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Genetic assessment and potence ratio of various traits of okra (*Abelmoschus esculentus*) in mid hills of Himachal Pradesh

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ABSTRACT

The selection of appropriate breeding strategies for achieving desired improvements in plant breeding necessitates a thorough understanding of the mechanism of gene expression implicated in the transmission of quantitative and biochemical characteristics. Line × tester study of 30 F_1 hybrids obtained by crossing 13 parental lines was carried out to assess gene action and potence ratio of such traits in okra (*Abelmoschus esculentus* L.) during rainy (*kharif*) seasons of 2021 and 2022 at research farm of Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh. Out of 22 traits, 20 indicated the preponderance of non-additive gene action and additive gene action for plant height and inter-nodal length. UHFO-6 and UHFO-9 were the best general combiners, whereas, UHFO-2 × Pusa Bhindi-5 and UHFO-10 × Hisar Unnat were the best specific combiners. For 20 traits, proportional contribution of lines was higher than the testers for total variance. Potence ratio indicated that majority of the traits in the hybrids had over dominance gene effect. Over dominance was expressed for pod length, pod diameter, number of pods per plant, average pod weight, and pod yield per plant, etc. To maximize the entire genetic potential of hybrids and parents with excellent per se performance, okra crop development initiatives must include heterosis, combining ability, proportionate contribution of genotypes and potence ratio.

Keywords: Gene action, Inheritance, Over dominance, Potence ratio

Okra (*Abelmoschus esculentus* L.; 2n=2x=130) is a well-known and widely utilized plant in the Malvaceae family. It is a native from Ethiopia-Africa grown all around the world (tropical and subtropical climates). Okra pods are abundant in protein, carbohydrate, iron, fibre, calcium, fat and phosphorus (Petropoulos *et al.* 2018). Dried seeds are used as a coffee replacement or supplement. In 2021, India's annual okra output was approx 6.81 million MT from 0.55 million hectares of land, with a productivity of 12.38 tonnes/ha (Anonymous 2022). Okra does well in both the plains and hills, preferring warm, wet weather in the growing season. It is a seasonal vegetable crop grown in northern India during the spring, summer, and rainy seasons. It is a significant vegetable crop for both home and foreign markets.

Due to low yielding cultivars and the prevalence of different pests and diseases, the yield potential is quite low (Ranga *et al.* 2022, Sharma and Singh 2023). By speeding productivity growth, hybrid breeding has assisted in breaking through yield constraints. Furthermore, exploitation of hybrid vigour, comprehending the genetics of different traits, and quality enhancement with a focus on the export market must be prioritized in crop improvement programmes (Labroo *et al.* 2021). This kind of study not only offers a vital understanding of parental selection but also offers knowledge about the nature and magnitude of gene action affecting the inheritance of desirable traits. Furthermore, the nature and direction of dominance may be determined using additive estimations. When developing promising cultivars through hybridization, plant breeders give careful consideration to the choice of parents. The superiority of a genotype with a higher yield may or may not be inherited by its progeny. The current study aimed to identify superior hybrids by evaluating gene action, combining ability and potence ratio for both morphological and biochemical traits.

MATERIALS AND METHODS

Present study was carried out during rainy (*kharif*) seasons of 2021 and 2022 at Vegetable research farm of Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh. 30 cross combinations were developed by crossing 10 lines and 3 testers [Arka Anamika (AU), Pusa Bhindi-5 (PB), Hisar

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Unnat (HU)] in line × tester design during 2021. All the parents and their respective F_1's were planted during 2022 in randomized complete block design (RCBD) with 3 replications. The standard cultural practices recommended were followed.

Data recording and statistical analysis: Data were recorded from 10 random plants in each genotype for 22 important horticultural and biochemical traits.

Using Microsoft-Excel 365, data were statistically evaluated using line × tester analysis according to Kempthorne (1957). Furthermore, additive and dominance components of variance and proportional contribution of lines, testers and their interaction were also calculated as described by Dabholkar (1992) and Singh and Chaudhary (1997). Potence ratio was computed to determine the degree of dominance as suggested by Mather (1949).

