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COMBINING ABILITY ANALYSIS FOR YIELD AND SOME OF ITS ASSOCIATED CHARACTERS IN CUCUMBER (CUCUMIS SATIVUS L.)

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ABSTRACT

Four genetically diverse parents were selected and crossed in a full diallel mating design involving the parents, direct F1s and reciprocal F1s. These parents were evaluated alongside with their 6 direct F1s and 6 reciprocal F1s in a randomized complete block design in 3 replications. Combining ability showed the dominance of additive gene action for all the traits under study. The result showed significant differences among the parents for all the characters except for number of days to emergence. The relative magnitude of GCA / SCA variance ratio was greater than unity suggesting the preponderance of additive gene action for all the characters under investigation. Based on an overall evaluation of GCA effects and per se performance, the parents Cu 100 and Cu 999 emerged as good general combiners. Among the crosses, Cu 100 x Cu 999 was considered best because it recorded highest per se performance for fruit yield.

Keywords: Cucumber, full diallel mating design, combining ability, gene action.

1. INTRODUCTION

Cucumber (*Cucumis sativus* var. *sativus* L.) is a member of an economically important family Cucurbitaceae which includes squash (*Cucurbita* spp.), watermelon [*Citrullus lanatus* (Thunb.) Matsum. & Nakai], and melon (*Cucumis melo* L.). After tomato (*Solanum lycopersicum* L) and watermelon (Robinson and Decker-Walters, 1997).

The demand for cucumber in recent years is on the increase in Nigeria, due to the continued overwhelming importance of cucumber's health benefit along with skin care. In spite of its relevance, low yields are obtained despite the high potential yield that can be achieved. The wide gap between the actual yields obtained and the potential yields is partly due to the growing of unimproved varieties by majority of farmers.

Thus, development of improved and high yielding cucumber hybrids through the exploitation of combining ability can help reduce this gap significantly. For this, a breeder needs to identify suitable breeding methodology, which primarily depends upon the combining ability, nature and magnitude of different types of gene actions and overall inheritance pattern for yield and yield contributing characters. Diallel mating design is widely used in plant breeding research to obtain information on genetic effects for a fixed set of parental lines or estimates of general combining ability, specific combining ability and reciprocal effects. Therefore, four genetically diverse parents viz., Cu999, Cu100, Cu 971 and Songhai local were subjected to diallel mating in the present study.

2. MATERIALS AND METHODS

The experiment was conducted at the Greenhouse and Research Farm of Federal University of Technology Owerri, Nigeria. This study was taken up by crossing four diverse cucumber genotypes in a full diallel mating design. Table 1 represents the cucumber genotypes and their sources used in the present investigation . Hand pinching (of the staminate flowers off the seed parent plants and pistillate flowers off the pollen parents) and pollination method were used as crossing method. The 4 parental lines, along with their 6 direct F_1s and 6 reciprocal F_1s progenies were evaluated using Randomized Complete Block Design in 3 replications. The experimental field size measuring 22.1m by 11.7m (258.57m^2) (0.025857ha) was marked out using measuring tape, rope and pegs. Seeds were sown using a spacing distance of 0.5cm x 0.5cm in a plot size of 1.5m x 1.0m (1.5m ^{2}) each, 0.8m and 0.5m alleys separated adjacent blocks and plots respectively. Regular weeding was done every two weekly interval using hoe. Observations were recorded on six randomly selected plants for 15 quantitative traits. The mean data were subjected to analysis of variance and the estimates of variance for general combining ability, specific combining ability and reciprocal effect were computed by Method 1 (Model I) as suggested by Griffing (1956a and b).

Table 1. Cucumber genotypes and their sources.

S/N	Genotypes	Origin
1.	‘Songhai local’	ADP
2.	‘Cu 100’	THAILAND
3.	‘Cu 971’	THAILAND
4.	‘Cu 999’	THAILAND

NIHORT: National Horticultural Research Institute Kano, Nigeria.
ADP: Agricultural Development Programme, Owerri,Nigeria.Thailand Agro Seed Company, Owerri, Nigeria.

