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Research Article

Combining Ability Studies for Yield-Attributing Traits in Ridge Gourd (*Luffa acutangula* (L.) Roxb.)

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Abstract

The present study on combining ability in ridge gourd (*Luffa acutangula* (L.) Roxb.) was conducted at the Department of Horticulture, UAS, GKVK, Bengaluru, during 2024-2025 to identify superior parents and hybrids for yield and earliness. Ten parents and 21 hybrids were evaluated using a Randomized Complete Block Design (RCBD). Analysis of variance revealed significant genetic variability among the parents and hybrids for all traits, indicating the importance of both additive and non-additive gene action. Among the parents, IC-344512 and Padmini were identified as the best general combiners for yield per hectare and average fruit weight, while IC-344652 and Kerala Local-3 exhibited significant negative General Combining Ability (GCA) effects for days to first female flower and days to harvest, making them superior donors for earliness. Specific Combining Ability (SCA) analysis highlighted Kerala Local-3 × Arka Sujat as the most promising hybrid, recording the highest significant positive SCA effects for total yield and fruit weight. For earliness, the cross Bangalore Local-1 × Arka Prasan emerged as the best specific combination, showing desirable negative SCA effects for flowering and harvest duration. The study confirmed the predominance of non-additive gene action for yield-related traits, suggesting that heterosis breeding is the most effective strategy for the genetic improvement of ridge gourd. The superior performance of the hybrid Kerala Local-3 × Arka Sujata for yield and Bangalore Local-1 × Arka Prasan for earliness suggests their potential for immediate commercial release. These elite hybrids can be exploited for commercial cultivation and future breeding programs.

Keywords: Ridge Gourd; Combining Ability; GCA; SCA; Earliness; Yield

Abbreviations

kcal: Kilocalories; g: Gram; GCA: General Combining Ability; SCA: Specific Combining Ability; m: Meter; cm: Centimeter; DFFF: Days to First Female Flower Appearance; NFFF: Node of First Female Flower Appearance; FS: Fruit Set (%); DFH: Days to First Harvest; FL: Fruit Length; FD: Fruit Diameter; AFW: Average Fruit Weight; NFV: Number of Fruits Per Vine; YPH: Yield Per Vine

Introduction

Gourds from the Cucurbitaceae family, like ridge gourd (*Luffa acutangula* (L.) Roxb.), 2n = 26, offer rich nutrition and medicinal value as low-calorie staples in healthy diets. Native to India, tropical Africa, and Asia, it goes by names such as ribbed gourd, Chinese okra, or locally as Turia (Gujarati), Hirekay (Kannada), and Koshataki (Sanskrit); only two Luffa species—ridge and sponge gourd—are commonly grown as vegetables. Its mature fibers form loofahs for sponges, mats, filters, and insulators.

Ridge gourd fruits provide fiber, vitamins (A, C), minerals (iron, calcium, phosphorus), protein, carbs, and low energy (17-20 kcal/100g), with 92.5% moisture [1]. Traditional uses include treating stomach issues, fever, conjunctivitis, and possessing purgative, antifungal and antitumor properties from compounds like luffein and cucurbitacin [2]. India leads production (~316,925 tonnes on 24,500 acres), mainly in spring-summer-rainy seasons across tropical regions [3].

This climbing vine has a taproot, 5-7 lobed ovate leaves, and mostly monoecious sex forms, though variations exist [4]. Male flowers cluster 10-20 on racemes with fused stamens; solitary female flowers are fragrant, both from leaf axils, with anthesis from 5-7 p.m. onward, influenced by temperature and humidity. Club-shaped fruits bear 10 ridges, many black wrinkled seeds (150-170g/1000), turning fibrous and inedible at maturity [5].

