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A Study of Combining Ability for Yield and its Components in Aggregatum Onion *(Allium cepa* L. var. *aggregatum* Don)*

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The nature and magnitude of combining ability was investigated in 30 hybrids of aggregatum onion resulting from matings of three testers and ten lines in respect of yield of bulbs and six yield contributing characters. The general and specific combining ability variances indicated the role of non-additive gene action for all the characters, suggesting that the improvement of these traits cou d be achieved through heterosis breeding. Among the parents, the line A C 863 and the tester A C 874 proved to be the best general combiners for yield. In the hybrids, no relationship could be established between *per se* performance and *sca* effects and therefore more emphasis has to be laid on *per se* performance than on specific combining ability effects in the choice of hybrids.

Aggregatum onion (*Allium cepa* L. var. *aggregatum* Don) is one of the most important vegetable crops cultivated in the state of Tamil Nadu. It differs from the common onion in several aspects and the most important of them is its mode of vegetative propagation. Continuous vegetative propagation has led to a narrow genetic base in this crop. Under such a situation the breeder has to look for additional sources of variation. Recently, much interest has been evinced in growing F_1 hybrids in several vegetable crops. In such programmes, it is necessary to study the relative ability of the parents to transfer economic traits to the hybrids. The present investigation was undertaken with a view to screen a number of lines in aggregatum onion, using the line X tester method of analysis as suggested by Kempthorne (1957). This will enable the identification of superior genotypes in a hybridization programme for the genetic improvement of yield and its attributes.

MATERIAL AND METHODS

The present investigation was carried out at the Department of Olericulture, Faculty of Horticulture, Tamil Nadu Agricultural University, Coimbatore involving ten lines (females) and three testers (males). It has been reported that geographic diversity is the key to genetic diversity and thus to hybrid vigour itself (Paschal and Wilcox, 1975). Keeping this in view, the lines and testers were chosen to represent various onion growing tracts of Tamil Nadu namely, AC 863 (Bhuvanagiri), AC 864 (Madurai) AC 865 (Dindugal), AC 866 (Pollachi), AC 867 (Thudiyalur), AC 868 (Mithilaipatti), AC 869 (Coimbatore), AC 870 (Madurai), AC

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871 (Ummiampatti) AC 872 (Manachanallur), AC 873 (Co.1), AC 874 (Co. 3) and AC 875 (Thudiyalur). Among the lines and tester AC 863, AC 864 and AC 874 represent early maturity group whereas AC 866, AC 871 AC 872 and AC 873, are of late maturity group. The bulbs size are bigger in AC 863, AC 866, AC 868, AC 872, AC 873 and AC 874. The lines AC 863, AC 866, AC 868, AC 872 and the tester AC 874 represent high yielding group. The storage quality was good in case of AC 863, AC 869, AC 872 and AC 874. The parents were non inberd lines. Forty day old seedlings of 30 crosses and 13 parents were transplanted at a spacing of 45 cm X 10 cm in ridges and furrows of 3 m length. In the seed to bulb generation, the lines AC 863, AC 866 and the tester AC 873 and AC 874 were proved to be good general combiners (Vadivel *et al.*, 1981). The bulbs harvested from seed to bulb generation were stored for 40 days at room temperature (26.2°c) and the bulbs of all the cross combinations and the parents were planted at a spacing of 45 X 15 cm in a randomised block design with three replications. Thirty plants were selected at random in each replication and data on plant height (cm), days to maturity, plant weight (g), individual bulb weight (g), number of bulbs per plant, yield of bulbs per plant (g) and shape index (height/diameter of the bulb) were recorded at maturity.

The observations recorded for the hybrids and parents were subjected to line × tester analysis and the estimates of general and specific combining ability were obtained by adopting the methods suggested by Kempthorne (1957), Comstock and Robinson (1952) and Rao *et. al.* (1968).

RESULTS AND DISCUSSION

Analysis of variance showed that the variances due to hybrids, lines, testers and line X tester interactions were highly significant for all the characters except in the case of variance of testers for shape index (Table 1). It is evident from Table 2 that the variances due to specific combining ability were of greater magnitude for all the characters than general combining ability variances. The ratios between general combining ability and specific combining ability variances were less than unity for all the characters, thus indicating the preponderance of non-additive gene action for these traits. A comparison of general combining ability variances due to lines and testers showed that the general combining ability variances of lines were greater for six characters and in the case of days to maturity, the variance was higher for testers.

The general combining ability effects of lines and testers presented in Table 3 indicated that the line AC 863 was found to be the best combiner for yield of bulbs per plant, individual bulb weight, plant weight and days to maturity, whereas the lines AC 865 and AC 871 appeared to be promising in respect of number of bulbs and height of plant and shape index respectively.

