GENOTYPE - ENVIRONMENT INTETRACTION ON SEED YIELD AND YIELD CONTRIBUTING CHARACTERS IN CHILLI (*Capsicum frutescens* L.)

BY

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This is to certify that the thesis entitled ***"GENOTYPE - ENVIRONMENT INTETRACTION ON SEED YIELD AND YIELD CONTRIBUTING CHARACTERS IN CHILLI (Capsicum frutescens L.)"*** *submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka-1207, in partial fulfillment of the requirements for the degree of* ***MASTER OF SCIENCE in GENETICS AND PLANT BREEDING****, embodies the result of a piece of bonafide research work carried out by Abdullah Al Noman, Registration No. 08-02996 under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

I further certify that such help or source of information, as has been availed of during the course of this investigation has duly been acknowledged.

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Dedicated

To My

Beloved Parents

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ABSTRACT

BY

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An experiment was conducted at the experimental field of Sher-e-Bangla Agricultural University during rabi, 2013-2014 with ten chilli (*Capsicum frutescens* L.) genotypes of different sources. It was laid out in randomized complete block design with three replications and four environments, to find out genotype or genotypes with high mean yield and good adaptation to different environments and assessment of the genotype and environment effect on chilli. Data were collected on several morpho-physiological yield contributing parameters. The Additive Main Effects and Multiplicative Interaction (AMMI) statistical model was used to describe Genotype x Environment Interaction (GEI) and adaptation to certain environments. The combined analysis of variance (ANOVA) indicated significant differences between genotypes and environments as main effects. GEI both linear and non- linear components were highly significant for most of the parameters except number of seeds per fruit and hundred seed weight. Env-3 and Env-4 were poor and Env-1 and Env-2 were found to be rich and favorable for chilli production. Where, Env-2 was found highly favorable for chilli production. The stable genotypes found were DBP 14 5G (China), BD-2059 and Bogura Jatt, exhibited intermediate mean yield and could be adopted for general cultivation. Kalo Dhawna morich, Bogurar Lomba Morich and Bullet exhibited comparatively higher mean yield but were unstable across the environments and can be recommended to cultivate in rich environments.

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LIST OF ABBREVIATIONS

Abbreviations		Full Word
AEZ	=	Agro- Ecological Zone
BARI	=	Bangladesh Agricultural Research Institute
DAS	=	Days After Sowing
DAT	=	Days After Transplanting
SAU	=	Sher-e- Bangla Agricultural University
HI	=	Harvest Index
DM	=	Dry Matter
cv.	=	Cultivar (s)
t/ha	=	Tons per hectare
M. tons	=	Metric tons
CV %	=	Percentage of Coefficient of Variation
ppm	=	Parts per million
^{0}C	=	Degree Celsius
m^2	=	meter square
NS	=	Non significant
cm	=	Centi-meter
No.	=	Number
var.	=	Variety
et al.	=	And others
etc.	=	Etcetera
i. e.	=	That is
RCBD	=	Randomized Complete Block Design
G	=	Genotype
E	=	Environment
GN.	=	Genotype Number
BD	=	Bangladesh
MOA	=	Ministry of Agriculture
BADC	=	Bangladesh Agricultural Development Corporation

Abbreviations		Full Word
BARC	=	Bangladesh Agricultural Research Council
BAU	=	Bangladesh Agricultural University
BBS	=	Bangladesh Bureau of Statistics
BER	=	Bangladesh Economic Review
BINA	=	Bangladesh Institute of Nuclear Agriculture
BRRI	=	Bangladesh Rice Research Institute
BSMRAU	=	Bangabandhu Sheikh Mujibur Rahman Agricultural University
DAE	=	Department of Agricultural Extension
FAO	=	Food and Agriculture Organization
CSIR	=	Council of Scientific and Industrial Research
CABI	=	Centre for Biosciences and Agriculture International
J.	=	Journal
Bred.	=	Breeding
Sci.	=	Science / Sciences
Bot.	=	Botany
Hort.	=	Horticulture
Res.	=	Research
Agric.	=	Agriculture
Agril.	=	Agricultural
Environ.	=	Environmental
Manage.	=	Management
Genet.	=	Genetics
Biol.	=	Biological
Veg.	=	Vegetable
Mol.	=	Molecular
Agron.	=	Agronomy
Appl.	=	Applied
Microbiol.	=	Microbiology
Chem.	=	Chemestry

Abbreviations		Full Word
Theor.	=	Theory
Adv.	=	Advanced/ Advance
Electron.	=	Electronic
Exp.	=	Experimental
Int.	=	International
Heredity.	=	Heredity.
Trop.	=	Tropical
U.	=	University
Biotech.	=	Biotechnology
Farm.	=	Farming
df	=	Degrees of Freedom
SE	=	Standard Error
CEC	=	Cation Exchange Capacity
EC	=	Emulsifiable Concentrate
cc	=	Cubic Centimeter

Chapter I
Introduction

CHAPTER I

INTRODUCTION

Chilli, belonging to the family solanaceae, is a common and widely distributed spices crop throughout the tropics. Over 100 species have been named under the genus *Capsicum*, but most workers recognize only two species, *Capsicum annuum* L. and *Capsicum frutescens* L. (Purseglove, 1968; Cobley, 1967; Berrie, 1977). Caselton (2004) lists around 400 variants of *Capsicum*. *Capsicum* goes by many common names, including pepper, chilli, chile, aji and paprika (Bosland and Votava, 2000). There is a distinct difference between the sweet pepper, *Capsicum annuum* and the hot chilli or cayenne pepper named *Capsicum frutescens*. *Capsicum frutescens* a wild, taller and with a more woody stock than *Capsicum annuum*, is generally cultivated in the warm regions of both hemispheres. *Capsicum grossuni* also a wild type, seems to be a variety of *Capsicum annuum* is cultivated in India under the name of Kafree murich and Kafree chilli, but Roxburgh (1832) did not consider it to be of Indian origin. It is now cultivated in every tropical country and provides the chief spices of the warmer parts of the world. Chilli is one of the most important ingredients used in the everyday diet of the people of South and South-East Asia. Chillies are the native of the tropical areas of Central America and the West Indies, but they quickly spread throughout the tropical world after the discovery of America and West Indies.

Chillies are widely used throughout the tropics and are major ingredients of curry powder in the culinary preparations. They extensively used in Central America as constituents of dishes such as tamales and 'chile con curne'. In its powdered form, it constitutes red or caynee pepper. Extracts of chillies are used in the production of ginger beer and others beverages. Cayenne pepper is incorporated in poultry feeds. *Capsicum frutescens* is used in medicine as carminatives internally, besides being in external counter irritant. The green chillies are rich in routine which is of immense pharmaceutical need

(Purseglove, 1977). It is quite rich in nutritive value and supposed to contain certain medicinal properties. (Choudhury, 1976). Commercial cayenne pepper is the preparation of dried, finely grounded mixture of various highly pungent or 'hot' forms of *Capsicum frutescens* L. These pungent are used in the manufacture of sauces and curry powders and in the preparations of pickles.

The chief constituent of chilli (*Capsicum frutescens* L.) pericurp is a crystalline colourless pungent principle known as capsaicin or capsicutin ($C_{18}H_{27}N0_3$) a condensation product of 3- hydroxy- 4- methoxy benzylalamine and decylenic acid which produces a highly irritating vapour on heating (Anonymous, 1952). Green chillies are rich in vitamin A and C and the seed contain traces of starch (Saimbhi *et al.*, 1977; Sayed and Bagavandas, 1980; Manu *et al.*, 2014). The fruits also contain a fixed oil, red colouring matter which is non-pungent and yield 20-25 percent alcoholic extract, dry matter 22.02% ascorbic acid 131.06 mg/l00g (fresh weight), oleoresin 66.53 ASTA units, colouring matter 67.38 ASTA units, capsaicin 0.34% (dry wt.) crude fibre 26.75% and total ash 6.69% (Bajaj *et al.*, 1980; Appendix IV). Chilli has high demand among the consumers due to its diversified uses. For the intensive cultivation and increased production of chilli, improved varieties/lines with desirable traits need to be identified through the world.

Chilli is an important spices crop in Bangladesh. It is a cash crop of the country too (Ahmed and Haque, 1980). Chilli is cultivated on small family owned farms where sale of its produce serves as a ready source of cash income throughout the year. A large number of cultivars or landraces are under cultivation in different parts of the country. At recent years, the total cultivated area under spices and condiments tends a decrease. Depending on yield and consumers preference, a number of chilli genotypes are being cultivated throughout the Country. Winter chilli contributes about 90% of its total production (Anonymous, 1987). The actual area under chilli cultivation in Bangladesh is not available due to its seasonal nature of cultivation. The total cultivated area is about twenty thousand acres in 2008 (BBS, 2008), which reaches a pick of about thirty three thousand acres (BBS, 2011), then decreases to twenty three thousand acres in 2012 (BBS, 2012) and seventeen thousand acres in 2013 (BBS, 2013). Approximate yield at those periods above was 109, 176, 126 and 95 thousand tons, respectively (BBS, 2013). In Bangladesh, the harvest price of chilli is about 65100 Taka per M. tons (BBS, 2013). A wide genetic diversity is found here due to the availability of different land races and their wild relatives. In spite of its importance no major breakthrough has been made and limited numbers of improved varieties are being grown on the country.

Under this situation, new avenues of crop improvement require to be exploited. For achieving a substantial genetic improvement, a high knowledge of genotype-environment interaction of existing land and improved lines are essential to improve new varieties of chilli in the country. During the process of development of superior varieties, genotype x environmental interactions are of major consequences to the breeder as these have masking effect on the performance of genotypes and the relative ranking of the genotypes do not remain same when tested over number of environments.

Stability is a genetic character (Perkins and Jinks, 1968) and it is possible to breed for stability in yield components. Stability of a hybrid line or a variety is most important for its spread. Selection of better plant type either from local or exotic genotypes can be of immense value to the breeder. Keeping this view in mind, 10 genotypes of chilli from different source were collected and their genotype-environment interaction was assessed by this study.

Yield stability over a range of environmental conditions is of great concern to plant breeders. Farmers are more interested in the cultivars that produce consistent yields under their growing conditions and breeders want to meet these needs (Mulema *et al.*, 2008). The reactions of crop varieties to the ever changing environments are complex. Variation in locations, seasons, involving physical, edaphic and biotic factors is important for adaptation of crop plants. In Bangladesh, edaphic variations over locations, temperature and rainfall differences greatly contribute for adaptation of different crops. Due to ever increasing food demands, improved varieties well adapted to changing condition is the need of the day and plant breeders are faced with the task of developing varieties for either closely defined environment or wide range of environments.

Laboratory studies of phenotypic stability by many workers provided fundamental knowledge on adaptation in plants. But there are gaps between laboratory and field studies. Acharya and Sharma (1985) reported that stability analysis under simulated environments cannot be substituted for several sites. Wide adaptability and stability are important consideration to plant breeders in the cultivar selection programme. Yield of a crop cultivar is an important criterion in evaluating stability. Stability parameters can be used for varital evaluation to lower risk, and to raise profit for the grower to account for variability in the yield over sites and to transfer technology to other environments without extensive experimentation at specific sites (Miah, 1980) Stability of varieties can be measured by determining interaction of varieties with locations and seasons. Uni location trials can serve the purpose provided different environments are created by planting experimental materials (Luthra *et al.* 1974. and Tehlan, 1973). Genotypes x environment interaction are nearly universal during the field testing phases. Such interactions confound the selection of superior cultivar by altering their relative productivities in different environments. Therefore, conceiving the above idea the present investigation was undertaken with the following objectives:

1. To find out stable genotypes of chilli under different environments.
2. To compare the average performance of genotypes in different environment.
3. To identify suitable environment for chilli.

Chapter II

Review of Literature

CHAPTER II

REVIEW OF LITERATURE

The chilli is the fruit of plants from the genus *Capsicum*, members of the nightshade family, Solanaceae. The substances that give chilli their intensity when ingested or applied topically are capsaicin (8-methyl-*N*-vanillyl-6-nonenamide) and several related chemicals, collectively called capsicinoids. Chilli peppers originated in the Americas (Dasgupta, 2011). After the Columbian Exchange, many cultivars of chilli pepper spread across the world, used in both food and medicine. Chillies were brought to Asia by Portuguese navigators' during the 16th century (Anonymous, 2002). The chilli pepper features heavily in the cuisine of the Goan region of India, which was the site of a Portuguese colony. Chilli peppers journeyed from India, through Central Asia and Turkey, to Hungary, where they became the national spice in the form of paprika. An alternate, although not so plausible account defended mostly by Spanish historians, was that from Mexico, at the time a Spanish colony, chilli peppers spread into their other colony the Philippines and from there to India, Bangladesh, China, Indonesia. To Japan, it was brought by the Portuguese missionaries in 1542, and then later, it was brought to Korea (Robinson, 2007). Though the history is ambiguous but it is an important crop in India and Bangladesh. But on chilli a little work is done worldwide as well as in Bangladesh. In this chapter an attempt has been made to briefly review some of the available works on chilli and few other crops having particular relevance to the present study.

2.1 Genotype × Environment interactions for fruit and seed yield related characters

It is not well understood is how the environment affects fruit and seed yield. For example, a chilli genotype may be classified to carry fruit in the short round shape and yield in one environment. However, this variety may not yield exactly the same fruit shape and yield when grown in different environments. This is because different genotypes are expected to have different responses to environmental variation. It was once believed that a given trait was by genes (genotype, G) or exposure to environmental variation (environment, E); eventually the concept of a genotype by environment (G x E) interaction was developed (Baker, 1988).

Kang (1998) mentioned that gene expression is subject to modification by the environment; therefore, genotypic expression of a phenotype is environmentally dependant. Stability in performance of a genotype over a wide range of environments is a desirable attribute and depends largely upon magnitude of genotype - environment interaction (Ahmad *et al.*, 1996). For stabilizing yield, it is necessary to identify the stable genotypes suitable for a wide range of environments. To identify such genotypes, genotype x environment interactions is of major concern for a breeder, because such interactions confound the selection of the superior cultivars by altering their relative productiveness in different environments (Eagles and Frey, 1977). Stability analysis is a good technique for measuring the adaptability of different crop varieties to varying environments (Morales *et al.*, 1991).

Suitable performance in diverse environments of certain genotypes with improved adaption to environment constraints has been suggested. Fruit shape traits, on the other hand, are rarely evaluated in diverse environments, except for peach and nectarines (Promchot *et al.*, 2008). Environmental factors are believed to affect tomato yield and quality (Ortiz *et al.*, 2007, Panthee *et al.*, 2012); grain shape of rice (Shi *et al.*, 2000). However, whether and how environmental conditions affect fruit shape, colour and yield of chilli and many other crops is largely unknown. Although the fruit qualities have been studied a lot, few researches were carried to investigate the Genotype x Environment interaction on different fruit morphology. A major focus of my thesis project was the characterization of G x E interactions on chilli fruit shape, size and yield.

The variant genotypic response to the environment factors such as temperature, soil type, nutrient level from different environments are a function of genotype x environment interactions. G x E interaction has been studied in many crops such as wheat (Taghouti *et al.*, 2010), rice (Shi *et al.*, 2000, Ahmed *et al.*, 2011) and soybean (Zhe *et al.*, 2010). Attempts have been made in tomatoes to evaluate genotypes for desired traits including yield, fruit weight (Ortiz *et al.*, 2007), aroma (Cebolla-Cornejo *et al.*, 2011) and quality (Panthee *et al.*, 2012) in diverse environments. But on chilli there are few attempts found worldwide as well as in Bangladesh on different yield contributing characters both on seed and fruit yield. Stability analysis in hot pepper was studied earlier in Asian Vegetable Research Development Centre by Yayeh zewdie and Paulos (1995). The significant G × E interaction in chilli and the differential response of chilli yield has been reported as early as Sooch *et al.* (1981) and Lohithaswa *et al.* (2000), Doshi and Shukla (2000) ,Senapati and Sarkar (2002), Nehru *et al.* (2003) and Wani *et al.* (2003) while nine elite chilli varieties from different South Asian Countries were evaluated for stability at Indian Institute of Horticultural Research, Bangalore by Madhavi Reddy and Sadashiva (2003) and ammi analysis for fruit yield stability of chilli was studied by Anand *et al.* (2006) and Vijayaragavan (2008).

Srividhya and Ponnuswami (2011) performed an experiment of genotype × environment interaction of five parents and four F_1 hybrids along with check at four environments for paprika fruit yield which was studied with Additive Main Effects and Multiplicative Interaction (AMMI) model. The combined analysis of variance of AMMI showed that the environment, genotype and G × E interaction were highly significant , suggesting a broad range of genotypic diversity and environmental variation. Three parents viz., Bydagi – kaddi, Simla Paprika and KTPL – 18 were found to be stable across environments for number of fruits per plant. The parent Arka Abir was found to be stable yielder across environments. The hybrid Arka Abir × Bydagi – kaddi cross was stable for the maximum three characters over environments and identified as having general adaptability.

Kallupurackal and Ravindran (2005) found that The *Capsicum annuum* being often cross pollinated crop is having good variability for yield and yield attributing characters across environments. Only F_1 hybrid involved was identified as stable performer under unfavourable environment for fruit yield.

Tembhurne and Rao (2013) evaluated twenty cytoplasmic genetic male sterility (CGMS) based F1 hybrids, three promising genotypes and a check were studied in three different environments for stability analysis. Variances due to genotypes × environment interactions were significant for all the characters except number of fruits per plant and fresh fruit weight per plant. Considering all the stability parameters, JCH-47, BCH-24 and BVC-37 exhibited wider stability for dry fruit yield per plant, JCH-01 had stability for favourable environment and JCH-05, JCH-14, JCH-23, JCH-24, JCH-54 and RCH-23 showed below average stability. Highest performing F_1 hybrid JCH-54 was identified as stable performer under unfavourable environment for dry fruit yield.

Zewdie and Bosland (2000) experimented in terms of capsicinoid content, of chilli (*Capsicum annuum* L.) genotypes to different environments. They found significant differences among the genotypes and among genotype x environment interactions over the environments. Among the genotypes in an environment, the within-genotype variances were also significantly different. The double haploid line, HDA 207, had low within-genotype variance for individual and total capsicinoids, with the exception of the isomer of dihydrocapsicin. Also for HDA 270, the genotype x environment interaction was negligible for individual and total capsicinoids, indicating stability across environments.

In case of tomato plant growth and fruits, in all aspects, have been evaluated in a lot of studies. However, the external factors such as grafting and genotype x environment interaction were relatively limited. For example, tomato rhizosphere, rich in microbes including both pathogens and beneficial contributors such as plant health promoting microbes and bio control agent aid in uptake nutrient will affect the host physiology and potentially, the biomass, leaf nutrient, fruit yield and shape. For example, a deficiency in calcium resulted in blossom end rot of tomato fruit in both yield and shape (Adams and Ho, 1993). Nutrient uptake such as phosphorous solubility or calcium increase either by microbes (Caballero-Mellado *et al.*, 2007) or by grafting (Leonardi and Giuffrida, 2006) will also affect the tomato physiology and even fruit shape, size and yield.

Murphy *et al.* (2011) conducted multi-environment trials to evaluate yield stability performance of genetic materials of wheat under varying environmental conditions. The relative performance of genotypes for quantitative characteristics such as yield and other characteristics, which influence yield, vary from an environment to another. Consequently, to develop a genotype with high yielding ability and consistency, high attention should be given to the importance of stable performance for the genotypes under different environments and their interactions which had important bearing on breeding for better varieties buffering (Allard and Bradshow, 1964).

Al-Aysh (2013) conducted an experiment with fourteen landraces of tomato (*Lycopersicon esculentum* Mill.) to estimate the magnitude of genotype-environment interaction and phenotypic stability for number of primary branches per plant, number of fruits per plant, fruit average weight (g) and fruit yield per plant (kg). For a given characteristic, a desirable, widely adaptable and stable genotype was defined as one with an individual mean performance greater than the grand mean, a regression coefficient ($b_i = 1$), and deviation mean squares ($S^2d_i = 0$). Mean squares due to genotypes (landraces), environments (years) and genotype x environment interaction were highly significant ($P \leq 0.01$) for most of the characteristics studied. The genotype-environment interaction (linear) components along with pooled deviation were significant for number of fruits per plant; suggested importance of both linear and non-linear components in building up total G x E interaction. Five landraces; 20198, 20292, 20339, 20364 and 20402 were considered high yielding, performance stable and suitable for all environments for fruit yield. While only one landrace 20303 was considered high yielding, stable and specifically adapted under favourable or rich environments.

Tiwari *et al.* (2013) evaluated with twenty five genotypes of tomato in RCBD with three replications under four environments to study the stability behaviour of genotypes under the four environmental conditions created with different doses of plant bioregulators. There was enough variability due to environments for all the traits except plant height. Significant variation due to G x E interaction was observed for all the traits except fruit weight. Pant T-5 and ARTH-3 were found to be only desirable stable genotypes for fruit yield per plant.

Roselloa *et al.* (2010) conducted a study on the evaluation of the genotype, environment and its interaction on carotenoid and ascorbic acid accumulation in tomato germplasm. Tomatoes are an important source of antioxidants (carotenoid, vitamin C, etc.) due to their high level of consumption. There is a great interest in developing cultivars with increased levels of lycopene, β-carotene or L-ascorbic acid. There is necessary to survey new sources of variation. In this study they investigated the potential of improvement for each character in tomato breeding programs, in a single or joint approach, and the nature of genotype (G), environment (E) and G x E interaction effects in the expression of these characters. The content of lycopene, β -carotene and ascorbic acid determined was very high in some phenotypes (up to 281, 35 and 346 mg kg-1 respectively). Nevertheless, the major contribution came from the genotypic effect along with a considerable G x E interaction. The joint accumulation of lycopene and β-carotene has a high genetic component. It is possible to select elite genotypes with high content of both carotenoids in tomato breeding programs but multi-environment trials are recommended. The improvement of ascorbic acid content is more difficult because the interference of uncontrolled factors mask the real genetic potential. Among the accessions evaluated they found, there are four accessions with an amazing genetic potential for functional properties that can be used as donor parents in tomato breeding programs or for direct consumption in quality markets.

Mandal *et al.* (2000) tested twenty tomato genotypes under three environments for stability analysis following the model of Eberhart and Russel. Among the five characters, viz., plant height, primary branch number, fruit number, fruit weight and yield studied, only fruit yield had the significant genotype-environment interaction and the same was due to linear component, Relative judgment of the genotypes from their stability parameters i.e. bi, S^2di and Pi revealed that Punjab Chhuhara, Kalyani Eunish, Pusa Ruby and Sel.7 were adapted specifically to favourable /better /rich environments and Arka Vikas, Marglobe Supreme, KBT-1 and Anand T-1 were adapted specifically to poor/unfavorable environments.

Ortiz and Lzzuierdo (1994) also reported that the environment subsequently affects the performance of tomato genotypes in Latin America and the Carribbean. In the present investigation, an attempt was made to screen out the promising tomato genotypes which would perform well in this region. In this context, a good collection of tomato genotypes were made from different sources and tested for their yield potentiality in this zone.

Pradeepkumar *et al.* (2001) conducted an experiment to quantify genetic variation in tomato for yield and resistance to Bacterial Wilt based on the idea that proper and systematic evaluation of genetic resources was essential to understand and estimate the genetic variability, heritability, genetic advance and genotype x environment interaction. They observed highly significant differences among the genotypes for all the traits as well as high genotypic coefficient of variation for all the characters. Higher heritability estimates and high genetic advance for all the characters indicated lesser influence of environment and higher role of additive gene action, respectively.

Aravindakumar *et al.* (2003) experimented eleven tomato (*Lycopersicon esculentum* Mill) genotypes for yield and its components under eight environments. Variance due to genotypes, environments, genotype x environment and G x E (linear) components were highly significant for average fruit weight, fruit polar diameter, fruit equatorial diameter, number of fruits per plant, yield per plant, early yield per plot and total yield per plot. The genotypes F_1 -124, 5hivaji and 855-211 were found to be desirable and stable for total yield per plot, while genotypes 5-72 and Rashmi were suited for favourable environments. The genotype Megha was found stable for early yield. The F_1 hybrids had greater stability for yield across environment compared to open pollinated varieties.

Hannan *et al.* (2007) investigated heterosis, combining ability and brix %, days to first fruit ripening and yield in tomato (*Lycopersicon esculentum* Mill.).The study was conducted on a 10 × 10 diallel set of tomato excluding reciprocals to quantify the extent of heterosis, combining ability and nature of gene action for yield with two important quality traits: brix% and days to first fruit ripening. They obtained significant differences among genotypes with environment interaction for all the traits. They concluded that predominance of non-additive gene action by genotype-environment interaction played a greater role in the inheritance of brix% and DFFR in tomato.

Mehta *et al.* (2011) investigated seven open pollinated genotypes of long brinjal in three environments under rainy season and irrigated situations for Chhattisgarh plains. Data analyzed for stability parameters and highly significant mean squares were observed for genotypes, genotype x environment interaction and environment (linear). IBWl-2007-1 was the most stable genotype under irrigated condition of Chhattisgarh plains for Kharif planting situations as it had high mean, regression coefficient not deviated from unity and non significant deviation from regression. Whereas, a local genotype was suitable for fruit yield under low yielding environment.

Beaver and Johnson (1981) studied yield stability of determinate and indeterminate soybean and found that a significant portion, but not all the genotypes × environment interaction could be explained by regression. The group, indeterminate cultivars in this study possessed desirable stability characteristics having average or greater than average seed yield response to environments of varying levels of productivity and minimum deviations from regression.

Mahesh and Sathyanarayana (2011) studied 26 accessions were initially screened for L-Dopa content and 5 accessions showed significant difference viz., 500153AP, 500149AP, 500150AP, 500101KA and IC385841 were selected for plantation during Kharif season.

Singh *et al.* (1991) found three genotypes i. e. HFG156 and HFG119 were most stable with high yield and unit regression coefficient for both the traits studied named green fodder and dry matter yield in cluster bean (*Cyamopsis tetragonoloba* L. Taub.). They studied by growing 14 genotypes over four years. The genotypes showed significant interactions with the environment for both the traits and a large portion of these interactions was accounted for by the linear regression on the environmental index for dry matter yield, whereas the reverse was the case for green fodder yield.

Singh and Chaudhary (1985) studied 32 soybean genotypes in three artificial environments and all 32 genotypes were found to be stable, except Bragg, HM33, SH2 and HM8 for days to maturity, yield, oil content and protein content, respectively. HM93, PK73-94, PK321, PK73-92, Bragg and SH_1 had the greatest stability, above average response and high seed yields.

Ashraf *et al.* (2001) conducted an experiment with thirteen advance lines and three checks of wheat were planted at nine locations to estimate genotype-environment interaction. Both the linear and nonlinear components were highly significant, indicating the presence of both predictable and un-predictable components of G $\times$ E interaction. The stability parameters for the individual genotype revealed that the genotype, 89R-35 and 90R-36 showed the regression closer to unity along with low deviation from regression and thus may be stated as stable genotypes.

