J. Environ. Sci. & Natural Resources, **5(2): 73-76, 2012** ISSN 1999-7361

Combining Ability and Gene Action for Different Root Characters in Spring Wheat

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Abstract

Combining ability and gene action for different root characters were studied in seven genotypes of spring wheat and their 21 F1s obtained from a diallel crosses. The experiment was conducted with 45 days aged plant in poly bags at the field laboratory of Department of Genetics and Plant Breeding, Bangladesh Agricultural University, Mymensingh. The parent Kheri was the best general combiner for different root characters. The crosses Sebia × SA-92, Sebia × HT-7 and SA-92 × Kherishowed positive and significant SCA effects for root length.Vr–Wr graph analysis showed that dry weight of root and shoot root ratio indicates epistasis. Whereas root length and dry weight of shoot showed over dominance. The crosses with SCA significant effects for root characters may be used in hybrid development in spring wheat.

Key words: Combining ability, Diallel cross, Epistasis, Genetic variance, Wheat

Introduction

Wheat (*Triticumaestivum*L.) is a member of family Poaceae and is one of the leading cereals of many countries of the world including Bangladesh. It is the most important food crop of in our country and is a main source of protein and energy.The production of wheat was 9.72 MT in 2010-2011 (BARI, 2011). The average yield of this crop is 1.95t/ha which is low compared to other wheat growing countries of the world. The Wheat Research Center (WRC) of Bangladesh Agricultural Research Institute (BARI) released some promising varieties which yield approached to 3 t/ha is in farmer's field. To increase the yield potential of the wheat varieties information on the genetic mechanisms, like combining ability is of major importance. Sprague and Tatum (1942) developed the concept of combining ability and coined the two terms: A. General combining ability (GCA) and B. Specific combining ability (SCA). In pursuit of rendering improvement in crop plants, the plant breeder must possess an adequate knowledge of combining ability and allied genetic parameters.Combining ability analysis developed by Griffing (1956) has been extensively used to derive such information in F1 generation. Its method I, and model I is the best in that it also gives the information for the effects of reciprocals. Singh *et al.* (1980), Bajwa*et al.* (1986), Malik *et al.* (1988) and Sattar *et al.* (1992) reported the both general and specific combining ability variances were highly significant for most of the characters including root related, indicating additive and nonadditivetype of gene action. While Mohy-ud-din and Shahzad (1998) and Khan and Ali (1998) reported significant general combining ability (GCA) variances for most of the characters.The breeders are often facing problems of selecting those parental lines, which in different cross combinations can furnish higher frequency of most desirable segregants. To achieve this goal, knowledge of prepotency of parental lines for combining ability is very useful in selection of desirable lines.In view of above facts, the present experiment was undertaken to estimate combining ability effects of different parents and crosses in F2segregating population and to determine the additive and nonadditive genetics effects of root related traits.

Materials and methods

Seven varieties of spring wheat crossed in a diallel system excluding the reciprocals. The varieties wereSebia, Peacock, SA-92, Sowght, HT-7, Chyria-3 and Kheri and their 21 cross combination (21 F1). The experiment was conducted in two years the selected parents and F_1s were sown in crossing blocks in the winter season of 1999 and 2000. The experiment was conducted under polybags planting condition. The seed of parents and their F1s were placed on moist filter papers in petridishes. Seed were germinated 2-3 days after placing these on petridishes. Four days old seedlings were transplanted in the polybags with 2 replication of randomized block design. After establishment of seedling one seedling was removed from each bag keeping other; thus keeping one plant per bags.Datawere collected on root length, root dry weight, shoot dry weight, root shoot ratio at 45 days age of the plant. For collecting data the bags were cut by fine knife and dipped in to pond water for half an hour to loosen the soil for easy separation of roots. The plants were then washed carefully to clean the roots on individual bag basis. The data were analyzed for combining ability as per the method 2, model 1 of Griffing (1950) and Vr-Wr graph of Jinks (1954) and Hayman (1954).