3. RESULTS AND DISCUSSION

Analysis of variance revealed significant differences among genotypes except for days to emergence (Table 2). Further analysis revealed significant mean squares due to the parents, direct F_1 and reciprocal F_1 (Table 3 and 4). The result of the mean performance of parents and their hybrids showed that hybrids had higher means than the parental lines for almost all the studied parameters; days to 50%emergence, days to male flower initiation, days to female flower initiation, number

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of pistillate flower per plant, days to maturity, number of branches, vine length, leaf area index, number of fruits, fruit length, fruit girth, fruit weight and fruit yield, with the exception of number of leaves where the parental lines had higher value compared to hybrids. These results were in agreement with the findings of Gharib (1991), Darwish (1992) and El-Mahdy *et al*. (1992) who recorded highly significant differences among parents and hybrids for total and marketable yield on weight and number basis, Samir and Ismail (2015) reported similar results in wheat.

Table 2. Analysis of variance showing the genotypic differences of the studied plant attributes derived from 4 x 4 diallel cross.

Source of variation	Df	DE	D50%E	N0L8WAP	LAI8WAP(cm)	N0FPP	FL(cm)	FG(cm)	FWPP(kg)	TFY ton ha-1
Block	2	3.94**	7.93**	30.94**	198.68	2.01	2.23	0.38	0.42**	7.25**
Genotype	15	0.68	1.38*	96.19**	3597.81**	18.99**	84.32**	11.86**	0.86**	22.92**
Error	30	0.49	0.83	1.58	155	0.75	4.13	0.4	0.05	0.88
CV (%)		17.24	18.52	4.55	9.02	13.02	7.29	9.12	16.02	11.2

DE -Days to emergence, D50%E -Days to 50% emergence , DMFI - Days to male flower initiation, DFFI - Days to female flower initiation, N0PFPP - Number of pistillate flower per plant, DM -Days to maturity, N0B8WAP - Number of branches at 8WAP, VL 8WAP(cm) - Vine Length at 8WAP, N0L8WAP - Number of leaves at 8WAP, LAI8WAP - Leaf Area Index at 8WAP(cm), N0FPP - Number of fruits / plant, FL(cm) - Fruit length(cm), FG(cm) - Fruit girth(cm), FWPP(kg) - Fruit weight /plant, TFY - Total fruit yield ton ha-1

Table 3 Mean Performance of the Parental lines, their Direct F1 and Reciprocal F1 of the growth traits of F1 generation in 4x4 diallel cross of cucumber.