Shah *et al.* (2009) conducted stability analysis with ten wheat varieties at nine different locations for three years. He found variety-location interactions were highly significant for all characters. The relative magnitude of interaction variance components indicated that relative performance of varieties for plant height, productive tillers, 1000-grain weight and grain yield were more inconsistent across locations. The stability parameters within variety mean square (S_i^2), variety coefficient of variation (CV_i%), ecovalence (W_i^2), variety interaction variance (σ_i^2), regression coefficient (b_i), deviation from regression mean square (δ_i^2) and coefficient of determination (R_i^2), revealed a range of stability for all characters.

With the trials conducted in two locations and over two years, the adaptation and stability statistics of 20 bread wheat genotypes were estimated for yield performances (Aycicek and Yildirim. 2006). There were differences in stability performances among the genotypes for the traits of plant height, grains spike^{-1}, grain weight spike^{-1} , 1000 kernels weight and grain yield. The instability for plant height and grain weight spike among the genotypes was originated from the mean squares of deviation from regression; for the other traits it was resulted from not only the mean squares of deviation from regression but also from the differences among regression coefficients of genotypes.

Ten genotypes of wheat were evaluated with respect to grain yield and its components to characterize their stability under four growing environments (Amin *et al.*, 1993). Significant G × E interaction was observed in the materials for all the characters. Based on phenotypic index, regression coefficient and deviation from regression parameter, only Aghrani was found as stable genotypes with wider adaptation which was conferred by the stability of spikes m^{-2}. Varieties like Kanchan and Akbar found suitable only for favourable environments. Lines BAW-59, BAW-60 and BAW-61 were found suitable for cultivation under marginal condition i. e. slightly unfavourable environments. The rest of genotypes exhibited different response over different environments for different characters.

Twenty genotypes of bread wheat were evaluated at three locations. Genotypes x locations interaction vis-a-vis stability were studied for days to maturity and grain yield by Barma *el al.*, 1994. Genotypes, locations and G x E interactions were found significant for both the traits. Significant genotypes x environments (linear) interactions also occurred for both maturity and yield indicating differential response among the genotypes. Estimated stability parameters (b_i and S^2d_i) for days to maturity indicated that the lines BAW-80, BAW-109, BAW-166 with least response to environments (b_i=l) and minimum deviation from regression (S^2d_i=0) were found stable over locations. However, the high yielding genotypes, BAW-78, BAW-87, BAW-106, BAW-121 and Kanchan were highly sensitive (bi>1.0) to location changes having minimum deviation from regression (S^2di=0) indicating suitability only for high yielding environments.

Broccoli *et al.* (2004) conducted an experiment by which fourteen commercial popcorn maize hybrids were evaluated in a randomized block design in three locations for two years in the region of the Buenos Aires province, Argentina. The interaction genotype x environment revealed environments favourable towards yield but which were simultaneously unfavourable towards expansion capacity, as well as genotypes stable for one of these variables but unstable for the other. However, some environments and genotypes were simultaneously favourable to both. Only a weak negative correlation was found between grain yield and expansion capacity, suggesting this relationship may not be very strong in these modern hybrids. Rounded grains showed higher expansion capacities, but this characteristic was negatively correlated to yield; roundness is therefore not recommended as a selection criterion. The prolificacy index correlated positively with yield but not with expansion volume, and is therefore a potential selection criterion.

An experiment was conducted by Mashark *et al.* in 2007 to determine the importance of genotype by environment interaction (GE) in late maturing lowland maize varieties to determine yield stability of the genotypes and use the information to exploit GE for the development of high and stable yielding varieties. Seven out of the nine genotypes were stable, when b-values alone were considered. When the b-values and the deviations from regression (S^2d) were considered, (GH24 x 1368) x 5012 and (GH22 x 1368) x 5012, were the most stable, but when the coefficient of determination was added to the b-value and S^2d, GH132 - 28 was the most stable genotype. A good level of precision was obtained with two replications, when genotypes were evaluated for 4 years at *8* locations.

Fifteen maize genotypes were tested by Admassu *et al* (2008) at nine different locations in 2005 under rain fed condition to determine stable maize genotypes for grain yield and determine genotypes with high yield and form homogenous grouping of environments and genotypes. There was considerable variation among genotypes and environments for grain yield. Stability was estimated using the Additive Main Effects and Multiplicative Interactions (AMMI). Based on the stability analysis, genotypes 30H83, BH-540, Ambo Synth-1, AMH-800 and BHQP-543were found to be stable for grain yield. The first two Interaction Principal Component axis (IPCA1 and IPCA2) were significant and cumulatively contributed 70.27% of the total genotype by environment interaction. The coefficient of determination (R^2) for genotypes 30H83 was as high as 0.92, confirming its high predictability to stability. Among the genotypes, the highest grain yield was obtained from genotype 30H83 and BH-541 (8.98 and 8.05 t ha-1) across environments. Clustering of AMMI-estimate values grouped genotypes in to four clusters and the environment in to three clusters. Environment Goffa was unique as it is grouped differently from all other environments.

Gezahegn *et al.* (2009) used eight drought tolerant maize lines and their 28 crosses with two local hybrids and evaluated separately in 12 environments to estimate the magnitude of genotype x environment interaction (GEI) and relationships between parents and progenies in stability. An additive main effects and multiplicative interaction (AMMI) model was used to analyze the grain yield data. The first two IPCAs of the AMMI 2 analysis accounted for 56 % of the GEI sum squares in trials of the hybrids. High yielding hybrids like O, P, S, Z, U, G and one of the checks (BH140) showed minimum GEI, indicating wide adaptation of these varieties over environments. In contrast, high yielding hybrids such as A, D and J adapted to unfavourable environments and K and T to favourable environments. Most of the crosses from drought tolerant parents were better than the check (BH540) in mean grain yield and stability.

Balestre *et al.* (2009) constructed an experiment and evaluated the phenotypic and genotypic stability and adaptability of maize hybrids using the additive main effect and multiplicative interaction (AMMI) and genotype x genotype-environment interaction (GGE) biplot models. They found that, the GGE biplot method to be superior to the AMMI 1 graph, due to more retention of GE and G + GE in the graph analysis. However, based on cross-validation results, the GGE biplot was less accurate than the AMMI 1 graph, inferring that the quantity of GE or G + GE retained in the graph analysis alone is not a good parameter for choice of stabilities and adaptabilities when comparing AMMI and GGE analyses.

Rahman *et al* (2010) carried out stability analysis to study stability in performance and genotype x environment interactions for 18 maize hybrids across three locations of NWFP during 2006. Analysis of variance indicated significant differences among the three locations for all the traits studied. Hybrids showed significant differences for all parameters except anthesis silking interval (ASI) and ear height, which were non-significant across the three locations. The hybrid x location interactions also revealed significant differences for days to 50% silking, days to 50% anthesis, ASI, grain moisture at harvest and grain yield per hectare while non significant differences were observed for plant height and ear height. Based on yield performance of hybrids across the three locations, Baffa ranked first as compared to the other two locations.

Sharma (2013) carried out an experiment for stability analysis with thirty six genotypes of Isabgol (*Plantago ovate* Forsk) under three environments to identify stable genotypes that could be cultivated uniformly under varied environmental conditions for yield and yield attributing traits. Pooled ANOVA for stability indicated that allthe genotypes of Isabgol were highly significant for all the characters. Mean squares arising due to genotype, G x E interaction and E + (G x E) were found significant for all the traits. Sufficient G x E (Linear) were exhibited by all the characters. The genotype RI-158 was superior in performance and stability for seed yield suggesting its suitability for inclusion on future breeding programme for development of stable variety. The genotypes, namely RI-138, Ri-3004, Ri-166, RAUI-Ja-2, RAUI-Ja-3, RAUI-B, RI-89, HI-2, GI-4 and Niharika were found suitable for high yielding environments, while genotypes GI-2, RI-1(9808) and RI-142 were best in the poor environments for seed yield.

Zhou *et al.* (2012) observed genotype by environment interaction (G x E) influences and complicates the selection of superior genotypes in trials by confounding the determination of true genetic values in sugarcane. Genotype by location interaction was significant for the irrigated and coastal long-cycle programs. Genotype by crop-year interaction was larger and more significant for rain-fed than for irrigated cropping system, indicating the importance of ratooning ability in rain-fed regions. Genotype by location by crop-year interaction was significant ($P < 0.01$) for yield and sucrose content, highlighting the complexity associated with breeding sugarcane. The coastal long-cycle program was the most complex and generally characterized by large G x E. Separating the coastal hinterland and coastal average potential would be recommended to reduce G x E.

Kishore *et al.* (2007) carried out a joint regression analysis over eight environments in 8 genetically diverse amaranth genotypes during Kharif seasons of 2001 – 2004 at Sangla (Dist. Kinnaur) and Salooni (Dist. Chamba) indicated the presence of genotype x environment interaction for all the traits studied. Significant pooled deviations for all the traits indicated predominance of the nonlinear component. Estimates of stability parameters revealed that no genotype was stable for the traits studied. Based on the mean performance (x), genotypes Annapurna, Suvarna and PRA-1 showed significantly higher seed yield than the Local check. Suvarna was significantly early in flowering (54 days) and maturity (107 days) than the other genotypes, whereas PRA-1 showed maximum mean plant height and inflorescence length. Significant linear regression coefficient value for seed yield indicated above average ($b>1$) stability for the genotype Annapurnai.e. Suitability for the input responsive environment, whereas for plant height the genotype was significantly least responsive i.e. exhibited below average ($b<1$) stability showing fitness for the low yielding environment. PRA-1 was also found to be significantly responsive for plant height in comparison to the Local check. Genotypes PRA-2 and the Local check exhibited least responsiveness for days to 50% flowering. Considering the stability parameters in general, genotype Suvarna is by far the best genotype followed by Annapurna and PRA-1 for cultivation in the higher regions of Himachal Pradesh.

Sojitra and Pethani (1998) experimented twenty nine bunch groundnut genotypes under four environments to estimate the stability parameters for 100seed weight. However, linear portion was significantly higher than non linear portion. Seventeen genotypes showed linear and 11 genotypes nonlinear sensitivity. Both the components of G x E interaction were present in genotype JB-224. The bold seeded genotype EC-100827 and small seeded genotype JB-215 showed wider adaptation. The bold seeded genotype JB-210 and small seeded genotype J-18 were highly responsive and suitable for favourable environments. Bold seeded genotype J-17, GG-2, J (E)-l, JB-223 and CGC-3 as well as small seeded genotypes ICGS-11, J-11, NRGS-4, J (E)-l, JB-187, J(E)-336 and GAUG-1 were found suitable for adverse environments.

The genotype X environment interaction by Mishra and Rai (1993) was studied for 10 parents and their 45 F1 hybrids for seed yield and 8 quality traits in linseed under 4 environments. Highly significant differences among genotypes, environments and E+ (GXE) interaction for all the characters were observed. The nonlinear component of GXE was significant for all the characters except protein and oil contents. G x E (linear) interaction was significant for all the characters except iodine value and palmitic acid. The variety T397 for seed yield per plant and oil content, R552 for protein content, R17 for palmitic acid and K2 for stearic acid was considered as stable. Cross combination T397 X LCK152 was stable for all the characters except stearic and oleic acids.

Abo-Hegazy *et al.* (2013) determined the performance and stability of 24 lentil (*Lens culinaris* Medik.) genotypes under a wide range of variable environments. The regression model were used to analyze the response of the lentil genotypes to variable environmental conditions for yield and some of its components in six experiments in three seasons under two locations. The performance of genotypes varied highly significantly from environment to another for all traits, except 100 seed weight as proved by significance of G x E. Four genotypes were stable for pods plant^{-1} either measured by Wi or S^2di. For this trait, all genotypes were non responsive to environmental conditions except PL81-17 which may behave positively to pod bearing conditions. For seed yield plant^{-1} only Sinai 1 was significantly unstable measured by Wi & S^2di, respectively. The significance of bi for seed yield feddan -1 proved that only 3 genotypes were responsive to environments. Two of them (XG88-17 and Giza 51) may behave better under good environments and the third (Giza 4) may be recommended under poor ones. It may be concluded in lentil breeding programs, which the performance of genotypes under each location should be evaluated firstly and those reliable ones will be tested for stability across various environmental conditions prior to recommendations.

Deka and Talukdar (1997) studied stability behaviour of twenty one germplasm collection of soybean for yield and different yield attributes under five different environments. Significant genotype X environment interactions were observed for almost all the characters. For characters like 100 seed weight and yield per plant, only linear component contributed significantly Towards G x E interaction. For rest of the characters both linear and nonlinear Components contributed towards G x E interaction variance. Genotypes Moti, PK-308, PK-472, BO-l, BO-12, Bragg and PK-73-203 showed average stability for seed yield. Whereas 05-16-1-37-1 hadab over average stability.

Kumar *et al*. (1996) conducted multilocation trials of 16 genotypes of desi and kabuli chickpea (*Cicer arietinum* L.) in a number of countries in three seasons at 17 (1981-82), 31 (1982-83) and 22 (1983-84). Mean squares for locations, genotypes and genotype x location interactions were significant. Locations and genotype x location interaction variances were much higher than those for genotypes. Genotypes exhibited relatively more interaction with winter-sown locations than with spring-sown locations. Desi types showed more variation than the Kabuli types. The mean squares due to desi and Kabuli type interactions were higher than those for either desi or for kabuli types in two of the three years. Yield performance of the Indian kabuli cultivar L550 was comparable with the best desi cultivar K850. Seed size did not appear to influence yield performance and stability. Annigeri, PantG114, ICCC8, L550 and ILC482 had relatively high yield with good stability.

Hanamaratti *et al.* (2010) evaluated the superior rice NIILs selected for productivity under artificial drought condition over three drought stress and three non-stress environments. AMMI based stability parameter; ASTABi and Rao's Index of stability were utilized to interpret the stability among the NIILs under stress and non-stress environments. The grain yield was much sensitive and highly influenced by environment resulting in higher G x E interaction under stress environments. Pooled deviation was highly significant indicating the presence of non-predictable components for grain yield and yield related traits. Based on ASTABi, RF-55-254 was most stable genotype which was also the best for grain yield (6613 kg/ha) in non-stress environments, while it was unstable under stress environments. The genotype, RF-55-198 was superior for yield as well as stability in stress environments and for overall adaptability.

Pande *et al.* (2006) evaluated twelve high yielding varieties (HYVs) of rice (*Oryza sativa* L.) for their adaptive advantage to various dry season rice ecologies under direct seeded wetland condition for yield and its' consistency. Duration in different varieties got delayed due to cold stress in November and December seeding and it varied in between 14 to 34 days. It was minimum in case of Vandana (14 days) and maximum in Saket 4 (34 days) due to effect of cold during growing season. Medium late variety Pusa 44 registered the highest yield (about 10 t/ha) when seeded in mid-November. IR 64, CR749-20-2 and Lalat, which are very popular in bora areas, performed equally well under mid-December seeding. The variety Vandana may be promising for Early Ahu areas of Assam orin the areas where rice is taken after mustard or potato asa direct seeded crop. Variety Tapaswini did not flower at all when sown in mid-February till the end of the season due to non-availability of appropriate short-day requirement. Desirable grain type and tolerance to blast of Khitishunder mid-February seeding has made it popular in the late bora areas of West Bengal. Varieties varied greatly in milling recovery - it was the highest when sown in between mid-November to mid-December, except in Saket4 and lowest in mid-January seeding and onwards, indicating grain-filling aspect for consideration as affected by weather .

Vijayakumar *et al.* (2001) evaluated performance of improved, high yielding varieties of rice over different agro ecological regions of India have been well documented by several workers. But the performance evaluation of rice hybrids which are recently evolved in India is yet to be assessed through multilocation trials. Results indicated a significant genotype x environment Interaction (GEI) that influenced the relative ranking of the hybrids across the locations. It was evident from AMMI analysis that genotype, environment and the first principal component of interaction effect accounted for 86.96% of treatment sum of squares and that the first five principal components of the interaction effect were found to be significant. The usefulness of the Procedure in selecting genotypes for general or specific adaptation is also brought out.

Reddy *et al.* (1998) studied Genotype x environment interaction for grain yield in 24 genotypes of lowland rice under five different environments in eastern India. Significant genotype (G) and environment (E) interaction was observed. Linear and non- linear components of G x E interaction were significant, linear component being the predominant. On the basis of stability parameters two genotypes, RAU79-2-14 and RAU617-59-14-1 were found to be most stable with high grain yield over different environments. The selection from Raipur (IET6286/Bd.83)-29 was identified as suitable genotype for favourable environments.

Mukherjee *et al.* (2013) studied genotype x environment interaction (GEI) of 42 rice genotypes tested over nine seasons was analyzed to identify stable resistance to blast disease incited by *Magnaporthe oryzae*. The genotypes were raised in uniform blast nursery in a randomized complete block design with three replications. The GEI was analyzed following the regression models as well as additive main effects and multiplicative interaction (AMMI) model. AMMI analysis of variance revealed that the first two interaction principal component axes (IPCA) explained 37.28 and 33.47% of the interaction effects in 14.63 and 14.02% of interaction degrees of freedom, respectively and rest of the five IPCAs were noisy. Integrating biplot display and genotypic stability statistics enabled five groupings of genotypes based on similarities in their performance across environments. The biplot generated using the environment and genotype scores for the first two IPCAs revealed the positioning of the five host genotype groups (HG) into four sectors. HG-1 constituting of 28 genotypes exhibiting low stability index, low IPCA 1 as well as IPCA 2 scores and low mean disease scores across seasons of testing, were identified as possessing stable resistance to the disease. Although, both regression and AMMI models were equally potential in partitioning of GEI, AMMI analysis and the biplot display were more informative in differentiating genotype response over environments, describing specific and non-specific resistance of genotypes, identifying most discriminating environments and thus could be useful to plant pathologists as well as breeders in supporting breeding program decisions.

Das and Deb (1996) studied thirteen autumn rice genotypes were evaluated in three environments under rain fed and direct seeded conditions. Both linear and non linear components of G x E interaction were significant for productive tillers/m^2 and grains per panicle, while only linear component was significant for grain yield. Under medium yielding environment suitable genotypes were China, Tulashi, Annada and Culture1 for grain yield; IET10898, IET10895, Tulashi, Annada and CR635-49 for productive tillers/m^2, and China and Annada for grains per panicle. Rangadoria, a local genotype, was suitable for grain yield under low yielding environment.

De *et al.* (1992) studied phenotypic stability in 47 rice genotypes under four different lowland situations for grain yield and its two important components, panicle weight and ear bearing tillers (EST) per hill. Significant genotypes (G) x environment (E) interactions were observed for all the traits. Among the linear and non linear components of G x E interaction, linear component was predominant for EBT per hill and nonlinear component for grain yield, while both are equally important for panicle weight. On the basis of stability parameters, the genotypes CR728-7-2·2, CR673-431 and Utkal Prava were identified as best cultures for both intermediate and semi-deep low land situations under direct seeded as well as transplanted conditions.

Singh and Chaudhary (2007) evaluated forty genotypes of wheat over six environments under different moisture regimes for their yield performance. Genotype x environment interaction were found significant for plant height, peduncle length, grain yield, biological yield, LPH/PH index, PULPH index PUPH index, ear length, tillers per meter and harvest index. On partitioning it into linear and non-linear components, both were responsible for expression of the traits. However, the linear component was found larger in magnitude than the non-linear component suggesting that the variation in the performance of different cultivars could be predicted. The genotypes RR49 and IB2K1-37 Were found to be stable across environments for grain yield, whilegenotypesRR888, RR49, IB2K1-66, RS897, RR 24 and IB2K1-37 were found to be stable across environments for yield component slike 1000 grain weight, biological yield and tillers parameter. Genotypes DL153-2, DL 788-2 and RR-19 were found to be having stable performance for plant height and component characters under stress environments.

Mehta *et al.* (2000) studied six promising wheats grown in randomized block design with three replications over a range of artificially created fertility gradient for two years. The stability analysis of the genotypes following the Eberhart and Russels model was performed. On the basis of mean performance overall fertility levels, HD2329, Kundan and DL803-3 were the highest Yielding wheats. Two genotypes viz., HD2329 and Kundan have the inherent attributes of responsiveness to high yielding environments as evidenced by unit linear regression coefficient (bi = 1) of the stability analysis. The distinctive behaviour between the two genotypes was revealed by another stability parameter wherein the deviations from regression were the highest for HD2329, showing that the variety is suited specifically to high yielding environments. Kundan showed the minimal (ali)' indicating that the varietal performance was stable even at the lower fertility levels.

Muralia and Sastry (1994) evaluated twenty one genotypes of wheat (*Triticum aestivum* L.) at four salinity levels for seedling emergence and establishment characters. The genotypes exhibited significant differences for all the traits studied. It was inferred that genotypes HO2385, KRL5, WH157, WH291 and VW120 were found to be ideal under conditions of salinity for all the characters. On the other hand, the genotypes HD2009, HUW300, Kharchia65 and Raj1482 were found suitable only for non saline conditions. Raj3214 was found to be stable for shoot length and osmolarity.

Stability analysis of 4 advanced generation lines along with six checks of wheat was made by Kishor *et al.* (1992) for six characters including three quality traits. The G x E interaction, environment (linear) and environment (nonlinear) components were highly significant for all the traits. Twenty nine genotypes showed stable response for tryptophan content and 12 for seed hardness. Many genotypes also showed stability for protein content. Grain yield was positively correlated with 1000-grain weight and harvest index but negatively associated with protein, tryptophan content, and seed hardness. Protein content showed positive association with tryptophan content and seed hardness.

Rajput and Ahmad (1992) reported the stability parameters for six traits related to quality and productivity performed in a U-parent diallel mating techniques of macaroni wheat (*Triticum durum* Desf.). Nonlinear components revealed highly significant difference for reproductive phase, seed hardness, protein content, and gluten content. The parent varieties Jori'c'69 and Raj911 appeared to be more adapted as they exhibited non significant deviation from regression, regression coefficient less than unity, and high grain yield. Jori'c' 69 also showed adaptation for Gluten content. Twenty cross combinations in Fl generation exhibited better stability for higher grain yield in comparison to their parental performances. The hybrids Meghdoot x WL1002 and NP404 x DWL5023 were stable for seed hardness, protein and gluten content.

Chapter III

Materials and Methods

CHAPTER III

MATERIALS AND METHODS

An experiment was conducted at the experimental field of Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh during the period from November 2013 to May 2014 to study on the Genotype × Environment interaction in chilli. The experiment was conducted to deal with major objectives of this thesis work. The materials and methods of this experiment are presented in this chapter under the following headings:

3.1 Location of the experimental site

The experimental area was situated at 23°46' N latitude and 90°22' E longitude at an altitude of 8.6 meter above the sea level. The experimental field belongs to the agro-ecological zone of "The Madhupur Tract", AEZ-28. The research work was conducted at the experimental farm of Sher-e-Bangla Agricultural University, Dhaka-1207. Allotted plot number was 2. Location of experimental site at Sher-e-Bangla Agricultural University is presented in Figure 1.

3.2 Climate of the experimental site

The experimental area was under the sub-tropical monsoon climate zone, which is characterized by heavy rainfall, high humidity, high temperature and relatively long day during the kharif season while hardly rainfall, low humidity, low temperature and short day during the rabi season. Rabi season is favourable for *Capsicum* cultivation. During the studying period, the crop received total rainfall of 67.57 mm (Appendix I). At that time, the average maximum and minimum temperatures were 30.98^{0}C and 19.31^{0}C, respectively (Appendix I).

During the period, according to Abhawa Bhaban (weather station) of Bangladesh, from December- January, the humidity was low and the

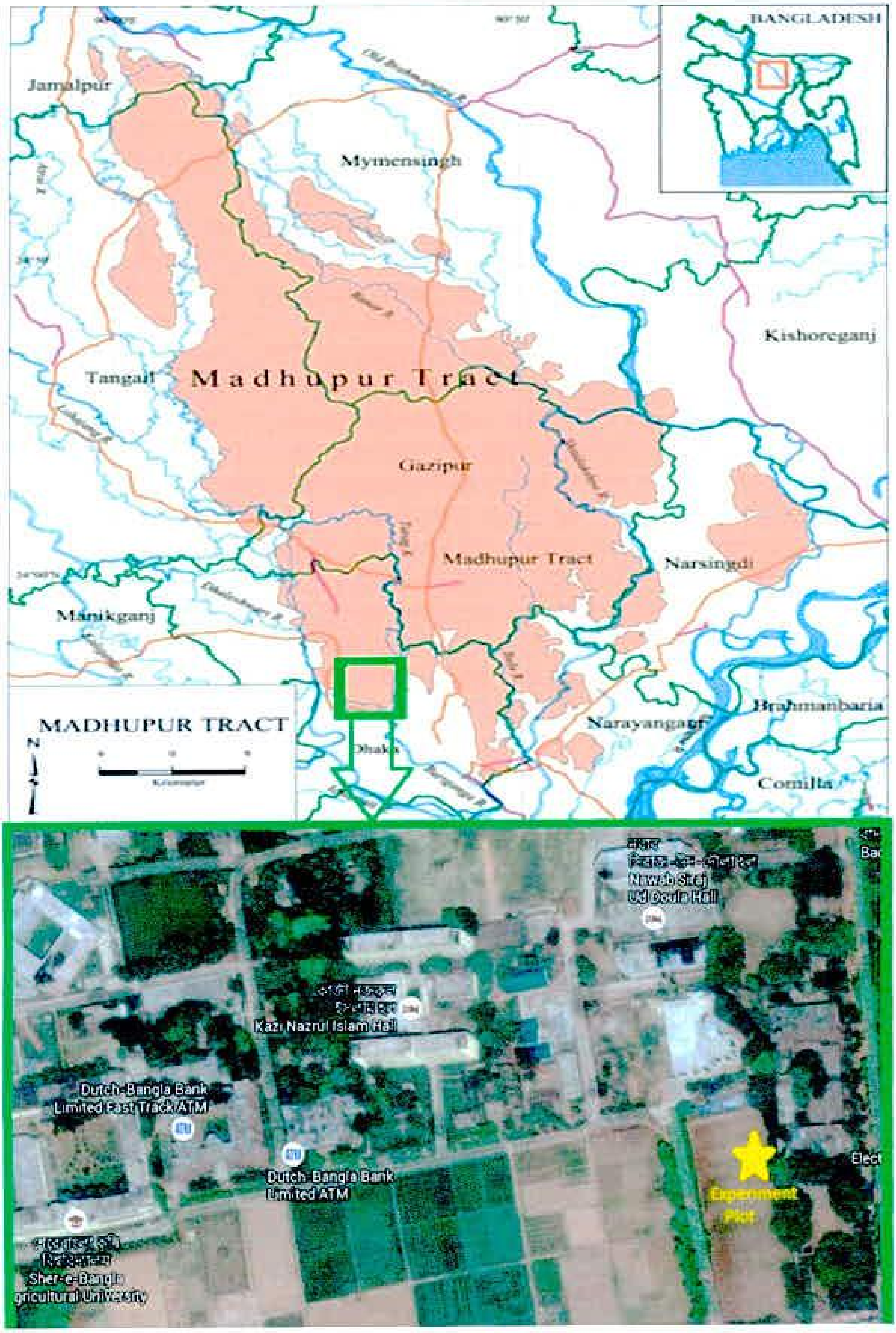


Figure 1. Location of the experimental site at SAU farm, Dhaka

temperature was mild with plenty of sunshine. The atmospheric temperature increased from February as the season proceeded towards summer. Brown to red, slight to strongly acid, finely structured, friable clay loams to clays, gradually intergrading into a mixed red, black and pale brown, friable, weathered Madhupur clay substratum to a deeper depth. This was a region of complex relief and soils developed over the Madhupur clay, where floodplain sediments buried the dissected edges of the Madhupur Tract leaving small hillocks of red soils as 'Islands' surrounded by floodplain. They occur extensively on the edges of broad level terraces in the Madhupur Tract and locally in the north-eastern edge of the Barind Tract (BBS, 2013).

