.37 | 1983.77 |
| Environment 2($E_2$) | 39.48 | 73.33 | 598.68 | 65.00 | 108.17 | 274.17 | 522.94 | 18.53 | 33.89 | 2085.00 |
| Environment 3 ($E_3$) | 40.04 | 81.83 | 656.64 | 67.11 | 109.28 | 289.33 | 555.78 | 18.38 | 34.37 | 2091.17 |
| Environment 4 ($E_4$) | 42.46 | 97.61 | 621.54 | 64.72 | 109.22 | 310.28 | 589.78 | 18.54 | 34.93 | 2182.56 |
| LSD 5% | 1.38 | 6.87 | 560.86 | 0.81 | 0.39 | 31.55 | 54.90 | 0.24 | 0.41 | 29.02 |
| ( G×E) | | | | | | | | | | |
| $G_1 \times E_1$ | 38.43 | 67.00 | 389.83 | 66.67 | 106.33 | 178.67 | 314.00 | 15.62 | 33.22 | 1722.33 |
| $G_1 \times E_2$ | 46.07 | 67.67 | 415.87 | 64.00 | 106.67 | 253.67 | 482.33 | 15.64 | 33.53 | 1812.67 |
| $G_1 \times E_3$ | 43.07 | 82.67 | 564.91 | 66.33 | 107.67 | 304.33 | 578.67 | 15.46 | 34.10 | 1803.00 |
| $G_1 \times E_4$ | 49.00 | 92.67 | 971.72 | 64.00 | 107.33 | 310.00 | 590.00 | 15.51 | 34.47 | 1804.33 |
| $G_2 \times E_1$ | 34.33 | 58.00 | 366.58 | 66.00 | 106.33 | 222.67 | 423.33 | 12.69 | 32.54 | 1810.00 |
| $G_2 \times E_2$ | 40.93 | 77.00 | 540.57 | 64.00 | 106.33 | 260.67 | 495.67 | 12.67 | 33.85 | 1880.67 |
| $G_2 \times E_3$ | 39.57 | 76.67 | 556.71 | 66.00 | 107.67 | 265.33 | 504.00 | 12.63 | 34.02 | 1877.00 |
| $G_2 \times E_4$ | 41.03 | 96.00 | 598.42 | 64.00 | 107.67 | 308.67 | 586.33 | 12.57 | 34.56 | 1874.33 |
| $G_3 \times E_1$ | 34.83 | 64.00 | 379.72 | 66.00 | 106.67 | 258.33 | 492.33 | 23.55 | 33.18 | 1904.67 |
| $G_3 \times E_2$ | 34.34 | 68.35 | 477.62 | 64.00 | 106.67 | 265.00 | 504.00 | 23.67 | 33.40 | 1994.33 |
| $G_3 \times E_3$ | 39.77 | 74.67 | 539.28 | 66.00 | 107.67 | 275.00 | 524.67 | 23.48 | 33.95 | 2000.00 |
| $G_3 \times E_4$ | 46.60 | 91.33 | 595.73 | 64.00 | 107.33 | 305.00 | 579.67 | 23.65 | 34.50 | 2005.00 |
| $G_4 \times E_1$ | 34.67 | 56.33 | 448.63 | 68.67 | 110.33 | 251.67 | 478.67 | 19.91 | 33.63 | 2233.00 |
| $G_4 \times E_2$ | 39.67 | 70.00 | 696.52 | 67.00 | 111.67 | 263.33 | 502.67 | 20.08 | 33.39 | 2298.33 |
| $G_4 \times E_3$ | 40.20 | 87.33 | 744.15 | 69.00 | 112.33 | 283.00 | 571.00 | 20.58 | 34.54 | 2302.00 |
| $G_4 \times E_4$ | 39.80 | 100.00 | 741.67 | 66.33 | 112.67 | 315.33 | 599.33 | 20.43 | 35.09 | 2326.00 |
| $G_5 \times E_1$ | 35.13 | 69.67 | 406.12 | 69.00 | 110.67 | 266.00 | 475.33 | 19.18 | 33.58 | 2058.00 |
| $G_5 \times E_2$ | 39.80 | 82.67 | 725.08 | 67.33 | 111.33 | 311.67 | 597.00 | 19.22 | 34.80 | 2216.33 |
| $G_5 \times E_3$ | 38.63 | 80.33 | 749.23 | 69.33 | 112.67 | 295.00 | 560.67 | 19.00 | 34.94 | 2249.00 |
| $G_5 \times E_4$ | 38.73 | 103.33 | 608.95 | 67.00 | 112.67 | 308.00 | 585.33 | 19.36 | 35.45 | 2182.33 |
| $G_6 \times E_1$ | 35.13 | 72.67 | 418.01 | 66.00 | 106.33 | 293.67 | 558.00 | 19.94 | 34.04 | 2176.33 |
| $G_6 \times E_2$ | 36.10 | 74.33 | 736.41 | 63.67 | 106.33 | 290.67 | 556.00 | 19.90 | 34.36 | 2307.67 |
| $G_6 \times E_3$ | 39.03 | 89.33 | 788.13 | 66.00 | 107.67 | 313.33 | 595.67 | 19.12 | 34.66 | 2316.00 |
| $G_6 \times E_4$ | 39.60 | 102.33 | 604.71 | 63.00 | 107.67 | 314.67 | 598.00 | 19.67 | 35.51 | 2303.33 |
| LSD 5% | 3.38 | 2.67 | 590.23 | 1.98 | 0.96 | 77.28 | 134.47 | 0.58 | 1.00 | 71.09 |

