RESEARCH ARTICLE

GENE ACTION STUDIES ON SEED YIELD AND QUALITY TRAITS IN RED SWEET PEPPER (*CAPSICUM ANNUUM* L. *GROSSUM*)

Cherry Nalwa* and Manish Kumar

Department of Seed Science and Technology
Dr Yashwant Singh Parmar University of Horticulture & Forestry,
Nauni, Solan (HP) 173 230, India
Email: cherrynalwa.123.cn@gmail.com

Abstract: Selection of suitable breeding methodologies in bringing desirable improvement in crop require the complete knowledge about the nature of gene action involved in the inheritance of quantitative and quality traits. Gene action of fruit yield and quality traits in sweet pepper (*Capsicum annuum* L. *grossum*) were studied through half-diallel analysis excluding reciprocals of 15 F_1 hybrids derived by crossing 6 parental lines. The present study indicated the preponderance of non-additive gene action for days to first flowering, fruit set, number of fruits per plant, fruit weight, fruit yield kg per plant, days to first ripe fruit harvesting , number of seeds per fruit, seed weight per fruit, seed yield per fruit, thousand seed weight and percent seed recovery. For fruit yield per plant dominant component of variance was observed which revealed the presence of non-additive gene action, hence heterosis breeding is required to be followed for exploitation of these traits. The preponderance of non-additive gene action in the inheritance of all the traits studied clearly suggested exploitation of heterosis breeding for the improvement of these traits and the presence of sufficient hybrid vigour in different hybrid combinations.

Keywords: Gene action, Sweet pepper, Variance, Half-diallel, Fruit yield

INTRODUCTION

Sweet Pepper (*Capsicum annuum* L. var *grossum*) is the most important fruit vegetable grown worldwide for its delicate taste, pleasant flavor and color. Under Indian conditions red, orange and yellow are grown commercially and growing conditions also influences the productivity of these peppers. Red sweet pepper fruits are known to have high nutritional values and biological pigments (lycopene, carotenoids and xanthophylls) Ghasemnezhad M *et al.* (2011). These have got a good potential as a greenhouse crop since quality of fruits is superior as compared to open field cultivation which fetches high prices in the market (Farooq *et al.* 2015). Since, different color variants especially red, yellow, orange and purple are grown commercially in the greenhouses.

There is a growing demand for developing and producing indigenous hybrid cultivars adapted to greenhouse conditions with high yield, good quality and tolerance to prevalent local races of pathogens. Knowledge on the genetic system controlling the quantitative and quality traits is important for formulating an efficient selection program through the use of suitable mating design. The information about the relative contribution of components of varaiation *viz.,* additive and non-additive is essential for effective crop improvement program (Azhar and Ajmal, 1999). The present study was, therefore, undertaken with a set of half-diallel crosses to elicit information about the nature and magnitude of gene action for yield and its components in sweet pepper so as to formulate suitable breeding strategy.

MATERIALS AND METHODS

Six diverse red sweet pepper genotypes *viz.,* RSPUHF-1, RSPUHF-2, RSPUHF-3, RSPUHF-4, RSPUHF-5 and RSPUHF-7 were chosen in this study to represent quantitative and quality traits. These six genotypes were involved in half-diallel mating design to develop 15 hybrids during 2017. All the F_1's along with their parents were evaluated in a Randomized Block Design with three replications during *kharif* 2018 at Experimental Farm of the Department of Seed Science and Technology, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan (H.P). There were ten plants of each entry in each replication in a plot having size 2.0 m x 1.0 m with spacing of 70 cm x 40 cm. Standard agronomic practices were followed for raising a healthy crop of bell pepper under protected condition as mentioned in the "Package of Practices of Vegetable Crops", published by the Directorate of Extension Education, Dr YS Parmar UHF, Nauni, Solan (YSP UHF, 2016). The observations were recorded on ten plants of each entry for the parameters *viz.,* days to first flowering, fruit set, number of fruits per plant, fruit weight, fruit yield kg per plant, days to first ripe fruit harvesting , number of seeds per fruit, seed weight per fruit, seed yield per fruit, thousand seed weight and percent seed recovery. Data was analyzed according to ANOVA, as outlined by Panse and Sukhatme (1985), to determine the significant differences among the genotype for all the characters. Components of genetic variance were estimated from the data

*Corresponding Author

obtained on the diallel crosses by the method given by Griffing's Method II and Model-I (Griffing, 1956).

