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Hybrid Vigour in *Ricinus communis* L. I. General Combining Ability Between Certain Egyptian Inbreds and TMV 1

by

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Introduction: The phenomenal increases in yield and improvement in other economic attributes obtained in the single and double cross hybrids of corn and the exploitation of the phenomenon of heterosis in other crop plants like tobacco, sugarbeet, *bajra*, *jowar* and vegetables for commercial production have led research workers on castor to examine the possibility of similar methods in this oilseed crop.

Encouraged by the results of previous investigations on hybrid vigour in castor, detailed studies were carried out to assess the general combining ability of a large number of exotic and indigenous inbreds in top crosses with the tester parent TMV 1 at the Castor Research Station, Salem. The results of the studies with six Egyptian inbreds are presented.

Materials and Methods: Top crosses were effected between six castor inbreds obtained from Egypt with accession numbers *R. c.* 539/1, *R. c.* 719/1, *R. c.* 719/2, *R. c.* 833, *R. c.* 840 and *R. c.* 870 with the tester parent, TMV 1. The resulting hybrids were raised along with their parents, during the monsoon seasons of 1964-65 to 1966-67 adopting the randomised blocks design replicated four times. Detailed observations on the morphological and economic plant attributes, besides yield and quality of beans were recorded in five plants in the hybrids and parents in each of the replications.

The hybrid vigour was estimated by comparing the F_1 with the superior parent in each of the characters as followed by Jones (1958).

Results: The mean values of the hybrids and their constituent parents in each of the twelve characters were calculated. The difference of the F_1 from the better parent as expressed in percentage is presented, separately for each of the cross combinations in Figs. 1 to 6.

The total number of branches, both primary and secondary, was 4.5 per plant in TMV 1, and two of the inbreds, *R. c.* 719/2 and *R. c.* 840

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excelled the tester parent. Significant transgressive intensification was evident in the hybrid involving *R. c.* 833 which recorded 33.3 % increase in the number of branches over the better parent. The other hybrids did not show any significant increase.

The main stem was 101.5 cm upto the main spike with 21.3 nodes in TMV 1, while in the inbreds, the height varied from 65.8 cm in *R. c.* 539/1 to 111 0 cm in *R. c.* 840 and the number of nodes was between 17.5 in *R. c.* 870 and 23.8 in *R. c.* 840. The hybrids recorded 59.3 (*R. c.* 539/1 × TMV 1) to 97.0 cm (*R. c.* 840 × TMV 1) in the height of the main stem with 14.8 (*R. c.* 833 × TMV 1) to 22.8 nodes (*R. c.* 840 × TMV 1). There was no positive deviation in any of the hybrids over their parents in the above two characters.

The mean number of days required for the plant from the date of sowing to put forth its first inflorescence was 86.2 in TMV 1, while in the inbreds, it was between 60.0 (*R. c.* 719/1) and 96.0 (*R. c.* 840). Among the hybrids, *R. c.* 539/1 × TMV 1 and *R.* c. 833 × TMV 1 exhibited dominance bios in the direction of lower values, thereby being significantly earlier than their respective pollen parents.

The length of the main racemes was 36.8 cm in TMV 1, between 27.8 cm *R. c.* 870) and 41.7 cm (*R. c.* 719/2) in the inbreds and between 34.8 cm (*R c.* 870 × TMV 1) and 55.5 cm (*R. c.* 833 × TMV 1) among the hybrids. The pistillate portion of the raceme was 27.3 cm long in the tester parent, and inbreds *R. c.* 870 and *R c.* 719/2 that recorded the shortest and the longest racemes among the inbreds continued to maintain their position as for the length of the pistillate portion also, with 12.8 cm and 27.3 cm respectively. Similarly, the hybrids involving *R. c.* 870 and *R. c.* 719/2 possessed the shortest and the longest female portion with 19.5 cm and 37.5 cm respectively. The F_1 of *R. c.* 833 × TMV 1 alone expressed significant heterotic effect by exceeding the better parent TMV 1 by 50.9% in the length of raceme and 37.3 % in the length of pistillate region. The female to male portion in this hybrid was 37.5 cm/18.0 cm and the pistillate flowers alone occupied 67.6 % of the total length of the raceme.

