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COMBINING ABILITY IN FORAGE SORGHUM (*SORGHUM BICOLOR* L. MOENCH)

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SUMMARY

General and specific combining ability variances and their effects were studied for nine characters in line x tester mating design in forage sorghum. Study indicated the estimates of variance among line with respect to gca was observed highly significant for all the characters and variance among testers with respect to gca was recorded highly significant for all the attributes. The variances among crosses due to interaction between lines x testers genotypes with respect to sca showed highly significant for all the traits.General combining ability effects and *per se* performance among the lines G-48, Pant Chari-3, UP Chari-1, HC-308 and HC-171were emerged as good general combiners. F_1's hybrids *i.e.*UP Chari-4 x HC-171, UP Chari-4 x HJ-541, Pant Chari-3 x HC-308 and CSV-15 x HJ-541were identified as best specific combiners for maximum attributes including green fodder yield for other contributing traits, which may be utilized for obtaining transgressivesegregants in the next generation and also could be exploited for development of hybrids.

Key words : *Sorghum bicolor*, combining ability

Sorghum is one of the most important fodder crops in the rain fed conditions of India as well as in Uttar Pradesh. The area under high forage yielding varieties is negligible in Western Uttar Pradesh. Hence, it is essential to develop superior varieties with a significant superiority in term of green fodder yield. Traits like grain and fodder yield are governed by polygenes with complex gene action, hence understanding the gene action would help plant breeders in selection appropriate breeding method. In addition, efficient transmission of desirable genes from selected parents to their progeny needs firm knowledge about gene action. At present sorghum is mainly used for grain and fodder and is one of the common grain sorghum which are rich in sugar juice can be used for sugar production. This crop is belongs to C_4 type of photosynthesis mature earlier under high temperature and short days. Cultivated sorghum are grouped into four main types based on primarily use of sorghum *viz.*, Grain sorghum, Sweet sorghum, Broom sorghum and Sudan grass etc. it also has greater potential for alcohol production by virtue of their high stem sugar concentration. In some developed countries it is used for preparation of syrup and alcohol for industrial purpose (Wadikar *et al.*, 2018). Globally sorghum is grown all over the world in more than 86 countries having area around 38 million ha under cultivation having annual grain production about 58 million tonnes. India is an agricultural country and has the largest livestock population in the world. Availability of green fodder plays an important role in livestock security. In India only 3.4% area under pasture and livestock are generally maintained on poor quality grasses available in the pastures or are stall fed, mainly on crop residues. India is already deficit in feed and fodder *viz.*, dry fodder (22%), green fodder (62%) and concentrates (64%). These shortages will further continue to exit because according to livestock census, 2019, India supports 20% of the livestock population of the world on only 2.3% geographical area having highest numbers of livestock (67.8 million) in Uttar Pradesh. The major constraint for low fodder production and productivity is the non availability of improved varieties of forage crops with good fodder quality to the farmers. For any dairy industry supply of nutritious fodder is a pre-requisite for its success. Forage sorghum is nutritive forage, more palatable with high dry matter production along with high dry

matter digestibility as compared to other *kharif* and summer season fodder crops. Generally, high LAI, LS ratio and plant height mainly contribute towards fodder yield and quality in forage sorghum (Satpal *et al.,* 2021) As area for fodder production is decreasing continuously over the decades, in such situation need of cultivation high yielding fodder varieties with better quality in forage sorghum (Kumari *et al*., 2020).

MATERIALS AND METHODS

In the present study, F_1's material was obtained from crossing twelve lines namely, UP Chari-4, G-48, HC-260, UP Chari-2, SSV-84, Pusa Chari-6, Pant Chari-2, HC-136, Pant Chari-7, Pant Chari-3, UP Chari-1 and CSV-15 and four Testers *viz*., HC-308, HC-171, UP Chari-3 and HJ-541 as per line x tester mating design in *Kharif* season 2018. The experiment was laid out with 48 F_1's progenies and their respective parentsin randomized block design with three replicationsat Crop Research Center, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut. Each F_1's and parents were grown in two rows 5.0 m long with the spacing of 30 cm. The recommended inter cultural practices were followed for raising the crop. Five competitive plants from each genotype were randomly selected from each replication for recording observations on days to 50% flowering, plant height, leaf length, leaf breadth, number of leaves per plant, leaf area, stem girth, total soluble solids and green fodder yield per plant.The progeny means were used for statistical analysis. Combining ability analysis was done according to Kempthorne (1957).