Identifying superior combiners is essential for successful heterosis breeding in hybrids. Combining ability analysis, introduced by [6], estimates parental performance in crosses to select optimal parents and hybrids, revealing gene actions that guide breeding strategies. General combining ability (GCA) measures a parent's average performance across multiple crosses, driven by additive genetic variance and additive × additive effects. Specific combining ability (SCA), by contrast, captures a specific hybrid's deviation from parental averages, linked to non-additive effects like dominance and epistasis.

The monoecious nature and significant floral biology of ridge gourd make it an ideal candidate for heterosis breeding. However, the successful exploitation of hybrid vigor depends on the correct choice of parents. Since yield and quality traits are complex and environmentally influenced, combining ability analysis is required to screen germplasm scientifically. By determining the magnitude of additive and non-additive gene action, this research aims to isolate superior inbreds for population improvement and elite specific combinations for the immediate release of commercial hybrids.

Materials and Methods

10 diverse ridge gourd genotypes were crossed in a Line × Tester mating system, producing 21 F1 hybrids. These hybrids and their 10 parents underwent evaluation in a randomized block design with three replications at the Department of Horticulture, UAS, GKVK, Bengaluru during 2024. Traits assessed on five plants per treatment included vine length (m), number of primary branches, days to first female flower appearance, node of first female flower appearance, sex ratio, fruit set percentage, days to first harvest, number of fruits per vine, fruit weight (g), fruit length (cm), fruit girth (cm), yield per vine (kg), and yield per hectare (t). Data was analyzed statistically, with combining ability estimates computed using Griffing's (1956) Method 2, Model 1. This approach helps identify superior parents and hybrids for traits like yield and yield attributing traits in ridge gourd breeding.

Results and Discussion

General combining ability (GCA) effects

The estimates of GCA effects for the parents are presented in Table 1, Table 2, and Table 3. These effects provide a measure of the additive gene action and help in the identification of superior parents for hybridization programs.

Parents	Vine length (m)	Number of primary branches	Internodal length (cm)
Lines			
IC-344652	0.042	0.156 *	0.068
IC-344512	0.058	-0.021	0.016
Kolar Local-2	-0.029	0.064	-0.143
Padmini	-0.184***	-0.392 ***	-0.443 ***
Bangalore Local-1	0.087*	0.106	0.198 *
Kerala Local-3	0.137***	0.170 **	0.440 ***
Raichur Local-2	-0.110**	-0.084	-0.137
SEM	0.037	0.060	0.092
CD @ 5%	0.075	0.122	0.186
CD @ 1%	0.101	0.163	0.248
Testers			
Kashi Khushi	-0.136***	-0.229 ***	-0.321 ***
Arka Sujat	0.088***	0.204 ***	0.322 ***
Arka Prasan	0.048	0.025	0.000
SEM	0.024	0.039	0.060
CD @ 5%	0.049	0.080	0.122
CD @ 1%	0.066	0.107	0.163

Table 1: General combining ability effects for vine length, number of primary branches and internodal length in ridge gourd.

Significant at P = 0.05, **Significant at P = 0.01, ***Significant at P = 0.001.

Parents	DFFF	NFFF	Sex ratio	FS	DFH
Lines					
IC-344652	-2.169 ***	-0.453 ***	0.121	2.951 *	-3.084 ***
IC-344512	1.072 **	0.153 *	-0.89	-2.867 *	1.067 **
Kolar Local-2	0.451	-0.082	0.696	-4.022 **	0.435
Padmini	0.053	0.189 **	0.161	6.416 ***	0.146
Bangalore Local-1	-0.505	-0.065	-1.055 *	-1.087	0.079
Kerala Local-3	-1.735 ***	-0.610 ***	0.35	1.038	-1.690 ***
Raichur Local-2	2.834 ***	0.868 ***	0.617	-2.429	3.048 ***
SEM	0.309	0.067	0.487	1.207	0.307
CD @ 5%	0.624	0.135	0.985	2.440	0.621
CD @ 1%	0.835	0.181	1.318	3.266	0.830

Testers					
Kashi Khushi	-0.263	0.100 *	-0.322	0.453	-0.119
Arka Sujat	0.443 *	0.064	-0.1	-0.774	0.368
Arka Prasan	-0.18	-0.164 ***	0.422	0.322	-0.249
SEM	0.202	0.044	0.319	0.791	0.201
CD @ 5%	0.406	0.088	0.645	1.598	0.406
CD @ 1%	0.547	0.118	0.863	2.138	0.544

Table 2: General combining ability effects for flowering traits in ridge gourd.