Total number of racemes per plant was 3.5 in TMV 1, while the inbreds had 2.8 (*R. c.* 833) to 4.5 (*R. c.* 840). All the hybrids exhibited transgressive intensification with 4.0 to 5.8 racemes per plant. Of them, the F_1 of *R. c.* 833 × TMV 1 alone showed significant vigour over its better parent.

With regard to the total number of capsules per plant, the pollen parent TMV 1 recorded 94.0 capsules, while the inbreds had 56.8 (*R.* c. 833) to 93.0 (*R. c.* 840). The hybrids in all the combinations except *R.* c. 870 × TMV 1

possessed positive deviation from the better parent, with 105.3 (*R. c.* 719/2 × TMV 1) to 147.1 (*R. c.* 833 × TMV 1) capsules. Among the combinations, significant dominance bios was ovident in *R. c.* 719/1 × TMV 1 with 134.5 capsules and *R. c.* 833 × TMV 1 with 147.1 capsules, both the hybrids registering 43.1 and 56.5 % increases over the tester parent.

Th yield of beans per plant was 67.5 gm in TMV 1, between 43.3 gm (*R. c.* 833) and 87.0 gm (*R. c.* 719/1) in the inbreds and from 66.0 gm (*R. c.* 870 × TMV 1) to 134.5 gm (*R.* c. 719/1 × TMV 1) in the hybrids. Except the hybrid involving *R. c.* 870, all others showed increases in yield over the better parent varying from 9.6 to 72.3 %. Of them, significant transgression was encountered in the hybrids involving *R. c.* 539/1, *R. c.* 719/1 and *R. c.* 833 which recorded 54.0, 54.6 and 62.3 % over their respective better parents.

Considering the duration of the crop, the tester parent TMV 1 with a mean duration of 192.2 days was exceeded by all the inbreds, except *R. c.* 840 by 5.8 to 20.8 days. *R. c.* 840 alone was shorter to TMV 1 by 5.2 days. The duration of all the hybrids was between that of their constituent parents and hybrid vigour in the direction of earliness was not evident.

Two quality attributes, oil content and weight of 1000 beans were considered. The tester parent TMV 1 recorded an oil content of 51.2 %, while it varied from 50.4 (*R. c.* 719/1) to 52.8 % (*R. c.* 539/1) in the inbreds. Four of the inbreds, *R. c.* 539/1, *R. c.* 719/2, *R. c.* 833 and *R. c.* 840 excelled the tester parent in oil content. The hybrids possessed oil content ranging from 52.3 (*R. c.* 870 × TMV 1) to 55.7 % (*R. c.* 719/1 × TMV 1). Though all the combinations exhibited positive deviation from their superior parent, there was no significant hybrid vigour expressed. In the weight of 1000 beans, TMV 1 recorded 238 gm, while the inbreds registered 290 gm (*R. c.* 539/1) to 333 gm (*R. c.* 719/1). All the inbreds were superior to TMV 1 in this attribute. The hybrids recorded intermediate values between their constituent parents, but approaching the Egyptian inbreds in all the combinations. Heterosis was not evident in any of the hybrids in this trait.

Considering all the attributes together for each of combinations, hybrid vigour was evidenced in the number of days to first flowering and yield of beans in *R. c.* 539/1 × TMV 1, total number of capsules and yield of beans in *R. .c* 719/1 × TMV 1 and number of days to first flowering, length of raceme, length of the pistillate portion, number of racems, total number of capsules and yield of beans in *R. c.* 833 × TMV 1. The other hybrids did not exhibit significant dominance bias in any of attributes studied (Fig. 13 to 18).

Difference of the hybrids from their parent in each of the attributes (Percentage)

characters studied

1. Number of branches.
2. Height up to the main raceme.
3. Node number of the main stem.
4. Number of days to first flowering.
5. Length of main raceme.
6. Length of pistillate region of the raceme.
7. Number of racemes per plant.
8. Number of capsules per plant.
9. Yield of beans per plant.
10. Duration of the crop.
11. Oil content.
12. Weight of 1000 beans.

Significant at $p=0.05$.