**Table 2:** Mean values of yield and its components of six lentil genotypes at final harvest as influenced by soil moisture for experiment 2010 – 2011.

| Genotype (G) | PH (cm) | BNPP | PAPP (cm) | Days 50% F | DM | PNPP | SNPP | 1000 S.W.g | TDM (g) | Yield kg/hac |
|---|---|---|---|---|---|---|---|---|---|---|
| Barimasur 1 ($G_1$) | 44.47 | 78.17 | 497.87 | 64.83 | 107.08 | 272.92 | 494.08 | 15.55 | 33.89 | 1795.33 |
| Barimasur 2 ($G_2$) | 39.81 | 77.50 | 525.12 | 65.58 | 107.00 | 266.83 | 508.25 | 12.64 | 33.67 | 1960.33 |
| Barimasur 3 ($G_3$) | 40.96 | 75.25 | 506.33 | 65.25 | 107.00 | 278.42 | 511.67 | 23.57 | 34.06 | 1975.92 |
| Barimasur 4 ($G_4$) | 40.53 | 80.67 | 668.71 | 68.17 | 111.50 | 274.25 | 539.75 | 20.26 | 34.04 | 2088.42 |
| Barimasur 5 ($G_5$) | 38.53 | 83.25 | 629.32 | 67.92 | 111.67 | 293.42 | 553.50 | 19.20 | 34.11 | 2182.67 |
| Barimasur 6 ($G_6$) | 38.59 | 84.75 | 656.89 | 66.25 | 107.00 | 299.92 | 577.83 | 19.64 | 34.36 | 2276.08 |
| LSD 5% | 0.60 | 5.26 | 61.02 | 1.32 | 0.52 | 25.70 | 52.96 | 0.35 | 0.80 | 29.41 |
| Environment (E) | | | | | | | | | | |
| Environment 1 ($E_1$) | 35.60 | 65.89 | 408.98 | 67.56 | 107.83 | 252.39 | 464.94 | 18.49 | 32.96 | 1990.61 |
| Environment 2( $E_2$) | 41.18 | 74.06 | 508.62 | 65.50 | 107.94 | 277.61 | 528.61 | 18.52 | 34.10 | 2083.83 |
| Environment 3 ($E_3$) | 40.66 | 82.78 | 667.64 | 67.33 | 109.17 | 284.78 | 541.39 | 18.38 | 34.29 | 2090.00 |
| Environment 4 ($E_4$) | 43.89 | 97.00 | 629.54 | 64.94 | 109.22 | 309.06 | 588.44 | 18.53 | 34.73 | 2181.39 |
| LSD 5% | 0.73 | 2.46 | 606.45 | 0.87 | 0.41 | 29.42 | 52.34 | 0.24 | 0.44 | 33.50 |
| ( G×E) | | | | | | | | | | |
| $G_1 \times E_1$ | 38.67 | 67.66 | 396.07 | 66.33 | 106.33 | 214.33 | 319.33 | 15.62 | 32.64 | 1722.33 |
| $G_1 \times E_2$ | 46.30 | 67.67 | 421.53 | 63.00 | 106.67 | 260.33 | 488.67 | 15.61 | 33.86 | 1813.33 |
| $G_1 \times E_3$ | 43.57 | 84.00 | 582.68 | 66.00 | 107.67 | 307.67 | 575.67 | 15.48 | 34.46 | 1801.33 |
| $G_1 \times E_4$ | 49.33 | 93.33 | 581.72 | 64.00 | 107.67 | 309.33 | 592.67 | 15.50 | 34.62 | 1804.33 |
| $G_2 \times E_1$ | 34.57 | 58.33 | 372.15 | 67.33 | 106.67 | 231.33 | 435.00 | 12.71 | 32.63 | 1812.67 |