3.3 Characteristics of soil

The land belongs to agro-ecological region of 'Madhupur Tract' (AEZ 28) of Nodda soil series. The soil was sandy loam in texture having pH 4.47- 5.63. The selected plot was a medium high land. The amount organic carbon content, total N, available P and available K were 0.82%, 0. 12%, 21 ppm and 0.27me per 100 gm of soil respectively (BBS, 2013).

3.4 Genetic materials used for the experiment

The study was performed with 10 genotypes of chilli of different origin / source. Among them 2 genotypes were collected from PGRC, Bangladesh Agricultural Research Institute (BARI), Gazjpur; 2 from BADC office, Muktagacha, Mymensingh ; 2 from BADC office, Asad gate, Dhaka; 1 from Siddik Bazar, Seed Market, Dhaka ; 1 from Barisal Nursery, Savar ; 1 from Supreme seed company ltd., Mymensingh (Table 1).

3.5 Design and layout of the experiment

The experiment was laid out in Randomized Complete Block Design (RCBD) with 3 replications. The field plot was divided into 3 blocks then each block was further sub-divided into 4 individual blocks sized 4.25 m x 1.6 m, where treatments were randomly assigned. Then in each plot the genotypes were assigned randomly in 10 lines. The whole plot length was 20.5 m and breadth was 8 m. Row to Row distance was 50 cm and Plant to Plant distance was 45 cm. The breadth of gutter between replications and between treatments was 75 cm and 50 cm respectively.

Table 1. The code, genotype name and source of collection of the 10 genotypes of chilli used in the experiment

Code	Genotype Name	Source of Collection
G1	Kalo Dhawna morich	Farmer, Ishwarganj, Mymensingh
G2	Bogurar Jhal Morich	BADC office, Muktagacha, Mymensingh
G3	Balojhuri	BADC office, Muktagacha, Mymensingh
G4	DBP 14 5G (China)	Siddik bazaar seed market, Dhaka
G5	Suryamukhi	Barisal Nursery, Savar
G6	Bogurar lomba Morich	BADC office, Asad gate, Dhaka
G7	BD-2059	PGRC, BARI, Gazipur
G8	BD-2122	PGRC, BARI, Gazipur
G9	Bogura Jatt	BADC office, Asad gate, Dhaka
G10	Bullet	Supreme seed company ltd.

PGRC= Plant Genetic Resource Centre, BARI= Bangladesh Agricultural Research Institute

3.6 Preparation of the experimental field

The selected field for growing *Capsicum* was first opened at 20 November, 2013 with power tiller and was exposed to the sun for a week. Then the land was prepared to obtain good tilth by several ploughing, cross ploughing and laddering. Subsequent operations were done with harrow, spade and hammer. Weeds and stubbles were removed; larger clods were broken into small particles, and finally attained into a desirable tilth to ensure proper growing conditions.

The plot was partitioned into the unit plots according to the experimental design as mentioned earlier. Recommended doses of well decomposed cowdung, manure and chemical fertilizers were applied and mixed well with the soil each plot. Proper irrigation and drainage channels were prepared around the plots. Each unit plot was prepared keeping 5 cm height from the drains. The bed soil was made friable and the surface of the bed was levelled. Four days before planting of *Capsicum* seedlings the fertilizers/manure (well rotten cowdung) was uniformly and thoroughly mixed with the soil. One-fourth of the urea and MP was applied during land preparation and the remaining three-fourth applied in three equal splits as top dress, one at the vegetative phase (30 DAP), second also at vegetative phase (45 DAP) and the other at flowering stage (60 DAP) (Table 2).

3.7 Manure and fertilizer

Manure and fertilizer were applied at the doses indicated below following the methods shown in Table 2.

Table 2. Doses and methods of application of manure and fertilizers for the production of chilli using seedling*

Manure and fertilizers	Dose (Kg/ha)	Dose/ plot	Application per plot			
			Basal dose	1st top dressing at 30 DAP	2nd top dressing at 45 DAP	3rd top dressing at 60 DAP
Cowdung	15000	20 Kg	20 Kg	-	-	-
Urea	275	500g	200g	100g	100g	100g
TSP	200	400g	400g	-	-	-
MP	200	400g	160g	80g	80g	80g
Gypsum	20	40g	40g	-	-	-
ZnO	10	20g	20g	-	-	-
Boric Acid	10	20g	20g	-	-	-
Furadon	10	20g	20g	-	-	-

*The Manure and fertilizers were given according to the environmental treatments whether necessary (Crop Production Techniques of Horticultural Crops, 2013)

3.8 Experimental plan and cultural environmental treatments

G × E interaction study was pursued using four cultural environments as detailed in Table 3. Organic fertilizer and other inputs used in creating the environments were at recommended rates, and for common inputs same rate was used in different environments.

Table 3. Organic fertilizer and other inputs used at recommended dose according to table 2 in different environments

Environments	Treatments
Env-1:	Urea + TSP + MOP + Gypsum+ ZnO
Env-2:	Urea + TSP + MOP + Cow dung
Env-3:	Urea + TSP + MOP + Boric Acid
Env-4:	Cow dung

3.9 Sowing of seed and intercultural operation in seedbed

Seeds were sown in a seed bed for raising seedlings. The seeds were sown on the 19th November, 2013. For transplanting of seedlings, it is maintained in rows keeping the row to row distance of 10 cm. Mulching with polythene was done to retain temperature for germination, as chilli seeds are very much sensitive to temperature. Seedbed size was 3 m x 1m. A lot of care was taken to obtain healthy seedlings. Weeding, hoeing and irrigation were also done properly.

There was an incidence of infestation with harmful insects like ants in some experimental plots. Mechanical control (hand picking) of insects as well as chemical control (i. e. Sevin 85 SP application) was done during the infestation.

3.10 Planting of chilli seedlings

Forty days old seedlings were transplanted in the experimental plots on 20th December, 2013 as per treatment. Planting was done at afternoon. One seedling was planted in each hole. After planting the bases of seedlings were covered with soil, and then pressed by hand.

3.11 Intercultural operations

A lot of care was taken to obtain healthy plants from transplanted seedlings. After transplanting, following intercultural operations were done for better growth and development.

3.11.1 Irrigation

Immediately after transplanting the experimental plot was semi- flooded by irrigation. The crop was irrigated when needed depending on the moisture status of the soil and requirement of plants.

3.11.2 Gap filling

Plots with transplanted seedlings were regularly observed to find out any damage dead seedlings for its replacement. Gap filling was done as and when required.

3.11.3 Weeding and mulching

Weeding and mulching were necessary to keep the plots free from weeds, easy aeration and for conserving soil moisture. When the plants were well established, the soil around the plant base was pulverized.

3.11.4 Top dressing

The remaining doses of Urea and MP were applied as top dressing in each plot by three equal installments.

3.11.5 Plant protection measures

The established plants were affected by aphids. Diazinon 6O EC (15 cc/10 liter) was applied against aphids and other insects. Chilli Plants infected with anthracnose and die back and were controlled by Spraying Cupravit (3g/1iter) at 15 days interval. Few plants found to be infected by bacterial wilt were uprooted.

3.12 Harvesting

Harvesting of fruits was started at 75 DAP and continued up to 125 DAP with an interval of 15-20days Harvesting was done usually by hand.

3.13 Data collection

In order to study the genotype-environment interaction among the genotypes, the data were collected in respects of 23 parameters. Parameters were plant height excluding root, length of root, number of primary branches per plant, number of secondary branches per plant, number of leaves per plant, number of leaves per branch, number of fruit per plant, number of fruit per primary branch, fresh weight of shoot, fresh weight of root, oven dry weight of shoot, oven dry weight of root, leaf area index, fruit length without panicle, individual fruit weight, number of seeds per fruit, weight of seeds per fruit, hundred seed weight, days to first flowering, days to 50% flowering, fruit diameter, fruit yield per plant during the growth of plants and at the harvesting time of the crop, fruit number per plucking per plant (Tembhurne, 2013; Srividhya, 2010). During the plant growth, 1-3 plants were selected randomly from each unit plot in each line according to requirement for data collection. The sampling was done in such a way so that the border effects were completely avoided. For this purpose, the outer two lines and the extreme end of the middle rows were excluded.

3.13.1 Days to first flowering

The number of days was counted from the date of transplanting to days to first flowering.

3.13.2 Days to 50% flowering

The number of days was counted from the date of transplanting to 50 per cent of plants flowered.

3.13.3 Plant height excluding root (cm)

The plant height was measured from ground level to tip of the plant excluding root expressed in centimeters (cm) and mean was computed at final day of harvest.

3.13.4 Root length (cm)

The root length was measured from ground level to tip of the root expressed in centimeters (cm) and mean was computed at final day of harvest.

3.13.5 Number of primary branches per plant

The number of primary branches arising from the main stem above the ground was recorded at 50 days after transplanting.

3.13.6 Number of secondary branches per plant

The number of secondary branches arising from the primary branches was recorded at 50 days after transplanting.

3.13.7 Number of leaves per plant

Total number of leaves in one randomly selected plant was recorded at 125 DAP.

3.13.8 Number of leaves per primary branches

Number of leaves per primary branch was counted at 125 DAP from three randomly selected branch of the sample plant.

3.13.9 Number of fruits per plant

The total number of marketable fruits harvested from one randomly selected plant in each line was counted in every plucking and those were summed to calculate number of fruits per plant.

3.13.10 Number of fruit per primary branches

The total number of marketable fruits harvested from one randomly selected plant's three primary branches. From each branch each plucking data was recorded and those were summed to calculate number of fruit per primary branch.

3.13.11 Fruit diameter (cm)

It was measured from fruit breadth at highest bulged portion of the fruit by using vernire caliper from of three randomly selected fruits from one randomly selected plant in each line.

3.13.12 Individual fruit weight (g)

It was measured from fruit weight at highest bulged portion of the fruit by using electric milligram sensitive weight measurer from of three randomly selected fruits from one randomly selected plant in each line.

3.13.13 Fresh weight of shoot (g)

Fresh weight of shoot was taken at final harvest day (125 DAP) without root from one selected plant in each line of every plot.

3.13.14 Fresh weight of root (g)

Fresh weight of root was taken at final harvest day (125 DAP) without shoot from one selected plant in each line of every plot.

3.13.15 Oven dry weight of shoot (g)

Oven dry weight of shoot was taken at 5 days later from final harvest day (130 DAP) when oven dried from shoot obtained during fresh weight data collection.

3.13.16 Oven dry weight of root (g)

Oven dry weight of root was taken at 5 days later from final harvest day (130 DAP) when oven dried from root obtained during fresh weight data collection.

3.13.17 Leaf area index

Leaf breadth in three sections (i. e. near top, middle, near base) of the leaf was taken from three randomly chosen leaves from one randomly chosen plant in every line of every subplot. Leaf length without panicle was also recorded of above leaves respectively. Then leaf area index were calculated for each leaf.

3.13.18 Fruit length without panicle (cm)

Fruit length without panicle was taken from three randomly chosen fruits from one randomly chosen plant in every line of every subplot.

3.13.19 Number of seeds per fruit

Number of seeds per fruit was taken from three randomly chosen fruits from one randomly chosen plant in every line of every subplot.

3.13.20 Weight of seeds per fruit (mg)

Weight of seeds per fruit was taken from three randomly chosen fruits from one randomly chosen plant in every line of every subplot. It was weighed using milligram sensitive balance.

3.13.21 Hundred seed weight (mg)

Hundred seed weight was taken from seeds obtained during measurement of weight of seed per fruit. It was weighed using miligram sensitive balance.

3.13.22 Fruit yield per plant (g)

Total weight of all fruits per plant harvested at different plucking was recorded and summed. There were total three plucking.

3.13.23 Number of fruits per plucking per plant

Total number of fruits per plant harvested at single plucking was recorded. There were total three plucking.

3.14 Plant sampling/data recording in growth studies

The first plant sampling was done from each unit plot at 30 days after transplanting which was followed by every 10 days' intervals up to final harvest. From each line, 1-3 plants were selected randomly according to data collection requirement.

3.15 Statistical analysis

The data on growth parameters and other plant characters were statistically analyzed following standard procedure followed by Kulsum *et al.* (2013). ANOVA was used and the GEI was estimated by the AMMI model (Zobel *et al.,* 1988). In this model the contribution of each genotype and each environment to the GEI is assessed by use of the biplot graph display in which yield means are plotted against the scores of the IPCA1 (Zobel *et al.,*1988). The stability parameters, regression coefficient (bi) and deviation from regression (S^2di) were estimated according to Eberhart and Russell (1966). Significance of differences among bi value and unity was tested by t test, between S^2di and zero by F test (Eberhart and Russell, 1966). All the data were subjected to analysis using statistical analysis package software Cropstat version 7.2 (AMMI, SSA and ANOVA models) after Zobel *et al.* (1988).

3.15.1 AMMI model of stability analysis

The AMMI model has been extensively applied in the statistical analysis of multi-environment cultivar trials (Kempton, 1984; Gauch and Zobel, 1989, 1997; Crossa *et al.*, 1990). According to Oliveira *et al.* (2010) the AMMI analysis according to Zobel *et al.* (1988) combines in a single model additive components for the main effects of genotype (g_i) and environments (e_j), and multiplicative components for the effect of GE interaction (ge_{ij}). The model that describes the mean yield of a genotype i in environment j is given by:

$$\bar{Y}_{ij} = \mu + g_i + a_j + \sum_{k=1}^{n} \lambda_k \gamma_{ik} \alpha_{jk} + r_{ij} + \varepsilon_{ij}$$

where:

$\bar{Y}_{ij}$ is the average yield of i^{th} genotype in j^{th} environment, and is the overall mean yield

g_i is the effect of genotype i;

a_j is the effect of environment j;

λ_k is the k^{th} singular value of the original matrix interactions (GE);

γ_{ik} is the element corresponding to the i^{th} genotype in the k^{th} singular vector of the GE matrix column;

α_{jk} is the element corresponding to the j^{th} environment in the k^{th} singular vector of the GE matrix row;

r_{ij} is the noise associated with the expression (ge_{ij}) not explained by the retained principal components;

n is the number of axes or principal components retained to describe the GE interaction pattern;

ε_{ij} is the average experimental error associated with observation, assumed to be independent $\varepsilon \sim N(0, \sigma 2)$.

For the GE interaction, the biplot is interpreted by observing the magnitude and sign of the scores of genotypes and environments, for the axis (axes) of interaction. Thus, low scores (close to zero) represent genotypes and environments are little involved in the interaction and are characterized as stable. In an AMMI2 biplot, the points of stable genotypes and environments.

3.15.2 Eberhart and Russell's method of stability analysis

The model considered in this analysis is as follows:

$Yij = \mu i + biIj + \delta ij$ (i = 1, 2 --------- n and j = 1, 2 ---------- l)

Where,

Yij is the mean of the i^{th} variety at j^{th} environment

μi is the mean of the i^{th} variety over all environment

biIj is the regression coefficient that measures the response of the i^{th} variety to environment index.

i.e.:

$$bi = \sum_{J=1}^{n} YijIj / \sum_{J=1}^{n} Ij^2$$

Ij is the environmental index which is defined as the deviation of mean of all varieties at a given time from over all mean

i.e. $Ij = \bar{Y}.j - \bar{Y}..$

Where,

$\bar{Y}.j$ = Mean at j^{th} environment.

$\bar{Y}..$ = Over all mean

δij is the deviation from regresion of the i^{th} variety at the j^{th} environment i.e.

$$\sum_j \delta ij = \left[\sum_j yij^2 - \frac{Yi^2}{t}\right] - \frac{\left(\sum_j Yij\ Ij\right)^2}{\sum_j I_j^2}$$

Where t is the number of environment

The term phenotypic index has been introduced in the Eberhart and Russell (1966) model for easy interpretation and quick conclusion. The phenotypic index of a genotype may be considered as one of the stability parameters in place of overall variety mean and can be represented as pi = $\bar{Y}i$ - $\bar{Y}..$ i.e deviation of variety mean from grand mean.

With the restriction $\sum pi = 0$, where pi = phenotypic index for i^{th} genotype; the Eberhart and Russell's model was slightly modified by substituting pi for overall variety mean (μi) as follows:

$Yij = (\bar{Y}.. + Pi) + biIj + \delta ij$

And another stability parameter, S^2di was calculated as.

$S^2di = \left[\sum_j \delta ij^2 / S^{-2}\right] - (Se^2/r)$

Where S = no. of environments

Se^2 = MS for pooled error and

r = number of replications

The hypothesis that these is no response of variety to location (H_0: b = 0) and there is no deviation from regression (H_0: $S^2d = 0$) were tested approximately by the F-test. H_0: b= 0 where, F = MS due to linear regression/error MS H_0: $S^2d = 0$.

Where, F = MS due to deviation/pooled error MS. The individual variety response (Regression co-efficient) and their deviation from regression were tested by using appropriate t-test and F-test against the hypothesis that it did not differ significantly from unity and zero respectively as-

$$t = \left| \frac{1 - bi}{S_E(b)} \right|$$

Where,

$$S_E(b) = \frac{\sqrt{MS \text{ due to pooled deviation}}}{\Sigma_j I_j^2}$$

With (n-1) df, n = number of genotypes and F = $\left\lfloor \sum_j \delta^2 ij^2 / S - 2 \right\rfloor$ pooled error.

Chapter IV

Results and Discussion

Chapter IV

RESULTS AND DISCUSSION

4.1 Combined analysis of variance (ANOVA) according to the best AMMI model

Results of combined analysis of variance for twenty three characters viz. days to first flowering, days to 50% flowering, plant height excluding root (cm), root length (cm), number of primary branches per plant, number of secondary branches per plant, number of leaves per plant, number of leaves per primary branch, number of fruits per plant, number of fruit per primary branches, fruit diameter (cm), individual fruit weight (g), fresh weight of shoot (g), fresh weight of root (g), oven dry weight of shoot (g), oven dry weight of root (g), leaf area index, fruit length without panicle (cm), number of seeds per fruit, weight of seeds per fruit (mg), hundred seed weight (mg), fruit yield per plant and number of fruits per plucking per plant of ten genotypes at four environments are presented in Table 4. The mean sum of squares for the genotypes were highly significant for all the characters except weight of seeds per fruit and hundred seed weight which reveals the presence of genetic variability in the material under investigation for all the characters studied. The genotype x environment interactions both nonlinear and linear was significant for maximum of the characters except weight of seeds per fruit and hundred seed weight, when tested against pooled error, suggesting the data might be extended for stability analysis. The characters, weight of seeds per fruit and hundred seed weight showed insignificant genotype environment interaction, so were excluded from stability analysis. Highly significant mean sum of squares due to environments (linear) indicated the difference between the environments.

Table 4. Full joint combined analysis of variance including the partitioning of G x E interaction of ten genotypes of chilli

Source of variation	df	Mean Sum of squares							
		Days to first flowering	Days to 50% flowering	Plant height excluding root (cm)	Root length (cm)	Number of primary branches per plant	Number of secondary branches per plant	Number of leaves per plant	Number of leaves per primary branch
Genotype (G)	9	155.19**	156**	754.40**	15.62**	16.24**	98.77**	709136**	1110.30**
Environment (E)	3	0.83**	0.74**	1317.72**	20.11**	27.81**	106.43**	596767**	938.05*
Interaction (G x E)	27	0.69*	0.45*	107.16*	7.89*	3.40*	27.40**	216710*	347.04*
Ammi Component 1	11	0.30	0.41*	168.516*	10.94*	5.77*	24.11	240271**	405.01**
Ammi Component 2	9	0.15	0.20	93.02	7.79*	1.97	16.06	46136.7	204.18
Ammi Component 3	7	0.08	0.15	28.95	3.21	1.52	8.57	13280.5	53.92
G x E (Linear)	9	0.30	0.40*	59.68	7.76*	6.21*	19.03*	279158**	262.51
Pool Deviation	18	0.15	0.18	130.91*	7.95*	1.10	16.58	35486.3*	239.31
Polled error	105	0.34	0.40	83.54	6.33	3.02	15.15	90549	269.14

* indicates Significant at 0.05% level

** indicates Significant at 0.01% level

Table 4. (Continued).

Source of variation	df	Mean Sum of squares							
		Number of fruits per plant	Number of fruits per primary branch	Fruit Diameter (cm)	Individual Fruit weight (g)	Fresh weight of shoot (g)	Fresh weight of root (g)	Oven dry weight of shoot (g)	Oven dry weight of root (g)
Genotype (G)	9	20600.2**	216.19**	0.182**	0.691**	17335.9**	65.67**	1267.55**	16.15**
Environment (E)	3	18475.4**	235.83**	0.154 *	0.722**	30582.4**	71.49**	2275.12**	20.17**
Interaction (G x E)	27	9009.87**	46.27	0.066	0.063*	4184.02*	12.84	245.35*	3.47
Ammi Component 1	11	9138.74**	86.82**	0.132**	0.067**	8502.94**	27.93**	415.43*	7.42*
Ammi Component 2	9	533.77	21.01	0.032	0.012	1446.74	2.71	183.18	1.13
Ammi Component 3	7	419.49	15.02	0.079	0.006	916.51	2.14	58.03	0.25
G x E (Linear)	9	10133.2**	20.45	0.084*	0.068**	9868.15**	33.43**	468.84**	8.94**
Pool Deviation	18	948.23	59.18*	0.058	0.015	1341.95	2.54	133.61	0.73
Polled error	105	3187.68	36.11	0.054	0.025	3239.38	10.40	191.79	2.78

* indicates Significant at 0.05% level

** indicates Significant at 0.01% level

Table 4. (Continued).

Source of variation	df	Mean Sum of squares						
		Leaf area index	Fruit length without panicle (cm)	Number of seeds per fruit	Weight of seeds per fruit (mg)	Hundred seed weight (mg)	Fruit yield per plant (g)	Number of fruits per plucking per plant
Genotype (G)	9	220.49**	1.47**	1998.55**	0.39	0.23	14940.4**	2288.92**
Environment (E)	3	119.19**	4.41**	183.40**	0.37	0.30	41462.4**	2052.82**
Interaction (G x E)	27	29.99*	0.67*	27.36*	0.31	0.25	6627.60*	445.54**
Ammi Component 1	11	35.73*	1.10*	28.51*	0.75	0.62	6455.09*	1015.42**
Ammi Component 2	9	22.42	0.35	21.27	0.003	0.002	2528.68	59.31**
Ammi Component 3	7	11.41	0.42	10.23	0.002	0.003	597.28	46.61**
G x E (Linear)	9	38.60**	0.64*	30.18**	0.90	0.75	7226.45**	1125.91**
Pool Deviation	18	18.18	0.69*	16.95	0.07	0.03	1828.17	105.36**
Polled error	105	19.62	0.44	16.63	0.92	0.76	2999.63	4.01

* indicates Significant at 0.05% level

** indicates Significant at 0.01% level

4. 2 Stability analysis for different characters of ten genotypes of chilli

Eberhart and Russel (1966) emphasized the need of both linear (bi) and non-linear (S^2di) components of genotype x environment interactions in judging the phenotypic stability of a genotype. In this model, regression coefficient (bi) is considered as parameter of response and deviation from regression (S^2di) as the parameter of stability. Relatively lower value of bi, say around 1 will mean less responsive to the environmental change and therefore, more adaptive. If however, b is negative, the genotype may be grown only in poor environment. Deviation from regression (S^2di), if significantly different from zero, will invalidate the linear prediction. If S^2di is non-significant, the performances of a genotype for a given environment may be predicted. Therefore, a genotype whose performance for a given environment can be predicted i.e., S^2di is around 0 will said to be stable genotype.

Results of stability and response of the genotypes under different environments according to Eherhart and Russel are discussed character-wise as follows: Stability parameter i.e., regression coefficient (bi) and deviation from regression (S^2di) for days to first flowering, days to 50% flowering, plant height excluding root (cm), root length (cm), number of primary branches per plant, number of secondary branches per plant, number of leaves per plant, number of leaves per primary branch, number of fruits per plant, number of fruit per primary branch, fruit diameter (cm), individual fruit weight (g), fresh weight of shoot, fresh weight of root, oven dry weight of shoot, oven dry weight of root, leaf area index, fruit length without panicle, number of seeds per fruit, fruit yield per plant and number of fruits per plucking per plant of the individual genotypes are presented under the following heads.

4.2.1 Days to first flowering

Mean performance of the promising genotypes, their response and stability parameters phenotypic indices (Pi), regression coefficient (bi) and deviation from regression (S^2di) for days to first flowering are presented in Table 5.

Table 5. Stability analysis for days to first flowering of ten genotypes of chilli in four environments evaluated during rabi, 2013-14

Code	Genotype Name	Environments					Pi	bi	S^2di
		Env-1	Env-2	Env-3	Env-4	Overall Mean			
G1	Kalo Dhawna morich	47.00	47.33	47.67	48.00	47.50	-5.008	1.266	0.08
G2	Bogurar Jhal Morich	49.33	49.33	49.67	50.00	49.58	-2.925	1.077	0.01
G3	Balojhuri	60.67	59.33	60.33	61.67	60.50	7.992	3.002	0.26
G4	DBP 14 5G (China)	60.33	59.67	60.33	60.00	60.08	7.575	0.210	0.15
G5	Suryamukhi	41.33	41.33	42.33	42.67	41.92	-10.59	2.190	0.11
G6	Bogurar lomba Morich	53.33	54.67	54.00	53.67	53.92	1.408	-0.880	0.39
G7	BD-2059	58.33	58.00	57.67	58.67	58.17	5.658	0.822	0.19
G8	BD-2122	55.67	55.67	56.33	56.33	56.00	3.492	1.111	0.07
G9	Bogura Jatt	50.67	50.33	50.33	51.00	50.58	-1.925	0.855	0.06
G10	Bullet	47.00	46.67	46.67	47.00	46.83	-5.675	0.332	0.04
	E. Mean	52.37	52.23	52.53	52.90	52.51			
	E. Index (Ij)	-0.14	-0.28	0.25	0.39				
	CV%	1.03	1.00	1.02	0.79				
	LSD (0.05)	0.93	0.90	0.92	0.72				

Pi = Phenotypic Index, bi = Regression Coefficient, S^2di = Deviation from Regression
* indicates slopes significantly different from the slope for the overall regression which is 1.00

Among the genotypes Suryamukhi and Balojhuri took minimum and maximum days for first flowering, respectively. The environmental mean and genotypic mean ranged from 52.23 to 52.90 and 41.92 to 60.50, respectively.

Five genotypes i.e. Kalo Dhawna morich, Bogurar Jhal Morich, Suryamukhi, Bogura Jatt and Bullet, showed negative phenotypic index, which represents those genotypes were desirable for early first flowering. While the other five genotypes i. e. Balojhuri, DBP 14 5G (China), Bogurar lomba Morich, BD-2059 and BD-2122 had positive phenotypic index for days to first flowering, this represents the undesirability of those genotypes for early first flowering or desirability of those genotypes for late first flowering.