Among the three testers, AC 874 was the best general combiner for yield of bulbs per plant, individual bulb weight, number of bulbs per plant, plant weight and days to maturity. The tester AC 873 for plant height and AC 875 for shape index proved to be good general combiners. The high *gca* effect for yield of bulbs per plant in the parents AC 863 and AC 874, could be due to increased individual bulb weight,

Of the 30 hybrids, 18 showed positive specific combining ability effects for increased yield (Table 4). The hybrid AC 868 x AC 873 recorded the nighest and significant positive *sca* effect for bulb yield. The other hybrids to exhibit higher *sca* for bulb yield were, AC 864 x AC 873 and AC 863 x AC 873. The hybrids AC 866 x AC 874 and AC 865 x AC 875 for plant height, AC 870 x AC 873 and AC 867 x AC 873 for days to maturity AC 868 x AC 873 and AC 869 x AC 873 for plant weight, AC 864 x AC 874 and AC 866 x AC 874 for individual bulb weight, AC 863 x AC 874 and AC 872 x AC 875 for number of bulbs per plant and AC 872 x AC 874 and AC 868 x AC 875 for shape indiex showed the highest and favourable specific combining ability effects The hybrids AC 868 x AC 873, AC 870 x AC 873 and AC 863 x AC 874 involved high x low, low x low and high x high general combiners respectively. The high x low combination pointed to the importance of dominant gene action, whereas high x high combinations stressed the role of additive or additive x additive type of gene action. Such an explanation was also given by Hosfield *et al*. (1977) in onion. The hybrid AC 870 x AC 873 exhibited high negative specific combining ability effects for days to maturits, although both the parents involved were poor combiners, indicating thereby the role of complementary type of gene action. Similar findings have been reported by Singh and Dhaliwal (1971) in wheat.

The most outstanding general combiner was the tester AC 874, which ranked first in the *per se* performance as well as in the *gca* effects for yield as well as yield components. However, such a conclusion could not be drawn in the case of lines. Similarly, the *per se* performance of the hybrids when compared with their respective specific combining ability effects showed no relationship between these two criteria. Kalloo *et. al*. (1974) found very little relationship between specific combining ability effects and *per se* performance of the hybrids. As such, selection of hybrids on the basis of *per se* performance seems to be more relaiable than on specific cambining ability effects in so far as the present stuty with the aggregatum onion is concerned.

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TABLE 1 Line X tester analysis.

Source	Plant height	Days to maturity	Plant weight	Individual bulb weight	Number of bulbs per plant	Yield of bulbs per plant	Shape index
Hybrids	46.2820**	176.6013**	753.0629**	10 7726**	11.0617**	578.0142**	0.0784**
Lines	61.8325**	227.5315**	1210.9094**	18.0817**	17.1443**	758.6362**	0.1013**
Tester	110.5061**	627.4452**	1455.1732**	31.6709**	31.3409**	1163.8951**	0.0269NS
Lines X Testers	37.7707**	76.0425**	446.1274**	4.7960**	5.7672**	422.6053**	0.0737**
Error	5.5342	10.4127	37.3210	1.3731	1.4066	19.6879	0.0177

N S – Non significant

* * – Significant at 1% level

TABLE 2. Estimates of variances for combining ability

Source of Variation	Plant height	Days to maturity	Plant weight	Individual bulb weight	Number of bulbs per plant	Yield of bulbs per plant	Shape index
σ^2 GCA	2.8102	19.3049	45.4828	1.0298	0.9475	27 6236	0 000575
GCA lines	3.3846	11.1732	84.9757	1.4762	1 2641	37.3368	0.002814
GCA testers	2.6378	18.3801	33.6349	0.8958	0.8525	24.7097	0.001113
σ^2 SCA	8.8122	21.8767	136.2688	1.1409	1.4535	134 3058	0.019222
GCA/SCA	0.3263:1	0.8824:1	0.3337:1	0.9026:1	0.6519:1	0.2057:1	0.0299:1

TABLE 3. Estimates of general combining ability effects

Parents	Plant height	Days to maturity	Plant weight	Individual bulb weight	Number of bulbs per plant	Yield of bulbs per plant	Shape index
Lines							
AC 863	1.1019	−6.2202**	18 1779**	2.1708**	0.8187*	15.5809**	0.1308*
AC 864	−2.1659*	−6.5635**	−1.0887	0.3935	0.6910	−0.6857	−0.1149*
AC 865	−1.0392	−5.0969**	−12.9832**	−2.4895**	2.8354**	−9.9302**	−0.0297
AC 866	−1.8370*	3.5165**	2.1034	0.6276	−0.3923	3.2331*	−0.0130
AC 867	2.3919**	−2.8802**	0.1446	−0.6846	0.8410*	0.6642	0.0211
AC 868	2.5385**	−0.8216	16 0034**	1.8729**	−1.7367**	4.2053*	−0.0114
AC 869	0.0786	0.6465	−13.7499**	−0.8663*	−1.3090**	−12.5858**	−0.0549
AC 870	−1.1548	0.7598	−5.1554*	0.1367	−1.0201*	−2.4524	0.0119
AC 871	−3.0892**	6 2465**	−12.4165**	−1.3557**	−1.0923*	−9.5469**	0.2094**
AC 872	3.1752**	10.4131**	8 9646**	0 1954	0.3643	11.5176**	−0.1493**
S.E. (g)	0,7842	0.5891	2,0363	0.3906	0 3453	1.4790	0.0443
Testers							
AC 873	−1.2072*	4.0548**	0 7001	−0.3942	−1.0034**	−1.7001*	−0.0109
AC 874	0.6981	−4,9572**	6.5881**	1.1662**	1.0398**	6 9022**	0.0045
AC 875	0.5091	0.9024	−7.2882**	−0.7720**	−0.0364	−5,2021**	0.0064
S.E. (gi)	0,4295	1.0756	1.1154	0.2140	0.2170	0,8101	0.0243

*Significant at 5% level; **Significant at 1% lavel.

