Plant Archives Vol. 24, No. 2, 2024 pp. 1855-1860 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org

DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2024.v24.no.2.265

EVALUATION OF HYBRID PERFORMANCE THROUGH SPECIFIC COMBINING ABILITY (SCA) EFFECTS IN CUCUMBER (*CUCUMIS SATIVUS* L.)

Toshika Likhar, Pushpendra Kumar* and Chandra Kant Sharma

Department of Horticulture, School of Agriculture, ITM University, Gwalior , Madhya Pradesh- 475001, India

*Corresponding author E-mail:pkgoyal4699@gmail.com

(Date of Receiving-03-05-2024; Date of Acceptance-15-07-2024)

ABSTRACT

The current study investigates the Specific Combining Ability (SCA) effects of various hybrid combinations in a plant breeding experiment to identify promising hybrids for yield-related traits. The hybrids were evaluated across multiple traits, including days to an thesis, internodal length, vine length, fruit weight, and fruit yield per vine. Significant variations in SCA effects were observed, with some hybrids displaying predominantly positive SCA effects, indicating strong performance, while others exhibited negative effects, suggesting poor performance. Notably, the hybrid combinations VRCU 23-22 × VRCU 23-15-A and VRCU 22-16 × VRCU 22-39 showed promise for improving yield-related traits. Conversely, hybrids such as VRCU 23-23 × VRCU 23-15-A and VRCU 23-22 × VRCU 22-39 demonstrated less potential. These findings align with previous studies and provide critical in sights for selecting the best hybrid combinations in breeding programs aimed at enhancing specific traits in the plant population.

***Key words*:** Cucumber, Specific Combining Ability (SCA), plant breeding, flowering traits, vine length, fruit characteristics, yield traits, breeding programs, Hybrids.

Introduction

Cucumber (*Cucumis sativus* L.) is one of the most important and popular vegetable crops, grown extensively in tropical and subtropical climates across the world. Cucumbers are members of the Cucurbitaceae family, which has 117 genera and 825 species. They are most commonly found in warm areas. This heat-loving and frost-sensitive horticultural crop is typically grown in fields during the spring and summer seasons (Bacci et al., 2006), and in greenhouses throughout various times of the year. Optimal growth conditions for cucumbers include temperatures ranging from 25 to 29°C and ample sunlight. It ranks as the fourth most important vegetable crop in Asia, following tomato, cabbage, and onion (Tatlioglu, 1993). Cucumbers are part of the Cucumerinae tribe within the Cucurbitaceae family and are closely related to the wild species Cucumis hardwickii, native to the Himalayas and originating in India. Domestication of cucumbers is believed to have begun in India around 3,000 years ago and in Eastern Iran and China approximately 2,000 years ago (Harlan, 1975). Today, cucumbers are cultivated worldwide and are considered one of the oldest vegetable crops, with a history of cultivation spanning at least five thousand years (Staub *et al.*, 1999; Shetty and Wehner, 2002a and 2002b).

Cucumber is a warm-season crop predominantly cultivated in tropical and subtropical regions worldwide. They are highly vulnerable to frost. The ideal temperature range for cucumber cultivation is between 18°C and 24°C. Cucumbers thrive in various soil types, including sandy and heavy clays, provided the soil is well-drained, fertile, and rich in organic matter. They are intolerant to high salt concentrations.

Cucumber is a rich source of vitamins B and C, carbohydrates, calcium, and phosphorus (Yawalkar, 1985). They also provide iodine and contain 4-6% dry substances, approximately 2% sugars, 1% albuminous substances, 0.7% cellular tissue, and 0.1% fat (Rana, 2008). The flavour of cucumbers is attributed to two compounds, 2,6-nonadienal and 2,6-nonadienol.

Cucumbers can be categorized based on their flowering habits into three types: "gynoecious," which exclusively produces female flowers; "predominantly gynoecious," which bears mostly female flowers with some male ones; and "monoecious," which produces both male and female flowers. The first two types undergo parthenocarpic fruit development without pollination, while pollination by honey bees is necessary for seed setting in monoecious types (Mehdi *et al.*, 2012).