*Significant at P = 0.05, **Significant at P = 0.01, ***Significant at P = 0.001.

DFFF-Days to first female flower appearance, NFFF- Node of first female flower appearance, FS- Fruit set (%), DFH- Days to first harvest.

Parents	FL	FD	NFV	AFV	YPH
Lines					
IC-344652	3.152 ***	0.021	0.365	13.958 ***	1.078 ***
IC-344512	6.633 ***	0.135 **	-0.177	33.887 ***	2.666 ***
Kolar Local-2	-1.869 ***	0.385 ***	-1.515 ***	-30.773 ***	-4.637 ***
Padmini	-5.015 ***	0.093 *	1.643 ***	6.512	2.410 ***
Bangalore Local-1	0.298	0.081 *	0.027	0.717	0.777
Kerala Local-3	1.495 ***	-0.317 ***	0.37	3.711	1.364 ***
Raichur Local-2	-4.694 ***	-0.399 ***	-0.713 **	-28.011 ***	-3.658 ***
SEM	0.222	0.039	0.238	1.375	0.276
CD @ 5%	0.449	0.078	0.480	2.779	0.557
CD @ 1%	0.600	0.105	0.643	3.719	0.745
Testers					
Kashi Khushi	-6.580 ***	0.251 ***	-0.035	-23.687 ***	-2.476 **
Arka Sujat	3.283 ***	-0.148 ***	0.177	2.632 **	0.575 *
Arka Prasan	3.298 ***	-0.102 ***	-0.142	21.056 ***	1.902 ***
SEM	0.145	0.025	0.156	0.900	0.180
CD @ 5%	0.294	0.051	0.314	1.892	0.365
CD @ 1%	0.393	0.068	0.421	2.434	0.488

Table 3: General combining ability effects for yield and yield attributing traits in ridge gourd.

*Significant at P = 0.05, **Significant at P = 0.01, ***Significant at P = 0.001.

FL- Fruit length (cm), FD- Fruit diameter, NFV- Number of fruits per vine, AFW- Average fruit weight (g), YPH- Yield per hectare (t).

Growth parameters

For vine length, the parent Kerala Local-3 exhibited the highest significant positive GCA effect (0.137), followed by Bangalore Local-1 (0.087), indicating their potential to produce vigorous progeny. In contrast, Padmini recorded a highly significant negative GCA effect (-0.184), suggesting it is a good combiner for breeding compact or dwarf types, which are often desirable for high-density

planting (Table 1). Similar results regarding the selection of parents for vine length based on GCA effects were reported by [7] in ridge gourd.

Regarding the number of primary branches (Table 1), Arka Sujat (0.204) and Kerala Local-3 (0.170) were the best general combiners, showing significant positive effects. Increased branching is generally associated with higher fruit-bearing potential in cucurbits [8] in ridge gourd.

Flowering and earliness traits

Negative GCA effects are desirable for days to first female flower appearance (DFFF) and node of first female flower (NFFF) as they indicate earliness. As shown in Table 2, IC-344652 (-2.169) and Kerala Local-3 (-1.735) exhibited highly significant negative GCA effects for days to first female flower appearance, making them excellent general combiners for earliness. Similarly, for node of first female flower appearance, Kerala Local-3 (-0.610) and IC-344652 (-0.453) recorded significant negative values.

