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Research Article

Genotype-environment Interaction for Yield and Yield Associated Traits in Chilli

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ABSTRACT

The present study was conducted on six chilli genotypes across 4 environments in randomized complete block design with three replications during 2019-20 to evaluate the performance of chilli genotypes with higher yield and stability. The AMMI (Additive main effect and Multiplicative Interaction) model was used to estimate the genotype-environment interaction. Genotypes and environments were significantly varied for all the traits, which revealed the presence of genetic variability in the materials under study. The total sum of squares for genotype (G), environment (E) and G × E interactions ranged from 27.44 to 80.49%, 1.26 to 45.09% and 14.60 to 62.67% interactions respectively. The genotypes account large proportion (> 50%) of total variation for Number of fruits per plant and fruit length, which means that genotype, was more important factor for these traits. GGE biplot methodology was used for graphical display of yield data after subjecting the genotypic means of each environment to GGE biplot. Principle components Analysis (PC1 and PC2) were used to depict the stability and superiority performance of the genotypes for yield and yield related traits. the chilli genotypes Co631(G6) and Co632 (G5) were stable and had comparatively less fluctuation for yield and yield related trait across environments which was found promising for recommendation and release for wider adapted variety. Cross over GEI across environment and among genotypes showed that the most general adopted environment with high mean performance, Magura has the best condition for growing chilli.

Introduction

Chili (*Capsicum annuum* L.) (2n=24) self-pollinating plants from Solanaceae family believed to have originated somewhere in Central or South America (Katherine et al., 2014) and were first cultivated in Mexico (Kraft et al., 2014). Now Chili has been cultivated worldwide and is an important spice as well as vegetable crop. Throughout the world, chili is consumed fresh, dried or in powder (El-Ghoraba et al., 2013). It is an indispensable spice essentially used in every food for its pungency, taste, color and aroma. It is rich in proteins, lipids, carbohydrates, fibres, mineral salts (Ca, P, Fe) and in vitamins A, D3, E, C, K, B2 and B12. The area under chilli production in Bangladesh is 96804 hectares during 2018-19, with a total production of 149473 metric tons (BBS, 2020). The national average yield of chilli is 1.544 tons/ha. The main causes of the lower production are the gradual reduction in the amount of land that may be used to grow chilli, crop competition during the rabi season and general agro-climatic changes. Unfortunately, the production cannot meet the demand. Bangladesh imports about 13000 metric tons of dried chilli for mitigating local demand of the country. Lack of high yielding least adapted varieties to diverse agro-ecological conditions is the major reason of low productivity. To boost up the production Spices Research Centre, Bangladesh Agricultural Research Institute scientists are working relentlessly to assess the way of improvement. Adaption of Improve varieties with higher endurance at diverse agro-ecological condition is key to increase production. Information on the genotypes adaptability and stability

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performance could be obtained by analyzing how genotypes interact with location and other management circumstances.

The relative performance of the genotype can be altered with changes in the environments and these different responses are due to the Genotype Environment Interaction (GEI) because, there are environments that are either favourable or unfavourable to certain genotypes. Numerous methods for analyzing multi environment trials data have been developed to expose pattern of G × E interaction, Joint regression (Noman, 2014), and currently AMMI (Gauch, 1992) and GGE biplot (Genotype main effect plus genotype by environment interaction). AMMI model combines the analysis of variance of genotypes and the environment main effect with principle component analysis of the GEI into a unified approach (Abu et al., 2011). Multi environment Yield Trials (MEYT) are conducted for different crops throughout the world (Ahmadi et al., 2012 and Dehghani et al., 2006) not only to identify high yielding cultivars but also to identify sites that best represent the target environment (Yan et al., 2001). As usual in Multi Environment Yield Trial a number of genotypes are tested over number of sites and year to see adaption of the crop. But, it is often difficult to determine the pattern of genotypic responses across environments without the use of appropriate analytical tools such as GGE biplot (Sran et al., 2021) for graphical display of data. The measured yield of each genotype in each test environment is a result of genotype main effect (G), an environment main effect (E) and genotype × environment (GE) interaction (Yan and Kang, 2003). Though Environment is accountable for about 80 % of the total yield variation; however, it is only Genotype and G×E interaction that are relevant for genotype evaluation and mega environment classification (Ahmadi et al. 2012 and Kaya et al., 2006). GE interaction is related to component of yield variation across environments for a genotype that cannot be explained either by Genotype or Environment alone (Yan et al., 2001). GE interaction reduces the genetic progress in the plant breeding program through minimizing the association between phenotype and genotype (Silva et al., 2016). Hence, GE interaction must be either exploited by selecting superior genotype for each a specific target environment or avoided by selecting widely adapted and stable genotype across wide range of environments (Barchenger et al., 2018). GE interaction is used to determine if a genotype is widely adapted for a wide range of environmental conditions or selected for different sub environments while the GGE biplot has been used effectively to identify the GE interaction pattern of the data. It clearly shows which genotype won in which environments simplifying mega environment identification. Therefore, the present study was conducted to evaluate the yield performance of each genotype and select the best performing one to be release as a chilli variety in relation to particular mega environment.