Genotype	D50%E	DMFI	DFFI	N0PFPP	DM	N0B8WAP	VL8WAP(cm)	N0L8WAP	LAI8WAP(cm)
Parents									
Cu 999	3.50b	23.00e	26.00e	6.33e	48.00f	3.00a	238.30a	38.33a	202.43a
Cu100	5.17b	25.33e	29.00e	10.67a	49.67f	1.67e	184.47e	31.03c	158.12c
Cu971	5.83a	27.33e	31.33d	6.83e	52.67e	1.67e	103.38i	22.40h	101.85h
Songhai local	5.33a	30.33a	36.00a	6.67e	56.00a	0.33f	103.92i	19.623i	89.53h
Direct F_1									
Cu 999 x Cu100	4.25b	23.33e	26.00e	8.50d	47.67f	2.67b	224.59b	36.50a	188.50a
Cu 999 x Cu971	4.25b	24.17e	27.33e	6.83e	49.00f	3.00a	186.39d	19.30b	162.44b
Cu 999 x Songhai local	4.17b	25.17e	28.33e	6.50e	50.50f	2.33c	174.91f	29.67d	146.26d
Cu100 x Cu 971	5.33a	25.83e	29.67e	9.33b	51.50f	1.67e	157.56h	27.91e	129.34e
Cu 100 x Songhai local	4.83b	27.50e	31.33d	8.67c	52.00f	2.00d	162.04g	27.08e	122.10f
Cu971 x Songhai local	5.92a	28.83c	33.33b	6.50e	53.33d	1.33e	105.23i	20.71i	99.23h
Reciprocal F_1									
Cu100 x Cu 999	4.50b	24.67e	27.50e	9.50b	48.33f	2.33c	240.10c	32.87b	183.44a
Cu971 x Cu 999	4.92b	25.67e	29.33e	7.00d	50.67f	2.00d	168.67f	28.50e	152.46c
Cu971 x Cu 100	5.67a	26.17e	29.67e	8.00e	51.50f	1.33e	139.65h	24.67f	123.57f
Songhai local x Cu 999	4.50b	27.67e	31.83d	6.50e	52.67e	2.33c	154.55h	26.88e	136.49e
Songhai local x Cu 100	5.33a	28.00d	32.33c	8.00e	53.67c	1.33e	132.39h	23.45g	116.73g
Songhai local x Cu 971	5.25b	29.50b	33.50b	7.00d	54.53b	1.00f	104.46i	19.96i	95.65h
Grand mean	4.92	26.41	30.16	7.68	51.36	1.88	158.8	27.6	138.01
Parental mean	4.96	26.5	30.58	7.63	51.59	1.67	157.52	27.85	137.98
Direct F_1 means	4.79	25.81	29.33	7.72	50.67	2.17	168.45	23.97	141.31
Reciprocal F1 means	5.03	26.95	30.69	7.67	51.9	1.72	156.64	26.86	134.72
CV%	18.52	4.36	7.73	11.72	2.24	23.52	9.21	4.55	9.02

*Means along the column with the same letter are not significantly different.

Table 4: Mean Performance of the Parental lines, their Direct F1 and Reciprocal F1 of the yield attributes of F1 generation in 4 x4 diallel cross of cucumber

Genotype	N0FPP	FL(cm)	FG(cm)	FWPP	TFY ton ha-[1]
Parents					
Cu 999	6.67e	36.99a	11.03a	2.44a	9.16d
Cu100	12.25a	23.73f	5.78f	1.52f	13.85a
Cu971	5.33g	32.53c	7.04c	1.02g	6.57h
Songhailocal	3.33h	19.53h	4.50g	0.72i	4.47i
Direct F1					
Cu 999 x Cu100	8.52c	32.30c	9.17b	2.27b	11.81b
Cu 999 x Cu971	6.37e	35.02b	10.11b	1.84d	8.92d
Cu 999 x Songhailocal	5.17g	28.14d	6.85d	1.58f	6.53h
Cu100 x Cu 971	9.40c	27.51e	6.24e	1.29g	10.87c
Cu 100 x Songhailocal	8.42c	21.35h	4.77f	1.01i	8.63e
Cu971 x Songhailocal	4.23h	26.42f	5.97e	0.89i	5.90i
Reciprocal F1					
Cu100 x Cu 999	10.25b	28.35d	6.82d	1.98c	12.26b
Cu971 x Cu 999	5.69f	34.46b	9.16b	1.66e	8.19f
Cu971 x Cu 100	6.92d	29.12d	6.98d	1.18h	9.36d
Songhailocal x Cu 999	4.17h	25.84f	6.94d	1.28g	5.36i
Songhailocal x Cu 100	5.92e	20.66h	4.53g	0.88i	7.023G
Songhailocal x Cu 971	3.83h	24.25g	5.13g	0.76i	5.13i
Grand mean	6.65	27.89	6.94	1.4	8.38
Parental mean	6.9	28.2	7.09	1.43	8.51
Direct F1 mean	7.02	28.46	7.19	1.48	8.78
Reciprocal F1 mean	6.13	27.11	6.59	1.29	7.89

