

BREEDING BRINJALS (*SOALNUM MELONGENA*) IN MADRAS

I. Hybrid Vigour in Brinjals*

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THE vital phenomenon of hybrid vigour in the brinjal has been studied by a number of workers, but all outside India. Pal and Singh (1943) are believed to be carrying on some studies on the practical utilization of this phenomenon and as yet their results are not made available. Considerable work on brinjal hybridization is reported to have been attempted at the New Jersey Agricultural College Experimental Station (Bayla, 1918), and interesting work on these lines has also been carried out in Japan. Bayla (1918) concluded that the F_1 hybrid plants were very much more vigorous, strong and healthy than either parent. Increase in yield in the hybrids has been recorded by many workers (Nagai and Kida, 1926; Tatesi, 1927; and Kakizaki, 1931, in Japan; Aver'Janova, 1941; Daskaloff, 1941, in Bulgaria). The cross that showed the highest increase yielded 140.8 per cent., more than the better parent, while another cross registered an increase of 222.2 per cent., over the poorer parent (Kakizaki, 1931).

Kakizaki (1931) came to the conclusion that the degree of hastening in fruit production of brinjal crosses is widely different according to the different combinations of varieties, that the cross is earlier than the average of both the parents in a majority of the cases, and that often the cross is earlier than the early parent. Schmidt (1935) reported similar results and observed that earliness was dominant and even transgressive and in one cross it even exceeded the earliest variety. He also observed that the combinations comprising the earliest variety were extremely early. Aver'Janova (1941) obtained similar results.

The possibility of capitalising hybrid vigour depends upon its extent and the cost of producing hybrid seed and it is likely to be most attractive commercially when a little labour results in the production of a large amount of seed (Hadfield and Calder, 1936). The brinjal is an example in which one cross will furnish a large amount of seed and it has been found by Kakizaki (1930) that the measure of improvement resulting from certain crosses more than compensates for the cost involved in producing the hybrid

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seed. Daskaloff (1941) agrees with Kakizaki and remarks that it is perfectly possible to produce heterosis or hybrid varieties on a commercial basis. It will be interesting to note that the Saitama Agricultural Experimental Station in Japan was yearly furnishing gardeners with F_1 seeds of two crosses of an amount to be used for the commercial culture of a total of about one hundred acres (Kakizaki, 1930).

With a wide collection of brinjal varieties in our country it is deemed possible that an improvement of this vegetable crop can be effected through the employment of F_1 hybrids, and as a preliminary step towards an intensive breeding project, the study of hybrid vigour in some Indian brinjals was undertaken by the author at the Agricultural Research Institute, Coimbatore, during the years 1943 to 1945.

MATERIALS AND METHODS

Materials

Seeds of all the available varieties of this vegetable were collected from various sources both from within and outside the province of Madras. A detailed study of all the samples was made and such of those with fixed characters were isolated for further study. For the present study two varieties, viz., "Raviya" from Baroda, and "Udipi" from the College Orchards, Coimbatore, were selected. These varieties differ from each other in many respects. The fruit of the Raviya is round in shape and dark purple in colour, while that of the Udipi resembles that of the former in size and shape, but it is dusky green in colour with white streaks extending upwards from the stigmatic end. While the Raviya is thornless, the Udipi is beset with thorns.

Methods

Emasculation.—The brinjal flower is in nature cross-pollinated by insects. The flowers are well adapted for this kind of pollination. Hence prior to the crossing of the flower there is a need for emasculation and bagging so as to avoid any chance contamination by insect or other agents. The emasculation is easy in the case of this plant and the method followed is the same as that described by Kakizaki (1931).

Crossings made.—For the study of hybrid vigour in the first generation the following crosses were made:—

1. Udipi as the pistillate or female parent and Raviya as the staminate or male parent, and
2. Raviya as the pistillate parent and Udipi as the staminate or male parent.

The seeds of the crossed fruit were collected when they were mature. To study the F_1 generation in comparison with the parental strains seeds were collected from the selfed fruit of both the parents also. The number of seeds in both the crossed and selfed fruit were counted and recorded. The weight of the seeds of the crossed as well as the selfed parental fruit was also determined.

The hybrid and the parental seeds were sown in equal numbers in seed pans and the germination percentage and the performance of the seedlings were observed in comparison with one another. The seedlings were transplanted in the field when they were a month old. The cross Udipi ♀ × Raviya ♂ was studied in detail in respect to all the plant characters. The results obtained are embodied in a subsequent part of this paper.

