# Genotypic × Environment Interaction and StabilityAnalysis for Bulb Yield and Yield Attributes in Onion (*Allium cepa*)


## ABSTRACT

An experiment was conducted for estimating the Genotypic × Environment interaction and stability for bulb yield and yield attributes in onion. 36 elite genotypes were evaluated during winter season (rabi) 2022-23 at three different environments in 3 replications. Estimate of environment wise analysis of variance suggested the significant differences for all the characters in all environments. Significant mean squares due to environments were also observed for all the traits under study showed that environments selected for study were random and different in agro-climatic conditions. Genotypes x interactions were significant for all the characters. Joint consideration of mean performance and stability parameters revealed that parents RO-1 and RO-59 were above average stable for bulb yield and were considered suitable for general adaptation. The crosses RO-1 × RO-59, RO-1 × Pusa Shobha, RO-1 × Pusa Madhavi, Pusa Shobha × Pusa Madhavi and Pusa Madhavi × Pusa Red were considered suitable for better environmental condition for bulb yield, while, the crosses RO-1 × Bhima Kiran, RO-59 × Pusa Madhavi, RO-59 × Pusa Red, Bhima Kiran × Bhima Shakti, Bhima Kiran × Pusa Shobha, Bhima Kiran × Pusa Madhavi and Bhima Kiran × Kashi No. 1 were considered suitable for general adaptation.



**Keywords:** Stable genotype, genotype x environment interaction, Onion, Stability




## INTRODUCTION

Onion (Allium cepa L.) is one of the important bulb crop of thefamily Amaryllidaceae and grown widely all over the world and consumedin various forms. It has been in cultivation for more than 4000 years agoamong vegetables. Onion is the third most important crop after potato andtomato. It is found in most market of the world throughout the year andcan be grown under wide range of Agro-climate condition. The maximumdiversity of Allium species is found in a belt from Mediterranean basin toIran and Afghanistan. Onion is cultivated mainly as annual for bulbproduction and biennial for seed production. The stability of performance of genotypes over environments is of great significance to the vegetable breeders in order to separate effect of environment. (Khar *et al*., 2010) Many varieties of different crops do not show consistency in performance when grown over environments owing to the presence of genotype × environment interaction. Such interactions change relative ranking of genotypes in different environments and also reduce magnitude of genetic differences among the genotypes. This poses a problem before the vegetable breeders in proper assessment of genotypes tested under different environmental conditions. The study of genotype × environment interaction is important not only from the genetical and evolutionary point of view but also gains significance to tackle agricultural problem in general and with regards to breeding in particular (Tahir *et al*., 2020). Stability study is not only important in finding out the stable genotypes for varied environmental conditions but also equally useful in screening the different genotypes for their comparative performance under a particular set of environments. Besides the high productivity of genotype, the stability of its performance is also necessary for stabilizing the production. Ceccarelli (1989) expressed that higher attention should be given to the assessment of yield stability. Eberhart and Russell (1966) discussed stability of genotypes in terms of three parameters – mean, regression or linear response and deviation from regression. They suggested that a stable variety is one with high mean, unit regression and least deviation from regression.



## MATERIALS AND METHODS

The experiment was conducted at Horticulture Research Farm, Sri Karan Narendra College of Agriculture, Jobner Rajasthan to evaluate the stability of genotypes in different environmental conditions in terms of bulb yield and yield related characters. During *rabi* 2021-22 crossing block was constructed and direct $F_1$ crosses were produced following a half diallel mating design. The experimental material consisting of 8 parents and 28 $F_1$'s were planted during *rabi* 2022-23. All the genotypes were sown under three different environments namely; early, normal and late environment. The experiment was laid down in randomized block design with three replications in all the environments. The plot for non-segregating generations (parents and $F_1$'s) represented two rows each. Rows were planted in 3m length spaced at 15cm apart and 10 cm interplant distance under all the environments. Non experimental rows were planted all around the experimental material to avoid any possible border effects. Sowing was done by hand drilling of the seeds in the soil. All other agricultural practices were done according to the recommendation and package of practices implemented at optimum period to establish good crop population in the field.Observations were recorded on five randomly selected competitive plants from each replication and environment for the bulb yield attributes and quality parameters namely, plant height, number of leaves, total chlorophyll content, number of days to 50% neckfall, average bulb weight, bulb volume, number of scales, neck thickness, equatorial diameter, polar diameter, polar : equatorial ratio, bulb yield, thrips incidence, purple blotch disease incidence, total soluble solids, allyl propyl disulphide.The data on each character for the genotypes were subjected to standard statistical analysis of variance for each environment separately [Panse andSukhatme, 1985]. Later the data of each were subjected to pooled analysis of variance [Singh and Choudhary, 1985]. The stability analysis was done according to Eberhart and Russell (1966) model.

