Plant Archives Vol. 17 No. 1, 2017 pp. 353-361 ***ISSN 0972-5210***

ESTIMATION OF GENETIC VARIATION, PATH ANALYSIS AND THRIPS REACTION STUDIES FOR YIELD AND YIELD ATTRIBUTING TRAITS IN CHILLI (*CAPSICUM ANNUUM* L.)

K. C. Megharaj*, P. S. Ajjappalavara, D. Satish, Revanappa and M. H. Tatagar

Department of Vegetable Science, College of Horticulture, University of Horticultural Sciences, Bagalkot - 587 104 (Karnataka), India.

Abstract

Forty six genotypes of chilli were evaluated during *kharif*, 2014 to study the nature and magnitude of genetic variability for growth, earliness, yield, biochemical and nutritional traits and also to identify resistance source for thrips incidence. Analysis of variance revealed highly significant differences among the genotypes for all the traits studied. The quantum of genetic variation as genotypic co-efficient of variation (GCV) was highest in biochemical and nutritional traits *viz*., non reducing sugar, phenols, phosphorus, potassium, magnesium, total chlorophyll, capsaicin content (green and red fruits) and capsanthin. Moderate GCV was observed for growth and yield parameters like plant height, plant spread, leaf area, plant canopy width, number of primary branches per plant, number of fruits per plant and fruit yield per plant. However, average fruit weight exhibited highest GCV as compared to the other yield characters. All growth, yield, biochemical and nutritional parameters showed high heritability coupled with high genetic advance over mean. Path analysis studies revealed that plant height, number of primary branches per plant, number of fruits per plant, total sugars showed the desirable positive and high direct effect on fruit yield. Phule Jyothi was found superior with highest fruit yield per plant with least thrips incidence.

Key words : Chilli, genetic variability, path analysis. biochemical traits , thrips resistance.

Introduction

The genus *Capsicum* is a source of products that are utilised around the globe used as a vegetable, spice, condiment, culinary supplement, medicine and also as an ornamental plant. Chilli is indispensable spice, essentially used in every Indian cuisine as they provide heat, colour and flavour. The pungency of chilli is due to a crystalline acrid volatile alkaloid called capsaicin (8-methyl-N-vanillyl-6-enamide), which is present in the placenta of fruit and has diverse prophylactic and therapeutic uses in allopathic and ayurvedic medicine. In addition, chilli extracts are also used in cosmetic products, paints and chilli sprays. The national and state productivity of the chilli is very low compared to the other developed countries. The reasons for the low productivity is, much of the area is occupied by the local low yielding genotypes and area under hybrids/improved varieties is less. Also chilli production in many of the places is constrained by several abiotic and biotic factors such as drought, salinity, flooding, soil acidity etc. and biotic factors like pest and diseases especially in tropical and sub-tropical countries. Chilli is most susceptible to several pest and diseases that can reduce the yield and quality of fruits. Nearly 25 insects have been recorded attacking chilli leaves and fruits in India of which thrips, *Scirtothrips dorsalis* Hood (Thripidae : Thysanoptera) is considered as the most serious and important pest (Butani, 1976). The estimated yield loss of more than 90% in chilli was observed due to thrips incidence (Kumar, 1995).

Chilli being often cross-pollinated crop, possess tremendous genetic variability for growth, yield and quality traits. Genetic improvement of any trait of interest in a particular crop is based on the extent of genetic variation, heritable component of variation and the process of the breeding methodology to exploit the available genetic variability present in the crop. As a first step, assessment of the extent of genetic variability present in the crop is most important. Germplasm is the source of genetic variability for all the characters including yield, quality

****Author for correspondence :*** E-mail : mkchorti@gmail.com

and resistance towards pest and disease. The available variability present in the germplasm can be utilised most efficiently by the plant breeder in crop improvement programme. This improvement programme is a continuous process by way of evaluation of germplasm collected from different sources for growth, yield, quality and resistance towards pest and disease characters and identifying or developing varieties or hybrids suitable to the ever changing climate and demand of the consumer. Therefore, in the present study, an attempt has been made to study the extent of genetic variability present in chilli genotypes for productivity related traits, path analysis and to identify the source of resistance to thrips incidence.