| $G_2 \times E_2$ | 41.10 | 77.67 | 551.29 | 65.00 | 106.33 | 265.33 | 507.00 | 12.66 | 33.77 | 1880.00 |
| $G_2 \times E_3$ | 40.20 | 80.00 | 567.42 | 66.33 | 107.67 | 267.33 | 497.33 | 12.64 | 33.81 | 1875.67 |
| $G_2 \times E_4$ | 41.37 | 94.00 | 600.27 | 63.67 | 107.33 | 303.33 | 593.67 | 12.56 | 34.48 | 1873.00 |
| $G_3 \times E_1$ | 35.07 | 64.33 | 386.11 | 66.33 | 106.34 | 262.00 | 503.33 | 23.55 | 33.31 | 1908.00 |
| $G_3 \times E_2$ | 41.03 | 71.33 | 486.18 | 64.67 | 106.67 | 268.67 | 520.67 | 23.66 | 33.85 | 1992.67 |
| $G_3 \times E_3$ | 40.83 | 75.00 | 547.47 | 65.67 | 107.33 | 275.00 | 453.00 | 23.45 | 34.67 | 1999.33 |
| $G_3 \times E_4$ | 46.90 | 90.33 | 599.86 | 64.33 | 107.67 | 308.00 | 569.67 | 23.63 | 34.41 | 2003.67 |
| $G_4 \times E_1$ | 34.97 | 65.00 | 458.93 | 69.67 | 110.67 | 257.00 | 483.33 | 19.96 | 32.96 | 2231.00 |
| $G_4 \times E_2$ | 39.80 | 70.33 | 708.71 | 68.00 | 110.33 | 269.33 | 501.00 | 20.09 | 34.16 | 2298.00 |
| $G_4 \times E_3$ | 40.67 | 88.00 | 753.12 | 68.67 | 112.33 | 256.33 | 579.00 | 20.55 | 34.15 | 2301.00 |
| $G_4 \times E_4$ | 46.70 | 99.33 | 761.71 | 66.33 | 112.67 | 314.33 | 595.67 | 20.43 | 34.91 | 2323.67 |
| $G_5 \times E_1$ | 35.23 | 69.33 | 409.92 | 69.00 | 110.33 | 263.67 | 483.67 | 19.20 | 32.80 | 2092.00 |
| $G_5 \times E_2$ | 39.43 | 80.66 | 733.37 | 67.33 | 111.00 | 309.33 | 588.33 | 19.21 | 34.35 | 2211.33 |
| $G_5 \times E_3$ | 39.20 | 80.67 | 753.12 | 68.67 | 112.67 | 293.00 | 557.67 | 19.02 | 34.29 | 2246.67 |
| $G_5 \times E_4$ | 39.07 | 102.33 | 617.36 | 66.67 | 112.67 | 307.67 | 584.33 | 19.37 | 35.00 | 2180.67 |
| $G_6 \times E_1$ | 35.10 | 70.67 | 427.42 | 66.67 | 106.67 | 286.00 | 565.00 | 19.93 | 33.44 | 2177.67 |
| $G_6 \times E_2$ | 39.40 | 76.67 | 765.82 | 65.00 | 106.67 | 292.67 | 566.00 | 19.88 | 34.64 | 2307.67 |
| $G_6 \times E_3$ | 39.50 | 89.00 | 795.65 | 68.67 | 107.33 | 309.33 | 585.67 | 19.11 | 34.37 | 2316.00 |
| $G_6 \times E_4$ | 39.97 | 102.67 | 616.86 | 64.67 | 107.33 | 311.67 | 594.67 | 19.65 | 34.99 | 2303.00 |
| LSD 5% | 1.80 | 4.092 | 539.67 | 2.12 | 1.01 | 72.06 | 128.20 | 0.58 | 1.09 | 82.071 |