RESULTS AND DISCUSSION

In breeding program a suitable breeding strategy for the purposeful management of genetic variability largely depends on type of gene action in the population for the traits under genetic improvement (Sprague, 1966). Gene action helps to set an appropriate breeding strategy to accumulate fixable genes through selection. Seed yield and its related parameters are quantitative traits, which are controlled by several genes and therefore shows range of value in segregating generations. Biometrical techniques dealing with genetic analysis

have helped plant breeders to ascertain the nature of gene action.

Analysis of variance

The analysis of variance carried out for different traits of sweet pepper *viz.,* days to first flowering, fruit set, number of fruits per plant, fruit weight, fruit yield kg per plant, days to first ripe fruit harvesting, number of seeds per fruit, seed weight per fruit, seed yield per fruit, thousand seed weight and percent seed recovery are presented in Table 1. Analysis of variance reported significant differences for all the traits studied and revealed that sufficient genetic variability was generated for yield and related traits indicating the importance of both additive and non-additive genetic components of variance after crossing six diverse genotypes of sweet pepper in a half-diallel mating design (excluding reciprocals).

Table 1. Analysis of variance for various traits in sweet pepper

Source	Sum of squares due to			
	Replications	Genotypes	Errors	Total
Df	**2**	**20**	**40**	**62**
Character				
Days to first flowering	289.238	620.762*	29.429	939.429
Fruit set (%)	80.889	1134.603*	19.778	1235.270
Number of fruits per plant	62.317	875.651*	54.349	992.317
Fruit weight (g)	1546.406	14197.532*	594.199	16338.137
Fruit yield (kg per plant)	7.557	68.657*	3.603	79.817
Days to first ripe fruit harvesting	127.524	885.714*	22.476	1035.714
Number of seeds per fruit	659.937	1632.603*	80.063	2372.603
Seed weight per fruit (g)	0.006	0.099*	0.003	0.107
Seed yield per plant (g)	345.550	935.862*	92.661	1374.074
1000 seed weight (g)	0.503	4.147*	0.124	4.774
Percent seed recovery (%)	0.002	0.275*	0.008	0.285

*Significant at 5% level of significance

Estimates of genetic components of variance

Nature of gene action has been inferred from the estimates of GCA and SCA variances. A perusal of data presented in table 2 indicated that the estimates of $\sigma^2 s$ were higher in magnitude as compared to $\sigma^2 g$ for most of the traits under study except for seed weight per fruit. Predictability ratio determines the type of gene action involved in the expression of traits and allows inferences about optimum allocation of resources in hybrid breeding. The closer the ratio is to one, the greater the prediction of gca alone, whereas a ratio with a value less than one shows sca

action (Baker 1978). The ratio (table 2) was found less than one for most of the traits *viz.,* days to first flowering (0.07), fruit set (0.05), number of fruits per plant (0.14), fruit weight (0.20), fruit yield kg per plant (0.17), days to first ripe fruit harvesting (0.06), number of seeds per fruit (0.11), seed weight per fruit (0.10), seed yield per fruit (0.07), thousand seed weight (0.15) and percent seed recovery (0.15). It confirmed the predominant role of non-additive gene action in the expression of almost all the traits under this study.

Non-additive gene action for fruit yield and component traits has also been recorded by Salazar and Vallejo (1990), Nascimento *et al*. (2004) and Kamble *et al*. (2009) for days to flowering. Ahmed *et al*. (1997) and Sood and Kumar (2011) for days to first ripe fruit harvesting, number of fruits per plant, fruit yield per plant and fruit weight suggesting that heterosis breeding will be better option for their improvement than other breeding approaches. Non-additive gene action for fruit yield has been reported by Kordus (1991) and Szwadiak and Kordus (1991). The preponderance of non-additive gene action in the inheritance of all the traits studied clearly suggested exploitation of heterosis breeding for the improvement of these traits and the presence of sufficient hybrid vigour in different hybrid combinations.