Materials and Methods

The present experiment was conducted at Horticulture Research and Extension Station (HRES), Haveri (Devihosur) during *Kharif* season, 2014. The details of the genotypes used in the study were presented in table 1. Seedlings of forty six chilli genotypes were raised in nursery beds and thirty eight days old seedlings were transplanted to the main filed. The experiment was laid out in a completely randomised block design replicated twice with the spacing of 75cm × 45 cm. Application of fertilizers and other cultural practices were done as per the package of practices. Observations were recorded on five randomly selected plants in each replication for genetic study with respect to different morphological characters *viz.,* plant height (cm), plant spread (cm), leaf area (cm^2), number of branches/plant, number of fruits per plant, average fruit weight (g), fruit yield per plant (kg). The different biochemical parameters and nutrients *viz.,* total phenols (mg/g), total sugars (mg/g), reducing sugars (mg/g), capsaicin (%), nitrogen (%), phosphorus (%), potassium (%), calcium (%), magnesium (%), sulphur (%) were estimated from all the 46 genotypes. The screening of genotypes against thrips incidence was carried out at experimental plot under unsprayed condition to maintain the thrips load. The fluctuation of thrips incidence was studied on *Kharif* planted chilli. The symptom of thrips damage was observed at 9th, 11th, 13th and 15th weeks after transplanting. The scoring was done according to the per cent damage caused by thrips and based on the genotype performance. Genotypic and phenotypic coefficients of variation were computed according to Burton and Devane (1953) and heritability (h^2) was worked out by using formula suggested by Falconer (1981). Genetic advance (GA) was computed using the formula given by Robinson *et al.* (1949) whereas, genetic advance as percentage over mean (GAM) was worked out as suggested by Johnson *et al.*

Table 1 : Details of chilli genotypes used for the study.

S. no.	Genotype
1	DCA-104
2	DCA-106
3	DCA-109
4	DCA-116
5	DCA-124
6	DCA-130
7	DCA-136
8	DCA-137
9	DCA-138
10	DCA-139
11	DCA-140
12	DCA-142
13	DCA-143
14	DCA-144-1
15	DCA-145
16	DCA-146
17	DCA-147
18	DCA-148
19	DCA-148-1
20	DCA-148-2
21	DCA-150
22	DCA-151
23	DCA-152
24	DCA-154
25	DCA-155
26	DCA-157
27	DCA-159
28	DCA-166
29	DCA-167
30	DCA-169
31	DCA-171
32	DCA-191
33	DCA-192
34	DCA-193
35	DCA-195
36	DCA-205
37	DCA-211
38	DCA-224
39	DCA-236
40	DCA-237
41	DCA-232
42	DCA-259
43	DCA-261
44	Phule Jyothi
45	Byadgi Kaddi
46	Byadgi Dabbi

(1955). Path coefficient analysis suggested by Wright (1921) and illustrated by Dewey and Lu (1959) was carried out separately to know the direct and indirect effects of the important component traits on fruit yield per plant.

Results and Discussion

Analysis of variance revealed highly significant difference among the genotypes for all the traits studied (table 2). The estimates of mean, range, genotypic and phenotypic coefficients of variation, heritability, genetic advance as percent of mean for growth, yield, biochemical and nutritional parameters were studied and the results were presented in table 3. From the table, it was evident that good amount of variation was observed for all the traits studied. The growth parameters like plant height, plant spread and plant canopy width showed moderate genotypic coefficient of variation and phenotypic coefficient of variation (11-20%), which were in accordance with Krishna *et al.* (2007). Moderate genotypic coefficient of variation and phenotypic coefficient of variation is also reported for leaf area. The moderate PCV and GCV indicates that these traits are governed by non additive gene action. Hence, there is a little scope for improvement of these traits through selection. The values of PCV for the number of primary branches per plant, resulted higher and moderate for the values of GCV indicating that apparent of variation is not only due to genotypes but also due to influence of environment factors which was also reported by Munshi *et al.* (2010). Hence, selection for improvement of such characters will not be rewarding. High heritability (>60%)

Table 2 : Analysis of variance (mean sum of squares) for growth, yield and biochemical parameters in chilli (*Capsicum annuum* L.).

S. no.	Source of variation/character	Replication	Genotype	Error	SED	CD (5%)	CD (1%)
	Degrees of freedom	**1**	**45**	**45**			
A.	**Growth parameters**						
1.	Plant height (cm)	26.24	153.72**	31.01	5.56	11.21	14.97
2.	Plant spread (cm)	115.20	59.45**	10.96	3.31	6.67	8.90
3.	Leaf area (cm²)	1.48	1.40**	0.23	0.48	0.98	1.31
4.	Plant canopy width (cm)	103.24	63.14**	12.23	3.49	7.04	9.40
5.	Number of primary branches/plant	0.001	0.43**	0.07	0.26	0.54	0.72
B.	**Yield parameters**						
6.	Number of fruits/plant	26.02	1128.13**	13.48	3.67	7.39	9.87
7.	Average fruit weight (g)	0.03	91.42**	0.009	0.097	0.19	0.26
8.	Fruit yield/plant (g)	234.33	5980.85**	69.57	8.34	16.79	22.43
C.	**Biochemical parameters**						
9.	Total sugars (mg/g)	0.0001	1.05**	0.0003	0.019	0.04	0.05
10.	Reducing sugars (mg/g)	0.0005	0.138**	0.0001	0.013	0.02	0.03
11.	Non reducing sugars (mg/g)	0.001	1.01**	0.0005	0.02	0.04	0.06
12.	Phenols (mg/g)	0.00	0.001**	0.00	0.002	0.005	0.007
13.	Ascorbic acid (mg/100 g)	45.88	1060.25**	29.35	5.41	10.91	14.57
14.	Chlorophyll (mg/g)	0.005	0.702**	0.0005	0.023	0.04	0.06
15.	Capsaicin (red fruit) (%)	0.00	0.08**	0.00	0.007	0.01	0.02
16.	Capsaicin (green fruit) (%)	0.00	0.15**	0.00	0.006	0.013	0.017
17.	Capsanthin (ASTA)	66.45	2269.76**	3.07	1.75	3.53	4.71
D.	**Nutritional parameters**						
18.	Nitrogen (%)	0.005	0.26**	0.004	0.06	0.13	0.17
19.	Phosphorus (%)	0.00	0.008**	0.00	0.007	0.014	0.018
20.	Potassium (%)	0.05	1.09**	0.004	0.06	0.14	0.18
21.	Calcium (%)	0.008	0.092**	0.03	0.05	0.11	0.14
22.	Magnesium (%)	0.02	0.09**	0.001	0.03	0.07	0.09
23.	Sulphur (%)	0.00	0.001**	0.00	0.006	0.013	0.017
24.	Thrips incidence (%)	0.225	65.92**	2.15	1.46	2.97	3.94