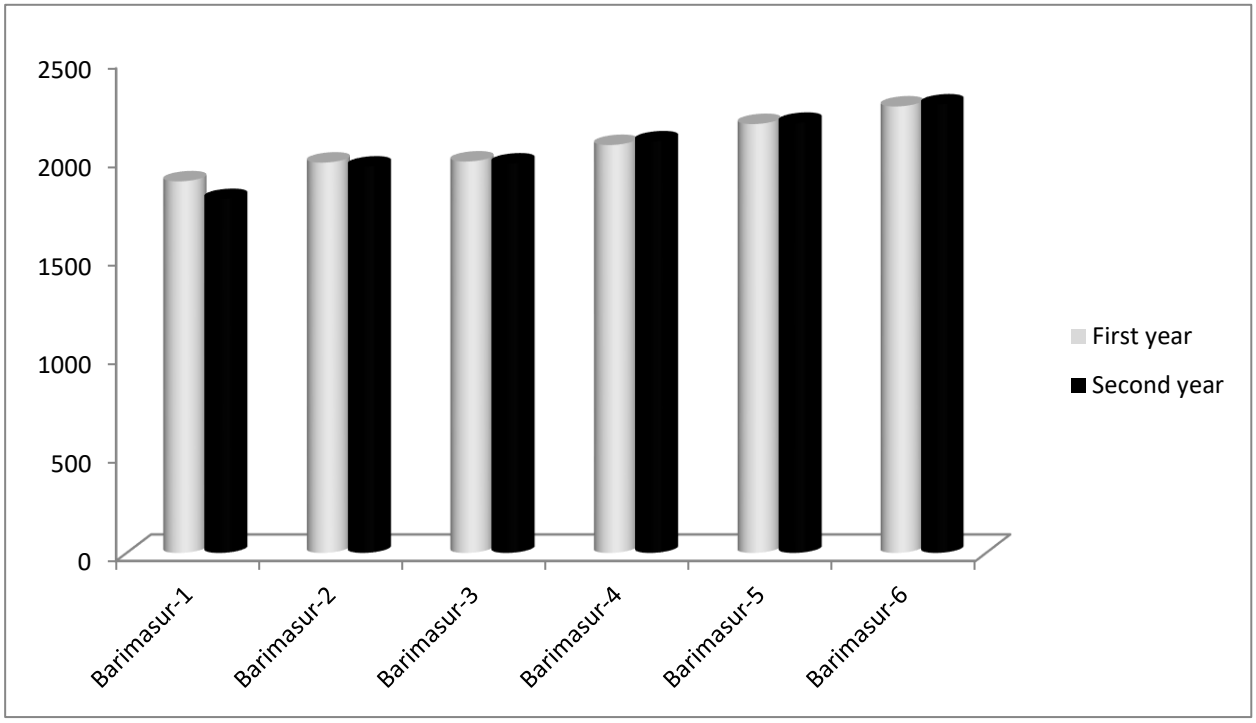


**Fig.1: Production on grain yield of six lentil genotypes.**

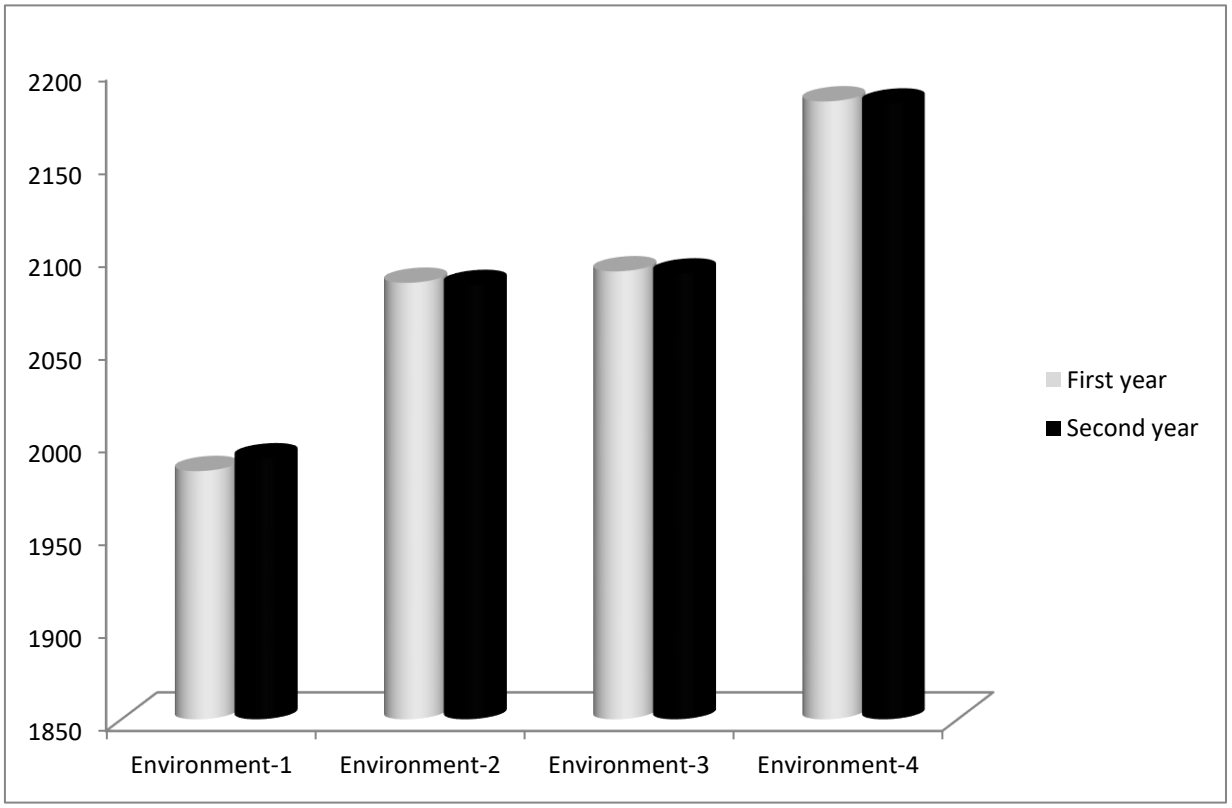


**Fig.2: Effect of genotypes and environments on grain yield of six lentils.**

## Correlation Coefficients

Correlation study of lentil on (**Table 3**) plant height, branch number per plant, plant area per plant, days to 50% flower and days to maturity were the most important yield components in the present investigation. These components were significantly correlated with all other yield components in both the years. The results showed that branch number per plant, plant area per plant, days to 50% flower, days to maturity and seed number per plant had positive correlation with grain yield. Significant and positive correlations were also obtained by several workers such as Nandan and Pandey (1980), Sarwer *et al.* (1984), Saraf *et al.*(1985) and Baidya *et al.* (1988) in lentil and Haque (1997) in chilli.