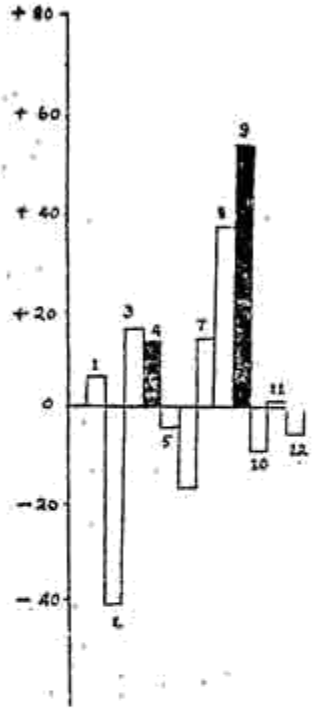


Fig 1 *R. c* 539/1×TMV 1

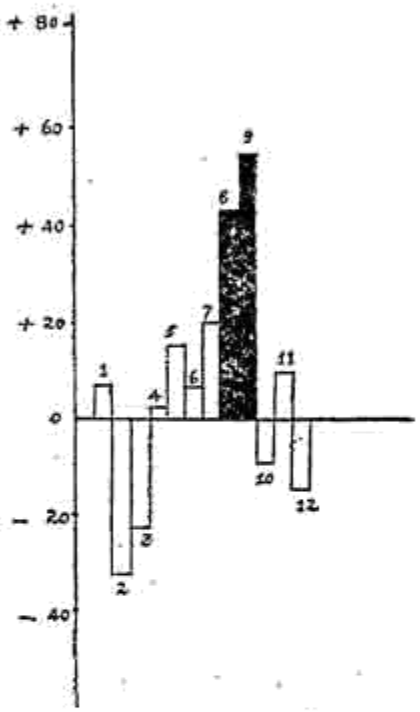
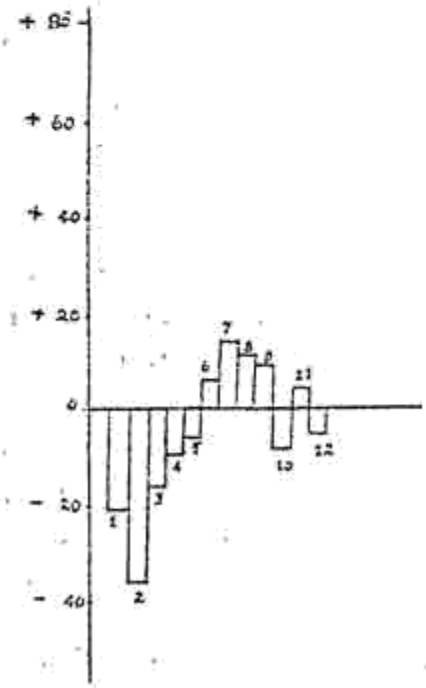