For sex ratio, a negative GCA effect is preferred as it implies a higher proportion of female flowers (Table 2). Bangalore Local-1 (-1.055) and IC-344512 (-0.890) were identified as good combiners for improving female flower production. Conversely, Raichur Local-2 showed a positive GCA effect (0.617), indicating a tendency towards maleness, which is less desirable for yield [9] in ridge gourd.

The GCA effects for days to first harvest and fruit set percentage are presented in Table 2. For days to first harvest, IC-344652 (-3.084) and Kerala Local-3 (-1.690) were identified as good general combiners due to their significant negative GCA effects, indicating earliness. Conversely, Raichur Local-2 (3.048) and IC-344512 (1.067) were poor combiners with significant positive effects, consistent with findings by [10] and [11] in ridge gourd.

For fruit set percentage, Padmini (6.416) and IC-344652 (2.951) exhibited significant positive GCA effects and were classified as good combiners. In contrast, Kolar Local-2 (-4.022) and IC-344512 (-2.867) showed significant negative effects, making them poor combiners for this trait.

Yield and yield attributing traits

The GCA effects for yield and its components are detailed in Table 3. IC-344512 was the best general combiner for yield per hectare (2.666) and average fruit weight (33.887), followed by Padmini (2.410 for yield) and IC-344652 (1.078).

For Fruit Length, IC-344512 (6.633) and Arka Prasan (3.298) showed high positive GCA effects, indicating their suitability for breeding long-fruited varieties. Fruit Diameter, Kolar Local-2 (0.385) and IC-344512 (0.135) were significant positive combiners.

For yield per vine, six parents exhibited significant positive General Combining Ability (GCA) effects (Figure 1). Among them, IC-344512 (0.514) and Arka Prasan (0.355) were identified as the best general combiners. In contrast, Kolar Local-2 recorded the lowest GCA effect (-0.891), classifying it as a poor combiner.

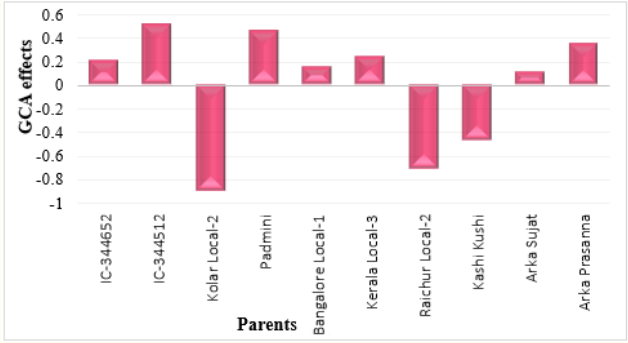

Figure 1: GCA effects of parents for yield per vine (kg).

High positive GCA for yield indicates additive gene action. The parents IC-344512, Padmini, and Arka Prasan consistently showed positive significant effects for yield per hectare, marking them as the most promising candidates for future breeding programs aimed at yield improvement [12] in ridge gourd.

Specific combining ability (SCA) effects

Specific combining ability (SCA) effects represent the deviation of hybrid performance from the value expected based on the general combining ability (GCA) of the parents. These effects are indicative of non-additive gene action, including dominance and epistasis, which can be exploited through heterosis breeding. The estimates of SCA effects for 21 hybrids for various traits are presented in Table 4, 5 and 6.