1	2	3	4	5	6	7	8
AC 869 × AC 874	2.9159*	−2·8698	−15.6968**	−0.8234	−0.3599	−15.1176**	0.1454
AC 870 × AC 874	2.6759	9.9202**	1.9832	−0.5034	−0.5499	3.4024	0.0814
AC 871 × AC 874	1.5159	7.0402**	−14.9668**	−0.2634	−1.3298	−13.0076**	0.0674
AC 872 × AC 874	2 0858	5.4702**	− 6.9168	1 5366*	−1.8598*	− 6.2376*	0.3994**
AC 863 × AC 875	0.6559	0.4502	−21.4168**	−0.8634	− 1.0999	−26.2976**	0.1806*
AC 864 × AC 875	3.0859	9.0202**	−12.2868**	−1.7834*	0.9301	−20.1476**	0.0636
AC 865 × AC 875	7.6559**	0.6702	4.5032	0.5266	0.8001	3.8324	−0.1184
AC 866 × AC 875	−1.3841	−0.1898	−11.3568**	−1.4134*	0.0002	−8.5076**	0.2156*
AC 867 × AC 875	5.8459**	4.0502*	10 4532*	0.1666	0.7402*	8.3824**	−0.0833
AC 868 × AC 875	− 2.1241	7.9702**	−16.3468**	−2.0134*	0.0601	−14.5776**	0.3706**
AC 869 × AC 875	6.5759**	8.1302**	− 1.3768	0 3466	0.8501	1.3524	0.1936*
AC 870 × AC 875	3.8959*	3.7302*	− 5.7868	.5465	1.2301	−8.4976**	0.0154
AC 871 × AC 875	0.1658	2 6598	9.1132*	0.3066	1.5702*	7.1124*	0.1226
AC 872 × AC 875	0 2559	1.3702	9.6432*	−0.2734	3.1501**	9.9124**	−0.0554
S E. (ij)	1.3583	1.8630	3 5271	0.6765	0.6847	2.5618	0.0768

*Significant at 5% level.

**Significant at 1% level.

TABLE 4 Estimates of specific combining ability effects

Hybrids	Plants height	Days to maturity	Plant weight	Individual bulb weight	Number of bulbs per plant	Yield of bulbs per plant	Shape index
AC 863 × AC 873	−5.7741**	−0.7898	12.5662**	1.1966	−1.7499*	11.7724**	−0.2703**
AC 864 × AC 873	−3.6141*	−12.7798**	11.7632**	−0.6534	−0.0199	15.1724**	−0.3144**
AC 865 × AC 873	−2.1141	−5.4598*	10.5232*	0.4166	−0.4798	11.4524**	−0.1243
AC 866 × AC 873	−6.4141**	−4.3793*	−4.3068*	−0.4434	−0.2399	1.4024	−0.3714**
AC 867 × AC 873	−4.8741**	−13.0098**	5.9032	−0.4534	−0.6901	13.9324**	−0.1034
AC 868 × AC 873	0.0759	−7.9998**	20.0232**	1.3866*	0.8901	15.6124**	−0.3284**
AC 869 × AC 873	−9.4641**	−5.2698*	17.0932**	0.5166	−0.4199	13.8024**	−0.3104**
AC 870 × AC 873	−6.4651**	−13.0498**	3.8332	−0.0434	−0.6529	5.8324*	−0.0654
AC 871 × AC 873	−1.6541	−4.3598*	5.8532	0.0266	−0.2198	5.7524*	−0.2474**
AC 872 × AC 873	−2.3241	−6.8293**	−2.7268	−1.2234	−1.2493	−3.6276	−0.3504**
AC 863 × AC 874	5.3659**	0.3192	8.8332*	−0.0334	3.2001**	14.3724**	0.1136
AC 864 × AC 874	0.5459	4.5902*	0.6032	2.6566**	−0.5999	5.0224	0.1356
AC 865 × AC 874	−5.5141**	4.7702*	−15.0168**	−0.9134	−0.2098	−15.3776**	0.2364**
AC 866 × AC 874	−7.8159**	4.6702*	11.6632**	2.0266**	0.3501	7.1024*	0.1844*
AC 867 × AC 874	−0.9441	8.9602**	−16.3568**	0.4265	−1.3898*	−22.4276**	0.2114*
AC 868 × AC 874	2.0759	0.0502	−3.2168	0.9365	−0.8899	−1.2576	−0.0456