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Combining ability analysis for green pod yield and its components in inter sub-species of cowpea [*Vigna unguiculata (L) Walp.*] ssp.

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Abstract Six lines, two each from *Vigna unguiculata* ssp. *unguiculata* (vegetable type), *Vigna unguiculata* ssp. *unguiculata* (grain type) and *Vigna unguiculata* ssp. *sesquipedalis* (vegetable type) as female parents and four testers from *unguiculata* ssp. *unguiculata* (three vegetable type and one grain type) as male parents were crossed in line x tester matting design. The ICP-38, ICP-42, Indira Hari and Arka Garima were good general combiner for earliness and ICP-42, ICP-54, Pusa Komal, Arka Garima and Indira Hari for green pod yield per plant. The cross combinations ICP-42 x Arka Garima, ICP-54 x Indira Hari, ICP-26 x Khalleshwari and ICP-49 x Khalleshwari were found best for number of pods per plant whereas, crosses ICP-42 x Arka Garima, ICP-42 x Indira Hari, and ICP-54 x Arka Garima showed high significant and positive sca effects with high mean for green pod yield per plant.

Keywords : Combining ability, yield, cowpea, *Vigna unguiculata*

Introduction

Cowpea is an important legume rich in protein, mainly used for green immature pods, pulse and fodder. In the cultigen cowpea, four sub species have been identified, in which *unguiculata*, the grain types and *sesquipedalis*, the yard long bean (vegetable) type are most commonly cultivated. The green immature succulent pod of vegetable cowpea has equivalent in nutritional composition as other beans and good replacement with lower expenses. The most encountered problem with cultivation of yard long bean or vegetable type is providing space and support for its vigorous viny growth habit (Valarmathi *et al*. 2007). Hence, replacement of yard long bean with bush type vegetable cowpea having either bushy or semi trailing growth habit with incorporation of earliness, more number of seeds per pod and high protein content in green pods will be rewarding. For genetic improvement of any crop the most important prerequisite is selection of suitable parents, which would combine well and produce desirable segregants in adequate frequency, because the high yielding parent may not necessarily transfer its superiority to the progenies in the cross. It is therefore, necessary to know the genetic architecture of parents on the genetic contribution for yield and its related characters would help in identifying promising lines and superior crosses in early generation itself. Keeping these views, the above mentioned subspecies were subjected to genetical analysis to identify the best combiners and crosses for future exploitation.

Materials and Methods

The experiment was conducted during *Kharif* season of 2007 to 2008 at Department of Horticulture, IGKV, Raipur (C.G.). The experiment comprises of six lines, two each from *Vigna unguiculata* ssp. *unguiculata* (vegetable type), *Vigna unguiculata* ssp. *unguiculata* (grain type) and *Vigna unguiculata* ssp. *sesquipedalis* (vegetable type) as female parents and four testers from *Vigna unguiculata* ssp. *unguiculata* (three vegetable type and one grain type) as male parents were crossed in line x tester matting design. Genotypes ICP-26 (L_1) and ICP-38 (L_2) as seed type and ICP-45 (L_4) and ICP-49 (L_5) as vegetable type from ssp. *unguiculata* and ICP-42 (L_3) and ICP-54 (L_6) as vegetable type from

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sesquipedalis were selected as lines and four genotypes *viz*., Pusa Komal (T_1), Arka Garima (T_2), Indira Hari (T_3) as vegetable type and Khalleshwari (T_4) as seed type from ssp. *unguiculata* were selected as testers for line x tester cross. All the parents along with their 24 F_1s were grown in randomized block design with three replications. Each genotype consisted of three rows of 3.15 m long and 7 plants in each row. The spacing given was 60 cm between rows and 45 cm within a row. Observations were recorded on ten randomly tagged competitive plants from each genotype and data were subjected to combining ability analysis as per Kempthorne (1957).

Results and Discussion

The analysis of variance for combining ability in respect of 19 characters is tabulated in Table 1. Partitioning of variance due to crosses into interaction components were significant for all the characters under study. Thus the significance of mean squares due to lines and testers were tested for all most of the characters whereas, crosses also showed significant differences for all the characters. The mean square due to lines were recorded higher for plant height, per cent pod set, days to final picking, pod length, pod weight, fruiting duration and number of pickings indicating the greater diversity among the lines as compared to the testers whereas, in rest of the characters testers had higher diversity as compared to the lines. Similar views were also expressed by Pal *et al.* (2002).