RESULTS AND DISCUSSION

The components of variance for general combining ability (GCA) and specific combining ability (SCA) were highly significant for all the characters namely, days to 50% flowering, plant height, leaf length, leaf breadth, number of leaves per plant, leaf area, stem girth, total soluble solids and green fodder yield per plant. Estimates of variance due to line x tester showed highly significant for all the attributes (Table 1), indicating the preponderance of additive gene action which could be exploited for the improvement of these traits by mass selection. Similar observations have been reported earlier Chikuta *et al.* (2017). The results of analysis of variance revealed that significant variability existed among the parents with regard to all the characters except leaf breadth under investigation. Such divergences of parents lead to development of hybrids that differed significantly among themselves for all the attributes. Estimates of analysis of variance due to line showed highly significant for all the characters except leaf breadth and tester exhibited highly significant for all the traits. Further partitioning of treatment variance into parents *vs* crosses was found highly significant differences for all the characters (Table 2). These findings are in accordance with the results obtained in sorghum by Ingle *et al.* (2018). Parents among lines, out of twelve genotypes only six lines *viz*., UP Chari-4 (62.66) emerged as good general combiner for plant height, number of leaves per plant and green fodder yield. Parent G-48 (32.36) was identified as a good general combiner for all the attributes except leaf breadth. Genotype SSV-84 (43.96) appeared as a good general combiner for days to 50% flowering, plant height, leaf breadth, number of leaves per plant, leaf area and green fodder yield per plant. Line Pant Chari-7 (67.14) was found to be good general combiner forleaf area and green fodder yield per plant. Parent Pant Chari-3 (32.44) expressed as a good general combiner for all the attributes except stem girth. Genotype UP Chari-1 (45.30) considered as good general combiner for all the traits except leaf length and number of leaves per

TABLE 1
Analysis of variance for combining ability nine characters in forage sorghum

Source of variation	d. f.	Days to 50% flowering	Plant height (cm)	Leaf length (cm)	Leaf breadth (cm)	No. of leaves/ plant	Leaf area (cm^2)	Stem girth (mm)	Total soluble solids (%)	Green fodder yield/plant (g)
Line (GCA)	11	584.12**	4250.90**	124.78**	2.08**	9.31**	6700.50**	14.56**	1.88**	23935.22**
Tester (GCA)	3	67.14**	31267.22**	155.52**	5.16**	6.56**	29744.52**	68.76**	2.62**	315270.03**
Line x Tester (SCA)	33	34.44**	1319.28**	12.04**	0.60**	1.30**	2516.43**	14.44**	0.28**	8502.45**
Error	94	0.77	168.79	2.23	0.89	1.56	94.02	1.28	1.17	535.32

*Significant at 5 % probability level, and ** Significant at 1 % probability level.

TABLE 2
Analysis of variance for nine characters in parents and F1 generation of forage sorghum

Source of variation	d. f.	Days to 50% flowering	Plant height (cm)	Leaf length (cm)	Leaf breadth (cm)	No. of leaves/ plant	Leaf area (cm^2)	Stem girth (mm)	Total soluble solids (%)	Green fodder yield/plant (g)
Replication	2	1.70	56.56	0.34	0.03	0.74	93.67	0.11	0.03	243.56
Treatment	63	163.10**	3472.10**	52.78**	1.45**	4.60**	5618.54**	13.86**	2.43**	36742.56**
Parents	15	161.67**	4331.36**	56.92**	0.30	3.47**	2754.90**	7.35**	4.00**	43465.05**
Line	11	211.42**	2149.91**	59.18**	0.61	4.50**	2445.71**	5.58**	3.34**	33602.27**
Tester	3	47.70**	4167.22**	37.07**	1.42**	1.84**	4346.86**	8.54**	2.44**	64308.70**
Parents (L vs T)	1	1.23**	20711.46**	1.39**	0.56	0.03	460.03**	17.90**	15.32**	65820.83**
Parents vscrosses	1	74.53**	14508.96**	278.60**	10.41**	11.90**	67588.09**	153.90**	51.23**	127289.52**
Crosses	47	167.71**	3486.42**	55.26**	1.33**	2.54**	5458.74**	14.70**	0.78**	32376.12**
Error	126	0.68	184.35	2.56	0.04	0.47	132.42	1.34	0.16	432.78

*Significant at 5% probability level and ** Significant at 1% probability level.