Table 2. Estimates of genetic components of variance for different traits in sweet pepper

Character	$\sigma^2 gca$	$\sigma^2 sca$	$\sigma^2 g$	$\sigma^2 s$	$\sigma^2 g/\sigma^2 s$ (variance ratio)	Predictability ratio $(2\sigma^2 g/2\sigma^2 g+\sigma^2 s)$
Days to first flowering	148.667	472.095	14.90	442.66	0.03	0.07
Fruit set per cent	214.056	920.548	24.36	900.77	0.03	0.05
Number of fruits per plant	340.556	535.095	35.78	480.746	0.07	0.14
Fruit weight (g)	6686.116	7510.650	761.49	6916.451	0.11	0.20
Fruit yield kg per plant	29.872	38.784	30.28	35.181	0.09	0.17
Days to first ripe fruit harvesting	189.167	696.548	20.84	674.072	0.03	0.06
Number of seeds per fruit	562.806	1069.798	60.34	989.735	0.06	0.11
Seed weight per fruit (g)	0.031	0.068	3.5	0.065	0.05	0.10
Seed yield per fruit (g)	266.124	669.703	21.68	577.042	0.04	0.07
Thousand seed weight (g)	1.650	2.496	0.19	2.372	0.08	0.15
Percent seed recovery	0.108	0.167	0.0125	0.159	0.08	0.15

CONCLUSION

Sufficient genetic variability was generated for yield and related traits after crossing six diverse genotypes of sweet pepper in a half-diallel mating design (excluding reciprocals). The presence of non-additive gene action revealed that heterosis breeding is required to be followed for further improvement of sweet pepper.

REFERENCES

Ahmed, N., Khan, S.H. and Tanki, M.I. (1997). Combining ability analysis for fruit yield and some economic characters in sweet pepper (*Capsicum annuum* L.). *Capsicum and Eggplant Newsletter,* **16**: 72-75.

Azhar, F.M. and Ajmal, S.U. (1999). Diallel analysis of oil content in seed of *Gossypium hirsutum* L. *Journal of Genetics Breeding,* **53**: 19-23.

Baker, R.J. (1978). Issues in diallel analysis. *Crop Science,* **18**: 533-536.

Farooq, M., Ramzan, A., Chattha, M.R., Qasim, U., Nawab, N.N. and Hidyatullah, N.N. (2015). Studies on the performance of sweet pepper (*Capsicum annuum* L.) hybrids under plastic tunnel. *Science, Technology and Development*, **34**: 155-157.

Ghasemnezhad, M., Sherafati, M. and Payvast, G.A. (2011). Variation in phenolic compunds, ascorbic acid and antioxidant activity of five

coloured bell pepper (*Capsicum annum*) fruits at two different harvest time. *J. Func. Food,* **3**: 44-49.

Griffing, B. (1956). Concept of general and specific combining ability in relation to diallel crossing system. *Australian Journal of Biological Sciences,* **9**: 463-493.

Kamble, C. and Mulge, R. (2009). Studies on combining ability for growth and yield traits in capsicum (*Capsicum annuum* L.). *Crop Research Hisar,* **36**: 277-280.

Kordus, R. (1991). Diallel analysis of some characters in pepper. *Folia Horticulturae*, **3**: 51-63.

Nascimento, I.R., Maluf, W.R., Farai, M.V. and Valle, L.A.C. (2004). Combining ability and gene action in the expression of economically important traits in sweet pepper. *Ciencia-e-Agrotechologia,* **28**: 251-260.

Panse, V.G. and Sukhatma, P.V. (1985). Statistical Methods for Agricultural Workers. Indian Council of Agricultural Research, New Delhi. 381p.

Salazar, V.M. and Vallejo, C.F.A. (1990). Production and evaluation of hybrids of sweet pepper, *Capsicum annuum* L. on the basis of combining ability. *Acta Agronomica,* **40**: 716.

Sood, S. and Kumar, N. (2011). Genetic estimates of fruit yield and its component traits in bell pepper (*Capsicum annuum* L. *grossum* Sendt.). SABRAO *Journal of breeding and genetics*, **43**: 122-129.

Sprague, G.F. (1966). Quantitative Genetics in plant improvement. In: Plant Breeding: a symposium held at Iowa State University. The Iowa State University Press, Ames, Iowa. pp. 315- 354.

Szwadiak, J. and Kordus, R. (1991). Diallel analysis of yield and component traits in peppers. *Acta Agronomica,* **40**: 139-143.

YSP, UHF. (2016): Package of practices for vegetable crops. Directorate of Extension Education, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni Solan H.P. pp. 13-1.