Materials and methods

Site description

The experiment was conducted at four regional station of spices research centre of Bangladesh Agricultural Research Institute namely Gazipur, Magura, Lalmonirhat and Cumilla districts of Bangladesh during rabi 2019-20. Regional Spices Research Centre (RSRC), Gazipur site is situated at an altitude of 12 meters above sea level at latitude 23.9886613 N and longitude 90.4091495 E. The average annual rainfall in the area is 71.24 mm, with annual average temperature maximum 36°C and minimum 12.7°C. Regional Spices Research Centre, Magura site is situated at an altitude of 12.19 meters above sea level at latitude 23.49019 N and longitude 89.40205 E. The average annual rainfall in the area is 70.69 mm, with Annual average temperature maximum 34.74°C and minimum 9.63°C. Spices Research Sub Centre, Lalmonirhat was located at an altitude of 13 meter from sea level at 25.92377 N and 89.43127 E. The average annual rainfall is 70.69 mm, with annual average temperature maximum 37.22°C and minimum 10°C. Regional Agricultural Research Station (RARS), Cumilla was located at an altitude 15 meter from sea level at 23.47123 N and 91.15553 E. The average annual rainfall is 66.76 mm, with annual average temperature maximum 35.81°C and minimum 20.24°C. Soil chemical properties of different experimental sites were presented in Table 1.

Table 1. Observed soil chemical properties of the experimental sites

Location/Site	pH	Organic carbon	Total N	K	P	S	Zn
		(%)		meq 100 g^{-1}soil	ppm		
RSRC, Gazipur	6.2	0.89	0.08	0.08	7.78	6.57	0.57
RSRC, Magura	7.2	1.79	0.104	0.42	38.40	30.64	2.47
SRSC, Lalmonirhat	6.4	0.76	0.04	0.20	85.15	26.80	0.10
RARS, Cumilla	5.8	1.01	0.06	0.10	12	22	3.01

*RSRC-Regional Spices Research Center; SRSC-Spices Research Sub Center; RARS-Regional Agricultural Research Station

Six chilli genotypes (Table 2) including one check variety (BM-2) were evaluated in this study. The trials were laid out in RCB design with three replications. Forty-five days Seedlings of each genotype were transplanted at Gazipur on 25 November 2019, Magura on 27 November, Lalmonirhat on 25 November 2019 and Comilla on 26 November 2019. Unit plot size was 3m × 1m having spacing of 50 cm × 50 cm. Fertilization was done following recommended dose of fertilizer namely cow dung 5t/ha, N110P54K49S28Zn3B2 Kg/ha (FRG, 2018) were applied in the experiment field.