The genetic worth of the parents is decided on the basis of its combining ability. The combining ability had given useful information on the choice of patents in terms of expected performance of the crosses and their progenies. Also the parents having high general combining ability (gca) could be useful for producing transgressive segregants from advance generations. The estimates of general combining ability effects of lines and testers are presented in Table 2. The line ICP-42 had recorded significant gca values in desirable direction for most of the characters. Early flowering is desirable character therefore, negative gca effect value is important for this character. The parents, ICP-38, ICP-42, Indira Hari and Arka Garima were good general combiner for days to first flowering, days to 50 % flowering and days to first picking except Arka Garima for days to 50 % flowering. The lines ICP-26, ICP-38 and ICP-54 had significant negative gca effect that can contribute to develop bushy or semi trailing type genotype whereas, ICP-42 and ICP-45 had significant positive gca effect for plant height. High and significant gca estimates was observed in ICP-38, ICP-54 and Khalleshwari for number of branches per plant while parents ICP-26, Pusa Komal and Indira Hari for number of nodes per plant. The results are in close conformity with the findings of Tiwari *et al.* (1993), Patel *et al.* (1994) and Pal *et al.* (2002) for earliness and Pal *et al.* (2002) for number of branches per plant.

High gca estimate was also recorded in ICP-26, ICP-38 and Arka Garima for number of flowers per cluster; ICP-42, Arka Garima and Khalleshwari for number of pods per cluster; ICP-42, ICP-54 and Khalleshwari for per cent pod set and ICP-42, ICP-45 and Indira Hari for days to final picking. However, ICP-42, ICP-54, Pusa Komal, Arka Garima and Indira Hari were identified as good combiner for pod length and pod weight whereas, ICP-42 and ICP-54 for number of pods per plant. The significant and high estimate of gca was noted in ICP-38, ICP-42 and Indira Hari for number of seeds per pod, ICP-42, ICP-45, ICP-49 and Indira Hari for fruiting duration, ICP-26 and Khalleshwari for per cent protein content in green pods, ICP-38, ICP-42, ICP-49, ICP-54, Pusa Komal, Arka Garima and Indira Hari for 100-seed weight and ICP-42, ICP-54, Pusa Komal, Arka Garima and Indira Hari for green pod yield per plant. Similar results was also reported by Hazra *et al.*(1996), Umaharan *et al.* (1997), Kumar and Sangwan (2005) and Pal *et al.* (2002).

The estimates of specific combining ability (sca) effects were given in Table 3. Among the twenty four crosses, ICP-26 x Pusa Komal, ICP-38 x Indira Hari, ICP-42 x Khalleshwari and ICP-45 x Arka Garima combined well to produce significant negative sca effects being desirable for both days to first flower and days to 50% flowering whereas, ICP-26 x Indira Hari, ICP-38 x Khalleshwari and ICP-45 x Pusa Komal and ICP-49 x Khalleshwari for days to first flowering and ICP-42 x Indira Hari and ICP-54 x Arka Garima for days to 50% flowering showed high negative sca effect. These results are similar to the findings of Mishra *et al.* (1987), Tiwari *et al.* (1993), Patel *et al.* (1994), Chaudhary *et al.* (1998) and Singh *et al.* (2004). For plant height, ICP-42 x Indira Hari followed by ICP-45 x Arka Garima, ICP-38 x Arka Garima, ICP-26 x Khalleshwari, ICP-49 x Khalleshwari expressed desirable sca effects. For number of branches per plant, ICP-49 x Khalleshwari, ICP-38 x Pusa Komal and ICP-38 x Arka Garima and for number of nodes per plant ICP-26 Arka Garima and ICP-45 Indira Hari had showed significant positive sca effect. High significant and positive estimate of sca was noted in crosses ICP-38 x Indira Hari, ICP-38 x Pusa Komal, ICP-54 x Pusa Komal, ICP-26 x Arka Garima and ICP-26 x Indira Hari for number of flowers per cluster.