TABLE 3
Estimates of general combining ability effect of line and testers with respect to eleven characters of forage sorghum

Line/Tester	Days to 50% flowering		Plant height (cm)		Leaf length (cm)		Leaf breadth (cm)		No. ofleaves/ plant	
Line	Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA
UP Chari-4	65.10	-2.00	289.01	14.923**	87.40	-0.48	7.00	-0.02	12.22	0.59*
G-48	88.23	14.89**	248.76	22.94**	75.60	2.23**	7.19	-0.25**	13.06	0.53*
HC-260	72.65	13.69**	314.23	24.36**	71.40	5.69**	7.40	0.60**	15.66	-0.15
UP Chari-2	77.00	-2.14	291.56	-8.25*	67.90	5.86**	7.34	-0.07	17.50	0.55**
SSV-84	86.05	9.53**	212.21	35.41**	74.63	-1.60	7.52	0.32**	13.43	0.56**
Pusa Chari- 6	71.46	0.57	270.54	11.34*	71.66	0.41	7.46	-0.17	15.90	0.64**
Pant Chari -2	86.37	-1.89	230.61	12.29*	78.90	-0.23	7.40	0.19**	14.60	0.61**
HC- 136	93.69	7.68**	241.16	11.28*	74.93	2.48**	8.01	0.15	14.36	0.03
Pant Chari -7	81.63	1.45	292.24	3.88	75.08	0.17	7.51	-0.18	14.39	0.14
Pant Chari -3	81.68	6.09**	224.60	37.62**	82.44	5.59**	7.21	0.55**	14.73	0.66**
UP Chari-1	77.69	8.48**	240.66	16.88**	77.80	-1.79	8.09	0.55**	13.91	-0.49*
CSV-15	86.35	9.42**	288.98	24.89*	74.22	1.70	8.14	0.70**	14.43	1.34**
Tester										
HC-308	84.60	0.87**	328.40	14.00**	71.69	- 0.12	6.70	- 0.55	16.70	10.56**
HC-171	83.89	2.07**	374.60	33.02**	79.26	2.78**	8.01	10.63**	14.40	-0.16
UP Chari-3	88.15	0.94**	277.50	19.88**	76.41	1.81**	8.03	20.17**	13.44	0.49
HJ-541	91.77	-0.14	340.81	- 0.86	70.04	1.11**	8.16	- 0.19	14.49	19.04**

Line/Tester	Leaf area (cm^2)		Stem girth (mm)		Total soluble solids (%)		Green fodder yield/ plant (g)	
Line	Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA
UP Chari-4	3676.67	-0.34	17.39	-0.48	10.43	-0.03	347.50	62.66**
G-48	342.67	15.31**	17.48	1.44**	10.55	0.91**	319.40	33.26**
HC-260	439.02	1.62	16.29	0.05	10.26	-0.02	519.00	- 0.43
UP Chari-2	350.72	34.20**	16.74	1.27**	11.68	-0.04	570.80	-2.69
SSV-84	399.84	14.78**	16.30	0.66	9.44	-0.05	529.50	43.96**
Pusa Chari-6	421.90	-3.12	17.60	-0.69	10.00	0.81**	357.00	10.78
Pant Chari -2	377.52	22.94**	18.20	0.16	9.00	-0.02	463.78	-7.23
HC-136	424.65	-0.34	17.65	0.35	7.60	-0.04	531.92	5.04

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Table 3 contd..