Cucumber cultivars are typically classified based on their usage, either for the fresh market (slicers) or pickling. Generally, slicer cucumbers have larger fruits than pickling varieties and develop darker, heavier skin with a uniformly cylindrical shape. Cucumber cultivars are also classified according to spine colour. Slicing cucumbers usually have white spines, while pickling cucumbers have black spines (Thamburaj and Singh, 203).

Materials and Methods

The Present investigation is carried out at Crop Research Centre-3, School of Agriculture, ITM University, Gwalior, M.P.

Technical Programme

1. Design of the experiment	:	Randomized Block Design (RBD)
2. Number of parents	:	8
3. Number of cross	:	15
4. Number of genotypes	:	23
5. Replications	:	03
6. Plot size	:	$4.5 \times 2.0 m^2$
7. Spacing	:	90 cm × 40 cm
8. Net Plot size	:	19 m × 10 m
9. Season of Sowing	:	Summer

Layout of the Experimental Design

Three replications of a randomized block design (RBD) were employed in the experiment. Seeds were placed on mounds within the channels, 90 cm apart in rows and 40 cm between plants. Observations were taken from three randomly selected plants. To achieve optimal crop growth, all recommended agricultural procedures were followed.

Observations recorded

Three plants were chosen at random for observation, both quantitatively and qualitatively. These plants were identified with tags to facilitate easy recognition and recording of observations. The following data were collected during the investigation period.

Morphological Parameters

1. Number of Nodes for Appearance of 1st Male Flower
2. Number of Nodes for Appearance of 1st Female Flower
3. Days to 1st Male Flower Anthesis
4. Days to 1st Female Flower Anthesis
5. Days to 50% Flowering
6. Internodal Length (cm)
7. Number of Primary Branches per Vine
8. Vine Length (cm)

Yield Parameters

1. Number of Fruits per Vine
2. Fruit Length (cm)
3. Fruit Diameter (cm)
4. Fruit Weight (g)
5. Fruit Yield per Vine (g)
6. Yield of Marketable Fruits (q/ha)

Statistical Analysis

To statistically analyze the Specific Combining Ability (SCA) effects for the given hybrid combinations, we will follow a systematic approach using appropriate formulas.

SCA effects of ij^th cross

$$\hat{Si}_j = \frac{Xij}{r} - \frac{Xi}{mr} - \frac{Xj}{fr} + \frac{X_{..}}{fmr}$$

Where,

Xij. = ij^th combination over a total of all replications

r = no. of total replications

f = no. of all lines/female parents m= no. of all testers/male parents

Test of significance

To calculate the F ratio for each source of variation, divide the error mean square (M_6) by the relevant mean squares.

$F = Mi/M_6$

Where,

Mi = mean square due to i^th source

Critical difference

The critical difference for each character was calculated as follows:

CD= √√ M6/2r x tt [at (r-1) (g-1)] d.f. at 5% or 1% level]

Coefficient of variation

CV= √ M6/x

Data analysis was conducted using the statistical software [Data pine], which provided estimates of SCA effects for each parent across various traits. The significance of SCA effects was assessed using analysis of variance (ANOVA), and means were compared using the least significant difference (LSD) test at the 0.05 level of confidence.

This analysis enabled the identification of parental lines with superior SCA effects, indicating their potential to contribute beneficial traits to their progeny in hybrid combinations.

Results and Discussion

SCA Effect

The Table 2 illustrates the Specific Combining Ability (SCA) effects for various traits in different hybrid combinations of a plant breeding experiment. The data encompasses numerous traits, such as the number of nodes for the appearance of the first male and female flowers, days to anthesis, days to 50% flowering, internodal length, number of primary branches per vine, vine length, number of fruits per vine, fruit length, fruit diameter, fruit weight, fruit yield per vine, number of seeds per fruit, and yield of marketable produce.