Hybrids	Vine length (m)		
	Vine length (m)	Internodal length (cm)	Number of primary branches
IC-344652 × Kashi Khushi	0.327***	0.887 ***	0.569
IC-344652 × Arka Sujat	-0.11	-0.223	-0.044
IC-344652 × Arka Prasan	-0.217**	-0.664 ***	-0.525 ***
IC-344512 × Kashi Khushi	0.118	0.019	0.205
IC-344512 × Arka Sujat	0.057	0.293	0.276 *
IC-344512 × Arka Prasan	-0.175**	-0.312	-0.481 ***
Kolar Local-2 × Kashi Khushi	-0.215**	-0.102	-0.359 **
Kolar Local-2 × Arka Sujat	0.104	0.218	0.101
Kolar Local-2 × Arka Prasan	0.111	-0.116	0.258 *
Padmini × Kashi Khushi	0.210**	0.435 **	0.293 **
Padmini × Arka Sujat	-0.214**	-0.432 **	-0.336 **
Padmini × Arka Prasan	0.003	-0.003	0.043
Bangalore Local-1 × Kashi Khushi	-0.134*	-0.470 **	-0.361 **
Bangalore Local-1 × Arka Sujat	-0.065	-0.869 ***	-0.284 **
Bangalore Local-1 × Arka Prasan	0.199**	1.339 **	0.645 ***
Kerala Local-3 × Kashi Khushi	0.076	-0.478 **	0.054
Kerala Local-3 × Arka Sujat	0.139*	1.493 ***	0.411 ***
Kerala Local-3 × Arka Prasan	-0.214**	-1.015 ***	-0.466 ***
Raichur Local-2 × Kashi Khushi	-0.381***	-0.291	-0.401 ***
Raichur Local-2 × Arka Sujat	0.089	-0.480 **	-0.124
Raichur Local-2 × Arka Prasan	0.292***	0.771 **	0.525 ***
S.Em ±	0.06	0.16	0.10
CD @ 5%	0.13	0.32	0.21
CD @ 1%	0.17	0.43	0.28

Table 4: Specific combining ability effects growth parameters in ridge gourd.

Significant at P = 0.05, **Significant at P = 0.01, ***Significant at P = 0.001.

Hybrids	DFFF	NFFF	Sex ratio	FS	DFH
IC-344652 × Kashi Khushi	-0.06	-0.017	-1.348	7.675 ***	-0.147
IC-344652 × Arka Sujat	0.894	0.231	0.39	-7.811 ***	1.807 **
IC-344652 × Arka Prasan	-0.833	-0.214	0.958	0.136	-1.660 **
IC-344512 × Kashi Khushi	-0.428	-0.304 ^	0.503	5.171 *	-0.451
IC-344512 × Arka Sujat	-0.811	-0.175	-0.053	-2.283	-0.918
IC-344512 × Arka Prasan	1.239 *	0.479 ***	-0.451	-2.888	1.369 *
Kolar Local-2 × Kashi Khushi	0.303	-0.172	-1.639	-9.761 ***	0.421
Kolar Local-2 × Arka Sujat	1.057	0.19	0.239	2.839	1.241 *
Kolar Local-2 × Arka Prasan	-1.360 *	-0.018	1.4	6.923 **	-1.662 *
Padmini × Kashi Khushi	-3.699 ***	-1.663 ***	-0.405	2.511	-3.433 ***
Padmini × Arka Sujat	2.428 ***	1.299 ***	1.696	4.137	2.013 ***
Padmini × Arka Prasan	1.271 *	0.364 **	-1.292	-6.648 **	1.420 *
Bangalore Local-1 × Kashi Khushi	3.909 ***	1.515 ***	1.649	-4.449 *	3.550 ***
Bangalore Local-1 × Arka Sujat	0.013	-0.153	1.113	-6.553 **	-0.04
Bangalore Local-1 × Arka Prasan	-3.921 ***	-1.362 ***	-2.762 **	11.002 ***	-3.510 ***
Kerala Local-3 × Kashi Khushi	-0.511	0.026	-0.54	-2.735	-0.251
Kerala Local-3 × Arka Sujat	-2.801 ***	-0.932 ***	-2.156 *	10.132 ***	-3.008 ***
Kerala Local-3 × Arka Prasan	3.312 ***	0.906 ***	2.696 **	-7.397 **	3.259 ***
Raichur Local-2 × Kashi Khushi	0.487	0.615 ***	1.780 *	1.589	0.311
Raichur Local-2 × Arka Sujat	-0.78	-0.460 ***	-1.229	-0.461	-1.096 *
Raichur Local-2 × Arka Prasan	0.293	-0.155	-0.551	-1.127	0.784
S.Em ±	0.53	0.12	0.84	2.09	0.53
CD @ 5%	1.08	0.23	1.71	4.23	1.07
CD @ 1%	1.45	0.31	2.28	5.66	1.44

Table 5: Specific combining ability effects flowering traits in ridge gourd.