Combining ability

Combining ability was defined by Acquaah (2007) as the performance of a line with others in a cross. It is a useful breeding method in successful prediction of genetic capability of parental lines and crosses Singh et al. (2013). The combining ability analysis revealed highly significant (P<0.01) mean squares due to GCA for all the characters (Table 5). However, significant (P< 0.05) mean squares due to Reciprocal effect was recorded for vine length (cm), number of leaves, number of fruits, fruit length (cm), fruit girth (cm) and total fruit yield per hectare (t ha-1). Maternal and non-maternal reciprocal effects played an important role in the inheritance of these traits. SCA was statistically non-significant (P> 0.05) for all the characters indicating that additive gene effect played major important role in the genetic control of the traits under study than the non-additive (Table 5). As a consequence of negligible effects of the non-additive gene action in the present study, breeding approaches such as reciprocal recurrent selection, diallel selective mating, bi-parental mating and multiple cross would be useful breeding approaches for improving fruit yield potential from potential breeding material identified. These findings were in agreement with those reported by Hormuzdi and More who had earlier reported a significant role for GCA variance in fruit length and diameter amongst all the traits studied. The results contradict with the findings obtained by Chikeze et al., (2018). Such variations in the results may arise from differences in the genetic backgrounds of the varieties used in the various studies.

The GCA of the yield and yield component traits of the genotypes showed that ‘Cu 999’ had negative GCA effect in days to 50%emergence, days to male flower initiation, days to female flower initiation, number of pistillate flower per plant and in days to maturity but positive and significantly higher in number of branches at 8WAP, vine length at 8WAP, number of leaves at 8WAP, leaf area at 8WAP, number of fruits per plant, fruit length, fruit girth, fruit weight per plant and total fruit yield ton/ ha (Table 6). However, the GCA of ‘Cu 100’ was positive and significantly higher in number of pistillate flower/plant (1.49**), number of fruit/plant (2.59**), and total fruit yield ton/ ha (2.58**) than the rest of the genotypes, followed by ‘Cu 999’. Days to male and female flower initiations showed negative GCA effect in ‘Cu 999’ and ‘Cu 100’. In earliness to floral initiation, it showed that ‘Cu 999’ and ‘Cu 100’ genotypes are good combiners for early flower appearance. Moreover, the GCA of ‘Cu 999’ and ‘Cu 971’ were positive and significantly higher in fruit length and fruit girth than other genotypes. In terms of marketable fruit size, it showed that ‘Cu 999’ and ‘Cu 971’ genotypes are good combiners for fruit size. Apart from ‘Cu 999’ and ‘Cu 971’ for marketable fruit size, ‘Cu 999’ and ‘Cu 100’, were good general combiners in almost all the traits under study. In an earlier evaluation study, these genotypes maintained a relatively better performance in all the traits than the rest (Umeh et al., 2019).

Table 5. Analysis of variance for combining ability mean squares of some quantitative traits of cucumber genotypes from 4x4 diallel cross.