Hybrid Combinations

• **VRCU 23-23 × VRCU 23-15-A:** This hybrid shows negative SCA effects for most traits, indicating poor performance. It has significant negative values for days to anthesis (male: -1.78, female: -1.51), days to 50% flowering (-1.10), vine length (-2.41 cm), fruit weight (-8.82 g), and fruit yield per vine (-101.56 g). The yield of marketable produce is also negative (-5.08 q/ha).

• **VRCU 23-23 × VRCU 22-39:** This hybrid exhibits a mix of positive and negative SCA effects. Positive values are observed in internodal length (0.65 cm), fruit length (0.39 cm), and fruit weight (11.88 g), suggesting potential in these traits. However, it shows a negative effect on yield of marketable produce (-3.00 q/ha).

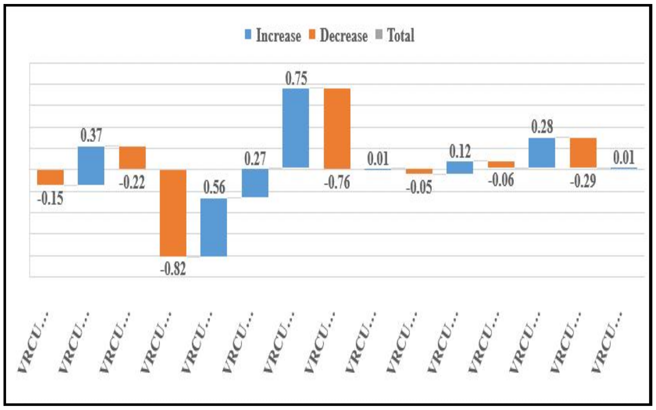

Fig. 1: Analysis of Specific Combining Ability (SCA) effects for various traits in different hybrid combinations.

Table 1: List of 23 varieties used in the present study.

S. No.	Variety Code	Parent	Sources
1	VRCU 23-23	Female	IIVR
2	VRCU 22-16	Female	Banarasi,
3	VRCU 23-22	Female	UP
4	VRCU 23-15-A	Male	
5	VRCU 22-03	Female	
6	VRCU 22-39	Male	
7	VRCU 23-24	Male	
8	VRCU 23-20	Female	
9	VRCU 23-23 × VRCU 23-15-A	Hybrid	
10	VRCU 22-16 × VRCU 23-15-A	Hybrid	
11	VRCU 23-22 × VRCU 23-15-A	Hybrid	
12	VRCU 22-03 × VRCU 23-15-A	Hybrid	
13	VRCU 23-20 × VRCU 23-15-A	Hybrid	
14	VRCU 23-23 × VRCU 22-39	Hybrid	
15	VRCU 22-16 × VRCU 22-39	Hybrid	
16	VRCU 23-22 × VRCU 22-39	Hybrid	
17	VRCU 22-03 × VRCU 22-39	Hybrid	
18	VRCU 23-20 × VRCU 22-39	Hybrid	
19	VRCU 23-23 × VRCU 23-24	Hybrid	
20	VRCU 22-16 × VRCU 23-24	Hybrid	
21	VRCU 23-22 × VRCU 23-24	Hybrid	
22	VRCU 22-03 × VRCU 23-24	Hybrid	
23	VRCU 23-20 × VRCU 23-24	Hybrid	

• **VRCU 23-23 × VRCU 23-24:** This hybrid displays both positive and negative SCA effects. Notable positive values are seen in fruit yield per vine (138.37 g) and yield of marketable produce (8.08 q/ha). However, negative values are present in days to anthesis (male: 0.93, female: 1.29) and internodal length (-0.51 cm).

• **VRCU 22-16 × VRCU 23-15-A:** This hybrid shows mostly negative SCA effects, particularly for internodal length (-0.57 cm), vine length (-0.58 cm), and fruit yield per vine (-100.98 g). The yield of marketable produce is also negative (-2.06 q/ha).