**Results and Discussion**

In the present investigation, the mean square due to environmental (E), genotype (G) × environmental (E), environmental (linear) and genotype × environmental (linear) were significant. The mean sum of squares due to pooled deviation (non linear) were significant indicating role of unpredictable causes affecting stability and prediction of these attributes would be difficult [Table-1]. Khar *et al*. (2010) and Tahir *et al.* (2020) in onion, Dhadukt*et al*. (2012), Singh *et al*. (2016) and Belay *et al.* (2019) in garlic, Tak *et al.* (2022) in cucumber also reported similar results.

For interpretation of results considering only bulb yield per plant, deviation from regression (unpredictable) was taken as a parameter of stability and regression coefficient as a parameter of responsiveness. The parents like RO-1 and RO-59 for average bulb weight and bulb yield, Pusa Madhavi for plant height and total chlorophyll content, Bhima Kiran, Pusa Shobha, Pusa Red for number of days to 50 % neckfall, Bhima Shakti for allyl propyl disulphide were stable but their performance was exhibiting average stability and adaptability, hence, most stable.

The parents like RO-1 for total soluble solids, Kashi No. 1 for allyl propyl disulphide, Pusa Madhavi for equatorial diameter exhibiting below average stability hence, were desirable for better environment. The Parents like RO-1 for neck thickness, bulb volume, number of scales, Bhima Kiran for number of leaves exhibiting above average stability hence, these crosses were suited for poor environmental condition [Table-2]. Among the $F_1$s RO-1 × Bhima Kiran, RO-59 × Pusa Red, Bhima Kiran × Bhima Shakti, Bhima Kiran × Pusa Shobha, Bhima Kiran × Pusa Madhavi and Bhima Kiran × Kashi No. 1 were most stable along with high mean value, hence were considered desirable. The crosses RO-1 × RO-59, RO-1 × Pusa Shobha, Pusa Shobha × Pusa Madhavi and Pusa Madhavi × Pusa Red had regression more than unity along with high mean value, exhibiting more responsiveness hence were considered desirable for better environmental conditions only. The crosse RO-1 × Kashi No. 1 had high mean value and regression coefficient more than unity, exhibiting less responsiveness, therefore were desirable for poor environmental condition [Table-2]. Khar *et al*. (2010) and Tahir *et al*. (2020) in onion, Dhadukt*et al*. (2012), Singh *et al*. (2016) and Belay *et al.* (2019) in garlic,Somanath (2008),Soni (2009),Yadav and Ram (2010), Singh and Ram (2010), Khan and Sarolia(2019), Farag et. al. (2019), Tak *et al.* (2022) in cucurbits also reported similar results.

Since *per se* performance and stability are two independent traits and are controlled by different sets of gene system (Yadav and Ram, 2010), It was expected that the stability of $F_1$s might be influenced by sets of genes for stability present in parents. The results indicated that sets of genes for stability were inherited from its parents but this relationship was not noticed in all the cases. On the basis of these results, it can be concluded that the inheritance of stability has differential behaviour for genotypes. Therefore, further study is needed to learn more about inheritance of stability.

## CONCLUSION

On the basis of phenotypic stability, parents viz. RO-1 and RO-59 were above average stable for bulb yield and were considered suitable for general adaptation. The crosses RO-1 X RO-59, RO-1 X Pusa Shobha, RO-1 X Pusa Madhavi, Pusa Shobha X Pusa Madhavi and Pusa Madhavi X Pusa Red were considered suitable for better environmental condition for bulb yield, while, the crosses RO-1 X Bhima Kiran, RO-59 X Pusa Madhavi, RO-59 X Pusa Red, Bhima Kiran X Bhima Shakti, Bhima Kiran X Pusa Shobha, Bhima Kiran X Pusa Madhavi and Bhima Kiran X Kashi No. 1 were considered suitable for general adaptation and the cross RO-1 X Kashi No. 1 was considered suitable for poor environmental condition in the favour of bulb yield (q /ha).

**Table - 1**: **Pooled analysis of variance showing mean squares of parents and $F_1$'s for yield and its contributing attributes**