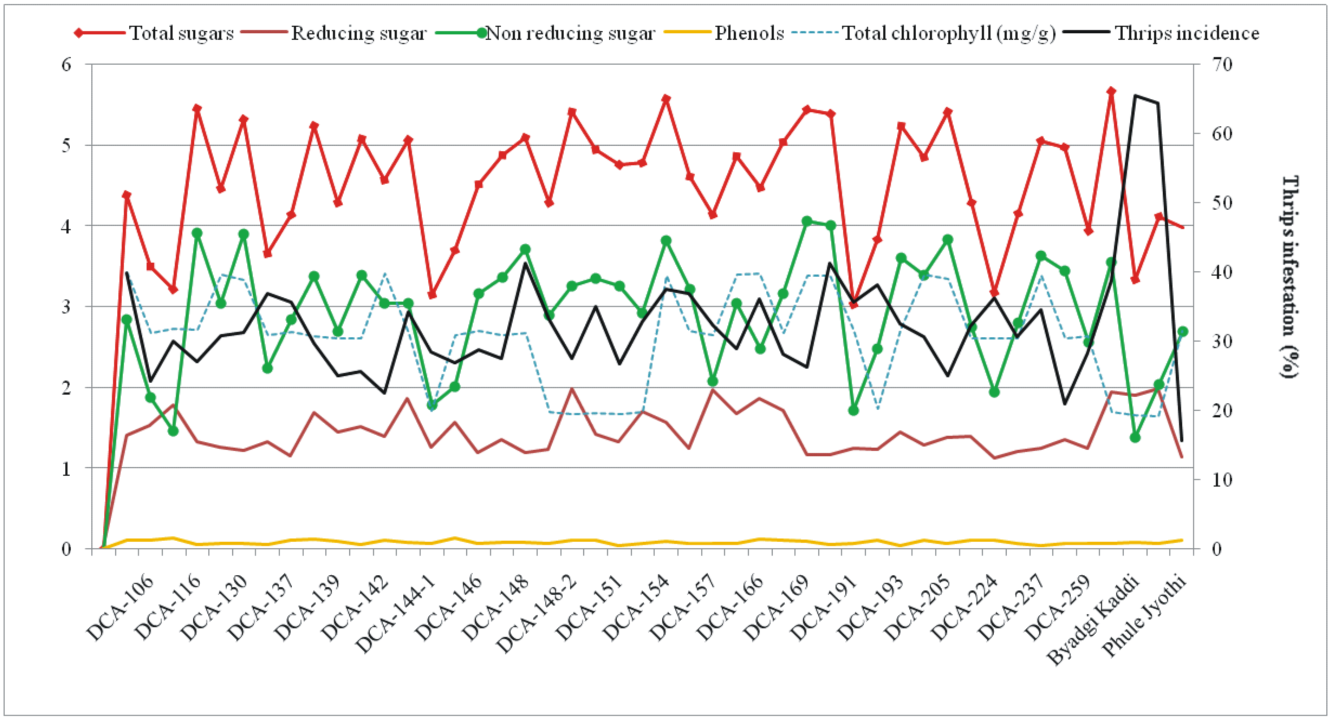

Fig. 1 : Genotypic reactions to biochemical constituents against thrips resistance.