EXPERIMENTAL RESULTS

1. *The percentage of seediness of the crossed fruit as compared with that of the parental ones.—*

TABLE I. *Showing the weight of the crossed fruit, percentage of seediness and the number of seeds as compared with those of the selfed fruits of the parents*

No.	Sample or cross	Weight of fruit in Gms.	Weight of seeds in Gms.	% seediness	No. of seeds in a fruit
1	Udipi ..	113.3	8.5	7.5	2350
2	Raviya ..	117.4	6.34	5.4	1915
3	Udipi ♀ × Raviya ♂ ..	102.3	7.06	6.9	1800
4	Raviya ♀ × Udipi ♂ ..	93.0	5.60	6.02	1568

The percentage of seediness of the crossed fruit is intermediate between that of the parent fruit. The number of seeds in the crossed fruit is less than that in the fruit of both the parental strains.

2. *Weight of seeds.—*

TABLE II. *Showing the weight of 500 crossed seeds as compared with that of the parent seeds*

Particulars		Raviya ♀ × Udipi ♂	Udipi ♀ × Raviya ♂
1	Weight of 500 seeds of the cross ..	1.81 gm.	1.96 gm.
2	" " of female parent ..	1.67 "	1.74 "
3	" " of male ..	1.74 "	1.67 "
4	" " of average of parents ..	1.71 "	1.71 "
5	% increase of the cross over—		
	(a) Female parent ..	8.38	12.64
	(b) Male ..	4.02	17.36
	(c) Average of parent ..	5.57	14.95

The crossed seeds are heavier than the parent seeds in both the crosses. They are also found to be heavier than the average of both the parents.

TABLE III. *Showing the weight of the embryo and the seed-coat of 500 seeds of the crosses as compared with those of the parents*

Particulars		Raviya ♀ × Udipi ♂	Udipi ♀ × Raviya ♂
1	Weight of 500 seeds of the cross ..	1.81 gm.	1.96
2	Cross—		
	(a) Weight of seed-coat ..	0.36 ..	0.39
	(b) " embryo ..	1.45 ..	1.57
3	Female parent—		
	(a) Weight of seed-coat ..	0.34 ..	0.36
	(b) " embryo ..	1.33 ..	1.38
4	Male parent—		
	(a) Weight of seed-coat ..	0.36 ..	0.34
	(b) " embryo ..	1.38 ..	1.33
5	Percentage increase of weight of embryo over		
	(a) Male parent ..	5.07	13.71
	(b) Female parent ..	9.02	18.04

The increase in weight of the crossed seed is due to the increase in weight of the embryo portion of the seed. The weight of seed-coat is almost the same as that of the heavier parent. The embryo of the crossed seed is distinctly heavier than that of both the parents.

3. Germination capacity.—

To determine the germination capacity of the hybrid seeds as compared with those of the parents six experiments were carried out and the average percentage of germination of the parents, Udipi and Raviya, and of the hybrids Raviya ♀ × Udipi ♂ and Udipi ♀ × Raviya ♂ were 66.1, 69.3, 71.6 and 71.0 respectively. From the data obtained it appears that the percentage of germination of the crossed seeds is greater than those of the seeds of the selfed parental strains, and that possibly the hybrid vigour is also manifest in the better germination of the hybrid seed.

4. Comparative height when 50 days old.—

TABLE IV. *Showing the average height of the F₁ plants in comparison with that of the parent plants at the time of transplanting (50 days old)*

Name of sample or cross	Average height of plant in each set of 20 plants in set No.					Average height of the plant in inches
	1	2	3	4	5	
1 Udipi ..	4.00	3.76	3.50	3.87	4.10	3.75
2 Raviya ..	3.42	3.80	4.20	3.25	3.76	3.67
3 Udipi ♀ × Raviya ♂	3.70	3.95	4.23	4.00	3.35	3.85

The difference between the height of the F_1 seedlings and that of the male and female parent seedlings is not appreciable.

4. *Plant characters.*—

TABLE V. *Showing the plant characters of the F_1 plants and the parental plants (average)*

Plant characters	Udipi	Udipi ♀ × Raviya ♂	Raviya
1 Height in cm. ..	62.0	65.5	54.0
2 Spread in cm. ..	56.5	85.0	82.0
3 Colour of stem and prickliness	All parts green, thorny, thorns green	Tender parts slightly purple, no thorns	Tender parts purple, no thorns
4 Leaf length in cm. ..	9.3	12.9	13.5
5 Leaf width in cm. ..	6.2	7.2	8.7
6 Margins of lamina ..	Slightly wavy	Slightly wavy	Slightly wavy
7 Inflorescence ..	Compound type	Compound type	Compound type
8 Flower colour ..	Light violet	Violet	Deep violet
9 No. of days to flower from date of sowing	125	107	128
10 Fruit colour ..	Dusky green with white streaks from apical end	Dark purple and shiny	Dark purple and shiny
11 Fruit shape and size ..	Round and medium	Round and medium	Round and medium
12 No. of fruits per plant ..	10	8	7
13 Yield in weight per plant in ozs.	34.0	42.2	36.0
14 % fruit attacked by fruit borer	12.0	17.2	17.6
15 Bud worm infection ..	Found	Found	Found