Results and Discussion

Analysis of variance for combining ability

The analysis of variances for combining ability for different root characters is presented in (Table 1). Both GCA and SCA variances were significant for all characters. The significant estimates of GCA and SCA variances suggest that both additive and nonadditive gene actions were involved for all characters, i.e root length, dry weight of shoot, dry weight of root and shoot variance (Table 1). Higher estimates of nonadditive genetic variance were observed for root length, dry weight of shoot, dry weight of root and shoot root ratio.The additive (δ^2_A) and nonadditive (δ^2_D) genetic variance were estimated from GCA and SCA variance (Table 1).

Table 1. Analysis of variance (mean squares) for combining ability for different root characters in spring wheat

Sources of variation	df	Root length	Dry weight of shoot	Dry weight of root	Shoot and root ratio
GCA	6	8.54**	1.25**	0.29**	1.12**
SCA	21	4.81**	0.87**	0.15**	0.35**
Error	27	2.09	0.31	0.05	0.15
δ^2_A	-	0.83	0.08	0.03	0.17
δ^2_D	-	2.72	0.56	0.10	0.20

** Indicate significant at 1% level of probability

GCA effects of the parents

Estimate of GCA effects of the parents for different root characters in spring wheat are shown in (Table 2). The parent Kheri was the best general combiner for different root characters. Kheri had positive and significant GCA effect for dry weight of root. Sowghat appeared as good general combiner for dry weight of shoot and shoot root ratio. Peacock was good general combiner for dry weight of root but not for shoot root ratio.

Table 2. Estimation of GCA effects of the parents for different root characters in spring wheat

Parents	Root length	Dry weight of shoot	Dry weight of root	Shoot-root ratio
Sebia	0.03	-0.06	0.01	0.01
Peacock	-0.04	0.31	0.20*	-0.24**
SA-92	0.56	-0.19	-0.01	-0.00
Sowghat	0.01	0.06	-0.33*	0.78**
HT-7	0.92	-0.70	-0.05	0.21**
Cheria-3	-1.31	0.18	-0.04	0.01
Kheri	0.23	0.41	0.22*	0.31**
S.E.(±)	0.45	0.17	0.07	0.01

** Indicate significant at 1% and * Indicate 5% level of probability

Over all study of GCA effects of the parents suggests that Kheri was the best general combiner for different root characters. Therefore this variety could be used as parent for different root improvement program in spring wheat.

SCA effects of the crosses

Estimation of SCA effects of the crosses for different root characters presented in the (Table 3). The crosses Sebia X SA-92, Sebia X HT-7 and SA-92 X Kheri had significant estimates of SCA effects for root length. Among these crosses Sebia X SA-92 also showed significant and positive SCA effects for root characters such as dry weight of shoot and shoot root ratio.

Table 3. Estimate of SCA effects of the crosses for different root characters in spring wheat

Crosses	Root length	Dry weight of shoot	Dry weight of root	Shoot-root ratio
Sebia × Peacock	1.39	-0.77	0.08	-0.6
Sebia × SA-92	3.33**	0.65	0.78**	-0.98**
Sebia × Shawgot	1.98	0.20	-0.04	0.52
Sebia × HT-7	2.87*	-0.20	-0.03	-0.06
Sebia × Chyria-3	0.31	-0.58	-0.14	-0.10
Sebia × Kheri	0.36	0.79	-0.05	0.13
Peacock × SA-92	-2.54*	1.01*	0.10	0.53
Peacock × Shawgot	0.02	0.64	0.13	-0.30
Peacock × HT-7	1.11	-0.61	-0.96**	1.29**
Peacock × Chyria-3	0.36	0.80	0.51*	-0.40
Peacock × Kheri	1.29	0.30	0.24	-0.29
SA-92 × Shawgot	-2.45*	-1.66**	-0.58*	0.51
SA-92 × HT-7	-0.76	0.30	0.25	-0.16
SA-92 × Chyria	-2.74*	-1.59**	-0.34	-0.03
SA-92 × Kheri	3.93**	1.10*	-0.42*	1.22*
Shawgot × HT-7	-2.61*	-0.99**	0.19	-0.25
Shawgot × Chyria-3	2.72	1.43**	0.14	-0.54
Shawgot × Kheri	0.28	0.77	0.36*	-0.50
HT-7 × Chyria-3	0.11	0.33	0.14	-0.11
HT-7 × Kheri	-1.53	0.50	0.16	0.32
Chyria-3 × Kheri	-3.61**	-0.74	-0.18	0.15
S.E. (±)	1.10	0.43	0.17	0.30