*Significant at P = 0.05, **Significant at P = 0.01, ***Significant at P = 0.001.

DFFF-Days to first female flower appearance, NFFF- Node of first female flower appearance, FS- Fruit set (%), DFH- Days to first harvest.

Hybrids	FL	FD	NFV	AFW	YPH
IC-344652 × Kashi Khushi	-9.245 ***	-0.266 ***	3.583 ***	-31.426 ***	1.313 **
IC-344652 × Arka Sujat	2.372 ***	-0.470 ***	-2.995 ***	14.395 ***	-2.375 ***
IC-344652 × Arka Prasan	6.873 ***	0.737 ***	-0.589	17.031 ***	1.062 *
IC-344512 × Kashi Khushi	6.720 ***	-0.234 **	-0.979 *	44.225 ***	2.832 ***
IC-344512 × Arka Sujat	9.384 ***	0.315 ***	0.743	24.886 ***	3.341 ***
IC-344512 × Arka Prasan	-16.104 ***	-0.081	0.236	-69.117 ***	-6.173 ***
Kolar Local-2 × Kashi Khushi	-0.227	0.163 *	-0.39	19.402 ***	1.672 **
Kolar Local-2 × Arka Sujat	7.283 ***	0.168 *	0.069	-14.057 ***	-1.292 *
Kolar Local-2 × Arka Prasan	-7.055 ***	-0.331 ***	0.321	-5.345 *	-0.38
Padmini × Kashi Khushi	3.418 ***	-0.442 ***	0.918 *	2.023	1.329 **
Padmini × Arka Sujat	-3.508 ***	0.007	-0.833 *	-17.286 ***	-2.789 ***
Padmini × Arka Prasan	0.09	0.434 ***	-0.084	15.263 **	1.460 **
Bangalore Local-1 × Kashi Khushi	-1.422 ***	0.410 ***	-1.829 ***	-12.721 ***	-3.679 **
Bangalore Local-1 × Arka Sujat	-10.262 ***	-0.434 ***	-2.917 ***	-40.540 ***	-7.760 ***
Bangalore Local-1 × Arka Prasan	11.683 ***	0.023	4.746 ***	53.262 ***	11.439 ***
Kerala Local-3 × Kashi Khushi	-2.592 ***	-0.332 ***	-0.675	-37.016 ***	-4.656 ***
Kerala Local-3 × Arka Sujat	2.022 **	0.567 ***	4.673 ***	63.832 ***	12.550 ***
Kerala Local-3 × Arka Prasan	0.57	-0.236 *	-3.998 ***	-26.816 ***	-7.894 ***
Raichur Local-2 × Kashi Khushi	3.347 ***	0.700 ***	-0.629	15.513 ***	1.190 *
Raichur Local-2 × Arka Sujat	-7.290 ***	-0.154 *	1.260 **	-31.229 ***	-1.675 *
Raichur Local-2 × Arka Prasan	3.942 ***	-0.547 ***	-0.631	15.716 ***	0.485
S.Em ±	0.38	0.07	0.41	2.38	0.48
CD @ 5%	0.78	0.14	0.83	4.81	0.96
CD @ 1%	1.04	0.18	1.11	6.44	1.29

Table 6: Specific combining ability effects yield and yield attributing traits in ridge gourd.

Significant at P = 0.05, **Significant at P = 0.01, ***Significant at P = 0.001.

FL- Fruit length (cm), FD- Fruit diameter, NFV- Number of fruits per vine, AFW- Average fruit weight (g), YPH- Yield per hectare (t).