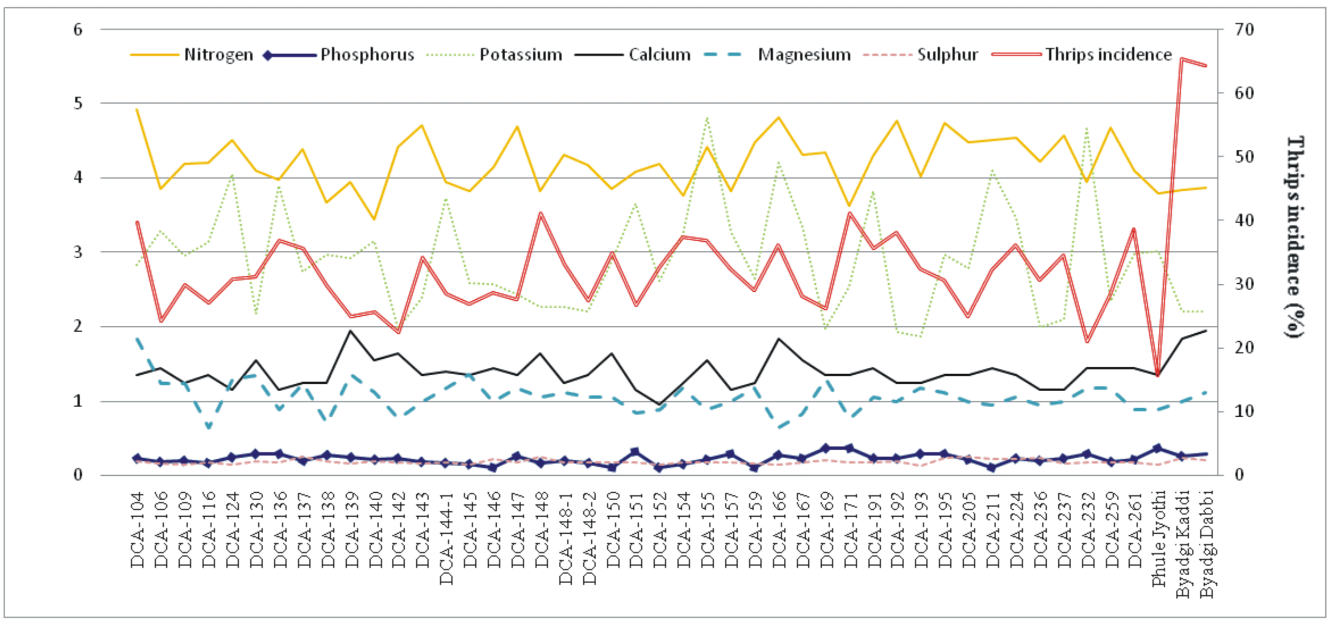

Fig. 2 : Genotypic reactions to nutrient composition against thrips resistance.

coupled with high genetic advance as per cent over mean (>20%) was recorded for the growth parameters *viz*., plant height, plant spread, plant canopy width, number of primary branches per plant and leaf area which suggests that the inheritance of such characters is governed mainly by additive gene effects and therefore, selection based on phenotypic performance may prove useful and similar results were also reported by Munshi *et al.* (2010) and Singh and Singh (2011). Average fruit weight showed high GCV, PCV and heritability coupled with high GAM which are in agreement with reports of krishna *et al.* (2007) indicating the existence of sufficient variability in the genetic stock and the predominance of additive gene effect with low influence of environment factors in expression of this trait. Thus, it is possible for improvement of this trait through selection. The number of fruits per plant and fruit yield per plant exhibited moderate GCV and PCV with high heritability and GAM are in agreement with the report of Sharma *et al.* (2009). It is possible to improve these characters by selection based on the role

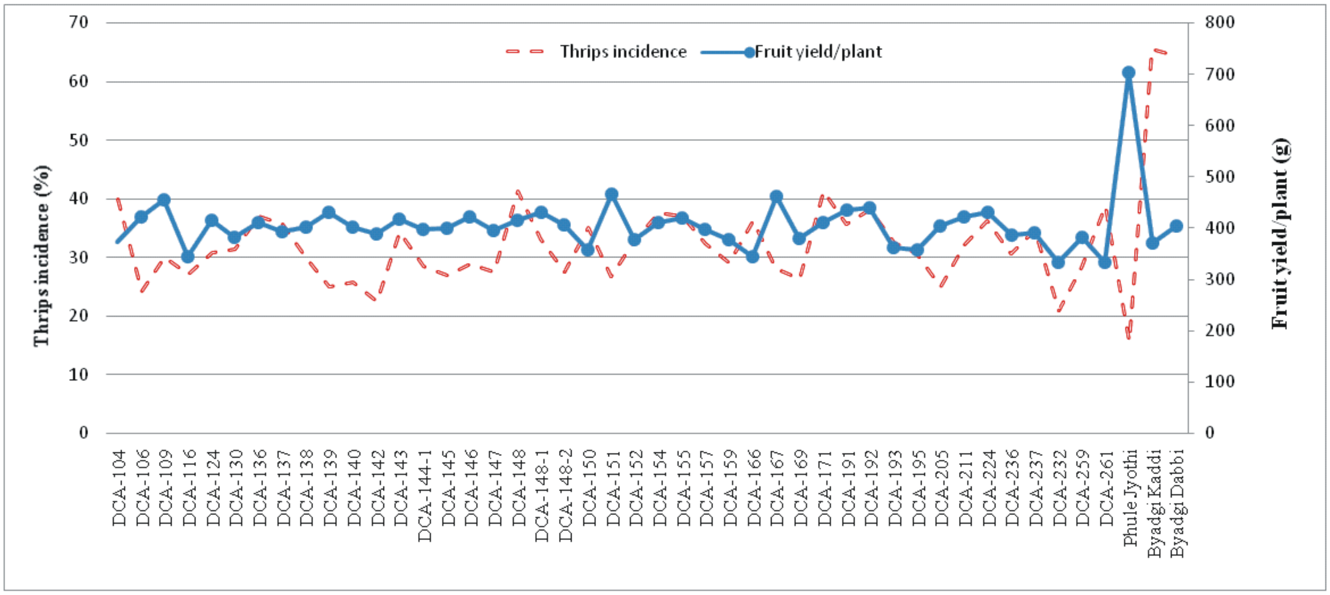

Fig. 3 : Yield potentiality of chilli genotypes against thrips incidence.

of additive gene effects governing these traits.