Table 2. List of genotypes with source tested in this experiment

Name of the genotypes	Source
Co446, Co525, Co626, Co631, Co632 and BARI Morich-2 (BM-2)	Regional Spices Research Centre, Bangladesh Agricultural Research institute, Gazipur

The entire quantity of cowdung, TSP, Gypsum and one third of MoP were applied at the time of final land preparation. Urea and rest of MoP were applied in three equal splits at 25, 50 and 75 days after transplanting. Manual weeding was done twice in all locations. Irrigation was applied at 30, 50, 70 90, 110 and 130 days after transplanting (DAT). To control Thrips and mite, Success (2.5 SC) @ 1.2 ml/L of water and Vertimec 18 EC @ 1.2 ml/L of water were sprayed at 30, 40, 50 and 60 DAT. Spreading of Anthracnose was prevented by spraying Tilt 250 EC @ 0.5 ml/L of water at 45, 55, 65 and 75 DAT.

Morphological data were collected from ten plants from each plot selected randomly to record data of Number of fruits per plant, single fruit weight (g), fruit length (cm), Fruit diameter (cm), and green fruit yield (ton/ha). Plot yield data was converted into yield ton per hectare.

The analysis of variance (ANOVA) was used and the G×E interaction was estimated by AMMI model (Srividhya and Ponnuswami, 2011). The data of quality traits were statistically analyzed as per randomized block design using GEA-R software program. The regression analysis proposed by Eberhart and Russell's model (Sran et al., 2021) was used for the estimation of the analysis of variance of stability parameters (i.e. Mean across environments, linear regression coefficient (b_i) and deviation from regression (S^2d_i) of individual genotypes and the significance of difference was tested at 5% and 1% level of significance. The analysis of variance for randomized block design was carried out by using the following model.

Yijk = m + gij + bk + eijk

Where, Yijk = phenotypic value of the ijth genotype grown in the kth replication
m = general population mean
gij = effect of the ijth genotype, where I, j, = 1…..g
bk = effect of the kth replication, where k = 1…..r
eijk = environmental effect

In this procedure, the contribution of each genotype and each environment to the G×E interaction is assessed by using of biplot graph in which yield means are plotted against the score of the first principal component of the interaction (PCA1). The GGE-biplot methodology, which is composed of two concepts, the biplot concept and GGE concept (Yan, W., 2000), was applied for visual examination of the G × E Interaction pattern of Multi Environment Yield Trial data by using GGE-biplot software (Yan, W., 2009).

Results and Discussion

Analysis of variance for genotype, environment and G × E interaction

The combined analysis of variance for five traits of six genotypes in four different environments is presented in table 3. The mean squares (MS) due to genotypes and environments showed significant differences, enlightening genetic variability among the genotypes and variability among the environments for all the traits. The mean Square due to G × E interactions were also significant for all the traits indicating differential performance of genotypes across the environments for the studied traits. Therefore, stability analyses for G × E interactions were carried for location specific adaptability of each genotype for the agronomic traits. The GE interaction affects most of the agronomic traits and indicated that the genotypes showed a differential response due to the environments (Lohithaswa et al., 2001). The differential response of chilli genotypes for agronomic traits through GGE Biplot and Eberhart and Russell's model was also noted by Sran and Jindal, (2019).

The ANOVA for agronomic traits has been given to represents the relative magnitude of Genotype, Environment and GE interaction for each character in Table 3. The total sum of squares for genotype, environment and GE interactions ranged from 27.44 to 80.49%, 1.26 to 45.09% and 14.60 to 62.67% respectively (Table 4).

Table 3. Analysis of variance represents stability parameters for agro-morphological traits in chilli

Traits \ Source of variation	Environment (E)	Genotypes (G)	G× E	PC1	PC2	PC3	PC4	Residual
df	5	3	15	7	5	3	1	48
No. of fruits per plant	31828.06**	25846.90*	4724.16*	7536.50*	2982.9	1064.0	0.00	1747.2
Single fruit weight (g)	0.46*	2.26**	1.42**	2.73*	0.43*	0.00	0.00	0.14
Fruit length (cm)	0.59*	9.06**	1.64**	3.17**	0.47	0.03	0.00	0.21
Fruit diameter (cm)	0.01	0.22**	0.09**	0.20**	0.00	0.00	0.00	0.02
Yield (t/ha)	150.65**	80.42**	9.89**	10.89**	9.67**	7.92**	0.00	2.51