For number of pods per cluster, ICP-42 x Indira Hari, ICP-26 x Khalleshwari, ICP-49 x Pusa Komal, ICP-54

Table 1: Analysis of variance for combining ability analysis for green pod yield and its component characters in cowpea

Character	df	Replications	Lines	Testers	Lines x Testers	Error
		02	05	03	15	46
Days to first flower		6.09	64.88*	213.22*	12.68 *	2.74
Days to 50% flowering		11.26	114.54*	252.38*	14.00*	3.16
Days to first picking		14.53	18.23*	159.42*	37.41*	4.26
Plant height (cm)		25.08	22945.02*	946.76*	227.00*	379.00
Number of branches per plant		0.46	19.47*	21.80*	1.58*	0.38
Number of nodes per plant		26.75	84.94*	514.03*	5.34	4.99
Number of flowers /cluster		0.67	5.69*	6.05*	1.51*	0.13
Number of pods/ cluster		0.35	0.57*	2.11*	0.77*	0.02
Per cent pod set		16.68	752.64*	88.95*	18.37	15.14
Days to final picking		7.24	833.25*	115.66*	13.15	20.97
Pod length (cm)		12.15	295.14*	143.45*	221.92*	5.11
Pod weight (g)		0.93	32.45*	17.52*	36.70*	0.37
Number of pods /plant		20.22	8.96*	17.53*	37.99*	5.34
Number of seeds / pod		0.30	23.43*	28.31*	1.03	2.64
Fruiting duration (days)		13.45	673.95*	523.41*	81.55*	17.66
Protein content in green pods (%)		0.01	0.23*	1.03*	0.43*	0.03
100 Seed Weight (g)		0.62	14.14*	16.65*	7.83*	0.31
Number of Pickings		0.24	21.47*	16.65*	12.39*	0.44
Green pod yield /plant (g)		214.23*	8452.11*	10366.87*	31636.71*	411.42*

* Significant at P = 0.05 level

Table 2: General Combining Ability (GCA) effects of lines and testers for green pod yield and its components

Parents	Characters																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Lines																			
ICP-26 (L_1)	3.28*	2.74*	2.97*	-19.59	-0.49*	5.25*	0.12*	-0.20*	-4.42*	-7.26*	-3.99*	-3.09*	-2.41*	-0.03	-10.24*	0.19	-1.76*	-2.78*	-82.47*
ICP-38 (L_2)	-3.47*	-4.68*	-3.78*	-52.62	2.10*	-0.45	1.05*	0.05	-6.11*	-12.43*	0.82	-0.07	1.42*	1.14*	-8.65*	0.01	0.40*	0.31*	4.07
ICP-42 (L_3)	-1.64*	-2.51*	-1.19*	65.66	-1.15*	-1.96*	-0.55*	0.10*	6.24*	6.49*	5.80*	3.68*	1.18	1.72*	7.68*	-0.07	0.72*	1.09*	94.30*
ICP-45 (L_4)	1.03*	0.99	0.56	38.61	-1.27*	-0.08	0.01	0.08	0.44	9.82*	-2.16*	-0.84*	-0.83	-0.03	9.26*	0.02	-0.51*	-0.32*	-27.33*
ICP-49 (L_5)	0.11	0.150.47		-9.2(	0.08	-1.24*	-0.15*	-0.09	-1.17	2.57	-4.38*	-0.21	-2.75*	-0.78	2.10*	-0.02	0.30*	-0.23	-31.38*
ICP-54 (L_6)	0.69	3.32*	0.97	-22.80	0.73*	-1.51*	-0.50*	0.06	5.01*	0.82	3.90*	0.53*	3.39*	-2.03*	-0.15	-0.03	0.86*	1.92*	42.81*
Testers																			
Pusa Komal (T_1)	-0.44	0.79	-0.08-1.24		-0.61*	3.02*	-0.15*	-0.44*	-5.54*	0.68	3.87*	1.07*	0.87	0.69	0.76	-0.25*	0.70*	0.99*	33.03*
Arka Garima (T_2)	-1.11*	-0.65	-1.25*10.38		-1.01*	-3.82*	1.08*	0.56*	0.05	0.35	3.43*	2.00*	0.71	-0.92*	1.60	-0.25*	0.92*	1.00*	46.80*
Indira Hari (T_3)	-3.28*	-4.60*	-3.58*-6.41		0.14	5.95*	-0.88*	-0.58*	-1.26	1.96*	5.24*	0.87*	0.41	1.19*	5.54*	-0.15*	1.03*	0.63*	21.00*
Khalleshwari (T_4)	4.83*	4.46*	4.92*-2.73		1.49*	-5.15*	-0.05	0.46*	6.75*	-2.99*	-12.55*	-3.94*	-1.99*	-0.97*	-7.90*	0.65*	-2.65*	-2.62*	-100.82*
SE (Lines)	0.37	0.39	0.404.31		0.14	0.49	0.04	0.04	0.66	0.64	0.50	0.10	0.47	0.31	0.67	0.04	0.08	0.12	4.64
SE (Testers)	0.28	0.30	0.313.34		0.11	0.38	0.03	0.03	0.51	0.50	0.39	0.08	0.37	0.24	0.52	0.03	0.06	0.10	3.60