The efforts have been made to analyse the biochemical and nutritional components in plants and fruit tissue which are playing a major role to resist many of the biotic stresses and also in the quality of fruits. The biochemical traits *viz.,* non reducing sugar, phenols, capsanthin, capsaicin content in both green and red fruit observed high GCV and PCV (>20%) which were similar to the findings of Srilakshmi (2006), Sonia *et al.* (2007), similarly total chlorophyll also had high GCV and PCV (>20%) in accordance with Dandunayak (2008), Datta and Das (2013). Whereas, phosphorus, potassium, magnesium, also had high GCV and PCV (>20%), which indicated the existence of sufficient variability in genetic stock studied and the environmental role is negligible. Hence, there is ample scope for improving these characters by direct selection. Similarly, total sugars, reducing sugar, ascorbic acid, exhibited moderate genotypic and phenotypic coefficient of variation (11-20%). Srilakshmi (2006), Dandunayak (2008), Sandeep (2007) and Munshi *et al.* (2010) have reported similar trends for these traits in the fruit content, whereas calcium and sulphur also exhibited moderate genotypic and phenotypic coefficient of variation (11-20%), which indicates that these traits are governed by non additive genes. Hence, there is little scope for improvement in these traits by selection as the characters are also influenced by environmental effects. The lower GCV and PCV were observed for nitrogen, which reveals the role of non additive gene action. High heritability coupled with high GAM was observed for non reducing sugar, phenols, total chlorophyll, capsaicin content in both green and red fruits, capsanthin, total sugars, reducing sugar, ascorbic acid, which were similar to the observations made by Srilakshmi (2006), Sonia *et al.* (2007) and Dandunayak (2008), whereas phosphorus, potassium, magnesium, nitrogen, calcium and sulphur also reported high heritability coupled with high GAM. The high heritability with high GAM estimates for these traits indicated the role of additive genes in governing their expression. Hence, selection on contents of biochemical and nutritional components would be rewarding in improvement of these traits.

Path analysis was worked out to find out the direct and indirect effect of growth, biochemical, nutritional composition and yield related traits on the fruit yield per plant (table 4). Among the seventeen traits chosen for path analysis, only plant height, number of primary branches per plant, number of fruits per plant and total sugars had significant positive direct effect with fruit yield which were similar to the findings observed by Srilakshmi (2006) and Ganeshreddy *et al.* (2008). Therefore, direct selection for these traits would be rewarding for improvement of fruit yield. The plant spread, reducing sugar and non reducing sugar had significant and negative direct effect with fruit yield. Thrips incidence exhibited significant and negative association with fruit yield as it has positive direct effect on reduction of fruit yield. Calcium, reducing sugar, sulphur and plant height showed positive indirect effect of the trait whereas, number of fruits per plant, total chlorophyll, non reducing sugar, number of primary branches per plant, potassium and phenols have negative indirect effect. The biochemical parametrs *viz*., calcium, reducing sugars and sulphur have

Table 3 : Estimates of mean, range, components of variance, heritability and genetic advance for growth, yield, biochemical and nutritional parameters in chilli (*Capsicum annuum* L.).