**Table 3**: Simple correlation coefficient between grain yield and yield components of six lentil genotypes as influenced by soil moisture (Upper diagonal shows values in 2010-2011 and lower diagonal shows values in 2009-2010 experiment).

| Characters | PH (cm) | BNPP | PAPP (cm) | Days to 50% F | DM | PNPP | SNPP | 1000 SW g | TDM (g) | Yield kg/hac |
|---|---|---|---|---|---|---|---|---|---|---|
| PH (cm) | - | 0.241* | 0.315* | -0.545** | -0.001 | 0.286* | 0.291* | -0.073 | 0.474** | 0.388 |
| BNPP | 0.181* | - | 0.491** | 0.150 | 0.509** | 0.411** | 0.484** | 0.192 | 0.216** | 0.614** |
| PAPP(cm) | 0.251* | 0.555** | - | 0.258 | 0.521** | 0.558** | 0.923** | 0.315 | 0.412** | 0.822** |
| D 50% F | -0.259* | 0.124 | 0.503 | - | 0.506** | -0.152 | -0.089 | 0.143 | -0.270* | 0.431** |
| DM | -0.042 | 0.292** | 0.612** | 0.593** | - | 0.338 | 0.389* | 0.158* | 0.176 | 0.559** |
| PNPP | 0.205* | 0.391** | 0.809** | -0.076 | 0.234 | - | 0.865** | 0.125 | 0.338** | 0.730** |
| SNPP | 0.215* | 0.472** | 0.933** | -0.128 | 0.252* | 0.920** | - | 0.127 | 0.389** | 0.737** |
| 1000 SW | -0.218 | 0.178 | 0.334 | 0.133 | 0.239* | 0.161 | 0.182 | - | 0.158 | 0.522** |
| TDM (g) | 0.208** | 0.241** | 0.425** | -0.028 | 0.378* | 0.360** | 0.364** | 0.118 | - | 0.459* |
| Yield kg/h | 0.435 | 0.626** | 0.945** | 0.493** | 0.515** | 0.771** | 0.931** | 0.336** | 0.413* | - |

## Path Coefficients

The results of path coefficient analysis (**Table 4**) are that plant area per plant showed the highest positive direct effect (both the years) and 1000 seed weight (1$^{st}$ year) and plant height (2$^{nd}$ year) showed the lowest positive direct effect on grain yield. Branch number per plant, days to 50% flower, days to maturity and 1000 seed weight showed the negative direct effect on grain yield. Seed number per plant showed the large positive indirect effect (both the years) and days to maturity (1$^{st}$ year) and 1000 seed weight (2$^{nd}$ year) showed the large negative indirect effect on grain yield through plant area per plant. These results are in agreement with findings in lentil by Sarwer *et al.* (1984), in wheat by Dewey and Lu (1959) and in chilli by Rammana *et al.* (1974).

**Table 4:** Path coefficient analysis of direct and indirect effects of grain yield components of six lentil genotypes in 2009-2010 experiment.