Again positive and negative environmental index (Ij) reflects the rich or favourable and poor or unfavourable environments for a character, respectively. However, for this trait negative environmental index (Ij) is the favourable environment for early first flowering. Thus the Env-3 and Env-4 was poor environments for early first flowering and rich environments for late first flowering. Env-1 and Env-2 was rich environment for early first flowering and poor environments for late first flowering in chilli production. Genotypes having negative bi value may be grown in poor environments (Muradunnabi, 2010). In that sense, Bogurar lomba Morich was found adaptive for poor environments.

The regression coefficient (bi) values of these genotypes ranged from 0.210 to 2.190. These differences in bi values indicated that all the genotypes responded differently to different environments. Considering the mean, bi and S^2di, it was evident that all the genotypes showed different response of adaptability under different environmental conditions. The genotypes Kalo Dhawna morich, Bogurar Jhal Morich, Bogura Jatt, BD-2059 and BD-2122 exhibited comparatively lower first flowering day, as their bi~1 and S^2di~0 indicated that the genotypes were stable across the environment. The cultivars which has significant deviation mean square (S^2di), implying that these cultivars have unstable performance across the testing environments (Worku and Zelleke, 2009). Tembhurne *et al.* (2013) found similar result on days to first flowering in chilli.

4.2.2 Days to 50% flowering

Mean performance of the promising genotypes, their response and stability parameters phenotypic indices (Pi), regression coefficient (bi) and deviation from regression (S^2di) for days to 50% flowering are presented in Table 6. Among the genotypes Suryamukhi and Balojhuri took minimum and maximum days for 50% flowering, respectively. The environmental mean and genotypic mean ranged from 53.37 to 54.00 and 43.67 to 60.67, respectively.

Five genotypes i.e. Kalo Dhawna morich, Bogurar Jhal Morich, Suryamukhi, Bogura Jatt and Bullet, showed negative phenotypic index, which represents those genotypes were desirable for early 50% flowering. While the other five genotypes i. e. Balojhuri, DBP 14 5G (China), Bogurar lomba Morich, BD-2059 and BD-2122 had positive phenotypic index for days to 50% flowering, this represents the undesirability of those genotypes for early 50% flowering or desirability of those genotypes for late 50% flowering. Again positive and negative environmental index (Ij) reflects the rich or favourable and poor or unfavourable environments for a character, respectively. However, for this trait negative environmental index (Ij) is the favourable environment for early 50% flowering. Thus the Env-3 and Env-4 was poor environments for early 50% flowering and rich environments for late 50% flowering. Env-1 and Env-2 was rich environment for early 50% flowering and poor environments for late 50% flowering in chilli production. Genotypes having negative bi value may be grown in poor environments. In that sense, Bogurar lomba Morich was found adaptive for poor environments.

The regression coefficient (bi) values of these genotypes ranged from 0.137 to 3.523. These differences in bi values indicated that all the genotypes responded differently to different environments. Considering the mean, bi and S^2di, it was evident that all the genotypes showed different response of

Table 6. Stability analysis for days to 50% flowering of ten genotypes of chilli in four environments evaluated during rabi, 2013-14

Code	Genotype Name	Environments					Pi	bi	S^2di
		Env-1	Env-2	Env-3	Env-4	Overall Mean			
G1	Kalo Dhawna morich	48.67	48.33	48.67	49.00	48.67	-5.025	0.957	0.01
G2	Bogurar Jhal Morich	50.33	50.33	51.00	51.00	50.67	-3.025	1.259	0.05
G3	Balojhuri	61.67	60.33	62.00	62.67	61.67	7.975	3.523*	0.07
G4	DBP 14 5G (China)	61.67	60.67	61.33	61.33	61.25	7.558	0.844	0.19
G5	Suryamukhi	42.33	42.67	43.33	43.67	43.00	-10.69	1.863	0.17
G6	Bogurar lomba Morich	54.67	56.00	55.33	54.67	55.17	1.475	-1.634	0.32
G7	BD-2059	59.33	59.33	58.67	60.00	59.33	5.642	0.605	0.40
G8	BD-2122	57.00	56.67	58.00	57.33	57.25	3.558	1.447	0.25
G9	Bogura Jatt	52.00	51.33	51.67	52.33	51.83	-1.858	1.284	0.10
G10	Bullet	48.33	48.00	48.00	48.00	48.08	-5.608	-0.137	0.04
	E. Mean	53.60	53.37	53.80	54.00	53.69			
	E. Index (Ij)	-0.09	-0.33	0.11	0.31				
	CV%	1.14	0.93	1.09	0.80				
	LSD (0.05)	1.05	0.85	1.01	0.75				

Pi = Phenotypic Index, bi = Regression Coefficient, S^2di = Deviation from Regression
* indicates slopes significantly different from the slope for the overall regression which is 1.00

adaptability under different environmental conditions. The genotypes Kalo Dhawna morich, Bogurar Jhal Morich, Bogura Jatt and DBP 14 5G (China) exhibited comparatively lower first flowering day, as their bi~1 and S^2di~0 indicated that the genotypes are stable across the environment. The genotype Balojhuri had bi value significantly different from the unity with insignificant S^2di value indicating high responsiveness of the genotype but suitable for Env-1 and Env-2. Tembhurne *et al.* (2013) found similar results on days to 50% flowering in chilli.

4.2.3 Plant height excluding root (cm)

Mean performance of the promising genotypes, their response and stability parameters phenotypic indices (Pi), regression coefficient (bi) and deviation from regression (S^2di) for plant height excluding root (cm) are presented in Table 7. Among the genotypes overall means of Kalo Dhawna morich and Bogurar Jhal Morich took maximum (76.87 cm) and minimum (34.67 cm) plant height, respectively. The environmental mean and overall genotypic mean ranged from 36.76 cm to 60.28 cm and 34.67 cm to 76.87 cm, respectively.

Three genotypes i.e. Kalo Dhawna morich, DBP 14 5G (China), BD-2059, showed positive phenotypic index while the other seven genotypes i. e. Bogurar Jhal Morich, Balojhuri, Suryamukhi, Bogurar lomba Morich, BD-2122, Bogura Jatt and Bullet genotypes had negative phenotypic index for plant height. Thus positive phenotypic index represented the higher plant height and negative represented the lower plant height among the genotypes.

Again positive and negative environmental index (Ij) reflects the rich or favourable and poor or unfavourable environments for a character, respectively. However, for this trait positive and negative environmental index (Ij) reflected the poor or unfavourable and rich or favourable environments for shorter plant stature, respectively. Thus the Env-3, Env-4 were rich and Env-1,

Table 7. Stability analysis for plant height excluding root (cm) of ten genotypes of chilli in four environments evaluated during rabi, 2013-14

Code	Genotype Name	Environments					Pi	bi	S^2di
		Env-1	Env-2	Env-3	Env-4	Overall Mean			
G1	Kalo Dhawna morich	99.89	80.07	67.50	60.02	76.87	28.64	1.141	198.67
G2	Bogurar Jhal Morich	38.06	42.50	24.08	34.03	34.67	-13.56	0.622	16.16
G3	Balojhuri	34.94	60.10	29.56	30.04	38.66	-9.564	1.022	108.80
G4	DBP 14 5G (China)	68.06	93.07	54.07	37.02	63.05	14.83	1.795	205.17
G5	Suryamukhi	42.08	56.49	31.11	34.01	40.92	-7.303	0.920	26.40
G6	Bogurar lomba Morich	34.02	55.07	24.04	35.07	37.05	-11.18	0.910	89.79
G7	BD-2059	78.10	63.07	51.04	47.02	59.81	11.58	0.954	112.70
G8	BD-2122	67.07	35.13	30.08	46.08	44.59	-3.636	0.524	349.52
G9	Bogura Jatt	49.06	60.17	19.06	37.03	41.33	-6.897	1.452	47.90
G10	Bullet	45.02	57.10	37.03	42.07	45.31	-2.920	0.660	23.05
	E. Mean	55.63	60.28	36.76	40.24	48.23			
	E. Index (Ij)	7.404	12.05	-11.47	-7.985				
	CV%	1.96	1.85	3.22	2.08				
	LSD (0.05)	1.87	1.91	2.03	1.43				

Pi = Phenotypic Index, bi = Regression Coefficient, S^2di = Deviation from Regression
* indicates slopes significantly different from the slope for the overall regression which is 1.00

Env-2 was poor environment for short statured chilli production which protects lodging. Genotypes having negative bi value may be grown in poor environments. In that sense, no genotypes were found adaptive for poor environments.

The regression coefficient (bi) values of these genotypes ranged from 0.524 to 1.795. These differences in bi values indicated that all the genotypes responded differently to different environments. Considering the mean, bi and S^2di three parameters, it was evident that all the genotypes showed different response of adaptability under different environmental conditions. The genotypes Bogurar Jhal Morich, Suryamukhi, Bullet exhibited comparatively lower plant height, as their bi~1 and S^2di~0 indicated that the genotypes were stable across the environment. Dwarf variety was required to maintain lodging. Any highly responsive genotypes couldn't be found to any rich environment. Tembhurne *et al.* (2013) found similar results on plant height excluding root in chilli.

4.2.4 Root length (cm)

Mean performance of the promising genotypes, their response and stability parameters phenotypic indices (Pi), regression coefficient (bi) and deviation from regression (S^2di) for root length (cm) are presented in Table 8. Among the genotypes Suryamukhi and Bogura Jatt took minimum root length (9.43 cm), where DBP 14 5G (China) took maximum root length (14.81 cm). The environmental mean and genotypic mean ranged from 10.56 cm to13.28 cm and 9.34 cm to 14.81 cm, respectively.

Five genotypes i.e. Kalo Dhawna morich, DBP 14 5G (China), BD-2059, BD-2122 and Bullet, showed positive phenotypic index, which represents those genotypes were desirable for higher root length. While the other five genotypes i. e. Bogurar Jhal Morich, Balojhuri, Suryamukhi, Bogurar lomba Morich and Bogura Jatt had negative phenotypic index for root length, this represented the undesirability of those genotypes for higher root length or desirability of those genotypes for lower root length.

Again positive and negative environmental index (Ij) reflects the rich or favourable and poor or unfavourable environments for a character, respectively. Thus the Env-1, Env-2 was rich and Env-3, Env-4 was poor environment for long rooted chilli

Table 8. Stability analysis for root length (cm) of ten genotypes of chilli in four environments evaluated during rabi, 2013-14

Code	Genotype Name	Environments					Pi	bi	S^2di
		Env-1	Env-2	Env-3	Env-4	Overall Mean			
G1	Kalo Dhawna morich	19.08	17.12	7.500	13.06	14.19	2.174	2.925	13.47
G2	Bogurar Jhal Morich	14.04	9.089	10.10	8.067	10.32	-1.690	1.043	6.98
G3	Balojhuri	11.10	13.04	7.111	13.00	11.06	-0.951	0.600	10.56
G4	DBP 14 5G (China)	17.07	18.00	17.07	7.089	14.81	2.791	2.594	19.69
G5	Suryamukhi	7.089	10.10	12.10	8.067	9.34	-2.676	-0.421	6.91
G6	Bogurar lomba Morich	12.09	13.13	13.10	8.100	11.61	-0.409	1.013	5.45
G7	BD-2059	14.10	16.06	11.00	13.07	13.56	1.541	1.162	2.58
G8	BD-2122	15.00	14.07	10.14	14.06	13.32	1.302	0.823	4.96
G9	Bogura Jatt	10.13	11.07	8.100	8.078	9.34	-2.670	1.021	0.23
G10	Bullet	12.16	11.09	14.10	13.07	12.60	0.588	-0.759*	0.74
	E. Mean	13.19	13.28	11.03	10.56	12.01			
	E. Index (Ij)	1.171	1.262	-0.983	-1.450				
	CV%	4.87	3.93	4.84	4.45				
	LSD (0.05)	1.10	0.89	0.92	0.81				

Pi = Phenotypic Index, bi = Regression Coefficient, S^2di = Deviation from Regression
* indicates slopes significantly different from the slope for the overall regression which is 1.00

production to uptake maximum input from land and to protect lodging. Genotypes having negative bi value may be grown in poor environments. In that sense, Suryamukhi and Bullet were found adaptive for poor environments.

The regression coefficient (bi) values of these genotypes ranged from 0.421 to 2.925. These differences in bi values indicated that all the genotypes responded differently to different environments. Considering the mean, bi and S^2di three parameters, it was evident that all the genotypes showed different response of adaptability under different environmental conditions. The genotypes BD-2059, Bogura Jatt and Bullet exhibited comparatively higher root length, as their bi~1 and S^2di~0 indicated that the genotypes are stable across the environment. Higher root length is required to maintain lodging. The genotype Bullet had bi value significantly different from the unity with insignificant S^2di value indicating high responsiveness of the genotype but suitable for Env-1 and Env-2.

4.2.5 Number of primary branches per plant

Mean performance of the promising genotypes, their response and stability parameters phenotypic indices (Pi), regression coefficient (bi) and deviation from regression (S^2di) for number of primary branches per plant are presented in Table 9. Among the genotypes BD-2122 and Kalo Dhawna morich took minimum number of primary branches per plant (3.16) and maximum number of primary branches per plant (10.42), respectively. The environmental mean and genotypic mean ranged from 3.800 to 7.567 and 3.167 to 10.42, respectively.

Five genotypes i.e. Kalo Dhawna morich, DBP 14 5G (China), Bogurar lomba Morich, BD-2059 and Bullet, showed positive phenotypic index, which represents those genotypes were desirable for higher number of primary branches. While the other five genotypes i. e. Bogurar Jhal Morich, Balojhuri, Suryamukhi, Bogura Jatt and BD-2122 had negative phenotypic index for root length, this represents the undesirability of those genotypes for higher number

Table 9. Stability analysis for number of primary branches per plant of ten genotypes of chilli in four environments evaluated during rabi, 2013-14

Code	Genotype Name	Environments					Pi	bi	S^2di
		Env-1	Env-2	Env-3	Env-4	Overall Mean			
G1	Kalo Dhawna morich	12.67	16.00	3.000	10.00	10.42	4.942	3.077	6.20
G2	Bogurar Jhal Morich	3.000	5.000	3.000	3.000	3.500	-1.975	0.501	0.45
G3	Balojhuri	5.333	5.000	3.000	4.333	4.417	-1.058	0.498	0.56
G4	DBP 14 5G (China)	7.000	9.667	5.000	2.000	5.917	0.442	1.634	4.56
G5	Suryamukhi	6.000	5.000	5.000	4.000	5.000	-0.475	0.176	0.87
G6	Bogurar lomba Morich	6.667	6.667	5.333	5.000	5.917	0.442	0.656	0.29
G7	BD-2059	7.000	9.000	4.000	4.667	6.167	0.692	1.367*	0.04
G8	BD-2122	4.000	3.667	2.333	2.667	3.167	-2.308	0.402	0.27
G9	Bogura Jatt	4.333	7.000	2.333	5.000	4.667	-0.808	0.995	1.43
G10	Bullet	4.000	8.667	5.000	4.667	5.583	0.108	0.894	3.26
	E. Mean	6.000	7.567	3.800	4.533	5.475			
	E. Index (Ij)	0.525	2.092	-1.675	-0.942				
	CV%	12.46	12.69	14.94	13.36				
	LSD (0.05)	1.28	1.65	0.97	1.04				

Pi = Phenotypic Index, bi = Regression Coefficient, S^2di = Deviation from Regression
* indicates slopes significantly different from the slope for the overall regression which is 1.00

of primary branches or desirability of those genotypes for lower number of primary branches.

Again positive and negative environmental index (Ij) reflects the rich or favourable and poor or unfavourable environments for a character, respectively. Thus the Env-1, Env-2 was rich and Env-3, Env-4 was poor environment for higher number of primary branches in chilli production to obtain maximum fruiting. Genotypes having negative bi value may be grown in poor environments. In that sense, no genotypes were found adaptive for poor environments.

The regression coefficient (bi) values of these genotypes ranged from 0.176 to 1.634. These differences in bi values indicated that all the genotypes responded differently to different environments. Considering the mean, bi and S^2di three parameters, it was evident that all the genotypes showed different response of adaptability under different environmental conditions. The genotypes Bogurar lomba Morich and BD-2059 exhibited comparatively higher number of primary branches, as their bi~1 and S^2di~0 indicated that the genotypes were stable across the environment. Higher numbers of primary branches are required to obtain more fruit. The genotype BD-2059 had bi value significantly different from the unity with insignificant S^2di value indicating high responsiveness of the genotype but suitable for Env-1 and Env-2. Tembhurne *et al.* (2013) found similar results on number of primary branches per plant in chilli.

4.2.6 Number of secondary branches per plant

Mean performance of the promising genotypes, their response and stability parameters phenotypic indices (Pi), regression coefficient (bi) and deviation from regression (S^2di) for number of secondary branches per plant are presented in Table 10. Among the genotypes Suryamukhi and Kalo Dhawna morich took minimum number of secondary branches per plant (3.250) and maximum number of secondary branches per plant (21.25), respectively. The

Table 10. Stability analysis for number of secondary branches per plant of ten genotypes of chilli in four environments evaluated during rabi, 2013-14

Code	Genotype Name	Environments					Pi	bi	S^2di
		Env-1	Env-2	Env-3	Env-4	Overall Mean			
G1	Kalo Dhawna morich	32.00	26.00	8.000	19.00	21.25	11.20	2.557	54.98
G2	Bogurar Jhal Morich	5.000	10.00	6.000	2.000	5.750	-4.300	0.653	9.57
G3	Balojhuri	12.00	10.00	4.000	8.000	8.500	-1.550	0.836	6.34
G4	DBP 14 5G (China)	13.00	20.00	10.00	3.000	11.50	1.450	1.685	29.18
G5	Suryamukhi	2.000	2.000	2.000	7.000	3.250	-6.800	-0.243	8.43
G6	Bogurar lomba Morich	14.00	14.00	11.00	11.00	12.25	2.200	0.628	0.63
G7	BD-2059	14.00	18.00	6.000	10.00	12.00	1.950	1.578*	0.22
G8	BD-2122	8.000	8.000	4.000	6.000	6.500	-3.550	0.542	0.81
G9	Bogura Jatt	4.000	14.00	4.000	10.00	8.000	-2.050	0.946	21.72
G10	Bullet	8.000	18.00	10.00	10.00	11.50	1.450	0.918	16.06
	E. Mean	11.20	14.00	6.500	8.500	10.05			
	E. Index (Ij)	1.150	3.950	-3.550	-1.550				
	CV%	13.83	14.35	13.86	17.18				
	LSD (0.05)	2.66	3.45	1.54	2.51				

Pi = Phenotypic Index, bi = Regression Coefficient, S^2di = Deviation from Regression
* indicates slopes significantly different from the slope for the overall regression which is 1.00

environmental mean and genotypic mean ranged from 6.500 to 14.00 and 3.250 to 21.25, respectively.

Five genotypes i.e. Kalo Dhawna morich, DBP 14 5G (China), Bogurar lomba Morich, BD-2059 and Bullet, showed positive phenotypic index, which represents those genotypes were desirable for higher number of secondary branches. While the other five genotypes i. e. Bogurar Jhal Morich, Balojhuri, Suryamukhi, Bogura Jatt and BD-2122 had negative phenotypic index, this represents the undesirability of those genotypes for higher number of secondary branches or desirability of those genotypes for lower number of secondary branches.

Again positive and negative environmental index (Ij) reflects the rich or favourable and poor or unfavourable environments for a character, respectively. Thus the Env-1, Env-2 was rich and Env-3, Env-4 was poor environment for higher number of secondary branches in chilli production to obtain maximum fruiting. Genotypes having negative bi value may be grown in poor environments. In that sense, Suryamukhi were found adaptive for poor environments.

The regression coefficient (bi) values of these genotypes ranged from 0.243 to 1.685. These differences in bi values indicated that all the genotypes responded differently to different environments. Considering the mean, bi and S^2di three parameters, it was evident that all the genotypes showed different response of adaptability under different environmental conditions. The genotypes Bogurar lomba Morich, BD-2122 exhibited comparatively higher number of secondary branches, as their bi~1 and S^2di~0 indicated that the genotypes were stable across the environment. Higher numbers of secondary branches are required to obtain more fruit. The genotype BD-2059 had bi value significantly different from the unity with insignificant S^2di value indicating high responsiveness of the genotype but suitable for Env-1 and Env-2. Tembhurne *et al.* (2013) found similar results on number of secondary branches per plant in chilli.

4.2.7 Number of leaves per plant

Mean performance of the promising genotypes, their response and stability parameters phenotypic indices (Pi), regression coefficient (bi) and deviation from regression (S^2di) for number of leaves per plant are presented in Table 11. Among the genotypes Suryamukhi and Kalo Dhawna morich took minimum number of leaves per plant (224.8) and maximum number of leaves per plant (1614), respectively. The environmental mean and genotypic mean ranged from 268.5 to 757.8 and 224.8 to 1614, respectively.

Three genotypes i.e. Kalo Dhawna morich, DBP 14 5G (China) and Bogurar lomba Morich, showed positive phenotypic index, which represents those genotypes were desirable for higher number of leaves. While the other seven genotypes i. e. Bogurar Jhal Morich, Balojhuri, Suryamukhi, BD-2059, BD-2122, Bogura Jatt and Bullet had negative phenotypic index for number of leaves, this represents the undesirability of those genotypes for higher number of leaves or desirability of those genotypes for lower number of leaves.

Again positive and negative environmental index (Ij) reflects the rich or favourable and poor or unfavourable environments for a character, respectively. Thus the Env-1, Env-2 was rich and Env-3, Env-4 was poor environment for higher number of leaves in chilli production to obtain maximum fruiting. Genotypes having negative bi value may be grown in poor environments. In that sense, BD-2122 was found adaptive for poor environments.

The regression coefficient (bi) values of these genotypes ranged from 0.061 to 4.168. These differences in bi values indicated that all the genotypes responded differently to different environments. Considering the mean, bi and S^2di three parameters, it was evident that all the genotypes showed different response of adaptability under different environmental conditions. The genotypes Bogurar lomba Morich and Bogura Jatt exhibited comparatively higher number of leaves, as their bi~1 and S^2di~0 indicated that the genotypes

Table 11. Stability analysis for number of leaves per plant of ten genotypes of chilli in four environments evaluated during rabi, 2013-14

Code	Genotype Name	Environments					Pi	bi	S^2di
		Env-1	Env-2	Env-3	Env-4	Overall Mean			
G1	Kalo Dhawna morich	2492	2550	495.7	918.7	1614	1139	4.168	134942.73
G2	Bogurar Jhal Morich	179.3	215.3	149.3	120.7	166.2	-309.1	0.158*	251.38
G3	Balojhuri	275.7	419.7	190.7	228.7	278.7	-196.6	0.378*	2255.82
G4	DBP 14 5G (China)	641.7	1314.	321.7	96.67	593.4	118.1	2.044	47017.39
G5	Suryamukhi	117.3	579.3	99.67	102.7	224.8	-250.6	0.766	31398.07
G6	Bogurar lomba Morich	432.7	792.3	319.7	420.7	491.3	16.02	0.712	18932.36
G7	BD-2059	728.7	567.0	371.7	192.7	465.0	-10.31	0.761	29597.24
G8	BD-2122	452.3	119.7	245.7	252.7	267.6	-207.7	-0.061	28019.76
G9	Bogura Jatt	260.7	619.7	155.7	235.3	317.8	-157.5	0.716	17813.86
G10	Bullet	431.7	401.7	335.7	168.7	334.4	-140.9	0.360	9148.15
	E. Mean	601.2	757.8	268.5	273.7	475.3			
	E. Index (Ij)	125.9	282.5	-207	-202				
	CV%	6.90	3.26	7.32	4.82				
	LSD (0.05)	71.16	42.32	33.74	22.62				

Pi = Phenotypic Index, bi = Regression Coefficient, S^2di = Deviation from Regression
* indicates slopes significantly different from the slope for the overall regression which is 1.00

were stable across the environment. Higher number of leaves is required to obtain more fruit. The genotype Bogurar Jhal Morich and Balojhuri had bi value significantly different from the unity with comparatively insignificant S^2di value indicating high responsiveness of the genotype but suitable for Env-1 and Env-2. Tembhurne *et al.* (2013) and Shrividya *et al.* (2011) found similar results on number of leaves per plant in chilli.

4.2.8 Number of leaves per primary branches

Mean performance of the promising genotypes, their response and stability parameters phenotypic indices (Pi), regression coefficient (bi) and deviation from regression (S^2di) for number of leaves per primary branch are presented in Table 12. Among the genotypes Bogurar Jhal Morich and Kalo Dhawna morich took minimum (35.72) and maximum (84.03) number of leaves per primary branch, respectively. The environmental mean and genotypic mean ranged from 31.08 to 52.59 and 35.72 to 84.03, respectively.

Three genotypes i.e. Kalo Dhawna morich, Bogurar lomba Morich and BD-2059, showed positive phenotypic index, which represents those genotypes were desirable for higher number of leaves per primary branch. While the other seven genotypes i. e. Bogurar Jhal Morich, Balojhuri, DBP 14 5G (China), Suryamukhi, BD-2122, Bogura Jatt and Bullet had negative phenotypic index, this represents the undesirability of those genotypes for higher number of leaves per primary branch.

Positive and negative environmental index (Ij) reflects the rich or favourable and poor or unfavourable environments for a character, respectively. Thus the Env-1, Env-2 was rich and Env-3, Env-4 was poor environment for higher number of leaves per primary branch in chilli production to obtain maximum fruiting. Genotypes having negative bi value may be grown in poor environments. In that sense, BD-2122 was found adaptive for poor environments.

Table 12. Stability analysis for number of leaves per primary branch of ten genotypes of chilli in four environments evaluated during rabi, 2013-14

Code	Genotype Name	Environments					Pi	bi	S^2di
		Env-1	Env-2	Env-3	Env-4	Overall Mean			
G1	Kalo Dhawna morich	100.1	104.8	89.78	41.44	84.03	39.52	2.956*	38.68
G2	Bogurar Jhal Morich	40.11	34.11	46.78	21.89	35.72	-8.783	0.683	102.12
G3	Balojhuri	51.33	34.00	44.22	38.00	41.89	-2.617	0.154	82.68
G4	DBP 14 5G (China)	53.78	49.11	35.78	30.11	42.19	-2.311	1.034	34.17
G5	Suryamukhi	14.78	25.44	13.89	17.89	18.00	-26.51	0.160	37.76
G6	Bogurar lomba Morich	41.56	87.00	36.22	49.78	53.64	9.133	0.924	668.35
G7	BD-2059	65.11	52.78	37.89	23.78	44.89	0.383	1.677	87.42
G8	BD-2122	57.44	18.22	60.11	40.00	43.94	-0.561	-0.300	547.74
G9	Bogura Jatt	35.78	82.78	33.56	23.89	44.00	-0.506	1.922	522.60
G10	Bullet	44.56	37.67	40.78	24.00	36.75	-7.756	0.791	32.22
	E. Mean	50.46	52.59	43.90	31.08	44.51			
	E. Index (Ij)	5.950	8.083	-0.6056	-13.43				
	CV%	25.30	21.85	14.63	27.93				
	LSD (0.05)	21.89	19.71	11.02	14.89				

Pi = Phenotypic Index, bi = Regression Coefficient, S^2di = Deviation from Regression
* indicates slopes significantly different from the slope for the overall regression which is 1.00

The regression coefficient (bi) values of these genotypes ranged from 0.154 to 2.956. These differences in bi values indicated that all the genotypes responded differently to different environments. Considering the mean, bi and S^2di three parameters, it was evident that all the genotypes showed different response of adaptability under different environmental conditions. The genotypes DBP 14 5G (China) and Bullet exhibited comparatively higher number of leaves per primary branch, as their bi~1 and S^2di~0 indicated that the genotypes were stable across the environment. Higher numbers of leaves are required to obtain more fruit. The genotype Kalo Dhawna morich had bi value significantly different from the unity with comparatively insignificant S^2di value indicating high responsiveness of the genotype but suitable for Env-1 and Env-2. Tembhurne *et al.* (2013) Found similar results on number of leaves per primary branches in chilli.