Source of variation	DF	Days to 50%emergence	Days to male flower initiation	Days to female flower initiation	Number of pistillate flower per plant	Days to maturity	Number of branches at 8WAP	Vine length at 8WAP(cm)	Number of leaves at 8WAP	Leaf area index at 8WAP(cm)	Number of fruits per plant	Fruit length(cm)	Fruit girth(cm)	Fruit weight per plant	Total fruit yield per hectare tha-1
GCA	3	6.14**	63.75**	110.02**	23.88**	80.91**	6.25**	25747.05**	451.41**	17663.21**	85.69**	405.01**	53.71**	4.05**	106.99**
SCA	6	0.03	0.24	0.68	0.28	0.73	0.42	71.93	0.51	89.01	0.39	1.04	0.84	0.05	1.91
GCA/SCA		-0.83	-1.21	-2.75	-5.44	-2.21	3.29	-22.51	-52.55	-33.16	-29.49	-16.22	15.14	0.5	12.88
Reciprocal	6	0.36	2.77	4.88	0.88	3.03	0.44	629.47*	14.26**	73.92	4.25**	7.24*	1.94**	0.06	1.89**
Maternal	3	0.59	5.44	9.3	1.65	5.85	0.53	1028.13**	24.27**	143.92	8.48**	13.38*	2.48**	0.12	3.70**
Non-maternal	3	0.12	0.1	0.47	0.1	0.22	0.36	230.81	4.25	3.92	0.03	1.1	1.40*	0.01	0.08
Error	30	0.83	6.17	5.43	0.81	5.02	0.19	213.71	1.58	155	0.75	4.13	0.4	0.05	0.88

Table 6. Estimate of general combining ability effects (gi) for each parent of the studied traits.

Parents	D50%	DMFI	DFFI	N0PFPP	DMAT	N0B8WAP	VL8WAP	N0L8WAP	LAI8WAP	NFP	FL	FG	FWP	TFY_HA
Cu999	-0.72**	-1.82*	-2.36**	-0.49*	-2.00**	0.71**	39.45**	5.28**	33.80**	0.03	4.37**	1.95**	0.54**	0.55*
Cu100	0.11	-0.64	-0.84*	1.49**	-0.86*	-0.04	14.39**	1.72**	9.50*	2.59**	-2.04**	-0.68**	0.06	2.58**
Cu971	0.45*	0.45	0.53	-0.39*	0.63	-0.17*	-25.21**	-2.78**	-17.21**	-0.76**	2.34**	0.27*	-0.19**	-0.69*

Songhailocal	0.16	2.01**	2.68**	-0.61*	2.23**	-0.50**	-28.63**	-4.22**	-26.07**	-1.85**	-4.67**	-1.54**	-0.42**	-2.44**
SE(gi)	0.16	0.44	0.41	0.16	0.4	0.08	2.58	0.22	2.2	0.15	0.36	0.11	0.04	0.17

*, ** Significant at 5% and 1% levels of eventuality, respectively

The specific combining ability (SCA) effects of the yield and yield component traits of the hybrid 'Cu999 x Cu 100' had a higher mean value of SCA effect in number of pistillate flower/plant, number of fruit/plant, fruit length and girth, fruit weight/plant and total fruit yield ton ha-1 than the other hybrids (Table 7). The hybrid 'Cu 999 X Songhai local' had negative SCA effect in all the traits except in number of days to maturity, number of branches at 8WAP and vine length at 8WAP. The hybrid 'Cu 100 X Cu971' had negative SCA effect in all the traits except number of days to 50%emergence , days to maturity, vine length at 8WAP, fruit length and fruit girth. Thus, the crosses, 'Cu 999 X Songhai local', and 'Cu 100 X Songhai local' were good specific combiners in days to 50% emergence and in days to male and female flower initiations. Also, 'Cu999 X Cu 100' was good specific combiner in number of pistillate flower per plant, leaf area index, number of fruit per plant, fruit length, fruit girth and total fruit yield ton/ha. These crosses with higher specific combining ability effects were useful to obtain high performing hybrids. This perhaps could be because they involved parents with high - high, high -low and low - low general combining ability effects which indicated the presence of additive, dominance and epistatic gene effects for controlling the traits (Chikezie et al., 2018). Also, the superiority of cross combinations involving high - low, or low - low general combiners as parents may be attributed to the genetic diversity among parents, in the form of number of heterozygous loci of the parents involved in the cross combinations (Kumar et al., 2006).