From the foregoing it is observed that—

(1) The F_1 plants are taller than those of both the parents and this hybrid almost resembles the female parent (Plate No. IX).

(2) In spread also the F_1 plants surpass both the parents.

(3) The F_1 plants are thornless like the male parent, and also resemble it in respect to the stem colouration.

(4) In the leaf character it is intermediate between the parents.

(5) In the colouration of the flowers, *viz.*, corolla, it is intermediate between the parents.

(6) In flowering, the hybrid plants are early flowering and they are 18 days earlier than the early parent.

(7) The purple colour of the fruit of the male parent is found to be dominant over the green mottled with white of the female parent.

(8) The fruit of the hybrid is of the same size and shape of both the parents.

(9) With regard to the number of fruit produced per plant the hybrids are intermediate between the parents.

(10) In respect to yield per plant by weight, the F_1 s excel both the parents, the percentage of increase over that of the male and female parents being 24.1 per cent., and 17.2 per cent., respectively.

(11) With regard to the resistance or susceptibility to insect pests such as the fruit borer and the bud worm, the hybrid plants did not show any appreciable improvement over those of the parents.

DISCUSSION

It has already been explained by a number of workers that appreciable increase in yield through the employment of F_1 hybrids is possible in the brinjal (Aver'Janova, 1941; Daskaloff, 1941; Kakizaki, 1931; Nagai and Kida, 1926; Tatesi, 1927). The practical utilization of this most promising line of improvement is partially limited firstly by the wide variation in the extent of improvement between the F_1 progenies of different intervarietal crosses ranging from 1 to 222 per cent., in the studies of Kakizaki (1931), and 17.2 per cent., over the better parent and 24.1 per cent., over the poorer parents in the present studies, and partly by the failure of some intervarietal crosses to register any improvement (Kakizaki, 1931). The possibility of decreased yield through such intervarietal crosses though confined to only a very few cases is sufficient to warrant the necessity for detailed investigation with the object of determining the optimum parental combinations. The possibility of capitalising hybrid vigour also depends upon the economics of such seed production. Fortunately crossing in brinjal has been found easy in the present study as well as by other workers, and each crossed fruit contains a very large amount of seed. Since the measure of improvement resulting from such crosses more than compensates for the cost involved in producing the hybrid seed, it is quite possible to produce hybrid varieties on a commercial basis.

It has been found that the F_1 plants of the cross between Udipi ♀ and Raviya ♂ has given clear indication of earlier germination and earliness of crop maturity than both the parents; earliness of flowering is a good varietal trait particularly from the point of view of the market. In yield the average of the hybrid plants has been recorded at 42.2 ounces per plant as against the mean yield of 34.0 and 36.0 ounces in the male and female plants respectively. The other promising feature in the F_1 is that it possesses some of the qualities desirable of a good brinjal plant, viz., (1) tallness, (2) good lateral expansion and branching habit and (3) fruit of attractive