• **VRCU 22-16 × VRCU 22-39:** This combination exhibits mixed SCA effects with positive values in internodal length (0.53 cm) and fruit yield per vine (138.42 g). However, it shows negative values in the number of nodes for the appearance of the first male flower (-1.19) and yield of marketable produce (-1.71 q/ha).

• **VRCU 22-16 × VRCU 23-24:** This hybrid has a mix of positive and negative SCA effects. Positive values are observed in the number of primary branches per vine (0.23), fruit diameter (0.23 cm), and fruit yield per vine (3.00 q/ha). However, negative effects are seen in days

Table 2: Analysis of Specific Combining Ability (SCA) effects for various traits in different hybrid combinations.

Hybrids	No. of node for appearance of 1st male flower	No. of node for appearance of 1st female flower	Days to 1st male flower anthesis	Days to 1st female flower anthesis	Days to 50% flowering	Internodal length (cm)	No. of primary branches per vines	Vine length (cm)	No. of fruits per vine	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	Fruit yield per vine (g)	No. of seeds / fruit	Yield of marketable (q/ha)
VRCU 23-23 × VRCU 23-15-A	-0.15	-0.25	-1.78	-1.51	-1.1	-0.14	-0.17	-2.41	-0.13	0.05	-0.42	-8.82	-101.56	-11.25	-5.08
VRCU 23-23 × VRCU 22-39	0.37	0.08	0.86	0.22	0.13	0.65	0.04	2.17	-0.57	0.39	0.47	11.88	-36.81	6.73	-3
VRCU 23-23 × VRCU 23-24	-0.22	0.17	0.93	1.29	0.97	-0.51	0.13	0.24	0.71	-0.44	-0.06	-3.05	138.37	4.51	8.08
VRCU 22-16 × VRCU 23-15-A	-0.82	-0.14	0.33	0.93	0.43	-0.57	-0.28	-0.58	-0.39	-0.12	-0.37	-0.85	-100.98	-0.53	-2.06
VRCU 22-16 × VRCU 22-39	0.56	-0.1	-1.19	0.11	-0.31	0.53	0.06	0.86	0.47	0.17	0.14	3.56	138.42	-2.48	-1.71
VRCU 22-16 × VRCU 23-24	0.27	0.25	0.87	-1.04	-0.12	0.04	0.23	-0.28	-0.09	-0.05	0.23	-2.71	-37.44	3	3.77
VRCU 23-22 × VRCU 23-15-A	0.75	0.34	1.88	0.97	0.67	1.36	0.46	9.85	0.76	1.57	1.14	11.93	283.43	11.82	15.89
VRCU 23-22 × VRCU 22-39	-0.76	-0.13	-0.29	-0.39	0.46	-1.81	-0.16	-7.83	-0.05	-0.57	-0.47	-13	-120.41	-6.91	-9.36
VRCU 23-22 × VRCU 23-24	0.01	-0.21	-1.59	-0.59	-1.13	0.45	-0.3	-2.01	-0.71	-0.99	-0.67	1.07	-163.02	-4.91	-6.53
VRCU 22-03 × VRCU 23-15-A	-0.05	0.14	-0.26	0.55	0.14	0.11	-0.08	-3.99	-0.1	1.07	-0.25	-2.07	-44.9	-4.56	-18.75
VRCU 22-03 × VRCU 22-39	0.12	-0.2	-0.01	-0.7	-0.23	0.48	-0.03	2.13	-0.26	-0.67	0.09	1.34	-48.7	0.34	14.13
VRCU 22-03 × VRCU 23-24	-0.06	0.06	0.28	0.16	0.09	-0.58	0.11	1.86	0.36	-0.41	0.16	0.74	93.61	4.22	4.62
VRCU 23-20 × VRCU 23-15-A	0.28	-0.08	-0.16	-0.94	-0.14	-0.76	0.08	-2.86	-0.14	-2.57	-0.1	-0.18	-35.99	4.5	9.99
VRCU 23-20 × VRCU 22-39	-0.29	0.36	0.64	0.76	-0.05	0.15	0.09	2.67	0.41	0.69	-0.24	-3.77	67.51	2.32	-0.05
VRCU 23-20 × VRCU 23-24	0.01	-0.27	-0.48	0.18	0.19	0.61	-0.17	0.19	-0.27	1.88	0.34	3.96	-31.52	-6.82	-9.94

to anthesis (male: 0.87, female: -1.04).