Fig. 2. *R. c.* 719/1×TMV 1



Fg. 3. *R. c.* 719/2×TMV 1

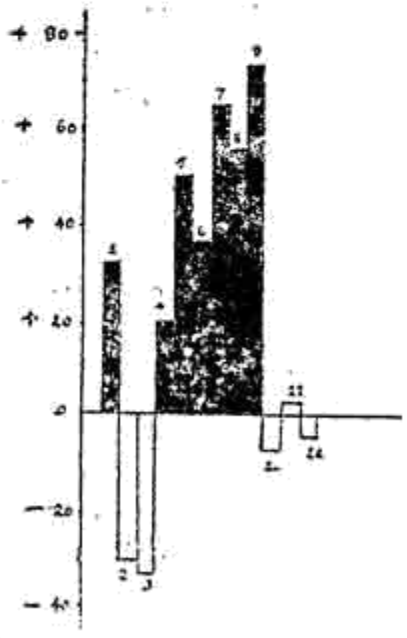


Fig. 4. *R. c.* 833×TMV 1

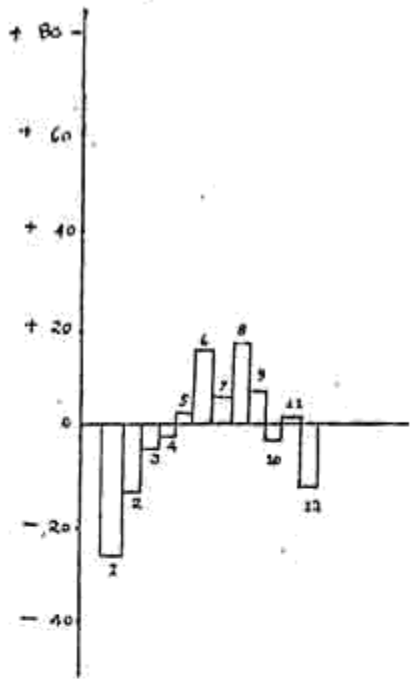


Fig. 5. *R. c.* 840×TMV 1

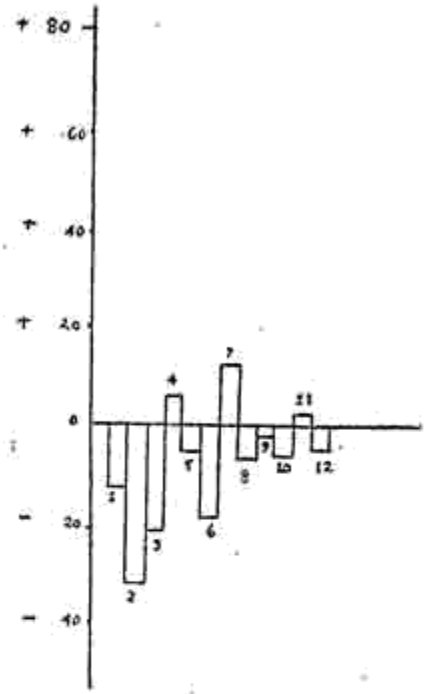


Fig. 6. *R. c.* 870×TMV 1

Discussion : The value of any inbred ultimately rests on its ability to produce superior hybrids in combination of other inbreds (Allard, 1960). Investigations on corn by Jenkins and Brunson (1932) proved that the inbreds could be best evaluated in top crosses with common tester parent for their general combining ability. Though this method helped in eliminating large scale diallel crossing between a number of inbreds selected for utilization in hybridization, it is only a fore-runner of the *inter se* crossing of top ranking inbreds necessary for determining the specific combining ability of individual inbreds to maximise the benefits of hybrid vigour (Sprague and Tatum, 1942). Realising the significance of determining the general combining ability of inbreds in a programme for the production ofsuperior hybrid seeds of castor, a comprehensive study was taken up and the results of such a study with six Egyptian inbreds were evaluated.

The superiority of the hybrids over the parental mean as well as over the better parent were considered as an expression of heterosis by many workers; but as the present work related to the practical exploitation of the phenomenon for large scale production, the superiority of the F1 over the better parent alone was taken into account. Among the vegetative characters considered, branching and plant height in castor were found to be greatly influenced by evironment (Kulkarni, 1959), while the node number to first infloresence was determined to be fairly constant and hereditary (Varisai Muhammed and Stephen Dorairaj, 1967). Sathyabalan (1961) did not find any significant deviation in plant height and node number in the hybrids between three long duration TMV strains and two short duration American

inbreds. Of the six combinations now studied, dominance bios was evident in the number of branches alone in the hybrid of *R. c.* 833 × TMV 1. There was significant intensification either in the height or in node number of the main stem in any of the combinations.

Among the other characters studied, the number of days to first flowering and duration help to decide whether the hybrids show earliness as a consequence of heterotic effect. Sathyabalan (1961) found no significant decrease in the number of days to flowering over the earlier parent and all the hybrids were intermediate in duration between their constituent parents. The top cross hybrids involving two of the Egyptian inbreds, R. *c.* 539/1 and R. *c.* 833 exhibited hybrid vigour towards earliness in flowering by 10.3 and 12.5 days when compared to their early parents. Regarding duration, all the hybrids were intermediate between the parents, in agreements with earlier records.

Considering the productive plant attributes such as length of the main raceme, pistillate region of the raceme, number of racemes and total number of capsules per plant which have a direct bearing on yield, the hybrid of *R. c.* 833 × TMV 1 expressed a significant dominance bios in all of them, while the F_1 of *R. c.* 719/1 × TMV 1 recorded increased vigour in the total number of capsules alone. Stein's (1958) observations on the number of racemes per plant revealed that the hybrids came very close to the parental arithmatic mean only and no hybrid vigour over the better parent was evident. Sathyabalan (1961) also did not encounter any heterosis in it. However, four out of the six combinations studied by him expressed vigour in the production of more number of capsules than their parents.