Growth parameters

For vine length, Positive SCA effects are generally desirable for vine length to ensure sufficient vegetative growth for supporting fruit yield (Table 4). The hybrid IC-344652 × Kashi Khushi exhibited the highest significant positive SCA effect (0.327), followed by Raichur Local-2 × Arka Prasan (0.292) and Padmini × Kashi Khushi (0.210). These hybrids involve combinations of parents with different GCA values suggesting the role of non-additive gene interactions. Similar findings of significant positive SCA for vine length in ridge gourd were reported by [7] in ridge gourd.

For the number of primary branches, the cross Bangalore Local-1 × Arka Prasan recorded the highest significant positive SCA effect (0.645), followed by IC-344652 × Kashi Khushi (0.569) and Raichur Local-2 × Arka Prasan (0.525). A higher number of branches is directly correlated with more fruiting nodes. The significance of SCA variance for this trait indicates that specific combinations can be selected for enhanced branching, as observed by [8] ridge gourd (Table 4).

Specific Combining Ability (SCA) effects for internodal length at various growth stages are presented in Table 4. Among the hybrids, the cross Kerala Local-3 × Arka Sujat exhibited the highest positive SCA effects for internodal length (1.493). These findings indicate that non-additive gene action played a significant role in determining internodal length at later growth stages, consistent with reports by [7] in ridge gourd.

Flowering traits

Negative SCA effects are desirable for days to first female flower appearance, as they indicate earliness (Table 5). The hybrid Bangalore Local-1 × Arka Prasan displayed the highest significant negative SCA effect (-3.921), followed by Padmini × Kashi Khushi (-3.699) and Kerala Local-3 × Arka Sujat (-2.801). These hybrids flowered significantly earlier than predicted by their parental performance, highlighting the presence of favorable non-additive genes for early maturity. These results align with the findings of [10], who emphasized the value of negative SCA for earliness in ridge gourd.

Lower nodal positions for the first female flower are associated with early fruit setting (Table 5). The cross Padmini × Kashi Khushi showed the most desirable significant negative SCA effect (-1.663), followed by Bangalore Local-1 × Arka Prasan (-1.362). Hybrids such as Kerala Local-3 × Arka Sujat (-0.932) also exhibited significant negative values, confirming their potential for early cropping.

For sex ratio, negative SCA effects are desirable as they indicate a higher proportion of female flowers (Table 5). The hybrids Bangalore Local-1 × Arka Prasan (-2.762) and Kerala Local-3 × Arka Sujat (-2.156) exhibited the highest significant negative SCA effects, identifying them as promising combinations for improved floral balance. Conversely, Kerala Local-3 × Arka Prasan (2.696) displayed the maximum positive SCA effect, indicating a tendency toward maleness.

Regarding earliness, Bangalore Local-1 × Arka Prasan (-3.510) and Padmini × Kashi Khushi (-3.433) were identified as superior specific combiners, showing significant negative SCA effects for days to first harvest. In contrast, Bangalore Local-1 × Kashi Khushi (3.550) recorded the highest positive effect, signifying late maturity (Table 5).

For fruit set percentage, significant positive SCA effects were observed in five crosses, with Bangalore Local-1 × Arka Prasan (11.002) and Kerala Local-3 × Arka Sujat (10.132) emerging as the best specific combiners. However, Kolar Local-2 × Kashi Khushi (-9.761) showed the highest negative SCA effect, making it a poor combiner for this trait (Table 5).

Yield and yield attributing traits

For fruit length, Bangalore Local-1 × Arka Prasan recorded the highest significant positive SCA effect (11.683), followed by IC-344512 × Arka Sujat (9.384) and Kolar Local-2 × Arka Sujat (7.283) (Table 6). This suggests that these specific combinations can be used to improve fruit size.