1. Days to first flower
2. Days to 50% flowering
3. Days to first picking
4. Plant Height (cm)
5. No. of branches/ plant
6. No. of nodes per plant
7. No. of flowers/cluster
8. No. of pods/cluster
9. Per cent pod set
10. Days to final picking
11. Pod length (cm)
12. Pod weight (g)
13. No. of pods /plant
14. No. of seeds/pods
15. Fruiting duration (days)
16. Protein cont. in green pods (%)
17. 100 seed weight (g)
18. No. of pickings
19. Green pod yield/ plant (g)

Table 3: Specific Combining Ability (SCA) effects of hybrids for green pod yield and its component characters

Hybrids	Characters																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
ICP- 26 x Pusa Komal	-1.56	-1.79*	-0.42	4.35	-0.04	-1.25	-0.60*	-0.06	3.09*	0.65	-1.21	0.00	-1.61	-0.36	1.07	-0.01	-0.21	-0.08	-13.17
ICP- 26 x Arka Garima	-0.56	-0.68	-1.25	8.69	-0.57*	2.47*	0.37*	0.14*	0.84	-0.35	-1.48	-1.50*	-1.59	0.25	0.90	0.04	-0.34*	-0.64*	-34.99*
ICP- 26 x Indira Hari	-2.39*	-0.40	-1.58*	-4.84	0.47	-1.76*	0.33*	-0.32*	-8.69*	3.04*	-1.32	-0.87*	-0.01	0.14	4.62*	0.00	-0.49*	-0.47*	-23.08*
ICP- 26 x Khalleshwari	4.50*	2.88*	3.25*	-8.20	0.13	0.55	-0.10	0.24*	4.76*	-3.35*	4.01*	2.37*	3.20*	-0.03	-6.60*	-0.03	1.03*	1.19*	71.25*
ICP- 38 x Pusa Komal	1.53*	0.29	0.33	-6.74	0.78*	-0.46	0.60*	-0.11	-3.58*	-0.85	1.60	0.21	1.27	-0.19	-1.18	0.07	-0.25	0.16	8.85
ICP- 38 x Arka Garima	1.53*	3.07*	1.83*	-8.39	0.51*	0.79	-0.90*	0.16*	7.73*	2.82*	1.74*	0.15	0.67	0.08	0.99	0.11	-0.36*	0.39	6.76
ICP- 38 x Indira Hari	-1.31*	-2.32*	-1.50*	4.27	0.09	0.00	0.80*	0.10	-4.68*	-2.46*	-2.20*	-0.72*	-0.29	-0.69	-0.96	0.04	0.31*	-0.14	-18.95*
ICP- 38 x Khalleshwari	-1.75*	-1.04	-0.67	10.86	-1.39*	-0.32	-0.50*	-0.14*	0.53	0.49	-1.14	0.35	-1.65	0.81	1.15	-0.22*	0.31*	-0.40	3.34
ICP- 42 x Pusa Komal	1.03	1.12	1.42*	-0.84	-0.10	0.62	0.27*	0.08	-2.06	-1.10	-1.27	-1.26	0.58	0.22	-2.51*	0.02	0.22	0.26	-16.23*
ICP- 42 x Arka Garima	0.69	2.57*	-0.08	10.43	0.10	-0.76	0.30*	-0.22*	-6.36*	-2.10	1.47	1.81*	3.49*	0.50	-2.01*	-0.05	0.44*	0.50*	51.81*