4.2.9 Number of fruits per plant

Mean performance of the promising genotypes, their response and stability parameters phenotypic indices (Pi), regression coefficient (bi) and deviation from regression (S^2di) for number of fruits per plant are presented in Table 13. Among the genotypes Suryamukhi and Kalo Dhawna morich took minimum (37.25) and maximum (148.7) number of fruits per plant, respectively. The environmental mean and genotypic mean ranged from 47.30 to 148.7 and 37.25 to 277.5, respectively.

Three genotypes i.e. Kalo Dhawna morich, Balojhuri and Bogurar lomba Morich, showed positive phenotypic index, which represents those genotypes were desirable for higher number of fruits per plant. While the other seven genotypes i. e. Bogurar Jhal Morich, DBP 14 5G (China), Suryamukhi, BD-2059, BD-2122, Bogura Jatt and Bullet had negative phenotypic index, this represents the undesirability of those genotypes for higher number of fruits per plant or desirability of those genotypes for lower number of fruits per plant.

Table 13. Stability analysis for number of fruits per plant of ten genotypes of chilli in four environments evaluated during rabi, 2013-14

Code	Genotype Name	Environments					Pi	bi	S^2di
		Env-1	Env-2	Env-3	Env-4	Overall Mean			
G1	Kalo Dhawna morich	381.0	510.0	150.0	69.00	277.5	183.7	4.606*	3452.09
G2	Bogurar Jhal Morich	35.00	54.00	75.00	44.00	52.00	-41.78	-0.010	442.70
G3	Balojhuri	111.0	138.0	54.00	93.00	99.00	5.225	0.594	884.90
G4	DBP 14 5G (China)	54.00	72.00	45.00	30.00	50.25	-43.53	0.407*	2.55
G5	Suryamukhi	40.00	44.00	35.00	30.00	37.25	-56.53	0.139*	1.91
G6	Bogurar lomba Morich	201.0	207.0	114.0	69.00	147.8	53.97	1.434	1142.21
G7	BD-2059	66.00	144.0	54.00	30.00	73.50	-20.27	1.112	224.04
G8	BD-2122	34.00	66.00	84.00	39.00	55.75	-38.03	0.121	787.70
G9	Bogura Jatt	54.00	150.0	66.00	39.00	77.25	-16.52	1.040	713.20
G10	Bullet	48.00	102.0	90.00	30.00	67.50	-26.27	0.557	882.76
	E. Mean	102.4	148.7	76.70	47.30	93.78			
	E. Index (Ij)	8.625	54.92	-17.08	-46.47				
	CV%	11.46	7.89	15.29	24.80				
	LSD (0.05)	20.12	20.12	20.12	20.12				

Pi = Phenotypic Index, bi = Regression Coefficient, S^2di = Deviation from Regression
* indicates slopes significantly different from the slope for the overall regression which is 1.00

Positive and negative environmental index (Ij) reflects the rich or favourable and poor or unfavourable environments for a character, respectively. Thus the Env-1, Env-2 was rich and Env-3, Env-4 was poor environment for higher number of fruits per plant in chilli production to obtain maximum fruiting. Genotypes having negative bi value may be grown in poor environments. In that sense, Bogurar Jhal Morich was found adaptive for poor environments.

The regression coefficient (bi) values of these genotypes ranged from 0.121 to 4.606. These differences in bi values indicated that all the genotypes responded differently to different environments. Considering the mean, bi and S^2di three parameters, it was evident that all the genotypes showed different response of adaptability under different environmental conditions. The genotype BD-2059 exhibited comparatively higher number of fruits per plant, as their bi~1 and S^2di~0 indicated that the genotype was stable across the environment. The genotype Kalo Dhawna morich, DBP 14 5G (China) and Suryamukhi had bi value significantly different from the unity with comparatively insignificant S^2di value indicating high responsiveness of the genotype but suitable for Env-1 and Env-2. Tembhurne *et al.* (2013) and and Srividhya *et al.* (2011) found similar results on Number of fruits per plant in chilli.

4.2.10 Number of fruits per primary branch

Mean performance of the promising genotypes, their response and stability parameters phenotypic indices (Pi), regression coefficient (bi) and deviation from regression (S^2di) for number of fruits per primary branch is presented in Table 14. Among the genotypes Bogurar Jhal Morich and Kalo Dhawna morich took minimum (10.08) and maximum (28.81) number of fruits per primary branch, respectively. The environmental mean and genotypic mean ranged from 6.300 to 17.30 and 10.08 to 28.81, respectively.

five genotypes i.e. Kalo Dhawna morich, Balojhuri, Bogurar lomba Morich, BD-2122 and Bogura Jatt, showed positive phenotypic index, which

Table 14. Stability analysis for number of fruit per primary branch of ten genotypes of chilli in four environments evaluated during rabi, 2013-14

Code	Genotype Name	Environments					Pi	bi	S^2di
		Env-1	Env-2	Env-3	Env-4	Overall Mean			
G1	Kalo Dhawna morich	38.11	45.78	20.22	11.11	28.81	15.42	1.920	250.35
G2	Bogurar Jhal Morich	3.889	10.33	21.67	4.444	10.08	-3.303	1.100	59.39
G3	Balojhuri	19.78	19.00	13.33	10.44	15.64	2.253	0.557	19.37
G4	DBP 14 5G (China)	6.778	4.000	7.333	3.222	5.333	-8.053	0.313	2.70
G5	Suryamukhi	3.556	4.889	10.22	3.667	5.583	-7.803	0.393	9.42
G6	Bogurar lomba Morich	32.56	22.33	20.67	12.11	21.92	8.531	1.117	61.43
G7	BD-2059	10.22	13.78	10.78	3.111	9.472	-3.914	0.838	5.79
G8	BD-2122	9.667	10.22	30.44	3.444	13.44	0.583	1.787	93.80
G9	Bogura Jatt	14.78	11.89	23.56	7.444	14.42	1.031	1.143	23.12
G10	Bullet	7.333	10.56	14.78	4.000	9.167	-4.219	0.832	7.26
	E. Mean	14.67	15.28	17.30	6.300	13.39			
	E. Index (Ij)	1.281	1.892	3.914	-7.086				
	CV%	5.77	2.96	4.00	15.27				
	LSD (0.05)	1.45	0.78	1.19	1.65				

Pi = Phenotypic Index, bi = Regression Coefficient, S^2di = Deviation from Regression
* indicates slopes significantly different from the slope for the overall regression which is 1.00

represents those genotypes were desirable for higher number of fruits per primary branch. While the other five genotypes i. e. Bogurar Jhal Morich, DBP 14 5G (China), Suryamukhi, BD-2059 and Bullet had negative phenotypic index, this represents the undesirability of those genotypes for higher number of fruits per primary branch.

Positive and negative environmental index (Ij) reflects the rich or favourable and poor or unfavourable environments for a character, respectively. Thus the Env-1, Env-2 and Env-3 were rich and Env-4 was poor environment for higher number of fruits per primary branch in chilli production to obtain maximum fruiting. Genotypes having negative bi value may be grown in poor environments. In that sense, no genotype was found adaptive for poor environments.

The regression coefficient (bi) values of these genotypes ranged from 0.313 to 1.920. These differences in bi values indicated that all the genotypes responded differently to different environments. Considering the mean, bi and S^2di three parameters, it was evident that all the genotypes showed different response of adaptability under different environmental conditions. The genotypes BD-2059, Bogura Jatt and Bullet exhibited comparatively higher number of fruits per primary branch, as their bi~1 and S^2di~0 indicated that the genotypes were stable across the environment. Any highly responsive genotypes couldn't be found to any rich environment.

4.2.11 Fruit diameter (cm)

Mean performance of the promising genotypes, their response and stability parameters phenotypic indices (Pi), regression coefficient (bi) and deviation from regression (S^2di) for fruit diameter (cm) are presented in Table 15. Among the genotypes Bogura Jatt and Bullet took minimum (0.683 cm) and maximum (1.417 cm) fruit diameter, respectively. The environmental mean and genotypic mean ranged from 0.768 cm to 1.059 cm and 0.683 cm to 1.417 cm, respectively.

Table 15. Stability analysis for fruit diameter (cm) of ten genotypes of chilli in four environments evaluated during rabi, 2013-14

Code	Genotype Name	Environments					Pi	bi	S^2di
		Env-1	Env-2	Env-3	Env-4	Overall Mean			
G1	Kalo Dhawna morich	1.078	0.956	0.989	0.611	0.908	-0.034	1.356	0.02
G2	Bogurar Jhal Morich	0.944	1.611	1.044	0.756	1.089	0.147	2.495	0.06
G3	Balojhuri	0.500	0.767	0.589	0.900	0.689	-0.253	-0.745	0.04
G4	DBP 14 5G (China)	1.200	0.867	1.333	0.533	0.983	0.041	1.800	0.12
G5	Suryamukhi	1.000	1.067	1.233	0.611	0.978	0.036	1.867	0.02
G6	Bogurar lomba Morich	1.000	0.956	0.956	0.822	0.933	-0.086	0.511	0.00
G7	BD-2059	1.089	1.056	1.044	0.644	0.958	0.016	1.542	0.01
G8	BD-2122	0.478	0.956	0.511	1.178	0.780	-0.161	-1.392	0.13
G9	Bogura Jatt	0.500	0.878	0.589	0.767	0.683	-0.258	0.041	0.04
G10	Bullet	1.733	1.478	1.600	0.856	1.417	0.475	2.520	0.08
	E. Mean	0.952	1.059	0.989	0.768	0.942			
	E. Index (Ij)	0.103	0.117	0.469	-0.174				
	CV%	3.17	8.98	5.28	7.67				
	LSD (0.05)	0.05	0.16	0.09	0.10				

Pi = Phenotypic Index, bi = Regression Coefficient, S^2di = Deviation from Regression
* indicates slopes significantly different from the slope for the overall regression which is 1.00

Five genotypes i.e. Bogurar Jhal Morich, DBP 14 5G (China), Suryamukhi, BD-2059 and Bullet, showed positive phenotypic index, which represents those genotypes were desirable for higher fruit diameter. While the other five genotypes i. e. Kalo Dhawna morich, Balojhuri, Bogurar lomba Morich, Bogura Jatt and BD-2122 had negative phenotypic index, this represents the undesirability of those genotypes for higher fruit diameter or desirability of those genotypes for lower fruit diameter.

Positive and negative environmental index (Ij) reflects the rich or favourable and poor or unfavourable environments for a character, respectively. Thus the Env-1, Env-2, Env-3 was rich and Env-4 was poor environment for higher fruit diameter in chilli production to obtain maximum fruit weight. Genotypes having negative bi value may be grown in poor environments. In that sense, Balojhuri and BD-2122 were found adaptive for poor environments.

The regression coefficient (bi) values of these genotypes ranged from 0.041 to 2.520. These differences in bi values indicated that all the genotypes responded differently to different environments. Considering the mean, bi and S^2di three parameters, it was evident that all the genotypes showed different response of adaptability under different environmental conditions. The genotypes Kalo Dhawna morich, Balojhuri, BD-2059, BD-2122 exhibited comparatively higher fruit diameter, as their bi~1 and S^2di~0 indicated that the genotypes were stable across the environment. Any highly responsive genotypes couldn't be found to any rich environment. Tembhurne *et al.* (2013) found similar results on days to 50% flowering in chilli.

4.2.12 Individual fruit weight (g)

Mean performance of the promising genotypes, their response and stability parameters phenotypic indices (Pi), regression coefficient (bi) and deviation from regression (S^2di) for individual Fruit weight are presented in Table 16. Among the genotypes Kalo Dhawna morich and Bullet took minimum (0.700 g) and maximum (2.128 g) individual Fruit weight, respectively. The

Table 16. Stability analysis for individual fruit weight (g) of ten genotypes of chilli in four environments evaluated during rabi, 2013-14

Code	Genotype Name	Environments					Pi	bi	S^2di
		Env-1	Env-2	Env-3	Env-4	Overall Mean			
G1	Kalo Dhawna morich	0.644	1.167	0.756	0.433	0.700	-0.533	1.078	0.02
G2	Bogurar Jhal Morich	1.233	1.467	1.289	0.867	1.214	-0.068	0.936	0.00
G3	Balojhuri	1.000	1.000	0.800	0.700	0.850	-0.408	0.425	0.01
G4	DBP 14 5G (China)	1.100	1.400	1.167	0.7667	1.108	-0.174	0.972	0.00
G5	Suryamukhi	1.900	1.967	1.667	1.200	1.683	0.401	1.164	0.03
G6	Bogurar lomba Morich	1.400	1.800	1.500	1.000	1.425	0.143	1.226	0.00
G7	BD-2059	1.200	1.378	1.300	0.900	1.194	-0.088	0.768	0.00
G8	BD-2122	0.967	1.100	0.967	0.733	0.942	-0.341	0.563*	0.00
G9	Bogura Jatt	1.467	1.633	1.589	1.333	1.506	0.223	0.485*	0.00
G10	Bullet	1.867	2.767	2.578	1.300	2.128	0.845	2.383	0.07
	E. Mean	1.278	1.568	1.361	0.923	1.283			
	E. Index (Ij)	-0.05	0.285	0.078	-0.359				
	CV%	2.08	0.39	2.29	0.00				
	LSD (0.05)	0.05	0.01	0.05	0.00				

Pi = Phenotypic Index, bi = Regression Coefficient, S^2di = Deviation from Regression
* indicates slopes significantly different from the slope for the overall regression which is 1.00

environmental mean and genotypic mean ranged from 0.923 g to 1.568 g and 0.700 g to 2.128 g, respectively.

Four genotypes i.e. Suryamukhi, Bogurar lomba Morich, Bogura Jatt and Bullet, showed positive phenotypic index, which represents those genotypes, were desirable for higher individual Fruit weight. While the other six genotypes i. e. Kalo Dhawna morich, Bogurar Jhal Morich, Balojhuri, DBP 14 5G (China), BD-2059 and BD-2122 had negative phenotypic index, this represents the undesirability of those genotypes for higher individual Fruit weight.

Positive and negative environmental index (Ij) reflects the rich or favourable and poor or unfavourable environments for a character, respectively. Thus the Env-2, Env-3 was rich and Env-1, Env-4 was poor environment for higher individual Fruit weight in chilli production to obtain maximum fruiting. Genotypes having negative bi value may be grown in poor environments. In that sense, no genotype was found adaptive for poor environments.

The regression coefficient (bi) values of these genotypes ranged from 0.425 to 2.383. These differences in bi values indicated that all the genotypes responded differently to different environments. Considering the mean, bi and S^2di three parameters, it was evident that all the genotypes showed different response of adaptability under different environmental conditions. The genotypes Kalo Dhawna morich, Bogurar Jhal Morich, DBP 14 5G (China), Suryamukhi and Bogurar lomba Morich exhibited comparatively higher individual Fruit weight, as their bi~1 and S^2di~0 indicated that the genotypes are stable across the environment. The genotype BD-2122 and Bogura Jatt had bi value significantly different from the unity with comparatively insignificant S^2di value indicating high responsiveness of the genotype but suitable for Env-2 and Env-3. Tembhurne *et al.* (2013) and and Srividhya *et al.* (2011) found similar results on individual fruit weight in chilli.

4.2.13 Fresh weight of shoot (g)

Mean performance of the promising genotypes, their response and stability parameters indices (Pi), regression coefficient (bi) and deviation from regression (S^2di) for fresh weight of shoot are presented in Table 17. Among the genotypes Bogurar Jhal Morich and Kalo Dhawna morich took minimum (208.2 g) and maximum (29.11 g) fresh weight of shoot, respectively. The environmental mean and genotypic mean ranged from 51.56 g to 170.5 g and 208.2 g to 29.11 g, respectively.

Three genotypes i.e. Kalo Dhawna morich, DBP 14 5G (China) and BD-2059, showed positive phenotypic index, which represents those genotypes, were desirable for higher fresh weight of shoot. While the other seven genotypes i. e. Bogurar Jhal Morich, Balojhuri, Suryamukhi, BD-2122, Bogura Jatt and Bullet had negative phenotypic index, this represents the undesirability of those genotypes for higher fresh weight of shoot or desirability of those genotypes for lower fresh weight of shoot.

Again positive and negative environmental index (Ij) reflects the rich or favourable and poor or unfavourable environments for a character, respectively. Thus the Env-1, Env-2 was rich and Env-3, Env-4 was poor environment for higher fresh weight of shoot in chilli production to obtain maximum fruiting. Genotypes having negative bi value may be grown in poor environments. In that sense, no genotype was found adaptive for poor environments.

The regression coefficient (bi) values of these genotypes ranged from 0.182 to 3.174. These differences in bi values indicated that all the genotypes responded differently to different environments. Considering the mean, bi and S^2di three parameters, it was evident that all the genotypes showed different response of adaptability under different environmental conditions. The genotypes Suryamukhi and BD-2059 exhibited comparatively higher fresh weight of shoot, as their bi~1 and S^2di~0 indicated that the genotypes were stable across the environment. The genotype Kalo Dhawna morich, Bogurar

Table 17. Stability analysis for fresh weight of shoot (g) of ten genotypes of chilli in four environments evaluated during rabi, 2013-14

Code	Genotype Name	Environments					Pi	bi	S^2di
		Env-1	Env-2	Env-3	Env-4	Overall Mean			
G1	Kalo Dhawna morich	232.5	400.5	77.00	122.8	208.2	111.2	2.561*	944.13
G2	Bogurar Jhal Morich	33.80	41.37	20.10	21.17	29.11	-67.93	0.182*	5.54
G3	Balojhuri	36.10	80.67	23.17	35.27	43.80	-53.24	0.417*	161.31
G4	DBP 14 5G (China)	208.8	455.6	143.5	24.00	208.0	110.9	3.174	3440.98
G5	Suryamukhi	42.60	145.0	49.20	25.30	65.53	-31.51	0.877	834.96
G6	Bogurar lomba Morich	55.00	145.4	44.93	46.93	73.06	-23.98	0.807	526.65
G7	BD-2059	198.3	193.8	92.60	82.60	141.8	44.79	0.995	1372.75
G8	BD-2122	140.0	31.40	24.40	48.10	60.97	-36.06	0.086	4277.59
G9	Bogura Jatt	50.50	97.97	15.50	49.47	53.36	-43.68	0.537	402.72
G10	Bullet	89.80	113.2	83.10	60.00	86.53	-10.51	0.364*	110.94
	E. Mean	108.7	170.5	57.35	51.56	97.04			
	E. Index (Ij)	11.70	73.45	-39.69	-45.47				
	CV%	4.68	0.65	9.59	2.30				
	LSD (0.05)	8.73	1.90	9.44	2.04				

Pi = Phenotypic Index, bi = Regression Coefficient, S^2di = Deviation from Regression
* indicates slopes significantly different from the slope for the overall regression which is 1.00

Jhal Morich, Balojhuri and Bullet had bi value significantly different from the unity with comparatively insignificant S^2di value indicating high responsiveness of the genotype but suitable for Env-1 and Env-2.

4.2.14 Fresh weight of root (g)

Mean performance of the promising genotypes, their response and stability parameters phenotypic indices (Pi), regression coefficient (bi) and deviation from regression (S^2di) for fresh weight of root are presented in Table 18.

Among the genotypes Bogurar Jhal Morich and BD-2059 took minimum (1.900 g) and maximum (10.43 g) fresh weight of root, respectively. The environmental mean and genotypic mean ranged from 2.333 g to 8.847 g and 1.900 g to 10.43 g, respectively.

Three genotypes i.e. Kalo Dhawna morich, DBP 14 5G (China) and BD-2059, showed positive phenotypic index, which represents those genotypes, were desirable for higher fresh weight of root. While the other seven genotypes i. e. Bogurar Jhal Morich, Balojhuri, Suryamukhi, Bogurar lomba Morich, BD-2122, Bogura Jatt and Bullet had negative phenotypic index, this represents the undesirability of those genotypes for higher fresh weight of root or desirability of those genotypes for lower fresh weight of root.

Again positive and negative environmental index (Ij) reflects the rich or favourable and poor or unfavourable environments for a character, respectively. Thus the Env-2, Env-3 was rich and Env-1, Env-4 was poor environment for higher fresh weight of root in chilli production to obtain maximum fruiting. Genotypes having negative bi value may be grown in poor environments. In that sense, BD-2122 was found adaptive for poor environments.

The regression coefficient (bi) values of these genotypes ranged from 0.046 to 4.262. These differences in bi values indicated that all the genotypes responded differently to different environments. Considering the mean, bi and

Table 18. Stability analysis for fresh weight of root (g) of ten genotypes of chilli in four environments evaluated during rabi, 2013-14

Code	Genotype Name	Environments					Pi	bi	S^2di
		Env-1	Env-2	Env-3	Env-4	Overall Mean			
G1	Kalo Dhawna morich	11.70	12.53	10.00	6.100	10.08	4.667	0.933	2.91
G2	Bogurar Jhal Morich	2.300	2.300	2.400	0.600	1.900	-3.517	0.245*	0.49
G3	Balojhuri	1.100	3.600	3.200	1.700	2.400	-3.017	0.320	1.03
G4	DBP 14 5G (China)	10.20	28.50	11.33	0.933	12.74	7.325	4.262*	3.27
G5	Suryamukhi	0.700	8.600	3.100	0.500	3.225	-2.192	1.300	3.24
G6	Bogurar lomba Morich	2.933	7.300	3.500	1.700	3.858	-1.558	0.877	0.49
G7	BD-2059	11.50	13.93	11.00	5.300	10.43	5.017	1.279	2.49
G8	BD-2122	4.300	1.500	1.800	1.900	2.375	-3.042	-0.111	2.38
G9	Bogura Jatt	2.700	3.200	1.100	2.900	2.475	-2.942	0.046	1.30
G10	Bullet	2.600	7.000	7.400	1.700	4.675	-0.742	0.848	5.28
	E. Mean	5.003	8.847	5.483	2.333	5.417			
	E. Index (Ij)	-0.41	3.430	0.67	-3.083				
	CV%	12.95	14.55	11.51	21.73				
	LSD (0.05)	1.11	2.21	1.08	0.87				

Pi = Phenotypic Index, bi = Regression Coefficient, S^2di = Deviation from Regression
* indicates slopes significantly different from the slope for the overall regression which is 1.00

S^2di three parameters, it was evident that all the genotypes showed different response of adaptability under different environmental conditions. The genotypes Kalo Dhawna morich and Bogurar lomba Morich exhibited comparatively higher fresh weight of root, as their bi~1 and S^2di~0 indicated that the genotypes were stable across the environment. The genotype Bogurar Jhal Morich and DBP 14 5G (China) had bi value significantly different from the unity with comparatively insignificant S^2di value indicating high responsiveness of the genotype but suitable for Env-2 and Env-3.

4.2.15 Oven dry weight of shoot (g)

Mean performance of the promising genotypes, their response and stability parameters phenotypic indices (Pi), regression coefficient (bi) and deviation from regression (S^2di) for oven dry weight of shoot are presented in Table 19. Among the genotypes Bogurar Jhal Morich and Kalo Dhawna morich took minimum (15.18 g) and maximum (67.65 g) oven dry weight of shoot, respectively. The environmental mean and genotypic mean ranged from 24.07 g to 55.00 g and 15.18 g to 67.65 g, respectively.

Three genotypes i.e. Kalo Dhawna morich, DBP 14 5G (China) and BD-2059, showed positive phenotypic index, which represents those genotypes, were desirable for higher oven dry weight of shoot. While the other seven genotypes i. e. Bogurar Jhal Morich, Balojhuri, Suryamukhi, Bogurar lomba Morich, BD-2122, Bogura Jatt and Bullet had negative phenotypic index, this represents the undesirability of those genotypes for higher oven dry weight of shoot or desirability of those genotypes for lower oven dry weight of shoot.

Again positive and negative environmental index (Ij) reflects the rich or favourable and poor or unfavourable environments for a character, respectively. Thus the Env-1, Env-2 was rich and Env-3, Env-4 was poor environment for higher oven dry weight of shoot in chilli production to obtain maximum fruiting. Genotypes having negative bi value may be grown in poor environments. In that sense, no genotype was found adaptive for poor environments.

Table 19. Stability analysis for oven dry weight of shoot (g) of ten genotypes of chilli in four environments evaluated during rabi, 2013-14

Code	Genotype Name	Environments					Pi	bi	S^2di
		Env-1	Env-2	Env-3	Env-4	Overall Mean			
G1	Kalo Dhawna morich	91.67	105.1	30.53	43.33	67.65	31.22	2.336	110.83
G2	Bogurar Jhal Morich	20.20	21.40	9.700	9.433	15.18	-21.25	0.415*	4.61
G3	Balojhuri	21.00	33.73	15.60	20.53	22.72	-13.71	0.453	19.97
G4	DBP 14 5G (China)	68.00	120.2	49.20	18.50	63.97	27.54	2.645	342.17
G5	Suryamukhi	21.80	55.67	24.00	15.73	29.30	-7.129	0.990	147.21
G6	Bogurar lomba Morich	26.67	53.27	22.67	23.57	31.54	-4.887	0.852	71.55
G7	BD-2059	62.33	60.00	38.40	33.50	48.56	12.13	0.886	57.69
G8	BD-2122	48.40	19.40	10.63	23.90	25.58	-10.85	0.333	354.77
G9	Bogura Jatt	28.83	40.40	5.400	24.03	24.67	-11.76	0.825	86.10
G10	Bullet	35.33	40.90	34.60	29.67	35.12	-1.304	0.266*	7.57
	E. Mean	42.42	55.00	24.07	24.22	36.43			
	E. Index (Ij)	5.994	18.57	-12.36	-12.21				
	CV%	3.83	5.74	2.87	3.93				
	LSD (0.05)	2.79	5.41	1.19	1.63				

Pi = Phenotypic Index, bi = Regression Coefficient, S^2di = Deviation from Regression
* indicates slopes significantly different from the slope for the overall regression which is 1.00

The regression coefficient (bi) values of these genotypes ranged from 0.266 to 2.645. These differences in bi values indicated that all the genotypes responded differently to different environments. Considering the mean, bi and S^2di three parameters, it was evident that all the genotypes showed different response of adaptability under different environmental conditions. The genotypes Bogurar lomba Morich and BD-2059 exhibited comparatively higher oven dry weight of shoot, as their bi~1 and S^2di~0 indicated that the genotypes were stable across the environment. The genotype Bogurar Jhal Morich and Bullet had bi value significantly different from the unity with comparatively insignificant S^2di value indicating high responsiveness of the genotype but suitable for Env-1 and Env-2.