Character	Mean	Range	PV	GV	PCV (%)	GCV (%)	h^2_{bs} (%)	GA	GAM (%)
A. Growth parameters									
Plant height (cm)	50.64	29.75-72.73	92.36	61.35	18.97	15.46	66.43	13.15	25.96
Plant spread (cm)	33.89	19.91-44.03	35.20	24.24	17.50	14.52	68.85	8.41	24.82
Leaf area (cm^2)	4.62	3.13-7.26	0.82	0.58	19.60	16.50	70.92	1.32	28.63
Plant canopy width (cm)	35.68	21.16-46.49	37.69	25.45	17.20	14.13	67.54	8.54	23.93
No of primary branches/plant	2.34	1.66-4.83	0.25	0.18	21.50	18.15	71.27	0.73	31.57
B. Yield parameters									
No of fruits/plant	180.52	151.33-299.16	570.81	557.32	13.23	13.07	97.64	48.05	26.61
Avg fruit weight (g)	17.23	1.75-33.30	45.71	45.70	39.23	39.23	99.98	13.92	80.80
Fruit yield/plant (g)	405.65	333.68-703.67	3025.21	2955.64	13.55	13.40	97.70	110.69	27.28
C. Biochemical parameters									
Total sugars (mg/g)	4.52	3.03-5.66	0.53	0.52	16.08	16.07	99.93	1.49	33.11
Reducing sugars (mg/g)	1.44	1.12-1.97	0.06	0.06	18.25	18.23	99.75	0.54	37.50
Non reducing sugars (mg/g)	2.92	1.35-4.06	0.50	0.50	24.38	24.37	99.89	1.46	50.17
Phenols (mg/g)	0.08	0.04-0.129	0.0006	0.0006	30.97	30.76	98.67	0.05	62.95
Ascorbic acid (mg/100 g)	152.59	104.16-187.48	544.80	515.44	15.29	14.87	94.61	45.49	29.81
Total Chlorophyll (mg/g)	2.63	1.64-3.41	0.351	0.350	22.51	22.49	99.84	1.21	46.30
Capsaicin (red fruit) (%)	0.25	0.03-0.92	0.043	0.043	82.21	82.15	99.85	0.42	169.11
Capsaicin (green fruit) (%)	0.38	0.04-1.09	0.07	0.07	71.44	71.42	99.94	0.56	147.09
Capsanthin (ASTA)	138.79	32.95-199.03	1136.41	1133.34	24.28	24.25	99.73	69.25	49.89
D. Nutritional parameters									
Nitrogen (%)	4.20	3.43-4.93	0.13	0.12	8.68	8.54	96.68	0.72	17.30
Phosphorus (%)	0.21	0.10-0.37	0.004	0.004	30.37	30.20	98.87	0.13	61.87
Potassium (%)	2.91	1.87-4.81	0.55	0.54	25.46	25.35	99.12	1.51	52.00
Calcium (%)	1.39	0.95-1.95	0.048	0.045	15.66	15.16	93.70	0.42	30.23
Magnesium (%)	1.04	0.63-1.83	0.049	0.047	21.13	20.87	97.47	0.44	42.44
Sulphur (%)	0.16	0.11-0.24	0.001	0.0009	18.35	17.94	95.56	0.06	36.14
Thrips incidence (%)	32.32	15.63-65.47	34.04	31.88	16.74	16.20	93.60	11.25	32.31

Table 4 : Genotypic path coefficient analysis among growth, yield, biochemical and nutrient composition related characters in chilli (*Capsicum annuum* L.).

@	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	rG
1	**0.278**	0.143	0.079	0.059	0.075	-0.103	-0.019	-0.093	0.016	-0.045	0.027	-0.0008	-0.067	-0.027	0.030	0.066	0.056	0.416**
2	-0.138	**-0.270**	-0.055	-0.071	-0.148	0.059	-0.033	0.069	-0.049	0.010	-0.002	-0.002	0.037	0.032	-0.029	0.021	0.014	0.477**
3	-0.011	-0.008	**-0.041**	-0.012	-0.003	0.001	-0.0005	0.001	-0.004	0.006	0.002	-0.003	0.001	0.003	0.007	-0.002	0.003	0.019
4	0.068	0.084	0.092	**0.319**	0.211	0.020	0.007	0.017	0.036	-0.021	-0.085	0.073	0.014	-0.038	-0.059	-0.012	-0.100	0.687**
5	0.204	0.415	0.063	0.497	**0.753**	-0.107	-0.113	-0.064	0.095	-0.015	-0.174	0.185	0.052	-0.041	-0.105	-0.164	-0.245	0.931**
6	-34.05	-20.19	-2.229	5.843	-13.04	**91.69**	8.498	85.94	-24.56	22.67	-4.699	6.717	-17.68	-6.531	-17.25	3.310	-15.81	-0.288**
7	2.297	-4.117	-0.435	-0.811	5.019	-3.085	**-33.29**	8.670	-6.208	9.687	5.313	4.888	1.217	-7.286	4.330	8.964	-11.08	-0.217*
8	31.75	24.40	2.569	-5.064	8.116	-88.73	24.65	**-94.67**	30.79	-32.40	-0.683	-11.53	16.50	13.83	12.96	-12.25	26.86	-0.204
9	0.006	0.020	0.012	0.012	0.014	-0.030	0.021	-0.037	**0.113**	0.009	0.014	-0.017	-0.001	0.024	0.016	0.009	-0.015	0.201
10	-0.014	-0.003	-0.014	-0.005	-0.001	0.021	-0.025	0.030	0.007	**0.087**	0.024	0.018	0.006	-0.007	0.014	0.002	-0.027	-0.057
11	0.010	0.001	-0.005	-0.027	-0.024	-0.005	-0.016	0.0007	0.013	0.029	**0.103**	-0.014	-0.002	-0.014	0.013	0.010	-0.005	-0.169
12	0.0002	-0.0006	-0.005	-0.015	-0.016	-0.004	0.009	-0.008	0.009	-0.013	0.008	**-0.065**	-0.001	-0.003	0.006	0.002	-0.003	0.254*
13	0.001	0.001	0.0003	-0.0004	-0.005	0.001	0.0003	0.001	0.0001	-0.0005	0.0002	-0.0002	**-0.007**	-0.0002	0.001	0.001	0.001	0.055
14	0.007	0.009	0.005	0.009	0.004	0.005	-0.017	0.011	-0.016	0.006	0.010	-0.004	-0.002	**-0.078**	0.0004	-0.015	-0.028	-0.092
15	-0.003	-0.003	0.005	0.005	0.004	0.005	0.003	0.004	-0.004	-0.004	-0.003	0.003	0.004	0.0001	**-0.030**	-0.0004	0.0004	-0.099
16	-0.034	0.011	-0.008	0.005	0.031	-0.005	0.039	-0.018	-0.012	-0.004	-0.015	0.004	0.023	-0.028	-0.001	**-0.144**	-0.038	-0.159
17	0.037	-0.009	-0.013	-0.058	-0.060	-0.032	0.061	-0.052	-0.024	-0.057	-0.010	0.010	-0.031	0.066	-0.002	0.049	**0.185**	-0.233*