Pant Chari -7	393.47	15.01**	18.90	0.91	10.78	-0.03	628.45	67.14**
Pant Chari -3	425.55	24.85**	18.23	0.04	8.45	0.77**	390.63	32.44**
UP Chari-1	424.24	24.47**	18.56	1.70**	10.34	0.76**	387.24	45.30**
CSV-15	434.78	49.63**	17.99	1.88**	10.81	0.05	533.62	0.40
Tester								
HC-308	354.01	30.55**	16.57	1.60**	0.37	0.72**	556.60	36.89**
HC-171	444.62	29.46**	19.01	0.48*	0.24	0.95**	576.91	45.35**
UP Chari-3	422.31	- 7.21	18.01	-0.23	0.32	- 0.38	331.44	- 6.52
HJ-541	409.43	33.08**	23.70	1.62**	0.34	-0.26	684.32	58.33**

*Significant at 5% probability level and ** Significant at 1% probability level.

TABLE 4

Estimates of specific combining ability effect with respect eleven characters in forage sorghum

Line/Tester	Days to 50% flowering		Plant height (cm)		Leaf length (cm)		Leaf breadth (cm)		No. of leaves/ plant	
Line	Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA
UP Chari -4 x HC-308	81.44	1.47**	370.00	-7.05	72.66	-0.72	7.33	-0.32*	15.76	0.95*
UP Chari -4 x HC-171	82.87	1.43**	395.53	23.20**	77.40	-0.68	8.58	0.19*	16.90	1.14**
UP Chari -4 x UP Chari-3	87.90	0.98	306.70	-8.81	76.59	1.07	8.76	0.65**	15.43	-0.05
UP Chari -4 x HJ-541	85.64	1.80**	326.66	28.10**	78.50	2.21**	7.74	0.89**	15.21	2.22**
G-48 x HC-308	80.82	0.93	316.49	14.31*	79.33	-1.32	7.50	0.26**	15.66	0.09
G-48 x HC-171	85.00	4.72**	323.92	16.28*	72.57	2.92**	8.33	0.34**	14.99	0.19
G-48 x UP Chari-3	81.42	1.61**	271.40	17.07**	73.83	3.16**	7.82	0.29**	14.39	0.26
G-48 x HJ-541	94.88	2.17**	353.81	15.92**	72.65	1.23	7.80	-0.23*	13.09	-0.87
HC-260 x HC-308	71.73	-1.01*	312.91	-5.58	88.63	0.15	7.30	-0.05	15.03	0.08
HC-260 x HC-171	72.60	5.19**	371.94	9.43	82.79	-1.58	6.78	1.13**	15.21	0.41
HC-260 x UP Chari-3	72.78	3.34**	325.81	1.13	70.69	0.08	8.59	0.77**	13.28	1.48**
HC-260 x HJ-541	84.30	-0.62	335.28	-5.67	72.60	1.66	8.21	0.54**	15.20	0.99*
UP Chari-2 x HC-308	83.86	0.82	303.16	15.54**	78.55	1.23	7.48	-0.09	16.00	0.72*
UP Chari-2 x HC-171	81.95	3.71**	305.70	36.63**	75.38	4.76**	8.20	0.20**	15.03	-0.41
UP Chari-2 x UP Chari-3	83.81	1.05*	288.53	-10.29**	65.66	-1.43	8.41	0.04	15.80	0.13
UP Chari-2 x HJ-541	82.44	1.03*	327.79	14.15**	64.69	4.32**	8.56	0.29**	15.09	-0.52*
SSV-84 x HC-308	84.11	1.48**	224.27	48.35**	73.77	0.69	8.87	0.22**	16.60	0.34
SSV-84 x HC-171	95.17	5.57**	282.00	26.60**	74.80	-2.00*	8.65	0.37**	14.83	-0.61**
SSV-84 x UP Chari-3	86.50	0.72	280.44	16.57*	74.30	1.91*	8.22	0.33**	14.00	0.08