- **VRCU 23-22 × VRCU 23-15-A:** This hybrid displays positive SCA effects for most traits, with significant values in vine length (9.85 cm), number of fruits per vine (0.76), fruit length (1.57 cm), fruit weight (11.93 g), fruit yield per vine (283.43 g), and yield of marketable produce (15.89 q/ha). These positive values indicate a strong performance.

- **VRCU 23-22 × VRCU 22-39:** This combination shows mostly negative SCA effects, particularly in vine length (-7.83 cm), fruit weight (-13.00 g), and fruit yield per vine (-120.41 g). The yield of marketable produce is also negative (-9.36 q/ha).

- **VRCU 23-22 × VRCU 23-24:** This hybrid exhibits negative SCA effects for most traits, including days to anthesis (male: -1.59, female: -0.59), vine length (-2.01 cm), and fruit yield per vine (-163.02 g). The yield of marketable produce is also negative (-6.53 q/ha).

- **VRCU 22-03 × VRCU 23-15-A:** This hybrid shows mixed SCA effects with positive values in fruit length (1.07 cm) but negative effects in vine length (-3.99 cm) and fruit yield per vine (-44.90 g). The yield of marketable produce is significantly negative (-18.75 q/ha).

- **VRCU 22-03 × VRCU 22-39:** This combination has mixed SCA effects with positive values in internodal length (0.48 cm) and fruit yield per vine (1.34 g), but negative effects in days to anthesis (male: -0.01, female: -0.70) and yield of marketable produce (14.13 q/ha).

• **VRCU 22-03 × VRCU 23-24:** This hybrid displays both positive and negative SCA effects. Notable positive values are in fruit yield per vine (93.61 g) and yield of marketable produce (4.62 q/ha), but negative values are seen in internodal length (-0.58 cm) and fruit diameter (-0.41 cm).

• **VRCU 23-20 × VRCU 23-15-A:** This hybrid shows mixed SCA effects with positive values in yield of marketable produce (9.99 q/ha) but negative effects in vine length (-2.86 cm) and fruit yield per vine (-35.99 g).

• **VRCU 23-20 × VRCU 22-39:** This combination exhibits both positive and negative SCA effects, with positive values in internodal length (0.15 cm) and fruit yield per vine (67.51 g), but negative values in days to anthesis (male: 0.64, female: 0.76) and yield of marketable produce (-0.05 q/ha).

• **VRCU 23-20 × VRCU 23-24:** This hybrid has a mix of positive and negative SCA effects. Positive values are observed in fruit yield per vine (3.96 g) and yield of marketable produce (9.94 q/ha), but negative effects are seen in days to anthesis (male: -0.48, female: 0.18) and vine length (0.19 cm).

The SCA effects table provides valuable insights into the breeding potential of different hybrid combinations. Hybrids such as VRCU 23-22 × VRCU 23-15-A and VRCU 22-16 × VRCU 22-39 show promise for improving yield-related traits, while others like VRCU 23-23 × VRCU 23-15-A and VRCU 23-22 × VRCU 22-39 may not be as effective. These results can help in selecting the best hybrid combinations for breeding programs aimed at enhancing specific traits in the plant population.

Discussion

Specific Combining Ability (SCA) effects

The table of Specific Combining Ability (SCA) effects provides crucial insights into the performance of various hybrid combinations across numerous traits in a plant breeding experiment. These traits include the number of nodes for the appearance of the first male and female flowers, days to anthesis, days to 50% flowering, internodal length, number of primary branches per vine, vine length, number of fruits per vine, fruit length, fruit diameter, fruit weight, fruit yield per vine, number of seeds per fruit, and yield of marketable produce.