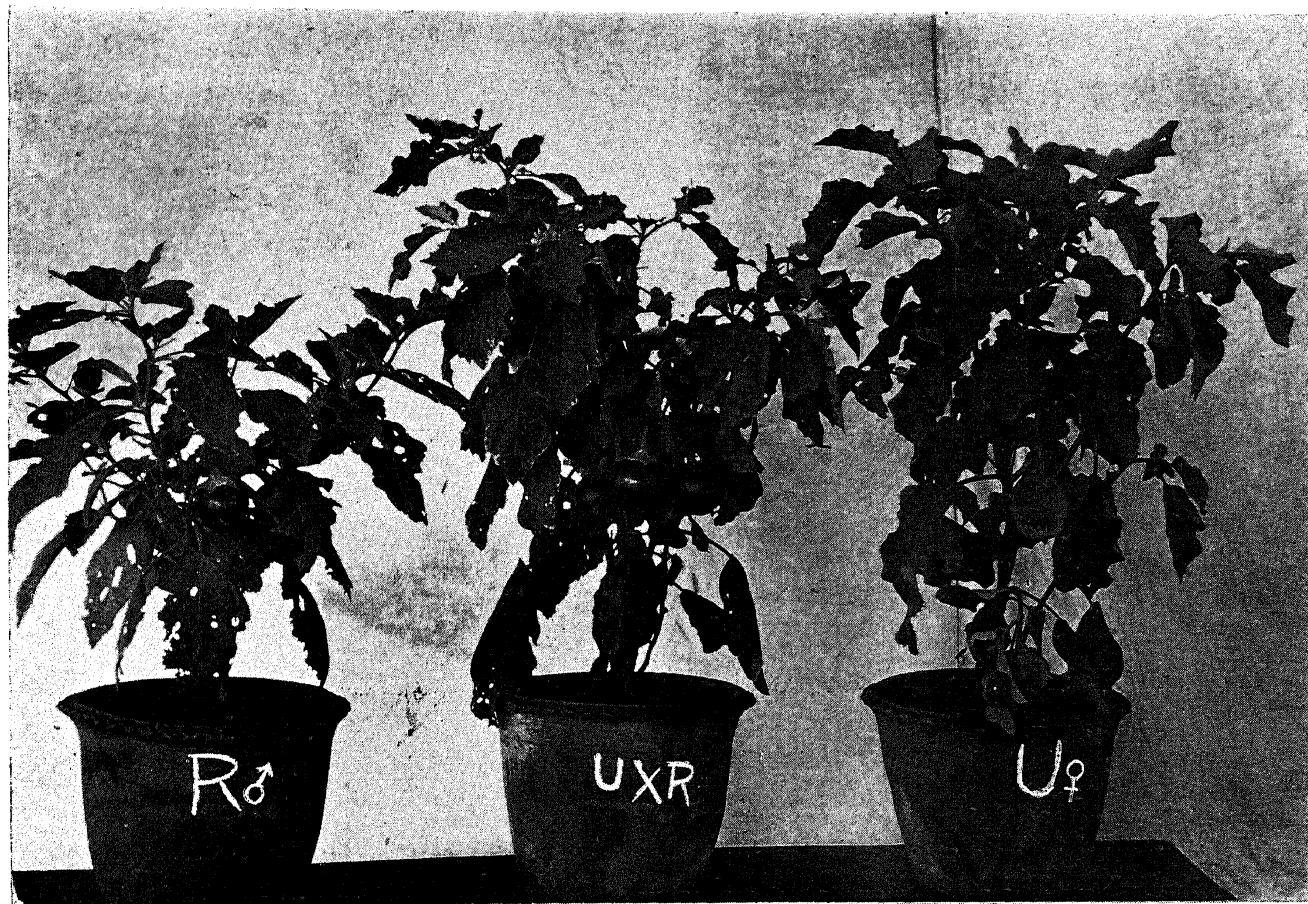
colour and decent shape, soft and with less seeds and the absence of thorns. All these represent economic improvements which indicate in some measure what can be expected from the pursuit of research on more extended lines.

Thus these preliminary observations on the influence of crossing on the performance of the first generation hybrid plants are suggestive of the potentialities. These various observations provide the necessary background for bringing about effective improvement through the use of hybrid vigour.

SUMMARY

1. For the study of hybrid vigour two varieties differing very widely from each other were chosen. In the cross between the varieties Udipi as the female parent and Raviya as the male parent, it has been observed at the very outset that the immediate effect of crossing manifest itself in the increased weight of the F_1 seeds. The F_1 seeds had a slightly higher percentage of germination than that of the parental strains.
2. The F_1 seedlings and plants exhibited better vigour than the parental seedlings from the very start. The cross resembled the male parent with respect to the fruit characters.
3. The thorny character of the female parent was totally absent in the case of the hybrid plants.
4. The hybrids flowered earlier than the earlier parent by 18 days, and yielded more than both the parents, the increase in yield being 17.2 per cent., over the better parent and 24.1 per cent., over that of the poorer parent.
5. Other observations with regard to plant and fruit characters are detailed in the text.
6. The importance of hybrid vigour in the brinjal crop improvement is therefore indicated.

In conclusion, the author wishes to gratefully acknowledge the kind help he had received from various sources during the course of his study. He is greatly indebted to his Professor, Sri. K. C. Naik, the Fruit Specialist to the Government of Madras, who suggested the problem and gave all necessary encouragement during the course of the study.



Showing the parents and the F₁ hybrid

R ♂—Raviya variety (male parent)
U ♀—Udipi variety (female parent)
U × R—The F₁ cross between Udipi ♀ and Raviya ♂

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