SSV-84 x HJ-541	77.22	4.93**	335.88	52.44**	74.80	-0.33	9.09	0.48**	15.49	-0.87
Pusa Chari-6 x HC-308	86.00	0.31	312.77	4.20	75.61	-0.82	7.43	0.11	16.02	-0.14
Pusa Chari-6 x HC-171	96.38	1.74**	357.02	-0.53	85.09	2.72**	8.23	0.72**	15.46	0.07
Pusa Chari-6 x UP Chari-3	83.00	3.58**	300.30	-4.37	73.60	0.69	7.54	0.58**	15.55	0.22
Pusa Chari-6 x HJ-541	79.98	1.36**	328.86	1.58	73.73	2.54**	8.32	0.17*	16.00	0.24
Pant Chari -2 x HC-308	84.80	-0.38	305.40	-4.98	73.86	2.76**	6.99	0.28**	16.20	-0.17
Pant Chari -2 x HC-171	87.70	2.33**	387.13	26.69**	80.73	1.34	8.26	0.20	15.46	-0.15
Pant Chari -2 x UP Chari-3	89.21	1.62**	292.70	-14.86**	75.86	1.21	8.46	0.43**	15.86	0.09
Pant Chari -2 x HJ-541	85.12	1.04*	320.30	-6.85	75.60	0.21	7.64	0.35**	15.53	-0.17
HC-136 x HC-308	94.36	0.57	309.26	20.40**	75.33	1.01	7.60	-0.15	15.40	-0.11
HC-136 x HC-171	97.25	-0.59	312.76	26.16**	77.26	0.17	9.23	0.68**	15.66	0.12
HC-136 x UP Chari-3	91.02	-1.25*	295.90	9.86	68.80	3.56**	8.47	-0.04	15.00	0.29
HC-136 x HJ-541	98.02	1.27*	301.53	-4.10	75.46	2.38**	7.98	0.49**	14.33	-0.71**
Pant Chari -7 x HC-308	82.28	2.01**	305.43	1.48	75.66	-1.39	7.16	-0.20	15.46	-0.12
Pant Chari -7 x HC-171	89.31	-0.31	367.56	-13.56**	79.66	-0.16	8.23	0.08	15.26	0.24
Pant Chari -7 x UP Chari-3	87.31	1.50**	298.30	-2.82	76.06	0.98	8.54	0.42**	14.26	-0.12
Pant Chari -7 x HJ-541	88.00	0.83	308.50	-12.22**	76.40	0.58	7.78	0.29**	15.73	0.11
Pant Chari -3 x HC-308	86.00	4.99**	271.73	5.45	85.53	3.09**	6.27	0.78**	16.73	0.81*
Pant Chari -3 x HC-171	85.00	5.09**	326.70	-10.36**	85.66	0.45	8.17	0.33**	14.13	1.03**
Pant Chari -3 x UP Chari-3	73.25	1.97**	282.20	18.75*	75.06	5.41**	7.67	-0.14	15.13	0.21
Pant Chari -3 x HJ-541	70.66	8.11**	248.48	34.57**	83.06	1.86*	8.36	0.60**	15.26	0.01
UP Chari-1 x HC-308	98.28	1.88**	307.33	4.27	76.73	1.57	8.91	0.76**	16.26	1.06**
UP Chari-1 x HC-171	96.33	-0.04	366.16	-13.05**	76.93	-1.00	8.87	-0.08	13.93	-0.11
UP Chari-1 x UP Chari-3	95.89	-0.30	300.63	0.40	73.60	0.41	8.48	0.43**	13.80	-0.01
UP Chari-1 x HJ-541	98.59	2.22**	302.10	17.73*	72.93	-0.99	8.62	-0.25*	14.40	-0.14
CSV-15 x HC-308	98.05	0.37	313.50	-9.50	78.13	-0.54	8.69	0.33**	12.40	0.89*
CSV-15 x HC-171	94.70	5.19**	389.16	16.11*	80.66	-0.78	9.10	-0.05	12.60	0.07
CSV-15 x UP Chari-3	101.37	2.88**	309.03	-11.14	77.80	1.09	8.66	0.47**	12.46	0.18
CSV-15 x HJ-541	99.90	1.94**	344.30	14.53**	77.66	6.23**	9.28	0.70**	13.26	1.64**

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Table 4 contd.