ICP- 42 x Indira Hari	0.19	-1.82*	0.25	-13.95	-0.39	-0.03	-0.60*	0.33*	11.64*	-1.71	4.46*	2.34*	-3.70*	0.06	-1.96	0.05	0.25	0.99*	39.98*
ICP- 42 x Khalleshwari	-1.92*	-1.88*	-1.58*	4.36	0.40	0.17	0.03*	-0.19*	-3.22*	4.90*	-4.65*	-2.89*	-0.38	-0.78	6.49*	-0.02	-0.92*	-1.74*	-75.56*
ICP- 45 x Pusa Komal	-1.64*	-1.04	-2.33*	7.26	0.35	-1.33	-0.36*	-0.01	2.60*	1.57	1.02	0.09	0.73	-0.03	3.90*	0.03	0.02	0.14	6.86
ICP- 45 x Arka Garima	-1.64*	-1.60*	-0.50	-8.63	0.28	-0.79	-0.19*	-0.06	0.95	0.24	-0.91	-0.72	-0.94	-0.08	0.74	-0.03	0.17	-0.11	-25.05*
ICP- 45 x Indira Hari	1.19	0.68	1.17	-1.24	-0.34	2.36*	0.24*	0.02	-2.40*	-0.71	-1.15	0.16	0.32	-0.19	-1.88	-0.04	-0.25	-0.19	2.65
ICP- 45 x Khalleshwari	2.08*	1.96*	1.67*	2.60	-0.29	-0.24	0.30*	0.05	-1.15	-1.10	1.04	0.46*	-0.11	0.31	-2.76*	0.04	0.06	0.16	15.54
ICP- 49 x Pusa Komal	0.94	-0.21	0.75	0.64	-1.20*	1.38	-0.33*	0.21*	5.77*	-0.18	-1.26	0.45*	-0.77	0.06	-0.93	-0.06	0.16	-0.29	-2.22
ICP- 49 x Arka Garima	0.28	-0.76	0.25	1.52	-0.54*	-1.50	0.23*	0.10	0.65	-0.51	-1.42	-0.33	-1.46	-0.33	-0.76	-0.02	0.16	-0.23	-20.24*
ICP- 49 x Indira Hari	0.78	1.85*	0.58	4.30	0.44	-0.09	-0.07	-0.31*	-5.97*	0.21	-1.24	-0.29	0.34	-0.11	-0.38	-0.01	0.19	0.10	-3.91
ICP- 49 x Khalleshwari	-2.00*	-0.88	-1.58V	-6.46	1.30*	0.21	0.16*	0.01	-0.46	0.49	3.93*	0.17	1.89*	0.39	2.07	0.09	-0.52*	0.42	26.37*
ICP- 54 x Pusa Komal	-0.31	1.62*	0.25	-4.67	0.21	1.05	0.42*	-0.11	-5.83*	-0.10	1.13	0.50*	-0.21	0.31	-0.35	-0.05	0.05	-0.18	15.90
ICP- 54 x Arka Garima	-0.31	-2.60*	-0.25	-3.62	0.21	-0.20	0.18*	-0.11	-3.81*	-0.10	0.60	0.59*	-0.18	-0.42	0.15	-0.05	-0.08	0.10	21.71*
ICP- 54 x Indira Hari	1.53*	2.01*	1.08	11.46	-0.28	-0.47	-0.72*	0.19*	10.10*	1.63	1.46	-0.62*	3.34*	0.81	0.54	-0.04	0.00	-0.30	3.32
ICP- 54 x Khalleshwari	-0.92	-1.04	-1.08	-3.17	-0.15	-0.38	0.11	0.03	-0.46	-1.43	-3.18*	-0.48*	-2.95*	-0.69	-0.35	0.13	0.04	0.38	-40.93*
SE ±	0.64	0.68	0.69	7.47	0.24	0.86	0.07	0.06	1.15	1.11	0.86	0.18	0.82	0.54	1.16	0.07	0.14	0.22	8.04