** Indicate significant at 1% and * Indicate 5% level of probability

Vr-Wr graph analysis

The analysis of Vr-Wr graph (Fig.1) showed nonsignificant regression coefficients from Zero for root length, dry weight of shoot, dry weight of root and shoot root ratio, indicates the presence of epistasis. Epistatic parents were identified by serially excluding array or array from the analysis. For root length and dry weight of shoot the parent SA-92 contained the epistatic alleles. After excluding single array root length and dry weight of shoot explaining additive dominance model but dry weight of root and root-shoot ratio could not explaining additive dominance model. Over dominance was observed for root length and dry weight of shoot.

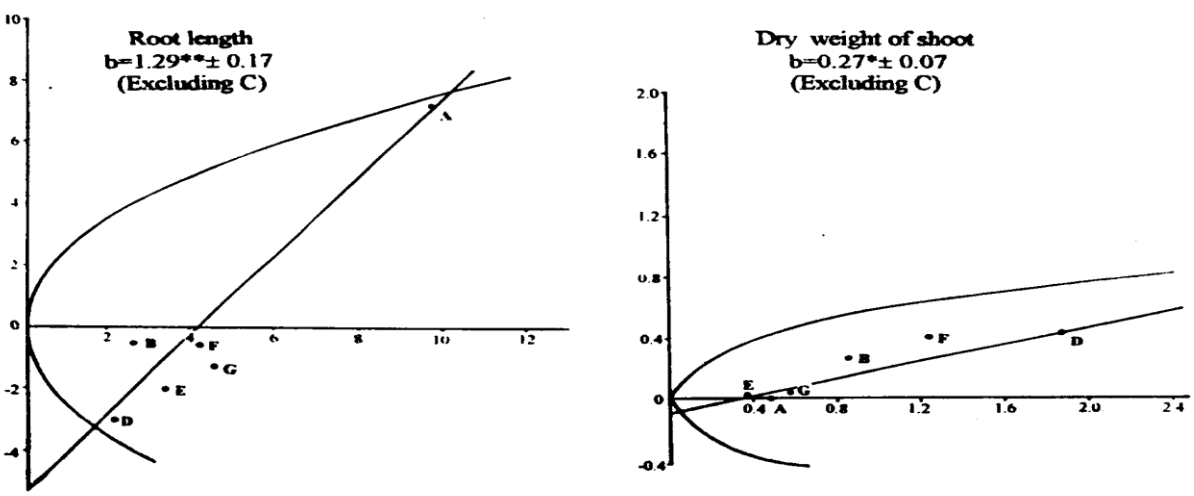

Fig. 1. Vr-Wr graph showing different root character of spring wheat (A= Sebia, B= Peacock, C= SA-92, D= Sowghat, E=HT-7, F= chyria and G= kheri. ** Indicate significant at 1% and * Indicate 5% level of probability)

The distribution of parents along the regression line, suggested that parent HT-7 contained more dominant alleles for the character dry weight of shoot and parent Peacock contained large number of dominant alleles controlled the characters root length.The present investigation was carried out to study the combining ability of different parents for root related traits. It was also meant to determine the nature of gene action, combining ability and genetic variance.Analysis of variance revealed that both GCA and SCA variances were important for all characters. The ratio of GCA to SCA revealed the presence of more additive gene action for root length, dry weight of shoot, dry weight of root and root-shoot ratio. Parent Kheri was identified as high combiners for most of the characters. When the overall SCA effect of crosses for all the traits is considered Sebia × HT-7, Sebia× HT-92 and SA-92 × Kheri were identified as good crosses and can be used in the future breeding programme.

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