RESULTS AND DISCUSSION

ANOVA for combining ability analysis: Mean squares (Table 1) due to crosses found significant for all the traits under study. This indicated that the experimental material had sufficient genetic diversity for different traits.

Gene action: Non-additive variances were found to be more important in the inheritance of all characteristics tested by the magnitude of σ^2GCA/σ^2SCA ratios. σ^2SCA were higher than the corresponding σ^2GCA for most of the traits except plant height and inter-nodal length (Table 2). Thus, indicating the preponderance of non-additive gene action in controlling the inheritance of traits that have higher σ^2SCA than σ^2GCA and can be improved through hybridization. Parents with a high SCA variance score imply that they are able to participate in the inheritance of this particular character to one or a few of their hybrids.

The magnitude of dominant variance (σ^2D) was higher than the corresponding additive variance (σ^2A) for most of the traits showing that non-additive gene action was pronounced in governing these traits. Further, the σ^2A/σ^2D variance ratio was less than unity for most of the traits under the present study, viz. first flowering node, number of primary branches per plant, pod length, pod diameter, days to first picking, harvest duration, dry weight, total sugar, total polyphenol and mucilage content. The predictability ratios for these traits were <0.50, again it confirmed that the inheritance of these traits are apparently controlled by non-additive gene action. The above results revealed the predominance of non-additive component of variance for the inheritance of these traits. Das *et al.* (2020) and Das *et al.* (2022) stated the significant role of both additive and non-additive gene action for the expression of multiple traits in okra and indicated a predominance of non-additive gene action in the expression of various quantitative traits, implying that the use of a population advancement method

Table 1 ANOVA for combining ability analysis in okra

S.V.	Replication	Cross	Lines	Testers	Line × Tester	Error	Total
df	2	17	9	2	18	58	128
Days to 50% flowering	3.75	73.33*	22.08*	36.91	54.11*	9.55	
First flowering node	0.22	4.18*	2.89*	1.82*	2.30*	0.27	
Plant height (cm)	1.97	2763.49*	1414.28*	12565.62*	506.64*	27.47	
Inter-nodal length (cm)	1.17	37.13*	10.30*	172.37*	10.77*	0.95	
Number of branches per plant	0.00	0.78*	0.35*	0.79*	0.48*	0.00	
Pod length (cm)	0.01	1.21*	8.15*	15.77*	6.65*	0.31	
Pod diameter (cm)	0.95*	0.09*	0.07*	0.01*	0.04*	0.00	
Number of pods per plant	2.82	53.47*	44.38	4.48	27.81*	6.12	
Average pod weight (g)	1.32	13.36*	3.90*	4.46*	10.17*	0.83	
Pod yield per plant (g)	1631.08	14094.72*	5779.70	7602.93	9577.06*	989.94	
Pod yield per hectare (q/ha)	322.09	2783.93*	1141.55	1501.74	1891.63*	195.55	
Days to first picking	15.12	75.21*	38.56*	73.61*	43.57*	8.37	
Harvest duration	-0.29	128.03*	79.77*	201.72*	58.62*	12.48	
Number of seeds per pod	1.38	108.52*	57.38*	26.86*	70.81*	5.04	
Hundred seed weight (g)	0.00	2.73*	1.13*	1.29*	1.87*	0.02	
Pod Colour at Maturity	0.02	0.81*	0.38*	0.16	0.55*	0.04	
Dry weight (g)	0.00	0.17*	0.11*	0.12*	0.09*	0.00	
Total sugar (%)	0.00	5.89*	3.19*	5.84*	3.32*	0.00	
Total polyphenol (%)	0.00	0.55	0.28*	0.35*	0.34*	0.00	
Total protein (%)	0.14	195.54*	93.11*	28.67*	134.94*	0.30	
Total nitrogen (%)	0.01	5.06*	2.40*	0.72*	3.50*	0.01	
Mucilage content (g)	0.00	0.05	0.03*	0.02*	0.03*	0.00	