Table 4. Simple Analysis of variance (ANOVA) for yield and yield associated traits in chilli genotypes

Trait	Source	d.f.	SS	Total Variation (%)	Pr>F
	E	3	95484.17	32.30	<.001
No. of fruits per plant	G	5	129234.48	43.72	<.001
	G×E	15	70862.46	23.97	<.001
	E	3	1.38	4.07	<.001
Single fruit weight (g)	G	5	11.28	33.26	<.001
	G×E	15	21.25	62.67	<.001
	E	3	1.76	2.46	<.001
Fruit length (cm)	G	5	45.32	63.21	<.001
	G×E	15	24.61	34.33	<.001
	E	3	0.03	1.26	<.001
Fruit diameter (cm)	G	5	1.11	43.26	<.001
	G×E	15	1.42	55.47	<.001
	E	3	451.95	45.09	<.001
Yield (t/ha)	G	5	402.11	40.11	<.001
	G×E	15	148.35	14.80	<.001

The genotypes account large proportion (> 50%) of total variation for number of fruits per plant and fruit length, which means that the genotype was more important factor for these traits. Similarly, a large source of variation due to the genotypes was also reported by Zewdie and Bosland, (2000) and Gurung et al. (2012). However, the experimental genotypes were grown over four different locations and even with these similar growing conditions, environment had more effect on most of the agronomic traits. But there were significant GE interactions that will minimize the utility of genotype mean as alone indicator of stability parameter (Zewdie and Bosland, 2000). The environmental effect accounts more than 40% variation for fruit yield per plant and 45 % for yield. The changes in environment have direct impact on crop growth, yield and the yield attributing traits of chilli vary from environment to environment (Cabral et al., 2017). While the traits namely fruit diameter (1.26%), Fruit length (2.46%) and single fruit weight (4.07%) were least influenced by environment. The impact of GE interactions was < 30% for almost all the studied traits except single fruit weight, and fruit length.

Gen.× Env. interaction with Eberhart and Russell's model analysis and GGE Biplots

The stability parameters for different agronomic traits represented in Table 5-9. The test genotype, Co631(G6) and Co632 (G5) exhibited higher mean with unit regression co-efficient (b_i >1) and the deviation from regression (S^2d_i) significantly different from zero (S^2d_i = 0) for number of fruits per plant (Table 5.) indicated their suitability for favourable environmental conditions. The genotype Co446 (G2) and Co632 (G5) contributed maximum in total variation (R^2>0.9.). Sharma et al. (2014) also reported the suitability of only few genotypes for similar traits in chilli under favourable cultivated conditions. The GGE Biplot for number of fruits per plant (Figure 1) shows the Average Environment Coordination (AEC) view. Within a single mega environment, genotype should be evaluated based on both mean performance and stability across environments.

The single arrow line in the AEC abscissa which points to higher mean yield across environments or to greater genotype main effect and the AEC ordinate is perpendicular to the AEC abscissa and points either direction away from the biplot origin indicating greater Genotype Environment Interaction (GEI) effect and reduced stability (Kaya et al., 2016).

Table 5. Stability parameters for number of fruits per plant in chilli

Genotypes	Cumilla	Gazipur	Lalmonirhat	Magura	Overall mean	b_i	S^2d_i	R^2
BM-2 (G1)	158.67	286.13	133.67	147.67	181.53	1.33**	2684**	0.627
Co446 (G2)	204.67	291.73	215.67	167.00	219.77	1.22^{ns}	47.0**	0.966
Co525 (G3)	193.00	193.73	146.67	144.33	169.43	0.39**	647**	0.355
Co626 (G4)	176.67	202.13	192.00	114.67	171.37	0.84^{ns}	328**	0.817
Co631 (G6)	239.33	282.03	375.00	227.67	281.01	0.71*	5261**	0.202
Co632 (G5)	237.00	333.50	255.00	180.33	251.46	1.50**	-56.8**	0.994
Mean	201.56	264.88	219.67	163.61	212.43			
Lsd	83.73	60.99	81.12	40.49	59.81			
CV (%)	22.84	12.66	20.30	13.60	17.81			