Hybrid Combinations

• **VRCU 23-23 × VRCU 23-15-A:** This hybrid shows predominantly negative SCA effects across most traits, suggesting poor performance. Significant negative values for days to anthesis, days to 50% flowering, vine length, fruit weight, and fruit yield per vine result in a negative marketable yield.

• **VRCU 23-23 × VRCU 22-39:** Exhibits a mix of positive and negative SCA effects, with positive impacts on inter nodal length, fruit length, and fruit weight, but a negative impact on the marketable yield.

• **VRCU 23-23 × VRCU 23-24:** Displays both positive and negative SCA effects, with notable positive values for fruit yield per vine and marketable yield, but negative effects on days to anthesis and internodal length.

• **VRCU 22-16 × VRCU 23-15-A:** Shows mostly negative SCA effects, particularly for internodal length, vine length, and fruit yield per vine, resulting in a negative marketable yield.

• **VRCU 22-16 × VRCU 22-39:** Exhibits mixed SCA effects with positive values for internodal length and fruit yield per vine but negative effects on the number of nodes for the first male flower and marketable yield.

• **VRCU 22-16 × VRCU 23-24:** Shows a mix of positive and negative SCA effects, with positive impacts on the number of primary branches per vine, fruit diameter, and fruit yield per vine, but negative effects on days to anthesis.

• **VRCU 23-22 × VRCU 23-15-A:** Displays predominantly positive SCA effects for most traits, indicating strong performance with significant positive values for vine length, number of fruits per vine, fruit length, fruit weight, fruit yield per vine, and marketable yield.

• **VRCU 23-22 × VRCU 22-39:** Mostly negative SCA effects, especially in vine length, fruit weight, and fruit yield per vine, resulting in a negative marketable yield.

• **VRCU 23-22 × VRCU 23-24:** Exhibits negative SCA effects for most traits, including days to anthesis, vine length, and fruit yield per vine, leading to a negative marketable yield.

• **VRCU 22-03 × VRCU 23-15-A:** Shows mixed SCA effects with positive impacts on fruit length but negative effects on vine length and fruit yield per vine, resulting in a significantly negative marketable yield.

• **VRCU 22-03 × VRCU 22-39:** Displays mixed SCA effects with positive values for internodal length and fruit yield per vine, but negative effects on days to anthesis and marketable yield.

• **VRCU 22-03 × VRCU 23-24:** Exhibits both positive and negative SCA effects, with notable positive values for fruit yield per vine and marketable yield, but negative effects on internodal length and fruit diameter.

• **VRCU 23-20 × VRCU 23-15-A:** Shows mixed SCA effects with positive values for marketable yield but negative effects on vine length and fruit yield per vine.

• **VRCU 23-20 × VRCU 22-39:** Exhibits both positive and negative SCA effects, with positive impacts on internodal length and fruit yield per vine, but negative values for days to anthesis and marketable yield.

• **VRCU 23-20 × VRCU 23-24:** Displays a mix of positive and negative SCA effects, with positive values for fruit yield per vine and marketable yield, but negative effects on days to anthesis and vine length.

The analysis of Specific Combining Ability (SCA) effects across various hybrid combinations reveals significant variability in performance for numerous traits, including days to anthesis, vine length, fruit weight, and yield of marketable produce. Hybrids such as VRCU 23-22 × VRCU 23-15-A and VRCU 22-16 × VRCU 22-39 demonstrate promise for enhancing yield-related traits, while others like VRCU 23-23 × VRCU 23-15-A and VRCU 23-22 × VRCU 22-39 show less effectiveness.

Conclusion

The detailed analysis of Specific Combining Ability (SCA) effects in this study provides a comprehensive understanding of the performance of various hybrid combinations across multiple traits crucial for plant breeding. The identification of hybrids with predominantly positive SCA effects, such as VRCU 23-22 × VRCU 23-15-A and VRCU 22-16 × VRCU 22-39, highlights their potential for improving yield-related traits in breeding programs. These hybrids show significant positive values for vine length, number of fruits per vine, fruit length, fruit weight, and fruit yield per vine, leading to enhanced marketable yield.