4.2.16 Oven dry weight of root (g)

Mean performance of the promising genotypes, their response and stability parameters phenotypic indices (Pi), regression coefficient (bi) and deviation from regression (S^2di) for oven dry weight of root are presented in Table 20. Among the genotypes Bogurar Jhal Morich and DBP 14 5G (China) took minimum (0.575 g) and maximum (5.850 g) oven dry weight of root, respectively. The environmental mean and genotypic mean ranged from 0.950 g to 4.373 g and 0.575 g to 5.850 g, respectively.

Three genotypes i.e. Kalo Dhawna morich, DBP 14 5G (China) and BD-2059, showed negative phenotypic index, this represents the undesirability of those genotypes for higher oven dry weight of root or desirability of those genotypes for lower oven dry weight of root. While the other seven genotypes i. e. Bogurar Jhal Morich, Balojhuri, Suryamukhi, Bogurar lomba Morich, BD-2122, Bogura Jatt and Bullet had positive phenotypic index, which represents those genotypes, were desirable for higher oven dry weight of root.

Again positive and negative environmental index (Ij) reflects the rich or favourable and poor or unfavourable environments for a character, respectively. Thus the Env-2 was rich and Env-1, Env-3, Env-4 was poor environment for higher oven dry weight of root in chilli production to obtain

Table 20. Stability analysis for oven dry weight of root (g) of ten genotypes of chilli in four environments evaluated during rabi, 2013-14

Code	Genotype Name	Environments					Pi	bi	S^2di
		Env-1	Env-2	Env-3	Env-4	Overall Mean			
G1	Kalo Dhawna morich	6.000	7.300	3.500	2.500	4.825	-0.832	1.363	1.71
G2	Bogurar Jhal Morich	0.70	0.700	0.700	0.200	0.575	1.117	0.123*	0.05
G3	Balojhuri	0.500	1.933	1.567	0.500	1.125	0.867	0.421	0.28
G4	DBP 14 5G (China)	3.700	13.90	5.300	0.500	5.850	-3.858	3.989*	1.03
G5	Suryamukhi	0.300	3.500	1.400	0.200	1.350	0.342	1.008	0.45
G6	Bogurar lomba Morich	1.300	3.000	1.600	0.500	1.600	0.392	0.729*	0.02
G7	BD-2059	5.567	8.800	4.000	2.400	5.192	-1.299	1.866	0.65
G8	BD-2122	1.867	0.500	0.600	0.700	0.917	1.276	-0.105	0.58
G9	Bogura Jatt	1.200	1.500	0.500	1.400	1.150	1.742	0.070*	0.29
G10	Bullet	0.966	2.600	3.20	0.600	1.842	0.250	0.536	1.50
	E. Mean	2.210	4.373	2.237	0.950	2.442			
	E. Index (Ij)	-0.233	1.931	-0.206	-1.492				
	CV%	9.58	12.83	11.26	25.50				
	LSD (0.05)	0.36	0.96	0.43	0.42				

Pi = Phenotypic Index, bi = Regression Coefficient, S^2di = Deviation from Regression
* indicates slopes significantly different from the slope for the overall regression which is 1.00

maximum fruiting and nutrient. Genotypes having negative bi value may be grown in poor environments. In that sense, BD-2122 was found adaptive for poor environments.

The regression coefficient (bi) values of these genotypes ranged from 0.070 to 3.989. These differences in bi values indicated that all the genotypes responded differently to different environments. Considering the mean, bi and S^2di three parameters, it was evident that all the genotypes showed different response of adaptability under different environmental conditions. The genotype Suryamukhi exhibited comparatively higher oven dry weight of root, as their bi~1 and S^2di~0 indicated that the genotype was stable across the environment. The genotype Bogurar Jhal Morich, DBP 14 5G (China), Bogurar lomba Morich and Bogura Jatt had bi value significantly different from the unity with comparatively insignificant S^2di value indicating high responsiveness of the genotype but suitable for Env-2.

4.2.17 Leaf area index

Mean performance of the promising genotypes, their response and stability parameters phenotypic indices (Pi), regression coefficient (bi) and deviation from regression (S^2di) for leaf area index are presented in Table 21. Among the genotypes Bogura Jatt and BD-2059 took minimum (7.290) and maximum (26.63) leaf area index, respectively. The environmental mean and genotypic mean ranged from 11.49 to 19.44 and 7.290 to 26.63, respectively.

Four genotypes i.e. DBP 14 5G (China), Suryamukhi, BD-2059 and Bullet, showed positive phenotypic index, which represents those genotypes, were desirable for higher leaf area index. While the other six genotypes i. e. Kalo Dhawna morich, Bogurar Jhal Morich, Balojhuri, Bogurar lomba Morich, BD-2122 and Bogura Jatt had negative phenotypic index, this represents the undesirability of those genotypes for higher leaf area index of shoot or desirability of those genotypes for lower leaf area index.

Table 21. Stability analysis for leaf area index of ten genotypes of chilli in four environments evaluated during rabi, 2013-14

Code	Genotype Name	Environments					Pi	bi	S^2di
		Env-1	Env-2	Env-3	Env-4	Overall Mean			
G1	Kalo Dhawna morich	7.176	20.23	10.91	7.873	11.55	-3.022	1.553	11.10
G2	Bogurar Jhal Morich	6.019	25.89	6.230	3.066	10.30	-4.269	2.952	9.35
G3	Balojhuri	13.17	12.71	4.224	8.075	9.543	-5.026	0.773	16.12
G4	DBP 14 5G (China)	18.05	25.69	17.83	18.07	19.91	5.341	1.048	2.62
G5	Suryamukhi	25.22	26.45	15.87	8.150	18.92	4.355	2.051	35.61
G6	Bogurar lomba Morich	3.901	12.70	10.25	3.459	7.578	-6.992	0.954	15.65
G7	BD-2059	23.05	30.11	22.46	30.92	26.63	12.06	0.311	28.61
G8	BD-2122	6.714	12.81	6.502	8.807	8.709	-5.860	0.660	5.06
G9	Bogura Jatt	9.079	9.543	6.810	3.730	7.290	-7.279	0.624	3.63
G10	Bullet	31.25	18.29	28.71	22.79	25.26	10.69	-0.926	35.92
	E. Mean	14.36	19.44	12.98	11.49	14.57			
	E. Index (Ij)	-0.21	4.871	-1.589	-3.075				
	CV%	4.35	4.06	5.90	4.59				
	LSD (0.05)	1.07	1.35	1.31	0.90				

Pi = Phenotypic Index, bi = Regression Coefficient, S^2di = Deviation from Regression
* indicates slopes significantly different from the slope for the overall regression which is 1.00

Again positive and negative environmental index (Ij) reflects the rich or favourable and poor or unfavourable environments for a character, respectively. Thus the Env-2 was rich and Env-1, Env-3, Env-4 was poor environment for higher leaf area index in chilli production to obtain maximum sunlight absorbance. Genotypes having negative bi value may be grown in poor environments. In that sense, Bullet was found adaptive for poor environments.

The regression coefficient (bi) values of these genotypes ranged from 0.311 to 2.952. These differences in bi values indicated that all the genotypes responded differently to different environments. Considering the mean, bi and S^2di three parameters, it was evident that all the genotypes showed different response of adaptability under different environmental conditions. The genotypes DBP 14 5G (China) and Bogura Jatt exhibited comparatively higher leaf area index, as their bi~1 and S^2di~0 indicated that the genotypes were stable across the environment. Tembhurne *et al.* (2013) and Kulsum *et al.* (2013) found similar results on leaf area index in chilli.

4.2.18 Fruit length without panicle (cm)

Mean performance of the promising genotypes, their response and stability parameters phenotypic indices (Pi), regression coefficient (bi) and deviation from regression (S^2di) for fruit length without panicle are presented in Table 22. Among the genotypes Kalo Dhawna morich and DBP 14 5G (China) took minimum (4.264 cm) and maximum (6.078 cm) fruit length, respectively. The environmental mean and genotypic mean ranged from 3.998 cm to 5.591 cm and 4.264 cm to 6.078 cm, respectively.

Three genotypes i.e. DBP 14 5G (China), Bogurar lomba Morich and BD-2059, showed positive phenotypic index, which represents those genotypes, were desirable for higher fruit length. While the other seven genotypes i. e. Kalo Dhawna morich, Bogurar Jhal Morich, Balojhuri, Suryamukhi, BD-2122, Bogura Jatt and Bullet had negative phenotypic index, this represents the

Table 22. Stability analysis for fruit length without panicle of ten genotypes of chilli in four environments evaluated during rabi, 2013-14

Code	Genotype Name	Environments					Pi	bi	S^2di
		Env-1	Env-2	Env-3	Env-4	Overall Mean			
G1	Kalo Dhawna morich	3.300	5.767	3.678	4.311	4.264	-0.504	0.984	1.13
G2	Bogurar Jhal Morich	4.567	4.378	4.533	3.767	4.311	-0.457	0.345	0.13
G3	Balojhuri	4.233	5.456	3.889	4.400	4.494	-0.274	0.629	0.42
G4	DBP 14 5G (China)	4.667	8.478	6.000	5.167	6.078	1.310	2.214	1.05
G5	Suryamukhi	4.967	4.411	5.667	3.833	4.719	-0.486	0.384	0.82
G6	Bogurar lomba Morich	4.967	4.456	6.067	4.667	5.039	0.271	-0.034	0.77
G7	BD-2059	5.089	7.267	5.267	4.533	5.539	0.771	1.697	0.23
G8	BD-2122	4.389	5.767	4.667	3.167	4.497	-0.271	1.597*	0.02
G9	Bogura Jatt	4.356	4.767	5.400	3.033	4.389	-0.379	1.130	0.36
G10	Bullet	5.300	5.167	3.833	3.100	4.350	-0.418	1.052	0.97
	E. Mean	4.583	5.591	4.900	3.998	4.768			
	E. Index (Ij)	-0.185	0.823	0.131	-0.773				
	CV%	1.20	2.55	3.38	5.23				
	LSD (0.05)	0.09	0.24	0.28	0.36				

Pi = Phenotypic Index, bi = Regression Coefficient, S^2di = Deviation from Regression
* indicates slopes significantly different from the slope for the overall regression which is 1.00

undesirability of those genotypes for higher fruit length or desirability of those genotypes for lower fruit length.

Again positive and negative environmental index (Ij) reflects the rich or favourable and poor or unfavourable environments for a character, respectively. Thus the Env-2, Env-3 was rich and Env-1, Env-4 was poor environment for higher fruit length in chilli production to obtain maximum fruiting. Genotypes having negative bi value may be grown in poor environments. In that sense, Bogurar lomba Morich was found adaptive for poor environments.

The regression coefficient (bi) values of these genotypes ranged from 0.034 to 2.214. These differences in bi values indicated that all the genotypes responded differently to different environments. Considering the mean, bi and S^2di three parameters, it was evident that all the genotypes showed different response of adaptability under different environmental conditions. The genotype Bogura Jatt exhibited comparatively higher fruit length, as their bi~1 and S^2di~0 indicated that the genotype was stable across the environment. The genotype BD-2122 had bi value significantly different from the unity with comparatively insignificant S^2di value indicating high responsiveness of the genotype but suitable for Env-2 and Env-3. Tembhurne *et al.* (2013) found similar results on days to 50% flowering in chilli.

4.2.19 Number of seeds per fruit

Mean performance of the promising genotypes, their response and stability parameters phenotypic indices (Pi), regression coefficient (bi) and deviation from regression (S^2di) for number of seeds per fruit are presented in Table 23. Among the genotypes Kalo Dhawna morich and Bullet took minimum (48.69) and maximum (119.6) number of seeds per fruit, respectively. The environmental mean and genotypic mean ranged from 74.87 to 84.50 and 48.69 to 119.6, respectively.

Table 23. Stability analysis for number of seeds per fruit of ten genotypes of chilli in four environments evaluated during rabi, 2013-14

Code	Genotype Name	Environments					Pi	bi	S^2di
		Env-1	Env-2	Env-3	Env-4	Overall Mean			
G1	Kalo Dhawna morich	48.00	55.67	45.78	45.33	48.69	-32.46	0.715	20.37
G2	Bogurar Jhal Morich	63.00	61.67	61.78	61.67	62.03	-19.12	0.040*	0.59
G3	Balojhuri	74.33	70.33	68.89	71.33	71.22	-9.928	-0.038	7.92
G4	DBP 14 5G (China)	88.33	97.00	98.22	88.00	92.89	11.74	0.814	26.75
G5	Suryamukhi	84.00	91.00	90.00	82.33	86.83	5.683	0.767	11.63
G6	Bogurar lomba Morich	119.7	108.0	108.0	92.67	107.1	25.93	2.080	64.94
G7	BD-2059	80.00	82.00	74.67	66.67	75.83	-5.317	1.510	5.63
G8	BD-2122	90.00	95.67	94.44	79.00	89.78	8.628	1.513	5.61
G9	Bogura Jatt	58.67	57.33	60.89	53.33	57.56	-23.59	0.584	5.74
G10	Bullet	121.0	126.3	122.7	108.3	119.6	38.43	1.813*	1.38
	E. Mean	82.70	84.50	82.53	74.87	81.15			
	E. Index (Ij)	1.550	3.350	1.383	-6.283				
	CV%	0.00	0.00	1.15	0.00				
	LSD (0.05)	0.00	0.00	1.63	0.00				

Pi = Phenotypic Index, bi = Regression Coefficient, S^2di = Deviation from Regression
* indicates slopes significantly different from the slope for the overall regression which is 1.00

Five genotypes i.e. DBP 14 5G (China), Suryamukhi, Bogurar lomba Morich, BD-2122 and Bullet, showed positive phenotypic index, which represents those genotypes, were desirable for higher number of seeds per fruit. While the other five genotypes i. e. Kalo Dhawna morich, Bogurar Jhal Morich, Balojhuri, Bogurar lomba Morich and Bogura Jatt had negative phenotypic index, this represents the undesirability of those genotypes for higher number of seeds per fruit or desirability of those genotypes for lower number of seeds per fruit.

Again positive and negative environmental index (Ij) reflects the rich or favourable and poor or unfavourable environments for a character, respectively. Thus the Env-1, Env-2, Env-3 was rich and Env-4 was poor environment for higher number of seeds per fruit in chilli production to obtain maximum seed yield. Genotypes having negative bi value may be grown in poor environments. In that sense, Balojhuri was found adaptive for poor environments.

The regression coefficient (bi) values of these genotypes ranged from 0.038 to 2.080. These differences in bi values indicated that all the genotypes responded differently to different environments. Considering the mean, bi and S^2di three parameters, it was evident that all the genotypes showed different response of adaptability under different environmental conditions. The genotypes BD-2059 and BD-2122 exhibited comparatively higher number of seeds per fruit, as their bi~1 and S^2di~0 indicated that the genotypes were stable across the environment. The genotype Bogurar Jhal Morich and Bullet had bi value significantly different from the unity with comparatively non-significant S^2di value indicating high responsiveness of the genotype but suitable for Env-1, Env-2 and Env-3. Tembhurne *et al.* (2013) found similar results on number of seeds per fruit in chilli.

4.2.20 Number of fruits per plucking per plant

Mean performance of the promising genotypes, their response and stability parameters phenotypic indices (Pi), regression coefficient (bi) and deviation from regression (S^2di) for number of fruits per plucking per plant are presented in Table 25. Among the genotypes Suryamukhi and Kalo Dhawna morich took minimum (12.42) and maximum (92.50) number of fruits per plucking per plant, respectively. The environmental mean and genotypic mean ranged from 15.77 to 49.57 and 12.42 to 92.50, respectively.

Three genotypes i.e. Kalo Dhawna morich, Balojhuri, Bogurar lomba Morich, showed positive phenotypic index, which represents those genotypes, were desirable for higher number of fruits per plucking. While the other seven genotypes i. e. Bogurar Jhal Morich, DBP 14 5G (China), Suryamukhi, BD-2059, BD-2122, Bogura Jatt and Bullet had negative phenotypic index, this represents the undesirability of those genotypes for higher number of fruits per plucking or desirability of those genotypes for lower number of fruits per plucking.

Again positive and negative environmental index (Ij) reflects the rich or favourable and poor or unfavourable environments for a character, respectively. Thus the Env-1, Env-2 was rich and Env-3, Env-4 was poor environment for higher number of fruits per plucking in chilli production to obtain maximum yield. Genotypes having negative bi value may be grown in poor environments. In that sense, Bogurar Jhal Morich was found adaptive for poor environments.

The regression coefficient (bi) values of these genotypes ranged from 0.010 to 4.606. These differences in bi values indicated that all the genotypes responded differently to different environments. Considering the mean, bi and S^2di three parameters, it was evident that all the genotypes showed different response of adaptability under different environmental conditions. The genotypes BD-2059 exhibited comparatively higher number of fruits per plucking, as their bi~1 and S^2di~0 indicated that the genotypes

Table 24. Stability analysis for number of fruits per plucking per plant of ten genotypes of chilli in four environments evaluated during rabi, 2013-14

Code	Genotype Name	Environments					Pi	bi	S^2di
		Env-1	Env-2	Env-3	Env-4	Overall Mean			
G1	Kalo Dhawna morich	127.0	170.0	50.00	23.00	92.50	61.24	4.606	383.56
G2	Bogurar Jhal Morich	11.67	18.00	25.00	14.67	17.33	-13.93	-0.010	49.19
G3	Balojhuri	37.00	46.00	18.00	31.00	33.00	1.742	0.594	98.32
G4	DBP 14 5G (China)	18.00	24.00	15.00	10.00	16.75	-14.51	0.407*	0.28
G5	Suryamukhi	13.33	14.67	11.67	10.00	12.42	-18.84	0.139*	0.21
G6	Bogurar lomba Morich	67.00	69.00	38.00	23.00	49.25	17.99	1.434	126.91
G7	BD-2059	22.00	48.00	18.00	10.00	24.50	-6.758	1.112	24.89
G8	BD-2122	11.33	22.00	28.00	13.00	18.58	-12.68	0.121	87.52
G9	Bogura Jatt	18.00	50.00	22.00	13.00	25.75	-5.508	1.040	79.24
G10	Bullet	16.00	34.00	30.00	10.00	22.50	-8.758	0.557	98.08
	E. Mean	34.13	49.57	25.57	15.77	31.26			
	E. Index (Ij)	2.87	18.31	-5.69	-15.49				
	CV%	5.77	2.96	4.00	15.27				
	LSD (0.05)	0.48	0.26	0.40	0.55				

Pi = Phenotypic Index, bi = Regression Coefficient, S^2di = Deviation from Regression
* indicates slopes significantly different from the slope for the overall regression which is 1.00

were stable across the environment. The genotype DBP 14 5G (China) and Suryamukhi had bi value significantly different from the unity with comparatively insignificant S^2di value indicating high responsiveness of the genotype but suitable for Env-1 and Env-2.

4.2.21 Fruit yield per plant (g)

Mean performance of the promising genotypes, their response and stability parameters phenotypic indices (Pi), regression coefficient (bi) and deviation from regression (S^2di) for fruit yield per plant are presented in Table 24. Among the genotypes Suryamukhi and Bogurar lomba Morich showed minimum (64.22 g) and maximum (223.5 g) fruit yield per plant, respectively. The environmental mean and genotypic mean ranged from 40.77 g to 197.3 g and 64.22 g to 223.5 g, respectively.

Five genotypes i.e. Kalo Dhawna morich, Bogurar lomba Morich, Bogura Jatt and Bullet, showed positive phenotypic index, were desirable for higher fruit yield. While the other six genotypes i. e. Bogurar Jhal Morich, Balojhuri, DBP 14 5G (China), Suryamukhi, BD-2059 and BD-2122 had negative phenotypic index, this represents the undesirability of those genotypes for higher fruit yield or desirability of those genotypes for lower fruit yield.

Again positive and negative environmental index (Ij) reflects the rich or favourable and poor or unfavourable environments for a character, respectively. Thus the Env-2 was rich and Env-1, Env-3, Env-4 was poor environment for higher fruit yield in chilli production to obtain maximum yield. Genotypes having negative bi value may be grown in poor environments. Here, Env-2 found rich due to use of balanced fertilizer from both organic and inorganic form.

The regression coefficient (bi) values of these genotypes ranged from 0.231 to 2.385. These differences in bi values indicated that all the genotypes responded differently to different environments. Considering the mean, bi and S^2di, it was evident that all the genotypes showed different response of

Table 25. Stability analysis for fruit yield per plant of ten genotypes of chilli in four environments evaluated during rabi, 2013-14

Code	Genotype Name	Environments					Pi	bi	S^2di
		Env-1	Env-2	Env-3	Env-4	Overall Mean			
G1	Kalo Dhawna morich	245.8	397.1	113.0	29.90	196.5	83.94	2.385	3325.26
G2	Bogurar Jhal Morich	43.17	79.20	96.67	38.13	64.29	-48.24	0.231	869.68
G3	Balojhuri	111.0	138.0	43.20	65.10	89.33	-23.21	0.504	1195.25
G4	DBP 14 5G (China)	59.40	90.8	52.50	33.00	58.93	-53.61	0.798	29.69
G5	Suryamukhi	76.00	86.53	58.33	36.00	64.22	-48.32	0.317*	108.92
G6	Bogurar lomba Morich	281.4	372.6	171.0	69.00	223.5	111.0	1.937	2770.02
G7	BD-2059	79.20	168.5	70.20	57.00	93.73	-18.81	1.121	168.57
G8	BD-2122	32.87	72.60	81.20	28.60	53.82	-58.72	0.256	682.30
G9	Bogura Jatt	89.20	205.0	115.3	72.00	120.4	7.833	1.065	165.37
G10	Bullet	89.60	282.2	232.0	39.00	160.7	48.17	1.487	6103.44
	E. Mean	110.76	189.25	103.34	46.773	112.5			
	E. Index (Ij)	-2.77	84.72	-10.19	-71.76				
	CV%	11.46	7.89	15.29	24.80				
	LSD (0.05)	20.12	20.12	20.12	20.12				

Pi = Phenotypic Index, bi = Regression Coefficient, S^2di = Deviation from Regression
* indicates slopes significantly different from the slope for the overall regression which is 1.00

adaptability under different environmental conditions. The genotypes BD-2059, DBP 14 5G (China) and Bogura Jatt exhibited comparatively higher stability, as their bi~1 and S^2di~0 indicated that the genotypes were stable across the environments. The genotype Kalo Dhawna Morich and Bogurar Lomba Morich Suryamukhi had bi value significantly different from the unity with significant S^2di value indicating high responsiveness of the genotypes but suitable for Env-2. The genotype Suryamukhi had bi value significantly different from the unity with comparatively insignificant S^2di value indicating high responsiveness of the genotypes to poor environment (Kulsum *et al.*, 2013). Tembhurne *et al.* (2013), Kulsum *et al.* (2013) and Srividhya *et al.* (2011) found similar results on fruit yield per plant in chilli and rice.

4.3 Interaction Biplot of AMMI model

The AMMI biplot provide a visual expression of the relationship between the First Interaction Principal Component Axis (IPCA1) or AMMI component 1 and Mean of genotypes and environment (Figure 2) with the biplot up to 100% of the treatment sum of squares. Consequently, biplots generated using genotypic and environmental scores of the AMMI 1 components can help breeders have an overall picture of the behavior of the genotypes, the environments and G × E (Manrique and Hermann, 2000; Kaya *et al.*, 2002; Tarakanovas and Ruzgas, 2006). The first interaction principal components axis (AMMI component 1) was highly significant and explained the interaction pattern better than other interaction axis. Balestre *et al.* (2009) found that, the GGE biplot method to be superior to the AMMI 1 graph, due to more retention of GE and G + GE in the graph analysis.

In Figure 2 the IPCA1 scores for both the genotypes and the environments were plotted against the mean yield for the genotypes and the environments, respectively. By plotting both the genotypes and the environments on the same graph, the associations between the genotypes and the environments can be seen clearly. The IPCA scores of a genotype in the AMMI analysis are an indication of the stability or adaptation over environments. The greater the

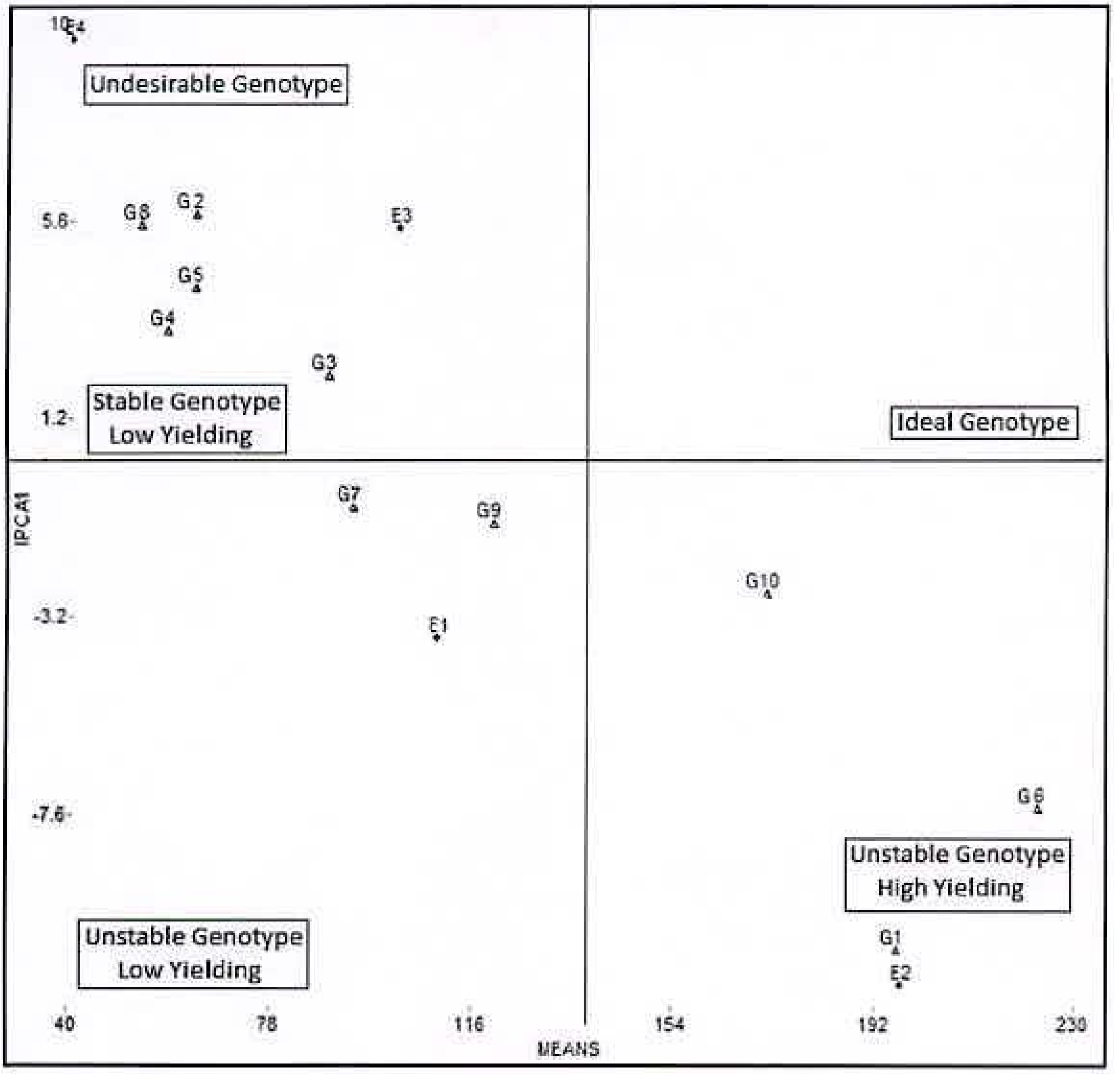


Figure 2. Interaction biplot of of AMMI1 where IPCA1 score (Y-axis) plotted against mean yield (X-axis) for ten genotypes of chilli.