*p<0.05, **p<0.01, ns=non-significant

Table 6. Stability parameters for single fruit weight in chilli

Genotypes	Cumilla	Gazipur	Lalmonirhat	Magura	Overall mean	b_i	S^2d_i	R^2
BM-2 (G1)	2.98	3.10	2.70	2.70	2.87	1.01**	-0.02^{ns}	0.635
Co446 (G2)	3.47	3.53	2.40	2.57	2.99	3.24**	0.08^{ns}	0.765
Co525 (G3)	2.12	2.17	3.07	3.13	2.62	2.71*	0.14*	0.611
Co626 (G4)	1.47	1.47	2.13	2.37	1.86	1.95^{ns}	0.13*	0.456
Co631 G(6)	3.50	3.40	3.03	2.20	3.03	-1.20**	0.43**	0.106
Co632 (G5)	1.93	1.73	4.13	3.13	2.73	6.79**	0.07^{ns}	0.240
Mean	2.58	2.57	2.91	2.68	2.68			
Lsd	0.72	0.88	0.39	0.48	1.04			
CV	15.29	18.94	7.36	9.74	13.25			

*p<0.05, **p<0.01 and ns=non-significant

Table 7. Stability parameters for fruit length in chilli

Genotypes	Cumilla	Gazipur	Lalmonirhat	Magura	Overall mean	b_i	S^2d_i	R^2
BM-2 (G1)	6.52	6.59	5.57	5.67	6.09	-2.99**	-0.07^{ns}	0.98
Co446 (G2)	6.59	6.37	5.77	5.13	5.96	-3.02**	0.124^{ns}	0.69
Co525 (G3)	4.26	4.29	4.53	4.77	4.46	1.10^{ns}	-0.05^{ns}	0.70
Co626 (G4)	3.86	3.79	3.67	4.33	3.92	0.31^{ns}	0.05^{ns}	0.03
Co631 (G6)	4.21	4.23	5.33	5.43	4.80	3.63*	-0.04^{ns}	0.94
Co632 (G5)	4.34	4.56	7.00	6.10	5.50	6.97**	-0.03^{ns}	0.98
Mean	4.96	4.97	5.31	5.24	5.12			
Lsd	1.14	1.15	0.47	0.36	1.11			
CV	12.58	12.69	4.89	3.81	8.97			

*p<0.05, **p<0.01and ns=non-significant

Table 8. Stability parameters for fruit diameter in chilli

Genotypes	Cumilla	Gazipur	Lalmonirhat	Magura	Overall mean ($\bar{X}$)	b_i	S^2d_i	R^2
BM-2 (G1)	1.22	1.22	1.06	1.20	1.18	0.307^{ns}	0.002^{ns}	0.008
Co446 (G2)	1.21	1.25	1.26	1.29	1.25	1.199^{ns}	-0.007^{ns}	0.722
Co525 (G3)	1.07	1.05	1.18	1.20	1.13	2.237^{ns}	-0.004^{ns}	0.524
Co626 (G4)	0.94	0.89	1.10	1.08	1.00	2.599^{ns}	0.003^{ns}	0.377
Co631 (G6)	1.56	1.73	1.12	1.20	1.40	-6.701^{**}	0.078**	0.322
Co632 (G5)	0.98	0.86	1.31	1.32	1.12	6.36**	0.037**	0.450
Mean	1.16	1.17	1.17	1.22	1.18			
Lsd	0.33	0.40	0.12	0.15	0.27			
CV	15.49	18.63	5.51	6.93	12.23			