With reference to the yield of beans, heterosis was recorded among others by Stein (1958), Anubhavanarayanan (1958) and Varisai Muhammad *et al* (1965). Yield increases of 87 to 132 % and 50.7 to 76.6 % over the high yielding parent were recorded by Zimmerman and Van Horn (1953) and Sathyabalan (1961). In the present studies, top crosses with *R. c.* 539/1, *R. c.* 719/1 and *R. c.* 833 recorded increased yield of 54.0, 54.6 and 72.3 % respectively over their better parents.

Stein (1958) found that seed weight of the hybrids approached the parental geometric mean, while heterosis over the superior parent was evidenced in three out of six hybrids by Sathyabalan (1961). He found no hybrid vigour for oil content. The hybrids now studied did not show any significant intensification in either of the quality traits.

The present investigations have thus led to the choice of three of the Egyptian inbreds, *R. c.* 833, *R. c.* 719/1 and R. *c.* 539/1 that possessed good

general combining ability with the tester parent TMV 1 and their possible utilization for testing their specific combining ability before they are considered for large scale production for the benefit of the cultivators.

Summary: Studies for determining the general combining ability of six Egyptian castor inbreds in top crosses with the tester parent TMV 1 were conducted at the Castor Research Station, Salem. Among the vegetative characters, there was no hybrid vigour either in the height of the stem or in the number of nodes. Dominance bias was evident in the number of branches per plant in the hybrid of R. c. 833×TMV 1. Of the attributes that help to decide the earliness of the crop *viz*, number of days to first flowering and the duration of the crop, hybrids involving R. c. 539/1 and R. c. 833 exhibited vigour in early flower production, while all the hybrids were intermediate between their constituent parents in duration.

In the attributes such as length of the main raceme, pistillate region of the raceme, number of racemes and total number of capsules per plant raceme the hybrid *R.c.* 833×TMV 1 expressed transgression in all the characters, while *R.c.* 719/1 × TMV 1 recorded increased vigour in the total number of capsules alone. Hybrids involving *R.c.* 539/1, *R.c.* 719/1 and *R.c.* 833 recorded significant yield increases of 54.0, 54.6 and 62.3% respectively over their better parent. No hetorosis effect was evident in oil content and seed weight in any of the combinations. The studies led to the choice of three of the Egyptian inbreds, *R.c.* 833, *R.c.* 719/1 and *R.c.* 539/1 that possessed good general combining ability with TMV 1 and their possible utilization for further exploitation.

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A Critical Study on the Comparative Performance of Dwarf Cavendish and Robusta in the Palar Basin of North Arcot District in Tamil Nadu

by

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Introduction: In banana the leading clones in world trade are Gros Michel, Lacatan, Robusta, Dwarf Cavendish and to lesser extent Lady's Finger (Virupakshi) in Australia. Of bananas entering the export trade, about 63% is Gros Michel and 35% is Cavendish bananas. In recent years, the area under Gros Michel has gone down considerably due to its susceptibility to Panama disease. The clone Gros Michel is now tending to be replaced by Cavendish clones, especially Robusta due to its immunity to Panama disease. Cavendish clones, especially Dwarf Cavendish are being cultivated in Tamil Nadu for a long time. A high yielding mutant of Dwarf Cavendish known as Robusta was spotted and developed by the Central Banana Research Station, Aduthurai. In view of our export prospects of Robusta this clone was selected for popularisation in the Dwarf Cavendish belt of North Arcot situated in the Palar basin. The Comparative performance of these two clones are presented in the paper.

Materials and Methods: A total number of ten representative gardens were selected in the Dwarf Cavendish belt of Palar Basin in North Arcot District of Tamil Nadu. Fifty suckers in each of Robusta and Dwarf Cavendish were planted in adjacent plots in two main planting seasons January and August, commencing from January, 1966. The studies were conducted in three seasons *viz.* January, 1966, August, 1966 and January, 1967. Both the clones were grown under indentical conditions. The manurial schedule and other cultural operations adopted also were similar.

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