Here, G1 = Kalo Dhawna morich, G2 = Bogurar Jhal Morich, G3 = Balojhuri,G4 = DBP 14 5G (China), G5 = Suryamukhi, G6 = Bogurar lomba Morich, G7 = BD-2059, G8 = BD-2122, G9 = Bogura Jatt, G10 =Bullet and E1 = Environment 1, E2 = Environment 2, E3 = Environment 3, E4 = Environment 4.

IPCA scores, negative or positive (as it is a relative value), the more specific adaptation of a genotype to certain environments. The more the IPCA score approximate to zero, the more stable or adaptation of the genotype in over all environments sampled.

Considering only the IPCA 1 scores Bogurar Jhal Morich (G2), Balojhuri (G3), Suryamukhi (G4), DBP 14 5G (China) (G5) and BD-2122 (G8) were low yielding and unstable (Figure 2). Kalo Dhawna morich (G1), Bogurar lomba Morich (G6) and Bullet (G10) is the high yielding and unstable genotype according to figure 2. We also found Env-2 as rich environment where, Kalo Dhawna morich (G1) and Bogurar lomba Morich (G6)were found highly responsive to rich environment (Env-2) in figure-2. BD-2059 (G7) and Bagura Jatt (G9) were found intermediate yielder and stable. But we didnt find any high yielding stable genotype according to figure 2.

Since IPCA 2 scores also play a significant role in explaining the GEI the IPCA1 scores were plotted against the IPCA2 scores to further explore adaptation (Figure 3). According to Figure 3 Kalo Dhawna morich (G1), Bogurar lomba Morich (G6) and Bullet (G10) was an outliner (unstable) followed by Bogurar Jhal Morich (G2), Balojhuri (G3), Suryamukhi (G5) and BD-2122 (G8) unstable but to a lesser extent. DBP 14 5G (China) (G4), BD-2059 (G7) and Bogura Jatt (G9) showed more stability when plotting the IPCA 1 and IPCA 2 scores where BD-2059 (G7) was highly stable.

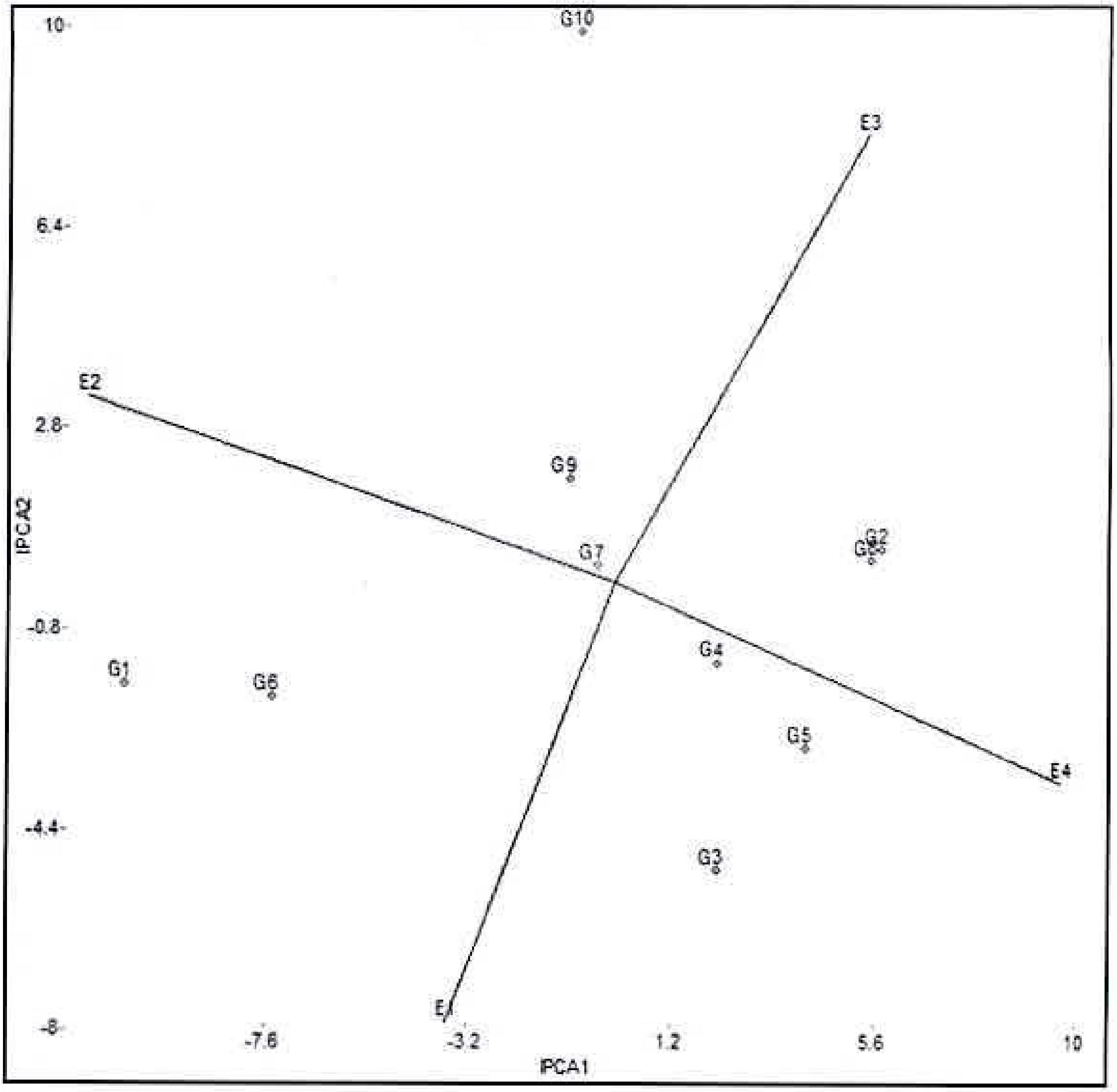


Figure 3. Interaction biplot of AMMI2 where IPCA2 score (Y-axis) plotted against IPCA1 score (X-axis) for ten genotypes of chilli.

Here, G1 = Kalo Dhawna morich, G2 = Bogurar Jhal Morich, G3 = Balojhuri, G4 = DBP 14 5G (China), G5 = Suryamukhi, G6 = Bogurar lomba Morich, G7 = BD-2059, G8 = BD-2122, G9 = Bogura Jatt, G10 = Bullet and E1= Environment 1, E2 = Environment 2, E3 = Environment 3, E4 = Environment 4.

Chapter V

Summary and Conclusion

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted at the experimental field of Sher-e-Bangla Agricultural University during rabi season 2013-2014 with ten genotypes of chilli of different source. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications in four different environments. The objectives of the experiment were to find best genotype or genotypes with high mean yield and good adaptation to different environments. Data were collected on days to first flowering, days to 50% flowering, plant height excluding root (cm), root length (cm), number of primary branches per plant, number of secondary branches per plant, number of leaves per plant, number of leaves per primary branch, number of fruits per plant, number of fruit per primary branch, fruit diameter (cm), individual fruit weight (g), fresh weight of shoot (g), fresh weight of root (g), oven dry weight of shoot (g), oven dry weight of root (g), leaf area index, fruit length without panicle (cm), number of seeds per fruit, weight of seeds per fruit (mg), hundred seed weight (mg), fruit yield per plant (g) and number of fruits per plucking per plant.

The analysis of variance (ANOVA) was used and the GE interaction was estimated by the AMMI model (Zobel *et al.*, 1988). The stability parameters, regression coefficient (bi) and deviation from regression (S^2di) were estimated according to Eberhart and Russel (1996). Significance of differences among bi value and unity was tested by t-test, between S^2di and zero by F-test.

In combined analysis of variance (ANOVA) according to the best AMMI model. The mean sum of squares for the genotypes were highly significant for all the characters except weight of seed per fruit and hundred seed weight and the mean sum of squares for environment and interactions were also significant for most of the characters.

According to Eherhart and Russel (1966) model regression coefficient (bi) is considered as parameter of response and deviation from regression (S^2di) as the parameter of stability. Relatively lower value of bi, say around 1 will mean less responsive to the environmental change and therefore, more adaptive. If however, bi is negative, the genotype may be grown only in poor environment. Deviation from regression (S^2di), if significantly different from zero, will invalidate the linear prediction. If S^2di is non-significant, the performances of a genotype for a given environment may be predicted. Therefore, a genotype whose performance for a given environment can be predicted i.e., S^2di~0 is said to be stable genotype. The genotype which have bi value significantly different from the unity with insignificant S^2di value indicating high responsiveness of the genotype suitable for rich environment.

Considering the mean, bi and S^2di, it was evident that all the genotypes showed different response of adaptability under different environmental conditions. The genotypes Kalo Dhawna morich, Bogurar Jhal Morich, BD-2059, BD-2122 and Bogura Jatt exhibited comparatively lower days to first flowering and were found stable across the environments. Kalo Dhawna morich, Bogurar Jhal Morich, DBP 14 5G (China) and Bogura Jatt exhibited comparatively lower days to 50% flowering and were found stable where Balojhuri showed high responsiveness to rich environments. Bogurar Jhal Morich, Suryamukhi and Bullet exhibited comparatively lower plant height and were found stable. BD-2059 and Bogura Jatt exhibited comparatively higher root length and were found stable where Bullet showed high responsiveness to rich environments.

The genotype Bogurar lomba Morich exhibited comparatively higher number of primary branches per plant and were found stable across the environments where BD-2059 showed high responsiveness to rich environments. Bogurar lomba Morich and BD-2122 exhibited comparatively higher number of secondary branches per plant and were found stable where BD-2059 showed high responsiveness to rich environments. Bogurar lomba Morich and Bogura

Jatt exhibited comparatively higher number of leaves per plant and were found stable where Bogurar Jhal Morich and Balojhuri showed high responsiveness to rich environments.

DBP 14 5G (China) and Bullet exhibited comparatively higher number of leaves per primary branch and found stable where Kalo Dhawna morich showed high responsiveness to rich environments. BD-2059 exhibited comparatively higher number of leaves per secondary branch and found stable where Kalo Dhawna morich, DBP 14 5G (China) and Suryamukhi showed high responsiveness to rich environments. BD-2059, Bogura Jatt and Bullet exhibited comparatively higher number of fruit per primary branch and found stable. Kalo Dhawna morich, Balojhuri, BD-2059 and BD-2122 exhibited comparatively higher fruit diameter (cm) and found stable. Kalo Dhawna morich, Bogurar Jhal Morich, DBP 14 5G (China), Suryamukhi and Bogurar lomba Morich exhibited comparatively higher individual fruit weight (g) and found stable where BD-2122 and Bogura Jatt showed high responsiveness to rich environments.

BD-2059 and Suryamukhi exhibited comparatively higher fresh weight of shoot and found stable where Kalo Dhawna morich, Bogurar Jhal Morich, Balojhuri and Bullet showed high responsiveness to rich environments. Kalo Dhawna morich and Bogurar lomba Morich exhibited comparatively higher fresh weight of root and found stable where DBP 14 5G (China) and Bogurar Jhal Morich showed high responsiveness to rich environments. Bogurar lomba Morich and BD-2059 exhibited comparatively higher oven dry weight of shoot and found stable where Bullet and Bogurar Jhal Morich showed high responsiveness to rich environments. BD-2059 and Suryamukhi exhibited comparatively higher fresh weight of root and found stable where Bogurar Jhal Morich, DBP 14 5G (China), Bogurar lomba Morich and Bogura Jatt showed high responsiveness to rich environments. DBP 14 5G (China) and Bogura Jatt exhibited comparatively higher leaf area index and found stable. Bogura Jatt exhibited comparatively higher fruit length without panicle and found stable where BD-2122 showed high responsiveness to rich environments.

BD-2059 and BD-2122 exhibited comparatively higher number of seeds per fruit and found stable where Bullet and Bogurar Jhal Morich showed high responsiveness to rich environments. BD-2059, DBP 14 5G (China) and Bogura Jatt exhibited comparatively higher number of fruits per plucking per plant and found stable where Suryamukhi and DBP 14 5G (China) showed high responsiveness to rich environments. BD-2059, DBP 14 5G (China) and Bogura Jatt exhibited comparatively higher fruit yield per plant and found stable where Suryamukhi showed high responsiveness to poor environments. Kalo Dhawna Morich and Bogurar Lomba Morich showed high responsiveness to rich environment.

The IPCA scores of a genotype in the AMMI analysis are an indication of the stability or adaptation over environments. The more the IPCA scores approximate to zero, the more stable or adaptation of the genotype in overall environments sampled. Considering only the IPCA 1 scores Bogurar Jhal Morich (G2), Balojhuri (G3), Suryamukhi (G4), DBP 14 5G (China) (G5) and BD-2122 (G8) were low yielding and unstable (Figure 2). Kalo Dhawna morich (G1), Bogurar lomba Morich (G6) and Bullet (G10) is the high yielding and unstable genotype according to figure 2. We also found Env-2 as rich environment where, Kalo Dhawna morich (G1) and Bogurar lomba Morich (G6) were found highly responsive to rich environment (Env-2) in figure-2. BD-2059 (G7) and Bagura Jatt (G9) were found intermediate yielder but stable. But we didnt find any high yielding stable genotype according to figure 2.

Since IPCA 2 scores also play a significant role in explaining the GEI the IPCA1 scores were plotted against the IPCA2 scores to further explore adaptation (Figure 3). According to figure 3 Kalo Dhawna morich (G1), Bogurar lomba Morich (G6) and Bullet (G10) was an outliner (unstable) followed by Bogurar Jhal Morich (G2), Balojhuri (G3), Suryamukhi (G5) and

BD-2122 (G8) unstable but to a lesser extent. DBP 14 5G (China) (G4), BD-2059 (G7) and Bogura Jatt (G9) showed more stability when plotting the IPCA 1 andIPCA 2 scores where BD-2059 (G7) was highly stable.

Based on the findings of the experiment, following conclusions can be made,

• Considering yield and most of the yield contributing characters, Env-3 and Env-4 were poor and Env-1 and Env-2 were found to be rich and favourable for chilli production.

• Considering yield and most of the yield contributing characters, the comparatively stable genotypes were DBP 14 5G (China), BD-2059 and Bogura Jatt across the four environments.

• The genotypes Kalo Dhawna morich, Bogurar lomba Morich and Bullet exhibited comparatively higher mean yield but were unstable across the environments and can be recommended to cultivate in rich environments.

• Env-2 for most of the yield contributing characters was found highly favourable for chilli production.

References

CHAPTER VI

REFERENCES

Abo-Hegazy, S. R. E., Selim, T. and Ashrie, A. A. M. (2013). Genotype x environment interaction and stability analysis for yield and its components in lentil. *J. Plant Bred. Crop Sci.*. **5**(5): 85-90.

Acharya, S. and Sharma, K. D. (1985). Stability analysis over locations vs unilocation testing under created environments in rice. *J. Crop Improvement.* **12**(2): 191-192.

Adams, P. and Ho, L. C. (1993). Effects of environment on the uptake and distribution of calcium in tomato and on the incidence of blossom-end rot. *Plant Soil.* **154**:127-132.

Admassu, S., Nigussie, M. and Zelleke, H. (2008). Genotype-environment interaction and stability analysis for grain yield of maize *(Zea mays* L.) in Ethiopia. *Asian J. Plant Sci.* **7**: 163- 169.

Ahmad, J., Choudhry, M. H., Salah-Ud-Din, S. and Ali, M. A. (1996). Stability for grain yield in wheat. *Pakistan J. Bot.* **28**: 61-65.

Ahmed, M. S. and Haque, M. A. (1980). Morphological characters and yields of five characters of chilli. *Bangladesh J. Hort.* **8**(1): 13-16.

Ahmed, Z. U., Panaullah, G. M., Gauch Jr, H., McCouch, S. R., Tyagi, W., Kabir, M. S. and Duxbury, J. M. (2011). Genotype and environment effects on rice (*Oryza sativa* L.) grain arsenic concerntration in Bangladesh. *J. Plant Soil.* **338**: 367-382.

Al-Aysh, F. M. (2013). Genotype-environment interaction and phenotypic stability for fruit yield and its components of tomato in Dara'a Governorate, Syria. *Res. J. Agric. Environ. Manage.* **2**(11): 371-377.

Allard, R. W. and Bradshaw, A. D. (1964). Implication of genotype-environment interactions in applied plant breeding. *Crop Sci.* **4**: 503-508.

Amin, M. R., Islam, A., Shaheed A. and Barma, N. C. D. (1993). Stability of yield and its components in wheat. *Bangladesh J. Agril. Sci.* **20** (2): 203-211.

Anand,G., Subraman, N. and Gopakumar, B. (2006). AMMI analysis for fruit yield stability of Chilli (*Capsicum annuum* L.). *J. Plantation Crops.* **34**(3): 239-242.

Ashraf, A. and Ramesha, M. S. (2001). Genotype x environment interaction effects on yield of ricehybrids in India. *Indian J. Genet.* **61**(2): 101-106.

Anonymous. (1952). Wealth of India, CSIR, New Delhi, India. pp. 5-6.

Anonymous. (1987). Annual reports on spices research. BARI. Gazipur. pp. 1-3.

Anonymous. (2002). The chile pepper institute newsletter. **3**(1): 3.

Anonymous. (2013). Crop production techniques of horticultural crops, Horticultural college and research institute. Tamil nadu agricultural university. Coimbatore – 641 003.

Aravindakumar, J. S., Mulge, R. And Pati, B. R. (2003). Stability of yield and its component characters in tomato (*Lycopersicon esculentum* Mill.). *Indian J. Genet.* **63**(1): 63-66.

Ashraf. M., Qureshi, A. S. and Khan, N. A. (2001). Genotype x environment interaction in Wheat. *Online J. Biol. Sci.* **1**(5): 356-357.

Bajaj, K. L., Kaur, G. and Sooch, B. S. (1980). Varietal variation in some important chemical constituents in chilli (*Capsicum annuum* L.) fruits. *Veg. Sci. J.* **7**:48-57.

Baker, R.J. (1988). Tests for crossover genotype x environment interactions. *Canadian J. Plant Sci.* **68**:405-410.

Balestre, M., Pinho, R. G. V., Souza, J. C. and Oliveira, R. L. (2009). Genotypic stability and adaptability in tropical maize based on AMMI and GGE biplot analysis. *J. Genet. Mol. Res.* **8**(4): 1311-1322.

Barma, N. C. D., Siddique, A. B. and Sarker, Z. I. (1994). Genotype and environment interaction and stability analysis in wheat. *Bangladesh J. Plant Bred. Genet.* **7**(1): 31-35.

BBS. (2008). Statistical Year Book of Bangladesh. Bangladesh Bureau of Statistics. Statistics Division, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh. **28**: 192.

BBS. (2011). Statistical Year Book of Bangladesh. Bangladesh Bureau of Statistics .Statistics Division, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh. **31**: 187.

BBS. (2012). Statistical Year Book of Bangladesh. Bangladesh Bureau of Statistics .Statistics Division, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh. **32** : 05-196.

BBS. (2013). Statistical Year Book of Bangladesh. Bangladesh Bureau of Statistics .Statistics Division, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh. **33**: 196-208.

Beaver, J. S., and Johnson R. R. (1981). Response of determinate and indeterminate soybeans to varying cultural practices in the northern USA. *Agron. J.* **73**: 833-838.

Berrie, A. M. M. (1977). An Introduction to the botany of major crop plants. Heyden, London. pp. 101-102.

Bosland, P.W. and Votava, E. J. (2000). Peppers: Vegetable and Spice Capsicums. CABI publishing. pp 204.

Broccoli, A. M. and Burak, R. (2004). Effect of genotype x environment interactions in popcorn maize yield and grain quality. *Spanish J. Agril. Res.* **2**(1): 85-91.

Caballero-Mellado, J., Onofre-Lemus, J., Estrada-de, L. P. and Martínez-Aguilar, L. (2007). The tomato rhizosphere, an environment rich in nitrogen-fixing Burkholderia species with capabilities of interest for agriculture and bioremediation. *Appl. Environ. Microbiol.* **73**:5308-5319.

Caselton, G. (2004). http://www.g6csy.net/chile/database.html

Cebolla-Cornejo, J., Rosello, S., Valcarcel, M., Serrano, E., Beltran, J. and Nuez, F. (2011). Evaluation of genotype and environment effects on taste and aroma flavor components of Spanish fresh tomato varieties. *J. Agric. Food Chem.* **59**:2440-2450.

Choudhury, B. (1976). Vegetab (4^{th} edn.). National Book Trust, New Delhi, India. Pp. 50-58.

Cobley, L. S. (1967). Origin of Cultivated plants. Hafier Publishing Company, N. Y. 288-290.

Crossa, J., Gauch, H. G. and Zobel, R. W. (1990). Additive main effects and multiplicative interaction analysis of two international maize cultivar trials. *Crop Sci.* **30**: 493-500.

Dasand, P. K. and Choudhury, P. K. D. (1996). Phenotypic stability for grain yield and its components in rainfed autumn rice (*Oryza sativa*). *Indian J. Genet.* **56**(2): 214-218.

Dasgupta, Reshmi, R. (2011). "Indian chilli displacing jalapenos in global cuisine – The Economic Times". *The Times of India*.

De, R. N., Reddy, J. N., Rao, A. V. S., Ramakrishnayya, G. and Pande, K. L. (1992). Stability of rice yield under different low land situations. *Indian J. Genet.* **52**(2): 139-143.

Deka, S. D. and Talukdar, P. (1997). Stability behaviour of some soybean [*Glycine max* (L.) Merill] genotypes under environmental variability. *Indian J. Genet.* **57**:36-39.

Doshi, K. M. and Shukla, P. T. (2000). Expression of heterosis in chilli (*Capsicum annuum* L.). Capsicum and Egg Plant Newsletter. **19**:66-69.

Eagles, H. A. and Frey, K. J. (1977). Repeatability of the stability variance parameter in oats. *Crop Sci.* **17**: 253- 256.

Eberhart, S. A. and Russel, W. A. (1966). Stability parameters for comparing varieties. *Crop Sci.* **6**: 36-40.

Gezahegn-Bogale, J. B., Van Rensburg, J. and Van Deventer, C. S. (2009). AMMI Analysis of Genotype x Environment Interaction for Grain Yield in Drought- Tolerant Maize *(Zea mays* L.). *East African J. Sci.* **8**: 2-10.

Gauch, H. G. and Zobel, R. W. (1989). Accuracy and selection success in yield trials. *Theor. Appl. Genet.* **77**: 473-481.

Gauch, H. G and Zobel, R. W. (1997). Identifying mega-environments and targeting genotypes. *Crop Sci.* **37**: 311-326.

Hanamaratti, N. G., Salimath, P. M., Vijayakumar, C. H. M., Ravikumar, R. L. and Kajjidoni, S. T. (2010). Genotype x environment interaction of near isogenic introgression lines (NIILs) under drought stress and non-stress environments in upland rice (*Oryza sativa* L.). *Indian J. Genet.* **70**(3): 222-228.

Hannan, M. M., Ahmed, M. B., Razvy, M. A., Karim, R., Khatum, M., Hayder, A., Hussain, M. and Roy, U. K. (2007). Heterosis and correlation of yield and yield components in tomato. *Am-Eurasian J. Sci. Res.* **2**(2):146-150.

Harshmehta, R. N., Sawhney, S. S., Singh, H. B., Chaudhary, D., Sharma N., and Sharma, J. B. (2000). Stability analysis of high yielding wheats at varying fertility levels. *Indian J. Genet.* **60**(4): 471-476.

Kallupurackal, J. A. and Ravindran, P. N. (2005). Over 225 high yielding spice varieties in India (part-I). Spice India. **18**:3-9.

Kang, M. S. (1998). Using genotype-environment interaction for crop cultivar development. *Adv. Agron.* **35**: 199-240.

Kaya, Y. K., Palta, E. and Taner, S. (2002). Additive main effects and multiplicative interactions analysis of yield performances in bread wheat genotypes across environments. *Turk. J. Agric.* 26: 275-279.

Kempton, R.A. (1984). The use of biplots in interpreting variety by environment interactions. *J. Agric. Sci. (Cambridge)*. **103**: 123-135.

Kishor, N., Chaubey, C. N. and Ahmad, Z. (1992). Stability analysis for yield and some quality traits in wheat (*Triticum aestivum* L.). *Indian J. Genet.* **52**(4): 356-360.

Kishore, N., Dogra, R. K., Thakur, S. R. and Chahota, R. K. (2007). Stability analysis for seed yield and component traits in amaranthus [*Amaranthus hypochondriacus* L.] in the high altitude dry temperate regions. *Indian J. Genet.* **67**(2): 153-155.

Kulsum, M. U., Hasan, M. J., AKTER, A., Rahman, H. and Biswas, P. (2013). Genotype-environment interaction and stability analysis in hybrid rice: an application of additive main effects and multiplicative interaction. *Bangladesh J. Bot.* **42**(1): 73-81.

Kumar, J., Singh, K. B., Malhotra, R. S., Mirandaand, J. H., GUPTA, T. D. (1996). Genotype x environment interaction for seed yield in chickpea. *Indian J. Genet.* **56**(1): 69-78.

Leonardi, C. and Giuffrida, F. (2006). Variation of plant growth and macronutrient uptake in grafted tomatoes and eggplants on three different rootstocks. *European J. Hort. Sci.* **71**:97-101.

Lohithaswa, H. C., Kulkarni, R. S. and Manjunath, A. (2000). Combining ability analysis for fruit yield, capsaicin and other quantitative traits in chilli (*Capsicum annuum* L.) over environments. *Indian J. Genet. Plant Bred.* **60**: 47-48.

Luthra, O. P., Singh, R. F. and Khakar S. N. (1974). Comparison of different stability models in wheat. *Theo. Appl. Genet.* **45**: 143-49.

Mahesh S. and Sathyanarayana N. (2011). The genotype x environment interaction and stability analysis for L-Dopa trait in Velvet bean (*Mucuna pruriens*) seeds. *Indian J. Genet.* **71**(3): 279-282.

Mandal, A. R., Senapati, B. K. and Maity, T. K. (2000). Genotype-enviroment interaction, stability and adaptability of tomato (*Lycopersicon esculentum* mill.). *J. Veg. Sci.* **27**(2): 225.

Manu, D. G., Tembhurne, B. V., Kisan, B., Aswathnarayana, D. S. And Diwan, J. R. (2014). Inheritance of fusarium wilt and qualitative and quantitative characters in chilli (*Capsicum annum* L.). *J. Agric. Environ. Sci.* **3**(2):434.