*p<0.05, **p<0.01 and ns=non-significant

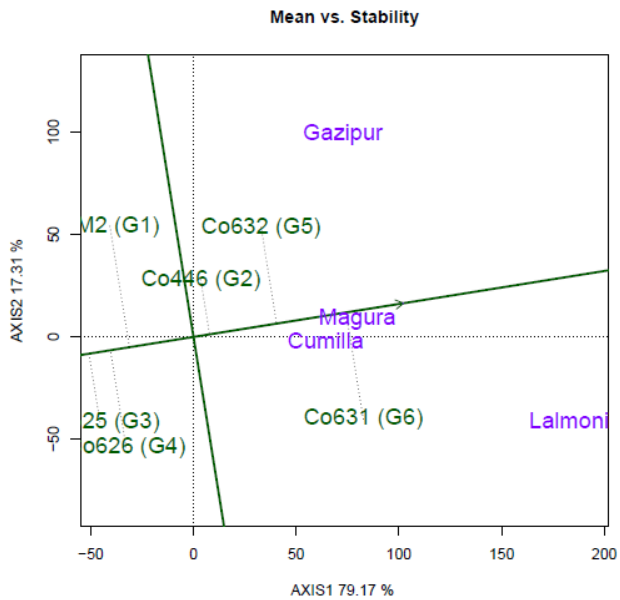

Figure 1. GGE biplot for Number of fruits per plant of 6 genotypes in 4 environments using genotypic and environmental scores.

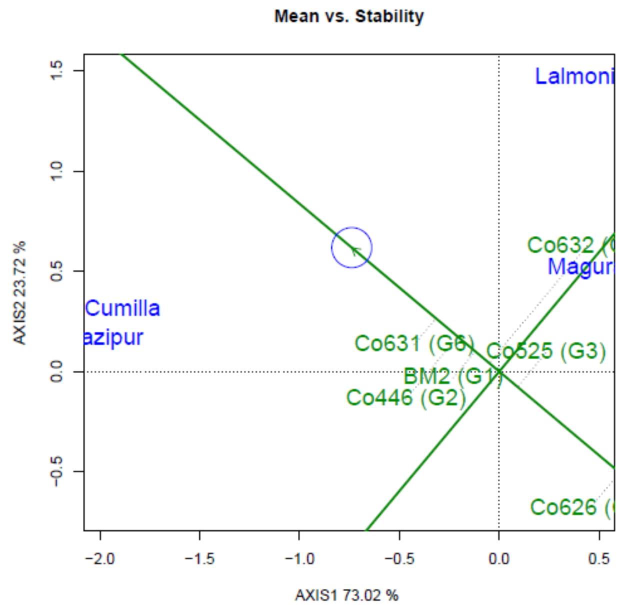

Figure 2. GGE biplot for single fruit weight of 6 genotypes in 4 environments using genotypic and environmental scores

Thus, across all environments genotype Co631(G6) and Co632 (G5) had the highest mean and specific adaptability to favorable environments. The genotype Co446 with shortest AEC ordinate indicating highly stable for across all environment. Also, it was found that all the environments had positive interaction with the genotypes. Gazipur had the above average number of fruits per plant compared to Cumilla, Magura and Lamonirhat. Whereas, Cumilla and Magura was suitable for selecting genotypes that had average environmental performance, because Cumilla and Magura had the lowest AEC ordinates, which exhibits its suitability for general adapted genotypes.

Based on the regression and mean in Table 6, the Check variety BM-2 (G1) had above average single fruit weight (g) with regression coefficient close to one (b_i>1) and non-significant deviation from regression (S^2d_i>0) indicated their suitability and adaptability across the environments. Chowdhury et al., (2001) Senapati and Sarkar, (2002), Nehru et al., (2003) and Tembhurne and Rao, (2013) also obtained similar results for investigating these characters. The GGE Biplot for single fruit weight (Figure 2) shows that the genotype Co631(G6) and Check variety BM-2 (G1) had the highest mean yield with shortest AEC ordinate indicating highly stable and general adaptability for across all environments.

Lalmonirhat and Magura had the above average number of fruits per plant compared to Cumilla and Gazipur. whereas, Magura was suitable for selecting genotypes that had average environmental performance, because Magura had the lowest AEC ordinates, which exhibits its suitability for general adapted genotypes.