The reciprocal effects of the yield and yield component traits of the cross combinations;' Cu 100 x Cu999 ', 'Cu 971x Cu 999', 'Songhai local x Cu 999' and 'Songhai local x Cu 100' had desirable reciprocal effect in days to 50%emergence and in days to male and female flower initiations. The hybrids, 'Cu971 x Cu 100' and 'Songhai local x Cu 100' showed desirable positive reciprocal effect in number of pistillate flower/plant. All the hybrids had negative reciprocal effect in days to maturity except the cross combination of Cu971 x Cu 100. The hybrid 'Songhai local x Cu 100' was positive and recorded the highest significant values for vine length at 8WAP, number of leaves at 8WAP and number of fruits per plant. 'Songhai local x Cu 100' and 'Cu971 x Cu 100' were the best reciprocal combiners for number of fruits per plant, 'Cu 100 x Cu999' had a significantly higher reciprocal effect in fruit length and fruit girth, and thus was the best reciprocal combiner for the traits. In fruit weight per plant, 'Cu 100 x Cu999' was the best combiner while for total fruit yield per hectare; the hybrids 'Songhai local x Cu 971' and 'Cu 100 x Cu999' were the best combiners (Table 8). The significant higher values for most of the traits for reciprocal effect, suggested that maternal and non-maternal effects played an important role in the control and inheritance of these traits, therefore, the transfer of desirable traits could probably be easier with the production of cytoplasmic male sterility (CMS) lines. On the other hand, the use of reciprocal crosses could be used for different purposes in hybrid seed production. These results were in consonance with the findings of Golabadi et al. (2015) in cucumber. It is worthy to note that in some of the traits investigated, parents with high GCA effects produced hybrids with low SCA and Reciprocal effects. This may be due to lack of complementation of the parental genes. On the other hand, parents with low GCA effects produced hybrids with high SCA and Reciprocal effects which can be attributed to complementary gene effect. Similar results were reported by Laxuman et al. (2012), Singh et al. (2013) in Momordica charantia L., Hussien and Hamed (2015) in Telfairia occidentalis Hook F., Reddy et al. (2013) in Abelmoschus esculentus (L.) Moench and Chikezie et al. (2018) in Cucumis sativus L.

Table 7. Estimates of specific combining ability effects (sij) for each cross combination of all studied traits.

Crossess	D50%E	DMFI	DFFI	N0PFPP	DM	N0B8WAP	VL8WAP(cm)	N0L8WAP	LAI8WAP(cm)	N0FPP	FL(cm)	FG(cm)	FWPP	TYFton ha-1
Cu999 X Cu 100	0.07	0.05	-0.2	0.32	-0.5	0.04	2.18	0.08	4.68	2.11	0.24	0.12	0.13	0.22
Cu 999 X Cu 971	-0.07	-0.11	0.01	0.11	-0.15	0.08	4.49	0.12	2.86	0.01	0.14	0.47	0.05	-0.36
Cu 999 X Songhailocal	-0.03	-0.18	-0.4	-0.07	0	0.25	0.63	-0.38	-4.36	-0.17	-0.6	-0.46	0.09	-0.19
Cu 100 X Cu971	0.02	-0.22	-0.2	0.18	0.37	-0.17	0.63	-0.24	-3.83	0.32	0.13	0.08	-0.03	0.05
Cu 100 X Songhailocal	-0.11	-0.03	-0.2	-0.22	0.1	0.33	-4.9	0.17	-2.01	-0.22	-0.17	-0.07	-0.1	0.1
Cu 971 X Songhailocal	0.05	0.3	0.05	0.07	-0.28	-0.04	2.66	-0.25	2.71	0	-0.22	-0.12	0.04	0.09
SE(gij)	0.29	0.8	0.75	0.29	0.72	0.14	4.72	0.41	4.02	0.28	0.66	0.2	0.07	0.3

D50%E -Days to 50% emergence , DMFI - Days to male flower initiation, DFFI - Days to female flower initiation, N0PFPP - Number of pistillate flower per plant, DM -Days to maturity, N0B8WAP - Number of branches at 8WAP, VL 8WAP(cm) - Vine Length at 8WAP, N0L8WAP - Number of leaves at 8WAP, LAI8WAP - Leaf Area Index at 8WAP(cm), N0FPP - Number of fruits / plant, FL(cm) - Fruit length(cm), FG(cm) - Fruit girth(cm), FWPP(kg) - Fruit weight / plant, TFYton ha-1 - Total fruit yield ton ha-1

Table 8. Estimate of reciprocal effects r(ji) for the studied traits.