| Characters | PH (cm) | BNPP | PAPP (cm) | Days to 50% F | DM | PNPP | SNPP | 1000 SW g | TDM (g) | Yield kg/hac |
|---|---|---|---|---|---|---|---|---|---|---|
| PH (cm) | **0.293** | -0.044 | 0.147 | 0.174 | -0.051 | -0.121 | -0.097 | 0.003 | 0.131 | 0.435 |
| BNPP | -0.055 | **-0.181** | 0.462 | -0.252 | 0.219 | 0.251 | 0.274 | 0.101 | -0.193 | 0.626 |
| PAPP (cm) | 0.177 | 0.394 | **0.961** | -0.657 | -0.731 | 0.930 | 0.941 | -0.566 | -0.504 | 0.945 |
| D 50% F | 0.076 | -0.033 | -0.272 | **0.169** | -0.049 | 0.280 | 0.320 | 0.020 | -0.018 | 0.493 |
| DM | -0.012 | 0.294 | -0.406 | -0.097 | **-0.252** | 0.401 | 0.494 | 0.231 | -0.138 | 0.515 |
| PNPP | -0.572 | 0.113 | 0.656 | 0.014 | 0.063 | **0.721** | 0.571 | -0.378 | -0.417 | 0.771 |
| SNPP | -0.585 | 0.126 | 0.662 | 0.016 | 0.074 | 0.677 | **0.957** | -0.425 | -0.571 | 0.931 |
| 1000 SW | 0.063 | 0.252 | -0.306 | 0.147 | 0.060 | -0.061 | -0.008 | **0.015** | 0.174 | 0.336 |
| TDM (g) | 0.261 | -0.088 | -0.108 | -0.019 | -0.095 | -0.156 | -0.115 | 0.102 | **0.631** | 0.413 |

**Bold and diagonal figures indicate the direct effect, Residual effect (R) = 0.14064**

**Table 5:** Path coefficient analysis of direct and indirect effects of grain yield components of six lentil genotypes in 2010-2011 experiment.

| Characters | PH (cm) | BNPP | PAPP (cm) | Days 50% F | DM | PNPP | SNPP | 1000 S.W.g | TDM (g) | Yield kg/hac |
|---|---|---|---|---|---|---|---|---|---|---|
| PH (cm) | **0.173** | -0.001 | 0.320 | 0.169 | -0.004 | -0.126 | -0.112 | 0.151 | -0.182 | 0.388 |
| BNPP | -0.018 | **0.283** | -0.084 | 0.192 | 0.233 | -0.151 | -0.101 | -0.116 | 0.376 | 0.614 |
| PAPP(cm) | 0.116 | -0.472 | **0.927** | -0.484 | -0.524 | 0.802 | 0.821 | -0.658 | 0.294 | 0.822 |
| D 50% F | 0.040 | 0.157 | -0.331 | **-0.198** | -0.114 | 0.502 | 0.639 | -0.103 | -0.161 | 0.431 |
| DM | -0.001 | 0.363 | -0.271 | -0.101 | **0.224** | -0.149 | 0.355 | 0.244 | -0.105 | 0.559 |
| PNPP | -0.221 | -0.488 | 0.794 | 0.029 | -0.442 | **0.792** | 0.782 | 0.085 | -0.601 | 0.730 |
| SNPP | -0.272 | -0.481 | 0.717 | 0.035 | 0.202 | 0.714 | **0.902** | -0.537 | -0.543 | 0.737 |
| 1000 SW | 0.327 | -0.101 | -0.113 | -0.064 | 0.377 | 0.421 | -0.012 | **-0.676** | 0.363 | 0.522 |
| TDM (g) | -0.035 | 0.052 | 0.248 | -0.054 | -0.040 | -0.268 | -0.146 | 0.107 | **0.595** | 0.459 |

**Bold and diagonal figures indicate the direct effect, Residual effect (R) = 0.21897**

**Stability Parameters**

The results of stability parameters analysis (**Table 6**) are that Barimasur-6 ($G_6$) showed the highest grand mean performance, regression value nearly one ($b_i$=1.00) and stability value nearly zero ($\overline{S}^2_{di} = 0$) most of the important characters such as branch number per plant, pod number per plant, seed number per plant and grain yield per hectare. These results are in close agreement with those of Ahmed and Pandey (1983) in lentil, Yadav and Rao (1985) and Shahmohamadi *et al.* (2005) in barely, Singh and Singh (1991) and Hasan (2001) in chickpea and Parth and Khan (1987) in wheat.