The fruit length found to be highest in Check variety BM-2 and Co 446 (2) with significantly higher mean value with higher regression coefficient (b_i <1) (Table 7.) and non-significant deviation from regression (S^2d_i≈0) revealed the specific adaptability to specific environments (Reddy and Sadashiva, 2003).

The GGE Biplot for fruit length (Figure 3) shows that the genotype Co446(G6) and Check variety BM-2 (G1) had the highest mean yield with shortest AEC ordinate indicating highly stable and general adaptability for across all environments. The Lalmonirhat and Magura had above average fruits length compared to Cumilla and Gazipur. whereas, magura was suitable for selecting genotypes that had average environmental performance, because Magura had the lowest AEC ordinates, which exhibits its suitability for general adapted genotypes.

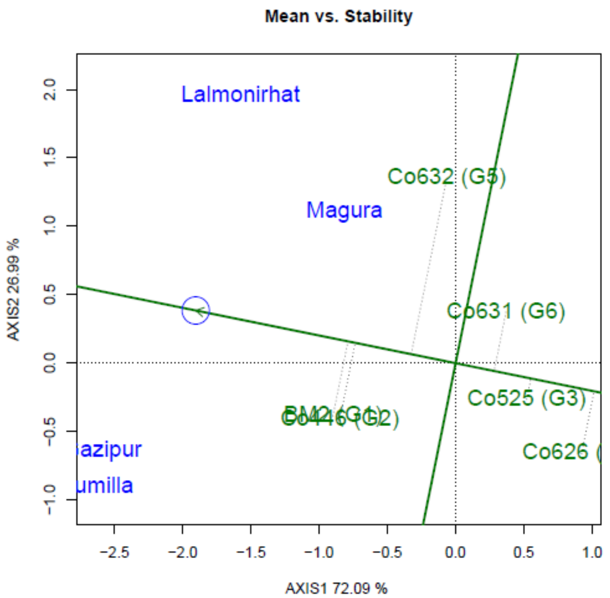

Figure 3. GGE biplot for fruit length of 6 genotypes in 4 environments using genotypic and environmental scores

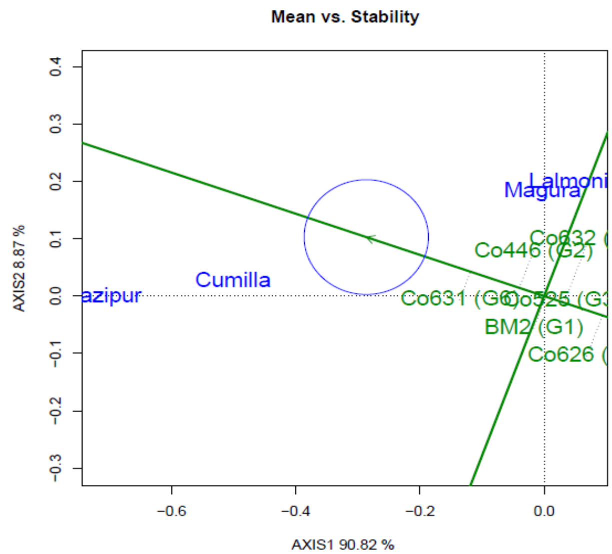

Figure 4. GGE biplot for fruit Diameter of 6 genotypes in 4 environments using genotypic and environmental scores.

Stability parameter in Table 8 shows that, the genotype Co631(G6) and Co446(G2) had above average fruit diameter (cm) with regression coefficient ($b_i>1$) and non-significant deviation from regression ($S^2d_i=0$) indicated their suitability and adaptability across the environments. Datta and Dey, (2009) also obtained similar results for fruit diameter of chilli. The GGE Biplot for fruit diameter (Figure 4) shows that the genotype Co631(G6), Co446 (G2) and Check variety BM-2 (G1) had the highest mean yield with shortest AEC ordinate indicating highly stable and general adaptability for across all environments.

Magura had the above average fruits length compared to Cumilla and Gazipur. whereas, Magura was suitable for selecting genotypes that had average environmental performance, because Magura had the lowest AEC ordinates, which exhibits its environmental suitability for general adapted genotypes.