Line/Tester	Leafarea		Stem girth (mm)		Total soluble solids (%)		Green fodder yield/ plant (g)	
Line	Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA
UP Chari 4 x HC-308	380.66	16.12*	19.87	1.72*	10.36	-0.25**	514.66	19.68
UP Chari 4 x HC-171	483.32	32.29**	20.39	3.13**	10.53	0.07	586.00	78.60**
UP Chari 4 x UP Chari-3	469.09	37.76**	15.89	3.67**	10.24	-0.11	349.20	26.74*
UP Chari 4 x HJ-541	419.28	29.58**	23.18	1.82**	10.26	0.18	390.20	95.02**
G-48 xHC-308	403.89	6.79	22.45	2.23**	10.33	0.55**	581.86	7.41
G-48 x HC-171	432.67	-7.16	21.54	-0.79	9.86	0.14	586.26	9.39
G-48 x UP Chari-3	413.45	6.80	20.48	-1.16	9.67	0.15	340.90	51.03**
G-48 x HJ-541	477.07	-5.43	23.14	-0.28	8.21	0.94**	608.93	24.24*
HC-260 xHC-308	411.49	-6.65	18.58	-0.22	10.74	0.50*	583.56	-2.62
HC-260 x HC-171	387.19	71.28**	21.08	0.17	11.22	0.14	579.56	-9.04
HC-260 x UP Chari-3	492.20	41.89**	20.78	0.56	10.90	-0.08	463.56	49.91**
HC-260 x HJ-541	481.10	39.72**	21.49	-0.51	11.05	0.44*	578.16	28.25*
UP Chari-2 xHC-308	382.56	9.49	21.56	1.58*	10.60	-0.18	582.96	0.04
UP Chari-2 x HC-171	455.52	13.19*	21.07	-1.01	10.86	0.13	589.96	-5.38
UP Chari-2 x UP Chari-3	399.92	-7.08	21.23	-0.16	10.64	0.01	412.76	2.37
UP Chari-2 x HJ-541	390.51	-14.34*	22.76	-0.41	10.40	0.14	606.13	2.97
SSV-84 xHC-308	444.55	14.17*	15.61	3.73**	10.22	0.16	586.83	46.80**
SSV-84 x HC-171	470.59	15.88**	22.09	0.64	9.78	-0.13	595.53	50.52**
SSV-84 x UP Chari-3	445.30	-19.64	21.84	1.09	9.76	-0.04	538.53	77.42**
SSV-84 x HJ-541	4767.34	15.30*	24.54	2.00**	9.44	0.01	673.76	1.90
Pusa Chari-6 xHC-308	415.33	2.08	19.91	1.86*	10.27	0.16	589.60	-8.01
Pusa Chari-6 x HC-171	499.38	23.66**	20.52	0.37	10.25	0.19	588.43	-21.60**
Pusa Chari-6 x UP Chari-3	419.40	25.56**	20.61	1.15	9.76	-0.09	394.36	30.72*
Pusa Chari-6 x HJ-541	435.90	-5.08	17.88	3.37**	9.11	-0.17	678.17	60.33**
Pant Chari -2 xHC-308	366.77	31.78**	20.10	1.16*	10.22	-0.09	582.30	4.98
Pant Chari -2 x HC-171	473.84	15.12*	20.45	-0.59	10.08	-0.08	592.50	2.76
Pant Chari -2 x UP Chari-3	466.17	36.87**	19.97	-0.37	9.98	-0.07	399.57	-5.22
Pant Chari -2 x HJ-541	410.04	20.21**	21.93	-0.20	9.93	0.15	595.04	-2.52
HC-136 x HC-308	396.98	-6.20	18.00	-1.13	10.10	-0.10	591.46	-10.28
HC-136 x HC-171	503.15	39.80**	21.65	0.41	9.97	-0.18	602.96	-11.20
HC-136 x UP Chari-3	413.91	20.02**	21.01	0.46	10.97	0.73**	407.53	-21.68**
HC-136 x HJ-541	421.30	13.58*	22.60	0.26	9.92	0.05	665.13	43.16**
Pant Chari -7 xHC-308	384.67	14.81*	22.20	2.51**	10.39	0.11	613.60	44.30**
Pant Chari -7 x HC-171	459.03	-0.62	21.10	-0.70	10.12	-0.01	635.20	35.12*
Pant Chari -7 x UP Chari-3	454.48	24.25**	19.39	1.72*	10.05	0.03	585.93	10.00
Pant Chari -7 x HJ-541	422.36	-8.82	22.80	-0.09	9.53	-0.12	657.00	-21.14**
Pant Chari -3 xHC-308	379.82	36.52**	16.28	2.48**	10.50	0.18	635.40	23.20*
Pant Chari -3 x HC-171	493.80	17.29*	21.58	0.72	10.01	0.55**	643.00	8.38
Pant Chari -3 x UP Chari-3	408.91	38.19**	21.02	0.84	9.96	-0.09	357.33	82.34**
Pant Chari -3 x HJ-541	505.47	57.43**	22.88	0.91	9.74	0.06	673.20	40.76**
UP Chari-1 xHC-308	492.27	56.35**	16.47	-0.48	10.34	0.41**	583.80	50.38**
UP Chari-1 x HC-171	484.70	-11.39	21.18	2.13**	9.90	-0.10	585.26	39.43*
UP Chari-1 x UP Chari-3	443.61	-23.06**	20.31	1.95*	10.17	0.08	348.20	-2.69
UP Chari-1 x HJ-541	445.72	-21.90*	16.55	3.60**	9.95	0.13	476.53	77.12**
CSV-15 x HC-308	492.38	21.20**	13.92	3.02**	10.45	0.17	582.46	-3.68
CSV-15 x HC-171	518.22	13.14*	17.55	-1.49*	10.13	0.10	592.86	-5.70
CSV-15 x UP Chari-3	485.07	16.86*	19.38	1.03	9.29	0.53*	360.33	53.29**
CSV-15 x HJ-541	511.69	18.81**	23.61	3.47**	9.42	-0.04	669.06	62.68**