Manrique, K., Hermann, M. (2000). Effect of G×E interaction on root yield and betacarotene content of selected sweet potato (*Ipomoea batatas*(L.) Lam.) varieties and breeding clones. *CIP*, Lima, Peru. pp. 281-287.

Mashark, S., Abdulai, P. Y. K., Sallah, K. and Safo-Kantanka, O. (2007). Maize grain yield stability analysis in full season lowland maize in Ghana. *Int. J. Agri. Biol.* **9**(1): 5-6.

Mehta, N., Khare, C. P., Dubey, V. K. and Ansari, F. S. (2011). Phenotypic stability for fruit yield and its components in rainy season brinjal (*Solanum melongena* L.) of Chhattisgarh plains. *Electron. J. Plant Bred.* **2**(1): 77- 79.

Miah, W. I. (1980). Stability of selected mung bean [*Vigna radiata*(L.) Wil.] cultivars evaluated under different growing conditions . Unpublished M.S. Thesis. UPLB. Philippines. pp. 146.

Mishra, V. K. and Rai, M. (1993). Stability analysis for seed yield, components of seed and oil in linseed (*Linum usitatissimum* L.). *Indian J. Genet.* **53**(2): 165-167.

Morales, A. C., Paragas, A. A., Carangal, V. R. (1991). Phenotypic stability for grain yield in mungbean (*Vigna radiata* L.). FLCG Newsletter, **16**: 12-15.

Mukherjee, A. K., Mohapatra, N. K., Bose, L. K., Jambhulkar, N. N. and Nayak, P. (2013). Additive main effects and multiplicative interaction (AMMI) analysis of G x E interactions in rice-blast pathosystem to identify stable resistant genotypes. *Indian J. Genet.* **8**(44): 5492-5507.

Mulema, J. M. K., Adipala, E., Olanya, O. M. and Wagoire, W. (2008). Yield stability analysis of late blight resistant potato selections. *Exp. Agric.* **44**: 145-155.

Muradunnabi, M. (2010). Genotype – environment interaction in hybrid maize (*Zea mays* L.). Thesis of BSMRAU, Gazipur-1706. pp 21-22.

Muralia, S. and Sastry, E. V. D. (1994). Stability analysis in wheat (*Triticum aestivum*) for seedling emergence and establishment characters at different salinity levels. *Indian J. Genet.* **54**(4): 351-356.

Murphy, K. M., Hoagland, L. A., Yan, L., Colley, M. and Jones, S. S. (2011). Genotype × environment interactions for mineral concentration in grain of organically grown spring wheat. *Agron. J.* **103**:1734–1741.

Naveen-Garg (2012). Genotype × environment interactions for shelf life and yield attributes in tomato hybrids heterozygous at rin, nor, or alc loci. *Int. J. Veg. Sci.* **14**(1):41-54.

Nehru, S. D., Manjunath, A. and Rangaiah, S. (2003). Genetic variability and stability for fruit yield and other metrical characters in chilli. (*Capsicum annuum* L.). *Indian J. Hort.* **39**:83-88.

Oliveira, R. L. D., Pinho, R. G. V., Balestre, M. and Ferreira, D. V. (2010). Evaluation of maize hybrids and environmental stratification by the methods AMMI and GGE biplot. *Crop Bred. Appl. Biotech.* **10**: 247-253.

Ortiz, R. and Lzzuierdo, J. (1994). Yield stability differences among tomato genotypes grown in Latin America and the Carabean. *Hort. Sci.* **29**: 1175-1177.

Ortiz, R., Crossa, J., Vargas, M. and Izquierdo, J. (2007). Studying the effect of environmental variables on the genotype x environment interaction of tomato. *Euphytica*. **153**:119-134.

Pande, K., Singhand, S. and Singh, O.N. (2006). Stability of rice (*Oryza sativa* L.) varieties for bora season of eastern India. *Indian J. Genet.* **66**(3): 191-195.

Panthee, D. R., Cao, C., Debenport, S. J., Rodr guez, G. R., Labate, J. A., Robertson, L. D., Breska III, A. P., Van der Knaap, E. and Gardener, B.B. M. (2012). Magnitude of genotype x environment interaction affecting tomato fruit quality. *Hort. Sci.* **47**:721-726.

Perkins, J. M. and Jinks, J. L. (1968). Environment and genotype x environment components of variability in multiple lines and crosses. *Heredity*. **23**: 339-356.

Pradeepkumar, T., Joy, D. B. M., Radhakrishnan, N. V. and Aipe, K. C. (2001). Genetic variation in tomato for yield and resistance to Bacterial Wilt. *J. Trop. Agric.* **39**:157-158.

Promchot, S., Boonprakob, U. and Bryrne, D. H. (2008). Genotype and environment interaction of chill peaches and nectarines in subtropical highland of Thailand. *Thai J. Agric. Sci.* **41**:53-61.

Promchot, S., Boonprakob, U. and Bryrne, D. H. (2008). Genotype and environment interaction of chill peaches and nectarines in subtropical highland of Thailand. *Thai J. Agric. Sci.* **41**:53-61.

Purseglove, J. W. (1968). Tropical crops, Dichotyledons John Wiley and Sons, New York. **2**: 524-530. Electronic Journal of Plant Breeding, **1**(3): 297-300a (June 2010)

Purseglove, J. W. (1977). Tropical Crops Dicotyledons 1 and 2. Longman, London. pp. 524-525.

Rahman, H., Durreshawar, S., Ali, F., Iftikhar, I. H., Khalil, S. M. A. and Ahmad, H. (2010). Stability analysis of maize hybrids across North West of Pakistan. *Pakistan J. Bot.* **42**(2): 1083-1091.

Rajput, S. C. and Ahmad, Z. (1992). Stability parameters in macaroni wheat. *Indian J. Genet.* **52**(4): 350-355.

Reddy, J. N., Paniand, D. and Roy, J. K. (1998). Genotype x environment interaction for grain yield in lowland rice cultlvars. *Indian J. Genet.* **58**(2): 209-213.

Reddy, K. M. and Sadashiva, A. T. (2003). Studies on yield stability in chilli (*Capsicum annuum* L). *Indian J. Hort.* **60**(2):183-187.

Robinson, S. (14 June 2007). "Chili Peppers: Global Warming". www.time.com. Retrieved 23 October 2013.

Roselloa, S., Adalidb, A. M., Cebolla-Cornejob, J. and Nuez, F. (2010). Evaluation of the genotype, environment and its interaction on carotenoid and ascorbic acid accumulation in tomato germplasm. *J. Trop. Agric.* **51**:132-135.

Roxburgh (1832). Flora indica or description of indian plants. Serampur. **1**:44.

Saimbhi, M. S., Kan, G. And Nandpuri, K. S. (1977). Qualitas Plantarum, **27**:171-175.

Sayed, S. And Bagavandas, M. (1980). Inheritance study in chilli (*Capsicum annum* L.). *South Indian J. Hort.* **28**(1): 20-24.

Scooch, B. S., Thakur, M. R. And Gupta, V. P. (1981). Stability analysis of some characters of chilli (*Capsicum annum* L.). *Indian J. Hort.* **39**:83-88.

Senapati, B. K. and Sarkar, G. (2002). Genotype- environment interaction and stability for yield and yield components in chilli (*Capsicum annum* L.). *Veg. Sci.* **29**(2): 146-148.

Shah, S. I., Sahito, H., Tunio, S. M. A. and Pirzado, A. J. (2009). Genotype-environment interaction and stability analysis of yield and yield attributes of ten contemporary wheat varieties of Pakistan. *Sindh U. Res. J.* **41** (1): 13-24.

Sharma, A. K. (2013). Stability analysis for economic traits in blond psyllium (*Plantago ovata* Forsk.). *Indian J. Genet.* **73**(2): 225-227.

Shi, C., Zhu, J., Wu, J. and Fan, L. (2000). Genetic and genotype × environment interaction effects from embryo, endosperm, cytoplasm and maternal plant for rice grain shape traits of *indica* rice. *Field Crops Res.* **68**:191-198.

Singh, G. P. And Chaudhary, H. B. (2007). Stability of wheat genotypes for yield and moisture stress tolerance traits, *Indian J. Genet.* **67**(2): 145-148.

Singh, J. V., Paroda, R. S., Arora, R. N. and Saint M. L. (1991). Stability analysis for green and dry fodder yield in cluster bean. *Indian J. Genet.* **51**(3): 345-348.

Singh, R. K. and Chaudhary, B. D. (1985). Biometrical methods inquantitative genetic analysis. Kalyani Publishers, New Delhi, Ludhiana, India. **3**: 39-78.

Sojitra, V. K. And Pethani, K. V. (1998). Stability for seed size in bunch groundnut (*Arachis hypogaea* Linn.). *Indian J. Genet.* **58**(2): 215-218.

Srividhya, S. and Ponnuswami, V. (2011). G × E interaction and stability of yield in paprika genotypes (*Capsicum annuum varlongum*) in Tamil Nadu. *Agric. Sci. Digest.* **31**(2): 86-92.

Taghouti, M., Gaboun, F., Nsarellah, N., Rhrib, R., El-Haila, M., Kamar, M., Abbad-Andaloussi, F. and Udupa, S. M. (2010). Genotype x environment interaction for quality traits in durum wheat cultivars adapted to different environments. *African J. Biotech.* **9**:3054-3062.

Tarakanovas, P., Ruzgas, V. (2006). Additive main effect and multiplication interaction analysis of grain yield off wheat varieties in Lithuania. *Agron. Res.* **41**(1): 91-98.

Tehlan, R. S. (1973). Studies on production pattern and correlation in wheat, M. Sc. Thesis. Horiana Agril. Univ. Hissar, India.

Tembhurne, B. V. and Rao, S. K. (2013). Stability analysis in chilli (*Capsicum annuum* L.), *J. Spices Aromatic Crop.* **22** (2): 154–164.

Tiwari, A. K. and Lal, G. (2013). Genotype – environment interaction and stability analysis in tomato (*Solanum lycopersicum* L.). *Indian J. Hill Farm.* **27**(2):16-18.

Vijayakumar, C. H. M., Ahmed, M. I., Viraktamath, B. C., Balakrishnan, R. (2001). Stability analysis of some improved rice hybrids in India. *Indian J. Genet.* **52**(2): 132.

Vijayragavan, V. (2008). Genetic analysis of Anthracnose resistance and marketable fruit yield in chilli (*Capsicum annum* L.). Ph. D. (Hort.) Thesis, Tamil Nadu Agricultural University, Coimbatore, India.

Wani, K. P., Ahmed, N., Tanki, M. I. And Narayan, R. (2003). Stability analysis of yield and quality characters in hot pepper (*Capsicum annum* L.). Capsicum and Eggplant Newsletter. **22**: 75-78.

Worku, M. And Zelleke, H. (2009). Genotype x environment interaction and yield stability of maize. *East African J. Sci.* **2**(1): 7-12.

Zewdie, Y. And Bosland, P. W. (2000). Evaluation of genotype, environment and genotype-by-environment interaction for capsaicinoid in *Capsicum annum* L. *Euphytica*. **111**:185-190.

Zewdie, Y. and Poulos, J. M. (1995). Stability analysisi in hot pepper. Capsicum and Eggplant Newsletter. **14**: 39-42.

Zhe, Y, Lauer, J. G., Borges, R. and De Leon, N. (2010). Effects of genotype x environment interaction on agronomic traits in soybean. *Crop Sci.* **50**: 696-702.

Zhou, M., Shailesh, V. J. and Maritz, T. (2012). Trends and implications of genotype by environment interaction in south african sugarcane breeding. *J. Crop Improvment.* 26(2): 96-103.

Zobel, R. W., Wright, J. M. and Gauch, J. H. (1988). Statistical analysis of yield trial. *Agron. J.* **80**: 388-393.

Appendices

APPENDICES

Appendix I. Temperature and rainfall during the growing period of 10 chilli genotypes

Month	Temperature (^{0}C)				Rainfall (mm)	
	2013-2014		2012-2013		2013-2014	2012-2013
	Maximum	Minimum	Maximum	Minimum		
November-13	30.2	18.5	19.1	28.7	0	68
December-13	26.3	15.6	14.5	24.0	4	5
January-14	34.2	12.3	14.5	24.1	0	10
February-14	28.9	17.5	16.0	28.5	0	2
March-14	33.4	22.1	22.1	33.0	49	36
April-14	32.2	24.4	23.7	33.5	30	269
May-14	31.7	24.8	25.8	34.6	390	140

Source: Statistical yearbook of bangladesh-2013 and 2014

Appendix II. Nutritive value per 100g edible portion of chilli (*Capsicum frutescence* L.)

Nutrients	Value	Nutrients	Value
Moisture	86.7 g	Phosphorus	80 mg
Protein	2.9 g	Iron	1.2 mg
Fat	0.6 g	Sodium	6.5 mg
Minerals	1.0 g	Potassium	217 mg
Fibre	6.8 g	Copper	1.55 mg
Carbohydrate	3.0 g	Sulphur	34 mg
Calcium	30 mg	Chlorine	15 mg
Magnesium	24 mg	Thiamine	0.19 mg
Riboflavin	0.39 mg	Vitamin A	2921 U
Oxalic Acid	67 mg	Vitamin C	111 mg

Source: The chile pepper institute newsletter

Appendix III. Mean performance chilli genotype trial at four environments during rabi, 2013-2014

Code	Genotype Name	Overall Mean							
		DFF	D50%F	PHER	RL	NPB	NSB	NL	NLPB
V1	Kalo Dhawna morich	47.50	48.67	76.87	14.19	10.42	21.25	1614	84.03
V2	Bogurar Jhal Morich	49.58	50.67	34.67	10.32	3.500	5.750	166.2	35.72
V3	Balojhuri	60.50	61.67	38.66	11.06	4.417	8.500	278.7	41.89
V4	DBP 14 5G (China)	60.08	61.25	63.05	14.81	5.917	11.50	593.4	42.19
V5	Suryamukhi	41.92	43.00	40.92	9.34	5.000	3.250	224.8	18.00
V6	Bogurar lomba Morich	53.92	55.17	37.05	11.61	5.917	12.25	491.3	53.64
V7	BD-2059	58.17	59.33	59.81	13.56	6.167	12.00	465.0	44.89
V8	BD-2122	56.00	57.25	44.59	13.32	3.167	6.500	267.6	43.94
V9	Bogura Jatt	50.58	51.83	41.33	9.34	4.667	8.000	317.8	44.00
V10	Bullet	46.83	48.08	45.31	12.60	5.583	11.50	334.4	36.75
	Grand Mean	52.51	53.69	48.23	12.01	5.475	10.05	475.3	44.51

DFF = Days to first flowering, D50%F = Days to 50% flowering, PHER = Plant height excluding root (cm), RL = Root length (cm), NPB = Number of primary branches per plant, NSB = Number of secondary branches per plant, NL = Number of leaves per plant, NLPB = Number of leaves per primary branch.

Appendix III. (Continued).

Code	Genotype Name	Overall Mean							
		NF	NFPB	FD	IFW	FWS	FWR	ODWS	ODWR
V1	Kalo Dhawna morich	277.5	28.81	0.908	0.700	208.2	10.08	67.65	4.825
V2	Bogurar Jhal Morich	52.00	10.08	1.089	1.214	29.11	1.900	15.18	0.575
V3	Balojhuri	99.00	15.64	0.689	0.850	43.80	2.400	22.72	1.125
V4	DBP 14 5G (China)	50.25	5.333	0.983	1.108	208.0	12.74	63.97	5.850
V5	Suryamukhi	37.25	5.583	0.978	1.683	65.53	3.225	29.30	1.350
V6	Bogurar lomba Morich	147.8	21.92	0.933	1.425	73.06	3.858	31.54	1.600
V7	BD-2059	73.50	9.472	0.958	1.194	141.8	10.43	48.56	5.192
V8	BD-2122	55.75	13.44	0.780	0.942	60.97	2.375	25.58	0.917
V9	Bogura Jatt	77.25	14.42	0.683	1.506	53.36	2.475	24.67	1.150
V10	Bullet	67.50	9.167	1.417	2.128	86.53	4.675	35.12	1.842
	Grand Mean	93.78	13.39	0.942	1.283	97.04	5.417	36.43	2.442

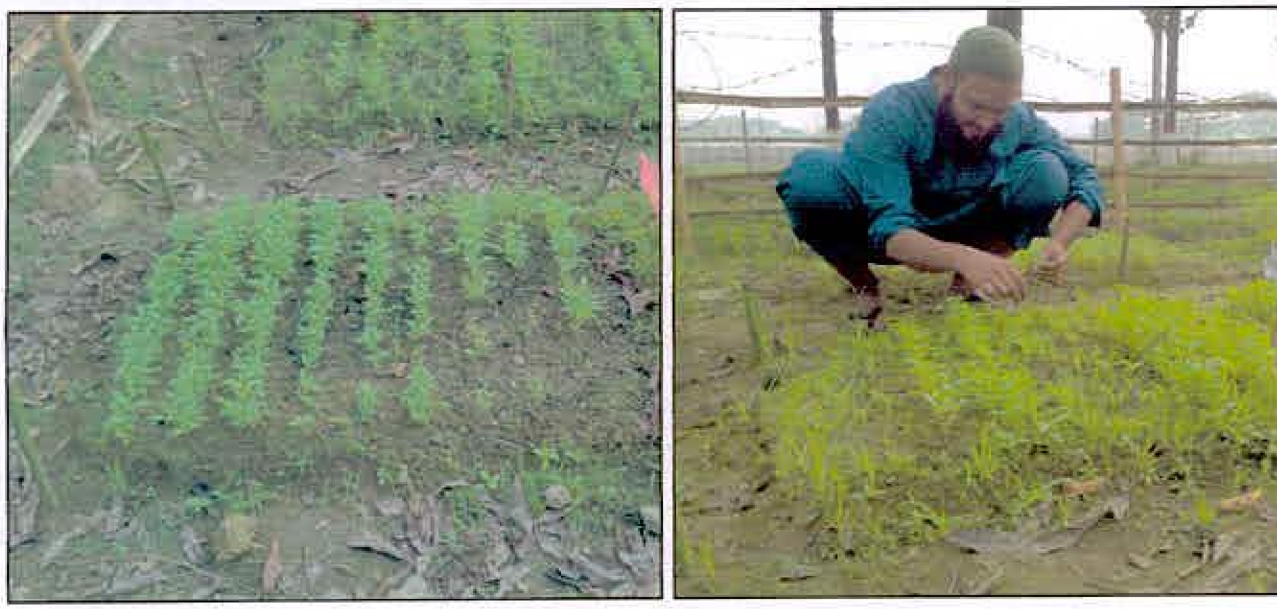
NF = Number of fruits per plant, NFPB = Number of fruit per primary branch, FD = Fruit diameter (cm), IFW = Individual Fruit weight (g), FWS = Fresh weight of shoot, FWR = Fresh weight of root, ODWS = Oven dry weight of shoot, ODWR = Oven dry weight of root

Appendix III. (Continued).

Code	Genotype Name	Overall Mean						
		LAI	FLWP	NSPF	WSPF	HSW	FY	NFPP
V1	Kalo Dhawna morich	11.55	4.264	48.69	0.1580	0.3228	196.5	92.50
V2	Bogurar Jhal Morich	10.30	4.311	62.03	0.2686	0.4331	64.29	17.33
V3	Balojhuri	9.543	4.494	71.22	0.2826	0.3969	89.33	33.00
V4	DBP 14 5G (China)	19.91	6.078	92.89	0.3410	0.3617	58.93	16.75
V5	Suryamukhi	18.92	4.719	86.83	0.3507	0.4042	64.22	12.42
V6	Bogurar lomba Morich	7.578	5.039	107.1	0.3534	0.3297	223.5	49.25
V7	BD-2059	26.63	5.539	75.83	0.2942	0.3875	93.73	24.50
V8	BD-2122	8.709	4.497	89.78	0.2532	0.2814	53.82	18.58
V9	Bogura Jatt	7.290	4.389	57.56	0.1857	0.3225	120.4	25.75
V10	Bullet	25.26	4.350	119.6	1.239	1.100	160.7	22.50
	Grand Mean	14.57	4.768	81.15	0.3727	0.4340	112.5	31.26

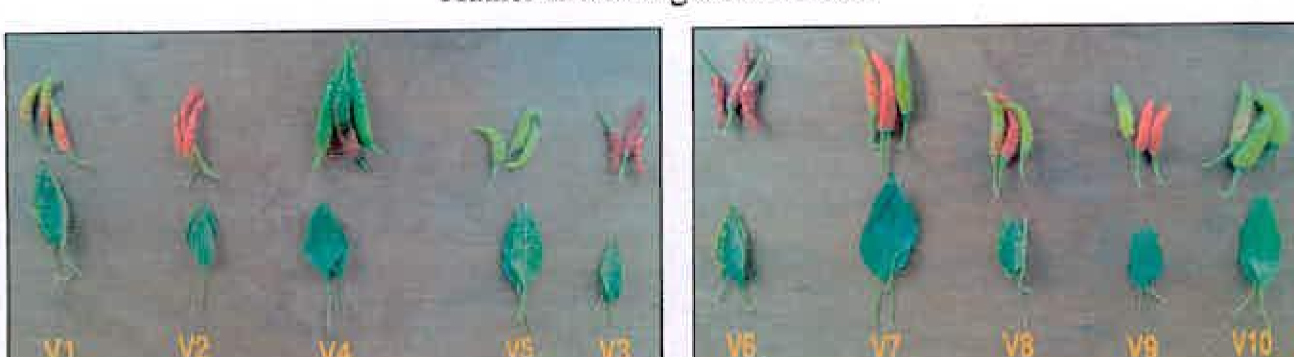
LAI = Leaf area index, FLWP = Fruit length without panicle, NSPF = Number of seeds per fruit, WSPF = Weight of seeds per fruit, HSW = Hundred seed weight, FY = Fruit yield per plant, NFPP = Number of fruits per plucking per plant.

Appendix IV. Some photographs of the experiment



Author is weeding at chilli seedbed

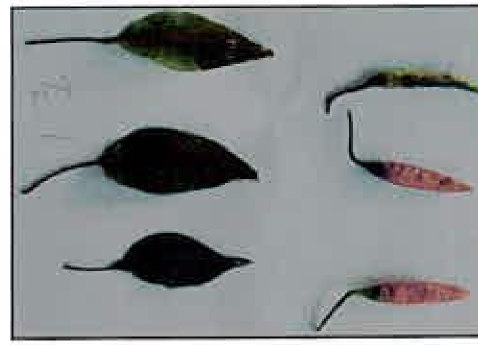
Author is working at chilli field



Leaves and fruits of 10 chilli genotypes (Code number shown)

Kalo
Dhawna
morich

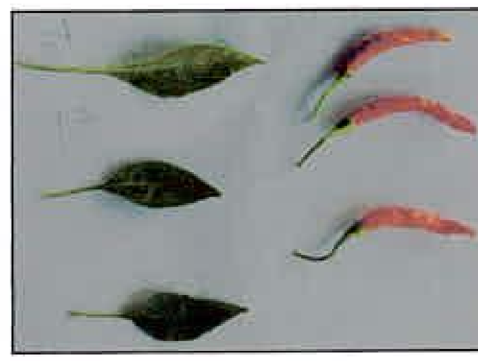
Env-1, Rep-1



Env-2, Rep-1

Bogurar
Jhal
Morich

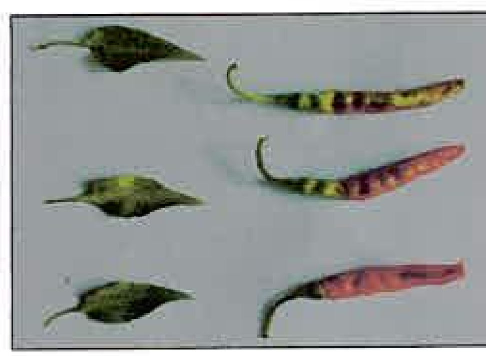
Env-2, Rep-3



Env-2, Rep-2

Balojhu
ri

Env-2, Rep-1



Env-2, Rep-3

DBP 14
5G
(China)

Env-2, Rep-2

Env-1, Rep-3

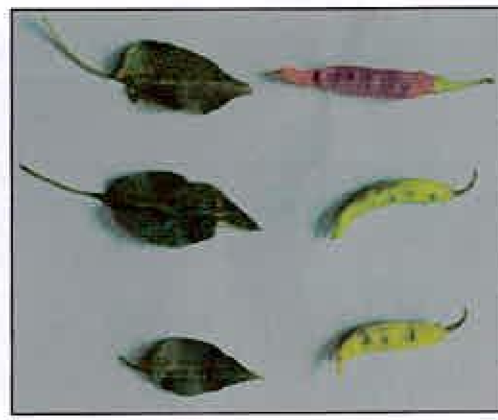
Suryam ukhi

Env-3, Rep-1

Env-1, Rep-3

Bogurar lomba Morich

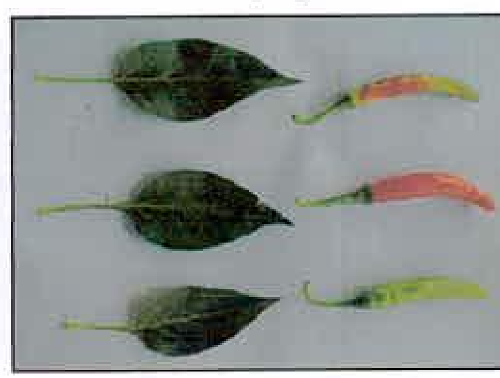
Env-2, Rep-1



Env-2, Rep-3

BD-2059

Env-2, Rep-3



Env-2, Rep-1

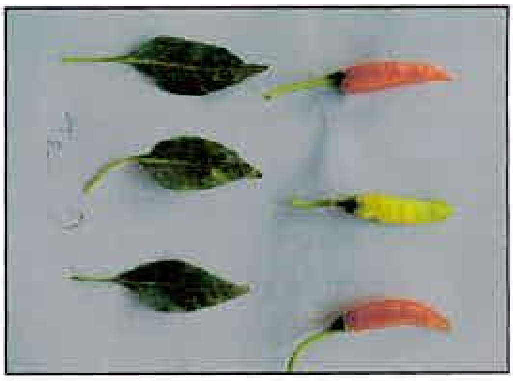
BD-2122

Env-1, Rep-3

Env-4, Rep-2

Bogura Jatt

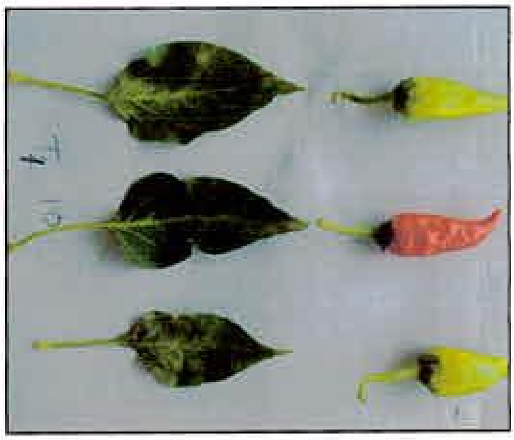
Env-1, Rep-1



Env-2, Rep-1

Bullet

Env-2, Rep-2



Env-1, Rep-3