Based on the regression value and overall mean in Table 9, the genotypes Co631(G6) and Co632 (G5) had above average yield (t/ha) with regression coefficient close to one ($b_i<1$) and non-significant deviation from regression ($S^2d_i\approx0$) indicated their suitability and adaptability across different environments. Anilkumar, et al., (2018) also obtained similar results for fruit yield in chilli.

Table 9. Stability parameters for fruit yield in chilli

Genotypes	Cumilla	Gazipur	Lalmonirhat	Magura	Overall mean	b_i	S^2d_i	R^2
BM-2 (G1)	10.62	14.11	9.39	15.70	12.46	0.78^{ns}	4.73**	0.58
Co446 (G2)	8.83	15.44	14.02	17.17	13.87	1.14^{ns}	2.26*	0.84
Co525 (G3)	7.74	12.00	10.06	18.01	11.95	1.49**	0.32^{ns}	0.96
Co626 (G4)	7.27	8.22	7.78	10.90	8.54	0.53**	-0.39^{ns}	0.91
Co631 (G6)	12.43	14.00	17.51	18.27	15.55	0.78^{ns}	3.23**	0.66
Co632 (G5)	11.19	13.33	16.16	20.25	15.23	1.27^{ns}	2.02*	0.88
Mean	9.68	12.85	12.49	16.72	12.93			
Lsd	2.58	2.95	0.87	3.61	2.74			
CV	14.63	12.63	3.85	11.86	11.47			

*p<0.05, **p<0.01and ns=non-significant

The single arrow line in the AEC abscissa which points to higher mean yield across environments or to greater genotype main effect and the AEC ordinate is perpendicular to the AEC abscissa and points either direction away from the biplot (Figure 5) origin indicating greater GEI effect and reduced stability (Jeeatid, et al., 2018). Magura had the above average fruits length compared to other locations. whereas, Magura was suitable for selecting genotypes that had average environmental performance, which exhibits its environmental suitability for general adapted genotypes.

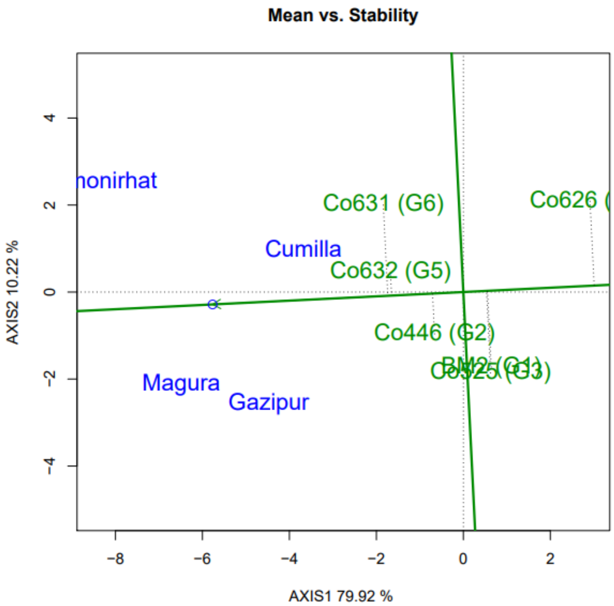

Figure 5. GGE biplot for yield of 6 genotypes in 4 environments using genotypic and environmental scores

Conclusion

Considering wide range adaptability as a breeding strategy, the best genotypes that combine high yield and yield related traits and stable performance across range of environments is the best. The result of this study indicated that, the chilli genotypes Co631 (G6) and Co632 (G5) were stable in suitable environments and had comparatively less fluctuation for yield and yield related trait across environments which was found promising for recommendation and release for wider adapted variety. Cross over Genotype Environment Interaction (GEI) across environment and among genotypes tested there were desirable genotypes in terms of high yield and stability. Whereas, considering GGE biplot GEC ordinates the most general adopted environment with high mean performance direction, Magura has the best growing condition for chilli.

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