Residual effect= 0.0654, Bold diagonal figures indicate direct effect rG= genotypic correlation coefficient of fruit yield

** Indicates significant at p=0.01 * Indicates significant at p = 0.05

1. Plant height 2. Plant spread 3 . Leaf area 4. No. of primary branches/plant 5. No. of Fruits/plant 6. Total sugars
7. Reducing sugars 8. Non reducing sugars 9. Phenols 10. Chlorophyll 11. Nitrogen 12. Phosphorus
13. Potassium 14. Calcium 15. Magnesium 16. Sulphur 17. Thrips incidence 18. Fruit yield/plant (kg)

positive association with thrips incidence, which ultimately resulted in decreased fruit yield. Similarly, total chlorophyll, non reducing sugar, number of primary branches per plant, potassium and phenols act as a repellent towards thrips incidence. The more reducing sugars resulted in more sweetness of leaves which act as a feeding stimulant for sucking pests. Similarly, higher total sugars with more non reducing sugars resulted in less sweetness of leaves which are not preferred by the thrips. So, the genotypes with higher total sugars and high non reducing sugars results in less damage by thrips (fig. 1). Whereas, the genotypes containing higher total sugars with high reducing sugars exhibited susceptibility towards thrips incidence. Phenols have long been reported to provide resistance in plants during host plant interactions by several workers like Mondal *et al.* (2013) and Subhash *et al.* (2013) as it increases the unpalatability of the food materials which may be the possible reason for receiving low incidence of thrips. Simultaneously, higher total chlorophyll content resulted in dark colour may not attract thrips. The nutrients like calcium and sulphur had a significant positive association with thrips damage (fig. 2). The present findings are in conformity with Saleem *et al.* (2013) against thrips in cotton. Calcium is an essential component in cell wall and membrane of plant cell which also helps in formation of new cells. Higher calcium results in formation of new cells, ultimately resulting in new tissues and young flesh which attracts more thrips population and had a positive effect in thrips damage, whereas, potassium has a negative effect on thrips incidence, which act as a resistant factor in plants.

In the present investigation, the thrips damage was ranged from 15.63% to 65.47%. The lowest per cent of damage was found in Phule Jyothi (15.63%). Besides, DCA-232 (20.94%), DCA-142 (22.5%), DCA- 106 (24.22%) and DCA-205 (25%) were found better in comparison to susceptible check Byadgi Kaddi (65.47%) and Byadgi Dabbi (64.38%), which recorded highest damage of thrips incidence (fig. 3). The variation in damage may be due to differential load of thrips population on different genotypes based on the morphological, biochemical or nutritional variations in plants. The genotypes which were highly susceptible may be more preferred by the thrips due to thin leaf, more sugar content, low chlorophyll and phenol content might have favoured more thrips population and thrips feeding damages the leaves, reducing the photosynthetic capacity, resulting in reduced fruit production (Shipp *et al*., 1998). Similarly, Phule Jyothi, which is moderately resistant recorded low sugar, higher phenol with moderate potassium content and rough leaves (visual observation). These traits might have avoided the thrips population and resulted less thrips infestation on it. The results were in accordance with Varadharajan and Veeravel (1996), Goffreda *et al.* (1990) and Mondal *et al.* (2013). Other factors beyond the scope of the investigations might also be the key factors of resistance to thrips. Any leaf character that interferes with the thrips life-cycle is a potential resistance factor, which may contribute to the mechanism of defence against thrips. It is known that both morphological and bio chemical characters of leaves can play a role in defence against insects (Rosenthal and Kotanen, 1994). The information generated from screening of chilli genotypes for thrips resistance and resistant source identified in the present study could be exploited further and can be used as a donor in thrips resistant breeding programmes. On the basis of genetics for different characters as summarized above, it can be concluded that there is an existence of greater amount of variability for the important yield attributing characters in different genotypes, which can be utilized for further improvement of chilli through hybridization program.

References

Burton, G. W. and E. M. Devane (1953). Estimating heritability in tall Fescue (*Festuca arunidinacea*) from replicated clonal material. *Agron. J.*, **45** : 478-481.

Butani, D. K. (1976). Pests and diseases of chillies and their control. *Pesticides*, **10** : 38-41.