x Indira Hari, ICP-38 x Arka Garima and ICP-26 x Arka Garima and for percent pod set ICP-42 x Indira Hari followed by ICP-54 x Indira Hari, ICP-38 x Arka Garima, ICP-49 x Pusa Komal, ICP-26 x Khalleshwari and ICP-26 x Pusa Komal had significant sca effects. These crosses are also showed high mean performance for this trait, without any parent of these crosses recorded high positive gca effect with high sca effects. Such behaviour has been attributed to accumulation of genes in crosses favouring clustering habit and confirms additiveness. High significant and positive sca effects for pod length were shown by ICP-42 x Indira Hari, ICP- 26 x Khalleshwari, ICP-49 x Khalleshwari and ICP-38 x Arka Garima. Among these only ICP-42 x Indira Hari and ICP-38 x Arka Garima showed high mean performance and high gca performance shown by one of the parent that attributed to importance of additive gene action and possibility of getting better transgressive segeregants for early generation selection. The crosses ICP-26 x Khalleshwari, ICP-42 x Indira Hari, ICP-42 x Arka Garima, ICP-54 x Arka Garima, ICP-54 x Pusa Komal, ICP-45 x Khalleshwari and ICP-49 x Pusa Komal had high significant and positive estimates of sca effects for pod weight and four crosses; ICP-42 x Arka Garima, ICP-54 x Indira Hari, ICP-26 x Khalleshwari and ICP-49 x Khalleshwari for number of pods per plant. These results are in confirmation with Tiwari *et al.* (1993), Hazara *et al.* (1996), Yadav *et al.* (2004) and Kumar and Sangwan (2005).

Only three crosses *viz.*, ICP-42 x Khalleshwari, ICP-26 x Indira Hari and ICP-45 x Pusa Komal expressed good sca effects for fruiting duration and ICP-26 Khalleshwari, ICP-42 Arka Garima, ICP-38 x Indira Hari and ICP-38 x Khalleshwari for 100-seed weight. Particularly in legume vegetables moderate protein content is more desirable than very high or low, as increase in protein content reducing pod yield. Therefore, positive estimate of GCA and SCA effects would be measured as desirable. ICP-38 x Arka Garima and ICP-54 x Khalleshwari had significant positive sca effects whereas cross ICP-38 x Khalleshwari showed significant negative sca effect which indicated that both parental and maternal genomes influenced the protein content in cowpea therefore cross like ICP-42 x Indira Hari having high green pod yield per plant (342.68 g) with moderate protein (2.97%) content should be promoted. The findings is in close agreement with Hazra *et al.*(1996). For green pod yield per plant, five crosses showed high significant and positive sca effects *viz.*, ICP-26 x Khalleshwari, ICP-42 x Arka Garima, ICP-42 x Indira Hari, ICP-49 x Khalleshwari and ICP-54 x Arka Garima.

It is clear from the results that in majority of the crosses good sca effects were observed. Most of the crosses included Good x Good, Good x Poor, Poor x Poor and Poor x Good type of general combiners. The desirable cross combination with Average x Average type and Poor x Poor type of general combiners were also obtained, which may be due to complimentary gene effects. The crosses involving with good gca effects can be exploited effectively by conventional breeding like pedigree method. However, The crosses involving one good combiner and another poor or average combiner could produce desirable transgressive segregants when additive gene action was working in good combining parents and epistatic effects also act in same direction. Similar results were also reported by Patel *et al.* (1994), Hazra *et al.* (1996) and Pal *et al.* (2002.).

सारांश

छः लाइने जिसमें प्रत्येक 2 *Vigna unguiculata* spp. *ungiculata* (वानस्पतिक प्रकार), *Vigna unguiculata* spp. *ungiculata* (बीज प्रकार) और *Vigna unguiculata* spp. *sesquipedalis* (वानस्पतिक प्रकार) से लेकर माता प्रजनक के रूप में और 4 परीक्षक *Unguiculata* spp. *unguiculata* (3 वानस्पतिक प्रकार और एक बीज प्रकार) से लेकर पित्त प्रजनक के रूप में लाइन x परीक्षक ढाचे में संकर किया। ICP-38, ICP-42 इन्दिरा हरि और अर्का गरिमा जल्दी होने वाली के लिए अच्छे सामान्य संयोजक थे और ICP-42, ICP-54, पूसा कोमल, अर्का गरिमा और इन्दिरा हरि हरी फली उपज प्रति पौध के लिए थे। संकर संयोजक ICP-42 x अर्का गरिमा, ICP-54 x इन्दिरा हरि, ICP-26 x खाली खरी और ICP-49 x खाली खरी फली संख्या प्रति पौध के लिए अच्छे थे। जबकि संकरो ICP-42 x अर्का गरिमा, ICP-42 x इन्दिरा हरि, ICP-54 x अर्का गरिमा श्रेष्ठ औसत के साथ श्रेष्ठ सार्थक और सकारात्मक विशिष्ट संयोजक प्रभाव हरी फली उपज प्रति पौध के लिए था।

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