| Particulars | Mean Squares | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Source of Variation | df | Plant height | Number of leaves | Chlorophyll content of leaves | Number of days to 50% neckfall | Average bulb weight (g | Bulb volume (cc) | Number of scales | Neck thickness (cm) | Equatorial diameter (cm) | Polar diameter (cm) | Polar : Equatorial ratio | Bulb yield (q/ha) | Total soluble solids (%) | Allyl propyl disulphide (mg/100g) |
| **Genotypes (G)** | 35 | 104.58** | 1.34** | 0.011** | 35.41** | 77.47** | 24.84** | 1.05** | 0.0153** | 0.13** | 0.12** | 0.0021** | 3313.48** | 0.74** | 353.23** |
| **Environment (E)** | 2 | 1353.74** | 26.36** | 0.074** | 813.29** | 4510.98** | 217.4** | 6.53** | 0.3003** | 0.51** | 1.08** | 0.0129** | 203060.96** | 0.65** | 2.23 |
| **G x E** | 70 | 22.42** | 0.39** | 0.01** | 14.04** | 11.86** | 11.77** | 0.45** | 0.0048** | 0.07** | 0.05** | 0.0024** | 528.02** | 0.36** | 226.23** |
| **E + (G x E)** | 72 | 59.4** | 1.11** | 0.011** | 36.24** | 136.83** | 17.48** | 0.62** | 0.013** | 0.08** | 0.08** | 0.0027** | 6153.9** | 0.37** | 255.35** |
| **E (linear)** | 1 | 2707.5** | 52.72** | 0.149** | 1626.57** | 9021.91** | 434.8** | 13.06** | 0.6005** | 1.02** | 2.17** | 0.0259** | 406122.09** | 1.31** | 209.7** |
| **G x E (linear)** | 35 | 17.36** | 0.34** | 0.014** | 21.2** | 9.15** | 9.62** | 0.53** | 0.0044** | 0.08** | 0.05** | 0.0028** | 412.58** | 0.28** | 468.48** |
| **Pooled deviation** | 36 | 26.72** | 0.43** | 0.005** | 6.69** | 14.16** | 13.53** | 0.36** | 0.0051** | 0.06** | 0.04** | 0.002** | 625.59** | 0.43** | 17.29** |
| **Pooled Error** | 216 | 4.653 | 0.097 | 0.001 | 2.653 | 4.033 | 2.507 | 0.04 | 0.001 | 0.017 | 0.017 | 0.0005 | 146.51 | 0.07 | 3.91 |

*, **Significant at 5 percent and 1 percent levels, respectively

## Table-2: Estimates of stability parameters for Bulb yield (q/ha)

| Parents/ cross | Bulb yield (q/ha) | | |
|---|---|---|---|
| | $\overline{X}$ | bi | $S^2_{di}$ |
| **Parents** | | | |
| RO-1 (P1) | 278.51 | 1.01 | -139.4357 |
| RO-59 (P2) | 267.47 | 0.99 | -36.3512 |
| BhimaKiran (P3) | 230.19 | 1.01 | -145.5624 |
| Bhima Shakti (P4) | 232.64 | 1.01 | 5.876 |
| PusaShobha (P5) | 230.93 | 1.01 | -145.8906 |
| PusaMadhavi (P6) | 223.30 | 1 | -102.653 |
| Kashi No. 1 (P7) | 209.51 | 0.92 | -127.4577 |
| Pusa Red (P8) | 206.92 | 0.95 | 0.2094 |
| **Crosses** | | | |
| P1xP2 | 344.32 | 1.37** | -132.8259 |
| P1xP3 | 282.51 | 1 | -118.9602 |
| P1xP4 | 232.86 | 0.6 | 665.8768* |
| P1xP5 | 320.75 | 1.45* | 215.3321 |
| P1xP6 | 325.79 | 1.44* | 180.6978 |
| P1xP7 | 286.96 | 0.71 | 143.4808 |
| P1xP8 | 289.33 | 1.07 | 3270.9129** |
| P2xP3 | 237.16 | 0.98 | -144.5181 |
| P2xP4 | 217.44 | 0.54 | 515.4691* |
| P2xP5 | 239.53 | 0.99 | -127.2998 |
| P2xP6 | 253.76 | 0.98 | -144.6507 |
| P2xP7 | 242.94 | 1.02* | -145.2297 |
| P2xP8 | 259.76 | 0.96 | -103.0539 |
| P3xP4 | 258.13 | 0.99 | -77.0878 |
| P3xP5 | 268.95 | 0.97 | -131.0191 |
| P3xP6 | 276.44 | 1.07** | -140.23402 |
| P3xP7 | 273.32 | 0.98** | -145.9341 |
| P3xP8 | 245.09 | 0.96 | -26.1832 |
| P4xP5 | 242.49 | 0.98 | 495.8368* |
| P4xP6 | 250.64 | 0.93 | -93.7499 |
| P4xP7 | 227.60 | 0.76 | 9322.33** |
| P4xP8 | 203.95 | 0.99 | 2858.816** |
| P5xP6 | 234.93 | 1 | -6.5113 |
| P5xP7 | 215.74 | 0.93 | 1160.4988** |
| P5xP8 | 271.47 | 1.37 | 253.6648 |
| P6xP7 | 222.26 | 1.03 | 314.983 |
| P6xP8 | 266.50 | 1.19 | 218.8018 |
| P7xP8 | 251.09 | 0.83** | -141.3573 |
| General mean | 253.37 | 1.00 | |
| S.E. (bi) | | 0.15 | |

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