Table 2 Genetic components of variances, superior parents and cross combinations identified based on GCA and SCA effects for different horticultural traits in okra

Trait	COV (Half-sib)	COV (Full-sib)	σ^2GCA	σ^2SCA	σ^2GCA/ σ^2SCA	σ^2A	σ^2D	σ^2A/σ^2D	Predictability ratio	GCA effect	SCA effect
Days to 50% flowering	-1.26	12.33	-1.26	14.85	-0.08	-2.53	14.85	-0.17	-0.20	-	UHFO-6 × HU, UHFO-4 × HU
First flowering node	0.00	0.68	0.00	0.68	0.00	0.01	0.68	0.01	0.01	-	UHFO-9 × HU
Plant height (cm)	332.48	824.68	332.48	159.72	2.08	664.96	159.72	4.16	0.81	UHFO-10, UHFO-14, UHFO-9	UHFO-5 × HU, UHFO-7 × HU
Inter-nodal length (cm)	4.13	11.54	4.13	3.27	1.26	8.26	3.27	2.22	0.72	UHFO-8, UHFO-6, UHFO-7	UHFO-2 × AA
Number of branches per plant	0.01	0.17	0.01	0.16	0.03	0.01	0.16	0.06	0.06	PB, AA	-
Pod length (cm)	0.27	2.66	0.27	2.12	0.13	0.54	2.12	0.25	0.20	-	UHFO-9 × PB, UHFO-6 × HU, UHFO-14 × AA
Pod diameter (cm)	0.00	0.01	0.00	0.01	0.00	0.00	0.01	0.00	0.00	-	UHFO-2 × PB
Number of pods per plant	-0.17	6.88	-0.17	7.23	-0.02	-0.70	28.92	-0.02	-0.05	UHFO-6, UHFO-9	UHFO-7 × AA, UHFO-6 × PB, UHFO-2 × PB
Average pod weight (g)	-0.31	2.50	-0.31	3.12	-0.10	-0.62	3.12	-0.19	-0.25	UHFO-3	UHFO-2 × PB, UHFO-14 × HU, UHFO-14 × AA
Pod yield per plant (g)	-147.99	2566.40	-147.99	2862.37	-0.05	-591.95	11449.49	-0.05	-0.12	UHFO-6, UHFO-9	UHFO-2 × PB, UHFO-10 × HU, UHFO-2 × AA
Pod yield per hectare (q/ha)	-29.32	506.90	-29.23	565.36	-0.05	-116.92	2261.45	-0.05	-0.12	UHFO-6, UHFO-9	UHFO-2 × PB, UHFO-10 × HU, UHFO-2 × AA
Days to first picking	0.64	13.02	0.64	11.74	0.05	1.28	11.74	0.11	0.10	PB	UHFO-10 × AA
Harvest duration	2.65	36.02	2.65	30.73	0.09	10.59	122.91	0.08	0.15	-	UHFO-4 × PB
Number of seeds per pod	-1.47	18.98	-1.47	21.93	-0.07	-2.94	21.93	-0.13	-0.15	-	UHFO-8 × HU, UHFO-6 × PB, UHFO-3 × PB
Hundred seed weight (g)	-0.03	0.55	-0.03	0.62	-0.06	-0.07	0.62	-0.11	-0.12	UHFO-8	UHFO-8 × HU, UHFO-9 × PB, UHFO-14 × HU
Pod Colour at Maturity	-0.01	0.14	-0.01	0.17	-0.08	-0.03	0.17	-0.18	-0.19	-	UHFO-8 × AA, UHFO-10 × HU
Dry weight (g)	0.00	0.03	0.00	0.03	0.03	0.00	0.03	0.00	-0.20	UHFO-9	UHFO-6 × HU, UHFO-9 × PB, UHFO-8 × PB

(*Conrd.*)

Table 2 (*Concluded*)