Conversely, for fruit diameter, negative or moderate values are often preferred depending on consumer preference. However, significant positive SCA was observed in IC-344652 × Arka Prasan (0.737) and Raichur Local-2 × Kashi Khushi (0.700). The variability in SCA effects for fruit dimensions points to the complex genetic control of fruit shape [13].

The hybrid Kerala Local-3 × Arka Sujat exhibited a remarkably highly significant positive SCA effect for average fruit weight (63.832), followed by Bangalore Local-1 × Arka Prasan (53.262) and IC-344512 × Kashi Khushi (44.225) (Table 6). These large

positive effects contributed significantly to the total yield per plant in these hybrids. The preponderance of non-additive gene action for fruit weight has been well documented in ridge gourd [5].

For the number of fruits per vine, five crosses exhibited significant positive SCA effects, with Bangalore Local-1 × Arka Prasan (4.746) and Kerala Local-3 × Arka Sujat (4.673) emerging as the most promising combinations (Table 6).

Regarding total yield per vine (Figure 2), ten crosses displayed significant positive SCA effects, indicating effective exploitation of non-additive gene action. Kerala Local-3 × Arka Sujat (2.434) and Bangalore Local-1 × Arka Prasan (2.170) were recognized as superior specific combiners for yield improvement.

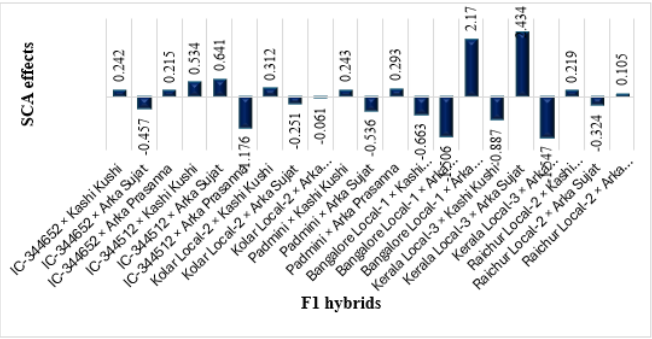

Figure 2: SCA effects of F1 hybrids for yield per vine (kg).

Yield is the ultimate objective of breeding programs. The analysis revealed that the hybrid Kerala Local-3 × Arka Sujat possessed the highest significant positive SCA effect (12.550) for yield per hectare. Other promising hybrids included Bangalore Local-1 × Arka Prasan (11.439) and IC-344512 × Arka Sujat (3.341) (Table 6). This reinforces the need to test specific combinations rather than relying solely on parental GCA. These results are in agreement with [12,14].

Conclusion

The results revealed significant genetic variability among ridge gourd genotypes, with both additive and non-additive gene actions governing key traits. Among the parents, IC-344512 and Padmini were identified as the best general combiners for yield per hectare, while Kerala Local-3 and IC-344652 proved superior for earliness traits. Regarding hybrid performance, Kerala Local-3 × Arka Sujata emerged as the top specific combination for total yield and fruit weight, exhibiting highly significant positive SCA effects. Similarly, Bangalore Local-1 × Arka Prasan was the most promising hybrid for earliness and floral traits, showing desirable negative SCA effects for days to flowering and harvest. These findings confirm the predominance of non-additive gene action for yield-related traits, suggesting that heterosis breeding is the most effective strategy for maximizing productivity in ridge gourd.

To translate these findings into practice, the elite hybrids identified, Kerala Local-3 × Arka Sujata and Bangalore Local-1 × Arka Prasan warrant evaluation in Multi-Location Trials (MLT) to confirm their stability across diverse environments. Simultaneously, the parents exhibiting high GCA (IC-344512 and Padmini) should be incorporated into hybridization programs to derive superior transgressive segregants in later generations. Future research should also focus on standardizing hybrid seed production technologies for these specific combinations to ensure economic feasibility for farmers.

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Conflict of Interest

Authors do not have any conflict of interest to declare.

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