*Significant at 5% probability level and ** Significant at 1% probability level.

plant. Among the testers HC308 (36.89) was appeared good general combiner for all the attributes except leaf length and leaf breadth. Male HC-171 (45.35) possessed as a good general combiner for all the characters except number of leaves per plant and tester HJ-541 (58.33) proved as a good general combiner forleaf length, number of leaves per plant, leaf area, stem girth and green fodder yield per plant (Table 3). The finding is in close agreement with previous reports Soujanya *et al.*(2018), Parmar *et al.* (2019) and Rathod *et al.* (2020). On the basis of overall *per se* performance and general combining ability effect among the parents, G-48, Pant Chari-3, UP Chari-1, HC-308 and HC-171 were identified as good general combiners for maximum 7 to 8 characters, including green fodder yield.These four top ranking parents selected on the basis of *per se* performance involved high general combiners and may be handled in suitable breeding programme *vis a-vis* selection breeding for improvement productivity of green fodder yield.Out

of the 48 F_1's hybrids, only twenty three cross combinations *viz.,*UP Chari-4 x HC-171 (78.60), UP Chari-4 x UP Chari-3 (26.74), UP Chari-4 x HJ 541 (95.02), G-48 x UP Chari-3 (51.03), G-48 x HJ-541 (24.24), HC-260 x UP Chari-3 (49.91), HC-260 x HJ-541 (28.25), SSV-84 x HC-308 (46.80), SSV-84 x HC-171 (5.052), SSV-84 x UP Chari-3 (77.42), Pusa Chari-6 x UP Chari-3 (30.72), Pusa Chari-6 x HJ-541 (60.33), HC-136 x HJ-541 (43.16), Pant Chari-7 x HC-308 (44.30), Pant Chari-7 x HC-171 (35.12), Pant Chari-3 x HC-308 (23.20), Pant Chari-3 x UP Chari-3 (82.34), Pant Chari-3 x HJ-541 (40.76), UP Chari-1 x HC-308 (50.38), UP Chari-1 x HC-171 (39.43), UP Chari-1 x HJ-541 (77.12), CSV-15 x UP Chari-3 (53.29) and CSV-15 x HJ-541 (62.68) were found significant and positive specific combining ability effects for green fodder yield per plant (Table-4). On the basis of overall findings and green fodder yields performance the hybrids *i.e.*, UP Chari-4 x HC-171, UP Chari-4 x HJ -541, Pant Chari-3 x HC-308 and CSV-15 x HJ-541 were considered as best specific combiners for maximum attributes including green fodder yield per plant for 7 to 8 other contributing traits,which may be utilized for obtaining trangressive segregants in the next generation. These findings were supported by Parmar *et al.* (2019) and Rathod *et al.* (2020).

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