Trait	COV (Half-sib)	COV (Full-sib)	σ^2 GCA	σ^2 SCA	σ^2 GCA/ σ^2 SCA	σ^2 A	σ^2 D	σ^2 A/σ^2 D	Predictability ratio	GCA effect	SCA effect
Total sugar (%)	0.06	1.23	0.06	1.11	0.06	0.12	1.11	0.11	0.10	UHFO-5, UHFO-3, UHFO-6	UHFO-7 × HU, UHFO-4 × AA, UHFO-8 × HU
Total polyphenol (%)	0.00	0.11	0.00	0.11	-0.01	0.00	0.11	0.00	-0.02	UHFO-4, UHFO-10	UHFO-8 × HU, UHFO-10 × AA, UHFO-4 × AA
Total protein (%)	-3.80	37.29	-3.80	44.88	-0.08	-7.60	44.88	-0.17	-0.20	UHFO-2, UHFO-10, PB	UHFO-5 × PB, UHFO-4 × HU, UHFO-10 × PB
Total nitrogen (%)	-0.10	0.97	-0.10	1.16	-0.09	-0.20	1.16	-0.17	0.00	UHFO-2, UHFO-10, PB	UHFO-4 × HU, UHFO-5 × PB, UHFO-10 × PB
Mucilage content (g)	0.00	0.01	0.00	0.01	0.00	0.00	0.01	0.00	0.06	UHFO-3, UHFO-8, UHF0-10	UHFO-2 × PB, UHFO-4 × HU, UHFO-8 × HU

in the form of line × tester mating layout could lead to the production of new varieties with better yields in okra. Since it was observed that SCA was the predominant contributor to genetic variance, thus, it is suggested that selection of SCA is likely to be the most effective method to exploit hybrid vigour. A plant breeder's ability to design an effective breeding programme is dependent on genetic information, particularly the kind and amplitude of gene action determining the transmission of crucial quantitative traits.

Identification of good general and specific combiners: All 10 lines and 3 testers showed significant GCA effect in desired direction, making them good general combiners for all traits except days to 50% flowering, first flowering node, pod length, pod diameter, harvest duration, number of seeds per pod, and pod colour at maturity (Table 2). These 13 parents could be used to attribute yield and other horticultural traits. The significant desired SCA effects showed that no single cross was a good particular combiner for all traits. The best parents, UHFO-6 and UHFO-9, had a GCA effect of 123.47 and 7.49, resulting in a mean performance of 307.77 g and 102.29 g/plant. The best cross combinations, viz. UHFO-2 × Pusa Bhindi-5 and UHFO-10 × Hisar Unnat, had a SCA effect of 38.29 and 38.81, resulting in a mean performance of 256.26. Wakode *et al.* (2016) and Narkhede *et al.* (2021) found comparable results for combining ability analysis. Combining ability analysis can find lines with strong potential to pass on desirable traits to their offspring and identify promising pod yield and its attribute. In addition, it explains the additive and non-additive gene activity involved in trait inheritance.

Proportional contribution of lines, testers and their interactions to total variance: Results (Fig. 1) revealed that the proportional contribution of lines ranged from inter-nodal length (54.62%) to pod diameter (0.85%), whereas, for testers it was from inter-nodal length (14.68%) to number of pods per plant (43.94%) and for line × tester it was from plant height (19.41) to average tender pod weight (80.63%). Per cent contribution of testers was higher than lines but lower than line × tester interaction for most of the traits except inter-nodal length. For these two traits, contribution of lines was more than the contribution from testers but less than the contribution from line × tester interaction. Similar findings were reported by Singh *et al.* (2015) and Das *et al.* (2020).

Potence ratio: Multiple trait potency ratios in single crossings demonstrated various degrees of dominant effects (Table 3). Overdominance is an intra-allelic interaction wherein the existence of many alleles produces superior results than homozygosity for either allelic state. The presence of various degrees of dominance, i.e. complete, partial and over in the inheritance was because of the asymmetrical distribution of positive and negative alleles and unequal distribution of dominant and recessive genes found in parents for these traits.