Reciprocal F1	Days to 50%emergence	Days to male flower initiation	Days to female flower initiation	Number of pistillate flower per plant	Days to maturity	Number of branches at 8WAP	Vine Length at 8WAP(cm)	Number of leaves at 8WAP	Leaf Area at 8WAP(cm)	Number of fruits per plant	Fruit length(cm)	Fruit girth(cm)	Fruit weight per plant	Total fruit yield per hectare tha-1
Cu 100 x Cu999	-0.13	-0.67	-0.75	-0.5	-0.33	0.17	12.13*	1.82**	2.53	-0.87*	1.98*	1.18**	0.15	0.53
Cu 971x Cu 999	-0.33	-0.75	-1	0.08	-0.83	0.5	8.86	1.72**	4.99	0.34	0.28	0.48	0.09	0.22
Cu971 x Cu 100	-0.17	-0.17	0	0.67	0	0.16	8.96	1.62**	2.88	1.24**	-0.8	-0.37	0.06	0.34
Songhailocal x Cu 999	-0.17	-1.25	-1.75	0	-1.08	0	10.18*	1.39*	4.89	0.5	1.15	-0.05	0.15	-0.15
Songhailocal x Cu 100	-0.25	-0.25	-0.5	0.33	-0.83	0.33	14.83*	1.82**	2.68	1.25**	0.35	0.12	0.05	0.29
Songhailocal x Cu 971	0.33	-0.33	-0.08	-0.25	-0.6	0.17	0.38	0.38	1.79	0.2	1.08	0.42	0.07	-0.07
SE r(ji)	0.37	1.01	0.95	0.37	0.91	0.18	5.97	0.51	5.08	0.35	0.83	0.26	0.09	0.38

D50%E -Days to 50% emergence , DMFI - Days to male flower initiation, DFFI - Days to female flower initiation, N0PFPP - Number of pistillate flower per plant, DM -Days to maturity, N0B8WAP - Number of branches at 8WAP, VL 8WAP(cm) - Vine length at 8WAP, N0L8WAP - Number of leaves at 8WAP, LAI8WAP - Leaf Area Index at 8WAP(cm), N0FPP - Number of fruits / plant, FL(cm) - Fruit length(cm), FG(cm) - Fruit girth(cm), FWPP(kg) - Fruit weight / plant, TFYton ha-1 - Total fruit yield ton ha-1

4. CONCLUSION

The additive gene action has been exploited more in cucumber, whereas the non-additive variance which is outcome of dominance and epistasis gene interaction remains to be utilized. This can be exploited for further improvement of cucumber through systematic breeding programme for the targeted environment. As a consequence of negligible effects of the non-additive gene action in the present study, breeding approaches such as reciprocal recurrent selection, diallel selective mating, bi-parental mating and multiple cross would be useful breeding approaches for improving fruit yield potential from potential breeding material identified. Finally, the parents Cu 999 and Cu 100, which possess favorable genes for fruit yield enhancement, could be exploited for use in new hybridization programs aimed at improving fruit yield of cucumber. The Cu 100 genotype was found capable of increasing fruit yield by increasing number of pistillate flowers per plant and number of fruits per plant, while the Cu 999 genotype was able to increase fruit size by increasing the vine length, number of leaves and leave area of the crop. The hybrid 'Cu999 X Cu 100' cross was found applicable in hybridization programs aimed at improving fruit yiel

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