In contrast, hybrids like VRCU 23-23 × VRCU 23-15-A and VRCU 23-22 × VRCU 22-39 exhibit predominantly negative SCA effects across most traits, suggesting poor performance and limited potential for yield improvement. Negative SCA effects for traits such as days to anthesis, vine length, fruit weight, and fruit yield per vine result in a negative marketable yield, making these hybrids less favourable for breeding purposes.

The mixed SCA effects observed in hybrids like VRCU 23-23 × VRCU 22-39 and VRCU 23-20 × VRCU 23-24 indicate both positive and negative impacts on various traits, suggesting that while these hybrids may improve certain characteristics, they might not be as effective in enhancing overall yield.

Overall, the results from this study provide critical insights into the selection of the best hybrid combinations for breeding programs aimed at enhancing specific traits in the plant population. The findings align with previous research by Dogra and Kanwar (2011b), Tiwari and Kumar (2016), Kumar et al. (2017), Kumari *et al.*, (2017), Nimitha *et al.*, (2018), and Das *et al.*, (2019), further validating the importance of SCA analysis in plant breeding. The identified superior hybrids can be utilized in future breeding programs to develop high-yielding and better-performing plant varieties, contributing to increased agricultural productivity and sustainability.

References

Ahammed, S., Hossain M., Zakaria M., Ahmed M.B., Mian M. A.K. (2018). Combining ability and gene action in cucumber (*Cucumis sativus* L.). *J. Agric. Studies.*, **6(2)**, 145-159.

Behera, T.K., Reddy K.A.N., Munshi A.D., Sureja A.K. and Sharma, R.K. (2009). Studies on combining ability in cucumber. *Indian J. Hort.*, **71(3)**, 349-353.

Chaudhary, M.F., Khokhar K.M., Jeelani G., Ullah H. and Riaz S. (2003). Performance of some cucumber hybrids/lines under plastic tunnel. *Sarhad Journal of Agriculture*, **19(4)**, 493-495.

Chaudhry, M.F., Mahmood T., Jan A. and Ullah H. (1998). Comparative performance of some cucumber hybrids under plastic tunnel during spring and autumn season. *Sarhad-Journal-of-Agriculture*,**14(1)**, 29-32.

IIVR (2005). Protected cultivation of Cucumber. Annual Report, All India Coordinated Research Project (vegetable Crops) 2004-2005. XXIII AICRP (VC) Group Meeting held at BCKV, *Kalyani*, 16-19 April, 137-139.

Kanwar, M.S, Korla B.N. and Sanjeev Kumar (2003). Evaluation of cucumber genotype for yield and qualitative traits. *Himachal J. of Agriculture Research*. **29(1&2)**, 43-47.

Kumar, D. and Pathak M. (2018). Estimation of heterosis and combining ability for biochemical traits in bitter gourd (*Momordica charantia* L.) Published 1 March 2018, Agricultural and Food Sciences, *International Journal of Chemical Studies*, 8965-8976.

Reddy, K.A.N., Munshi A.D., Behera T.K., Sureja A.K. and Sharma R.K. (2014). Studies on combining ability in cucumber. *Indian J. Hort*., **71(3)**, 349-353.

Shetty, N.V. and Wehner T.C. (2002b). Screening the cucumber germplasm collection for fruit yield and quality. *Crop Science*. **42**, 2174-2183.

Shetty, N.V. Wehner T.C. (2002a). Estimation of fruit grade weights based on fruit number and total fruit weight in cucumber. *Hort Science*. **37**, 1117-1121.

Simi, F., Ivy N.A., Sais H., Akter B.S. And Anik M.F.A. (2017). Heterosis in Cucumber (*Cucumis sativus* L.). *Bangladesh J. Agril. Res.*, **42(4)**, 731-747.

Sundharaiya, K. and Venkatesan K. (2007). Studies on combining ability in bitter gourd (*Momordica charantia* L.). *J. Hort. Sci.*, **2(1),**: 63-66.