Out of 30 crosses made, 22 crosses showed over dominance while 8 crosses showed partial dominance for days to 50% flowering. First flowering node observed

Table 3 Potence ratios for different horticultural traits in okra

Cross	FF	FFN	PH	IL	NBP	PL	PD	PP	PW	PYP	PYH	DFP	HD	NSP	HSW	CM	DW	TS	TPP	TP	TN	MC
UHFO-2 × AA	-75.63	-1.00	0.55	-0.69	1.64	-0.04	-4.98	-4.21	4.34	0.89	-4.10	-0.08	5.62	-1.72	-2.72	-0.34	0.93	-0.24	-11.10	0.06	0.06	-1.15
UHFO-2 × PB	4.64	-0.55	0.47	-1.23	-0.62	1.82	72.88	-4.15	-19.38	-7.83	-5.07	0.03	1.00	-1.03	-1.46	0.00	0.27	-0.33	-0.31	-1.52	-1.52	0.82
UHFO-2 × HU	10.81	0.55	0.19	0.01	2.20	3.09	1.00	-0.06	-6.75	-2.05	-1.83	-0.03	0.63	0.95	-3.06	-0.67	5.47	3.58	2.89	-2.37	-2.37	1.36
UHFO-3 × AA	0.12	-1.80	-1.53	-1.54	-4.41	-0.88	110.94	-1.80	-3.41	-2.08	-1.81	-0.01	-6.30	-0.63	-54.00	-5.06	26.65	0.23	1.60	2.05	2.05	0.02
UHFO-3 × PB	1.95	3.57	-2.68	0.97	-0.20	-4.02	3.05	0.29	-1.50	-0.29	-0.22	-0.03	0.28	10.86	0.06	-6.97	2.90	-0.25	2.49	-0.68	-0.68	0.29
UHFO-3 × HU	-1.33	-0.20	9.04	-0.74	-0.32	-1.91	1.00	-1.96	-5.72	-2.11	-2.28	-0.03	0.04	23.74	19.74	-1.51	0.11	-1.93	3.57	1.89	1.89	-0.70
UHFO-4 × AA	-1.22	2.40	-1.61	-1.09	0.26	12.20	0.34	0.33	-13.45	-0.67	-0.55	-0.02	-2.59	0.03	1.91	-0.33	264.59	-4.28	-0.61	-58.00	-58.00	-0.13
UHFO-4 × PB	-7.21	1.50	-2.05	0.10	-2.14	0.05	-1.99	-2.06	-11.30	-1.04	-0.84	-0.08	1.18	-2.79	-0.64	0.78	0.52	2.95	1.15	-0.54	-0.54	-3.68
UHFO-4 × HU	-3.83	-7.80	-23.60	-2.90	0.57	2.80	3.00	-2.79	1.51	-1.33	-1.46	-0.03	6.21	-6.05	-0.25	-1.00	1.35	16.00	1.11	27.61	27.61	-2.16
UHFO-5 × AA	-0.97	0.71	0.28	-0.48	1.00	0.73	0.00	-17.18	0.63	3.64	4.33	-0.01	-0.26	-0.24	-0.72	-0.13	-2.15	-3.56	1.88	-1.14	-1.14	9.75
UHFO-5 × PB	0.26	2.84	0.52	-2.18	0.25	0.38	-1.00	-1.00	0.61	1.15	1.35	0.02	-1.52	-1.88	-0.38	1.86	-0.32	-4.28	2.39	-7.08	-7.08	0.34
UHFO-5 × HU	0.35	-13.00	0.43	-0.71	-0.27	2.00	-1.00	-0.62	-0.95	-0.82	-0.84	-0.03	-1.56	-1.45	-0.48	-0.21	-2.82	-10.63	2.31	-8.36	-8.36	-17.40
UHFO-6 × AA	-6.57	2.08	-3.70	-0.92	-1.12	-0.35	0.34	-1.29	0.30	-1.18	-1.14	-0.02	3.07	-0.31	-0.42	3.00	-0.19	-2.52	0.94	-36.08	-36.08	-16.18
UHFO-6 × PB	7.29	2.63	0.00	2.24	-0.42	-1.18	0.99	-1.52	1.38	-1.21	-1.16	-0.04	4.56	-0.84	1.20	0.01	1.11	-0.97	3.71	-0.55	-0.55	1.68