**Table 6:** Estimates of stability parameters [Grand mean ($\bar{X}$), regression value ($b_i$) and stability ($\overline{S}^2_{di}$)] for plant height, branch number per plant, plant area per plant, pod number per plant, seed number per plant, 1000 seed weight and grain yield.

| Characters | Stability parameters | Genotypes | | | | | |
|---|---|---|---|---|---|---|---|
| | | G 1 | G 2 | G 3 | G 4 | G 5 | G 6 |
| Plant height | $\bar{X}$ | 44.31 | 39.89 | 40.02 | 40.26 | 38.61 | 38.38 |
| | $b_i$ | 1.362** | 0.921* | 1.423** | 1.094** | 0.532* | 0.614* |
| | $Sb_i$ | 0.262 | 0.154 | 0.147 | 0.261 | 0.153 | 0.142 |
| | $\overline{S}^2_{di}$ | 0.053 | 0.043 | 0.154 | 0.010 | 0.036 | 0.018 |
| Branch number per plant | $\bar{X}$ | 77.84 | 77.21 | 74.92 | 79.55 | 83.63 | 84.71 |
| | $b_i$ | 0.882* | 1.053** | 0.831* | 1.256** | 0.973** | 1.314** |
| | $Sb_i$ | 0.426 | 0.441 | 0.506 | 0.512 | 0.414 | 0.514 |
| | $\overline{S}^2_{di}$ | 0.039 | 0.057 | 0.017 | 0.029 | 0.050 | 0.015 |
| Plant area per plant | $\bar{X}$ | 492.37 | 520.12 | 502.29 | 663.29 | 625.82 | 646.89 |
| | $b_i$ | 0.980* | 0.819* | 0.693* | 1.150** | 1.116** | 1.137** |
| | $Sb_i$ | 0.371 | 0.394 | 0.231 | 0.382 | 0.401 | 0.425 |
| | $\overline{S}^2_{di}$ | 1.121 | -0.632 | 0.432 | 0.223 | 1.914 | 1.641 |
| Pod number per plant | $\bar{X}$ | 267.30 | 265.58 | 277.13 | 276.29 | 294.30 | 301.25 |
| | $b_i$ | 1.969** | 1.259** | 0.743* | 0.949* | 0.652* | 1.127** |
| | $Sb_i$ | 0.372 | 0.401 | 0.423 | 0.379 | 0.427 | 0.452 |
| | $\overline{S}^2_{di}$ | 0.096 | 0.083 | 0.020 | 0.038 | 0.050 | 0.012 |
| Seed number per plant | $\bar{X}$ | 492.67 | 505.29 | 518.42 | 538.84 | 554.04 | 577.38 |
| | $b_i$ | 2.270** | 1.191** | 0.480* | 0.961* | 0.804* | 1.093** |
| | $Sb_i$ | 0.419 | 0.523 | 0.534 | 0.637 | 0.501 | 0.612 |
| | $\overline{S}^2_{di}$ | 1.758 | 0.856 | 2.193 | 1.553 | 2.482 | 0.321 |
| 1000 seed weight | $\bar{X}$ | 15.56 | 12.64 | 23.58 | 20.26 | 19.20 | 19.65 |
| | $b_i$ | 1.108** | 0.833** | 1.693** | 1.123** | 1.469** | 1.766** |
| | $Sb_i$ | 0.099 | 0.131 | 0.201 | 0.146 | 0.192 | 0.138 |
| | $\overline{S}^2_{di}$ | -0.018 | 0.010 | 0.043 | -0.017 | 0.032 | -0.043 |
| Grain yield kg/hac | $\bar{X}$ | 1840.36 | 1970.42 | 1986.96 | 2079.13 | 2179.55 | 2275.96 |
| | $b_i$ | 0.745* | 0.554* | 0.823* | 0.626* | 1.321** | 1.035** |
| | $Sb_i$ | 0.387 | 0.292 | 0.386 | 0.379 | 0.401 | 0.482 |
| | $\overline{S}^2_{di}$ | 2.126 | 2.308 | 2.603 | 3.498 | 3.168 | 0.455 |

Therefore, to get higher yield, Barimasur-6 may be recommended with optimum soil moisture regimes in the northern region of Bangladesh.

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