Dandunayak (2008). Assessment of genetic diversity in local chilli collections (*Capsicum annuum* L.). *M. Sc. Thesis*, Univ. Agri. Sci., Dharwad, India.

Datta, S. and L. Das (2013). Characterization and genetic variability analysis in *Capsicum annuum* L. germplasm. *SAARC J. Agri*., **11(1)** : 91-103.

Dewey, D. R. and K. H. Lu (1959). A correlation and path coefficient analysis of components of crested wheat grass seed production. *Agron. J.*, **51** : 515-518.

Falconer, D. S. (1981). Introduction to quantitative genetics, *2nd edition Oliver and Boyd*, Edinburg, London, p. 316.

Ganeshreddy, M., H. D. Mohan Kumar and P. M. Salimath (2008). Correlation and path coefficient analysis in chilli (*Capsicum annuum* L.). *Karnataka J. Agri. Sci.*, **21(2)** : 259-261.

Goffreda, J. C., J. C. Steffens and M. A. Mutschler (1990). Association of epicuticular sugars with aphid resistance in hybrids with wild tomato. *J. Amer. Soc. Hort. Sci*., **115(1)** : 161-165.

Johnson, H. W., H. F. Robinson and R. E. Comstock (1955). Genotypic and phenotypic correlations in soyabean and their implications in selection. *Agron. J.*, **37** : 477-483.

Krishna, U., M. P. Patil, M. B. Madalageri, R. Mulge and Y. K. Kotikal (2007). Variability studies in green chilli (*Capsicum annuum* L.). *Karnataka J. Agril. Sci*., **20(1)** : 102-104.

Kumar, N. K. (1995). Yield loss in Chilli and Sweet pepper due to *Scirtothrips dorsalis* Hood (Thysonoptera : Thripidae). *Pest Manage. Hort. Ecosystems*, **1(2)** : 61-69.

Mondal, C. K., P. Acharyya and P. Hazra (2013). Biochemical basis of plant defence for leaf curl virus of chilli (*Capsicum annuum*). *Proceedings of the XV Eucarpia meeting on genetics and breeding of capsicum and eggplant*, 2-4 September 2013, torino – Italy.

Munish, A. D., B. K. Kumar, A. K. Sureja and S. Joshi (2010). Genetic variability, heritability and genetic advance for growth, yield and quality traits in chilli (*Capsicum annuum* L.). *India. J. Hort*., **67(1)** : 114-116.

Robinson, H. F., R. E. Comstock and V. H. Harvey (1949). Estimates of heritability and degree of dominance in corn. *Agron. J.*, **41** : 353-359.

Rosenthal, J. P. and P. M. Kotanen (1994). Terrestrial plant tolerance to herbivory. *Trends in Ecology and Evolution*, **9** : 145-148.

Saleem, M. W., S. Ahmed, W. Wahil and S. T. Sahi (2013). Resistance to thrips (*Thrips tabaci*) in Bt cotton genotypes in Punjab, Pakistan based on population dynamics and plant morpho-chemical properties. *International J. Agri. Biol*., **15 (2)** : 331-336.

Sandeep (2007). Genetic variability, correlation, morphological and molecular diversity in Byadgi Kaddi and Byadgi Dabbi chillies (*Capsicum annuum* L) accessions. *M. Sc. Thesis*., Univ. Agri. Sci., Dharwad, Karnataka, India.

Sharma, V. K., C. S. Semwal and S. P. Uniyal (2010). Genetic variability and character association analysis in bell pepper (*Capsicum annuum*. L). *J. Horti. Forest*., **2(3)** : 58-65.

Shipp, J. L, X. Hao, A. P. Papadopoulos and M. R. Binns (1998). Impact of western flower thrips (Thysanoptera : Thripidae) on growth, photosynthesis and productivity of greenhouse sweet pepper. *Scientia Horticulturae*, **72(2)** : 87–102.

Singh, D. K. and A. Singh (2011). Assessment of variability parameters and characters association for quantitative traits in chilli. *Progressive Agri*., **11(11)** : 113-116.

Sonia, S., B. Anil and Akhilesh Sharma (2007). Genetical study for quality traits in bell pepper (*Capsicum annuum* (L.) var. grosum sendt). *Indian J. Genet.*, **67(1)** : 95-96.

Srilakshmi, P. (2006). Genetic diversity for productivity and quality characters in chilli (*Capsicum annuum* L.). *M. Sc. Thesis*, Univ, Agri, Sci., Dharwad, Karnataka, India.

Subhash, B. K., K. H. Khader, A. K. Chakravarth, C. T. Ashok Kumar and P. Venkataravana (2013). Biochemical constituents influencing thrips resistance in groundnut germplasm. *Journal of Environmental Biology*, **35** : 675-681.

Varadarajan, S. and R. Veeravel (1996). Evaluation of chilli accessions resistant to thrips, *Scirtothrips dorsalis* Hood (Thysanoptera: Thripidae). *Pest Management and Economic Zoology*, **4** : 85-90.

Wright, S. (1921). Correlation and causation. *J. Agri. Res*., **20** : 557-587.