UHFO-6 × HU	-124.21	-1.00	-0.26	-0.68	-2.53	-1.50	5.00	-6.30	-0.54	-0.59	-0.49	0.00	0.75	0.86	0.73	-0.50	0.18	-1.32	-3.86	236.60	236.60	-2.08
UHFO-7 × AA	-4.75	0.33	-0.65	-5.11	1.00	-1.37	-1.00	-7.00	3.33	-3.26	-3.10	0.32	-1.63	-2.32	1.09	-1.00	4.28	0.98	1.41	1.38	1.38	-0.57
UHFO-7 × PB	-0.26	-19.18	-0.92	1.12	-3.20	4.25	2.95	-0.36	-13.70	-1.45	-1.40	0.01	-0.09	0.73	-2.24	0.00	1.94	0.79	0.90	1.25	1.25	4.96
UHFO-7 × HU	32.14	-1.50	-2.50	-0.03	-0.16	0.01	0.00	-0.43	-1.28	-0.64	-0.64	0.08	7.91	0.26	-2.33	-1.00	-0.05	-0.28	0.44	13.37	13.37	-0.41
UHFO-8 × AA	1.12	0.43	-0.91	2.01	-3.22	-3.32	1.02	-0.75	0.27	-0.18	-0.27	-0.03	3.04	0.06	-0.55	-2.97	1.49	19.50	-0.32	3.49	3.49	28.38
UHFO-8 × PB	-2.93	3.00	-0.39	-0.24	0.41	-3.76	-1.00	-1.59	4.61	-0.95	-1.06	-0.05	0.15	0.13	-1.40	-17.18	0.92	-0.20	2.07	1.02	1.02	0.21
UHFO-8 × HU	-1.16	0.82	-0.31	-0.78	-0.57	-8.82	0.00	-3.70	-4.06	-2.94	-2.70	-0.01	3.13	2.59	0.72	-1.79	3.85	5.53	-4.85	-5.54	-5.54	-10.23
UHFO-9 × AA	-3.00	3.29	-0.71	-0.65	2.70	0.60	-0.20	5.78	-9.67	13.82	8.81	0.02	-2.46	-0.69	-1.26	-0.34	-3.55	-1.11	-1.39	1.17	1.17	0.02
UHFO-9 × PB	4.75	1.00	-0.94	-1.08	-0.91	-30.99	1.99	8.58	14.06	6.60	5.14	-0.09	2.21	-0.42	0.58	0.00	5.09	-0.11	1.82	5.08	5.08	-1.05
UHFO-9 × HU	-3.80	0.00	-1.45	-0.55	1.00	4.00	1.00	0.69	-0.60	0.17	0.23	-0.05	0.78	-2.46	-0.33	-0.67	-0.92	2.50	4.32	0.47	0.47	-0.52
UHFO-10 × AA	-0.79	2.84	-0.92	-0.89	-0.32	-413.41	0.34	0.54	-1.40	0.22	0.17	-0.01	0.23	-1.54	-2.53	5.99	-0.45	0.89	-4.15	2.27	2.27	-0.14
UHFO-10 × PB	1.30	1.40	-1.12	0.39	-0.74	-2.43	-1.00	0.24	-24.20	0.83	0.75	-0.03	-0.68	-0.50	-0.48	-1.00	-26.37	1.45	-1.52	-2.30	-2.30	0.84
UHFO-10 × HU	-1.19	1.07	-1.23	-1.43	0.31	1.40	1.00	-4.14	-0.10	-1.67	-1.60	-0.03	0.40	-2.41	0.08	-1.12	-0.06	0.17	0.91	-2.14	-2.14	0.04
UHFO-14 × AA	0.26	-0.56	-0.92	-0.41	1.00	-0.40	-1.00	-2.89	1.17	-2.34	-2.12	-0.03	0.73	-0.64	-0.85	4.34	1.33	-3.00	3.12	0.07	0.07	0.81
UHFO-14 × PB	0.11	-0.46	-0.83	-1.06	0.60	-5.99	2.95	-2.65	1.33	-1.55	-1.38	0.01	-7.33	-0.51	-0.58	0.00	1.89	-2.07	-4.52	-8.25	-8.25	-42.50
UHFO-14 × HU	-3.20	-1.08	-1.23	-2.47	0.10	7.00	0.00	-0.03	10.48	0.76	0.73	-0.15	-0.53	0.61	0.01	-1.00	2.50	-0.67	-3.00	2.72	2.72	-0.64

FF, days to 50% flowering; FFN, first flowering node; PH, plant height (cm); IL, inter-nodal length (cm); NBP, number of primary branches per plant; PL, pod length (cm); PD, pod diameter (cm); PP, number of pods per plant; PW, average pod weight (cm), PYP, pod yield per plant (g); PYH, pod yield per hectare (q); DFP, days to first picking; HD, harvest duration; NSP, number of seeds per pod; HSW, 100-seed weight (g); CM, pod colour at maturity; DW, average pod dry weight (g); TS, total sugar (%); TPP, total polyphenol (%); TP, total protein (%); TN, total nitrogen (%); MC, mucilage content (g).

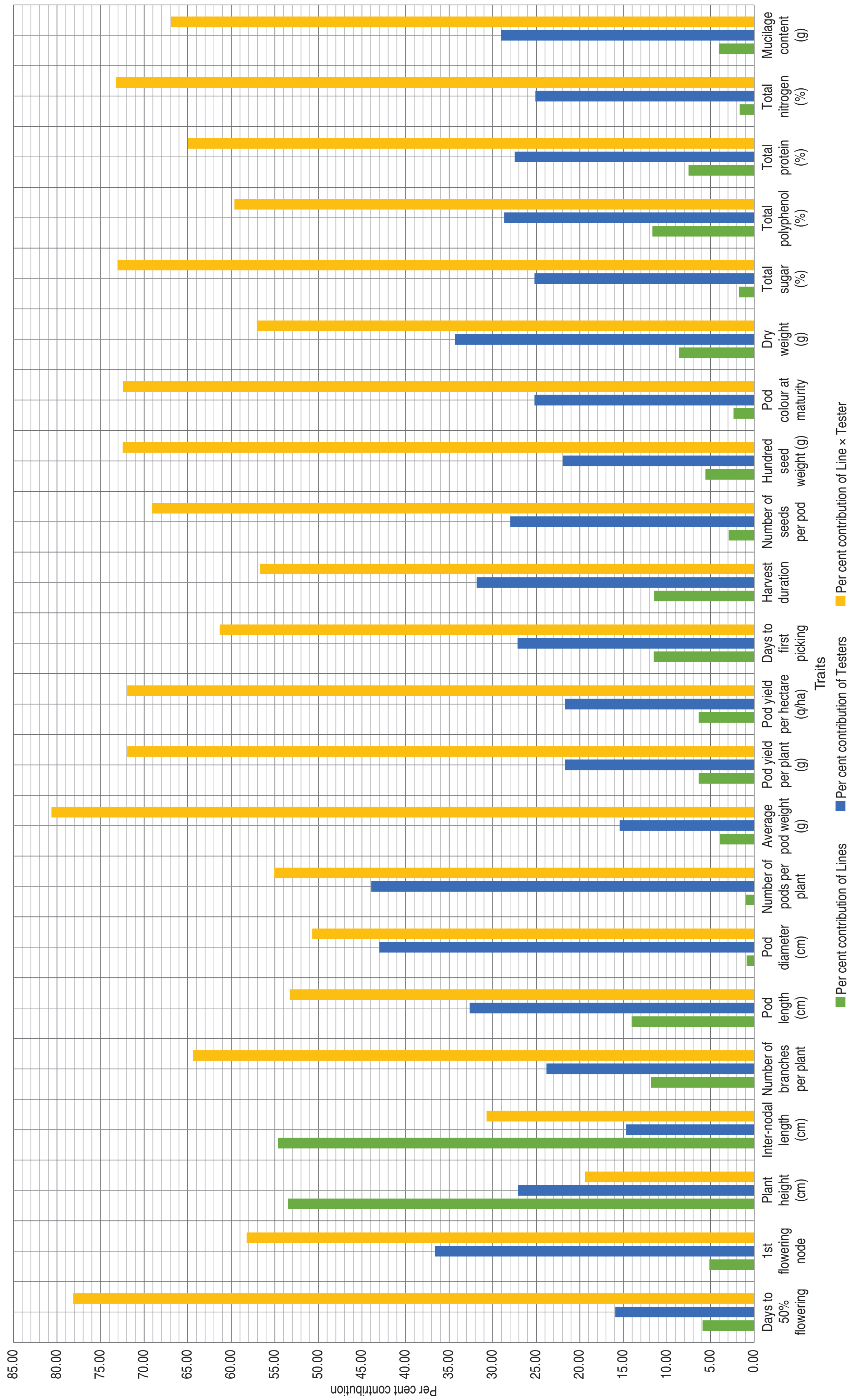

Fig. 1 Proportional contribution for different horticultural traits in okra.

complete dominance in UHFO-2 × AA and UHFO-6 × HU and UHFO-9 × PB; and UHFO-9 × HU had absence of dominance effect; nine crosses had partial dominance whereas 17 observed over dominance effects. For plant height, UHFO-6 ×PB showed no dominance, 17 crosses revealed partial dominance whereas, 12 genotypes had over dominance. 17 genotypes had partial dominance and 13 genotypes showed over dominance for inter-nodal length. 21 genotypes had over dominance and 9 genotypes had partial dominance for pod length. For pod diameter, 10 genotypes had complete dominance, 3 genotypes had absence of dominance, 5 genotypes had partial dominance and 12 genotypes had over dominance. For number of pods per plant, UHFO-5 × PB had complete dominance, 18 genotypes had over dominance and 11 had partial dominance. Average pod weight had 8 genotypes exerting partial dominance and 22 had over dominance. Pod yield per plant obtained 12 genotypes under partial dominance and 18 under over dominance. Number of seeds per pod and 100-seed weight both had 13 genotypes who exerted over dominance and 17 had partial dominance. Total sugar had 17 genotypes who obtained over dominance and 13 had partial dominance. 23 crosses had over dominance while 7 had partial dominance for total polyphenols. 14 crosses exerted over dominance while 16 had partial dominance for mucilage content. Das *et al.* (2020) also found similar results for potence ratio in okra.

After crossing 13 different genotypes of okra in a line × tester mating design, sufficient genetic diversity for yield and its contributing factors was obtained. It was found that parents which performed well for particular trait, possessed high potentiality for combining ability effects. From this study it is concluded that parental lines UHFO-6 and UHFO-9 could be exploited beneficially in future okra breeding programmes by adopting appropriate breeding strategy. The crosses UHFO-2 × Pusa Bhindi-5 and UHFO-10 × Hisar Unnat could be exploited for the production of F_1 hybrids for *kharif* season after further testing in multiple locations in the state. More than 50% of the cross combinations showed over dominance effects for yield and yield related traits. The existence of both non-additive and additive gene action suggested that heterosis breeding is essential for future okra development. Lines used in the study contributed more to the total variance than the testers. Because only the over dominant component of variation was discovered for diverse characteristics, heterosis breeding is necessary to utilise these qualities. Analysis of degree of dominance and predictability ratio also indicated the presence of non-additive gene action for all the traits.

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