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Hybrid Vigour in Cotton Improvement

by

M. STEPHEN DORAIRAJ[1]

Introduction: Exploitation of hybrid vigour has been proved to be a potential method of increasing yields in many of the crop plants. Attempts have been made by research workers in the field of cotton breeding to utilise this tool for increasing the production of cotton. The work so far done in this regard is presented in this article.

1. Old World Group: (*G. arboreum and G. herbaceum*):

(i) Intra-specific crosses: Among the intra-*arboreum* crosses involving three races, Hutchinson *et al.* (1938) found heterosis in yield of *kapas*, lint length, ginning per cent and node number (lower position)' Koshal *et al* (1940) found that out of the three crosses studied, higher percentage of mature hairs over the parental strains was encountered in two cases where 'Bani' was used as one of the parents. Ganesan (1942), as a result of his experiments with races belonging to *G. arboreum* concluded that seed weight itself have ample evidence of the manifestation of hybrid vigour in the seed and was a good index in forecasting hybrid vigour in the post-germination period. Govande and Joshi (1950) found in three inter-racial crosses of *G. arboreum* that in ginning per cent and staple length, the heterotic bias was towards a higher value than the parental mean. Santhanam (1951 a, 1952) recorded significant heterosis in final weight of the vegetative and reproductive parts representing the sum total of plants' metabolism and in respect of number of bolls and yield of seed cotton in inter-racial hybrids in *G. arboreum*. The crinckled leaf mutant of *G. arboreum* when crossed with its normal parent, exhibited vigour in height, fresh and dry weight and number of nodes (Santhanam, 1952 a).

In intra-*herbaceum* crosses, Kelker *et al* (1946) found heterotic effects in yield and lint length. Santhanam (1951 a) found increased vigour in intra-racial crosses within *G. herbaceum* race *wightianum*. Inter-racial crosses between *wightianum* and *persicum* exhibited hybrid vigour in flower and *kapas* production, yield of *kapas* and lint index.

(ii) Inter-specific crosses: Species crosses between *G. arboreum* and *G. herbaceum* studied by Santhanam (1951) showed significant heterosis in plant growth measured as height, yield of seed cotton, and lint length. The increase in yield of one such cross had been phenomenal, being 158 per cent over the local parent Karunganni-5, whose normal yield may be about

[1] Assistant in Oilseeds, Agricultural Research Station, Bhavanisagar.

325 lb. *kapas* per acre. Santhanam (1951 a) found the manifestation of vigour in most of the plant characteristics in inter-specific crosses. Loden and Richmond (1951) have also recorded vigour in inter-specific hybrids of Asiatic group in their experiments.

II. New World Group: (*G. hirsutum and G. barbadense*):

(i) Intra-specific crosses: Santhanam (1951 a) found Maraad x Quebradinho (Egyptian with Brazilian *barbadense*) hybrids showing significant transgressive heterosis in height, final weight of the plant and seed index.

Among certain intra-*hirsutum* hybrids, Brown (1927) recorded heterosis in plant height, flower production and yield of *kapas*. Intra-specific hybrids of G. *hirsutum* showed hybrid vigour in flower production, yield of seed cotton, earliness of boll opening and lint indices as recorded by Kime and Tilley (1947).

Among the different strains belonging to *G. hirsutum* included in the crossing programme by Santhanam (1951 a), heterosis in final weight, yield of *kapas*, and seed index was observed in certain of the crosses, all involving Co. 2 (Madras Cambodia) as one of the parents. Turner (1953) studied heterosis in crossing seven inbreds of Upland cotton and found certain of the hybrids showing vigour in yield of *kapas*. As a result of his experiment with intra-*hirsutum* crosses, Turner (1953 a) postulated that the more productive hybrid resulted from the crossing of lines having the same flowering season, but differing widely in their periods of boll setting. A study of the relative growth rates of an F_1 hybrid of *G. hirsutum* and its two parents, conducted by Harris and Loden (1954) showed the expression of hybrid vigour in dry weight of stem, leaves and fruits, total dry weight of above ground plant parts, number of squares and fruits and leaf-blade weight. Christidis (1955) recorded yield heterosis in some of his intra-*hirsutum* hybrids. In the work recently done at New Delhi, some F_1 hybrid combinations within *G. hirsutum*, have given 22 to 44 per cent more yield than H. 14, there being no impairment in fibre quality (Joshi, Bhale and Pathak, 1957). Dorairaj (1960) found that hybrids involving MCU. 1 with LL. 55 (Punjab), BP. 52 (Uganda) and DPL. 14 (U. S. A.) exhibited transgressive heterosis in yield of *kapas*, whereas only in the MCU. 3 x G. 1 (Dharwar) combination, significant transgression in yield was recorded. He recommended the two combinations *viz.*, MCU. 1 x DPL., 14 and MCU. 3 x G. 1 which showed intensification in boll number and yield of *kapas* to be useful materials for future exploitation.

Studies conducted with Coker 100 A as the tester parent and 22 other parental varieties revealed heterosis in lint yield and boll size.

Observations on heterotic effects (F_1 minus mid-parental values) at different environments indicated that the mangnitude of heterosis on a pound per acre basis remained fairly constant over a range of yield levels (Miller and Lee, 1964).

Four upland cotton varieties of different genetic origin and their diallel crosses studied by Hawkins *et al* (1965) showed that in four of the combinations, the F1s exceeded their better parent in lint yield by 18·4 to 24·2 per cent.

(ii) *Inter-specific crosses:* Balls (1908, 1919) observed increases in certain characters like height of plant, lint length, size of seed, number of nodes and greater internodal length in Egyptian *(G. barbadense)* x Upland *(G. hirsutum)* F_1 hybrids. He also noticed transgression in earliness of flowering in one case. Kearney (1923) found that the hybrids between Holden (Upland) x Pima (Egyptian) exceeded the greater parent in plant axis length, internodal length and other characters. Winesap (Upland) x Sea Island *(G. barbadense)* hybrid studied by Ware (1930, 1931) showed vigour in seed weight, lint index and length of internodes. Crosses between North and South American types of *G. hirsutum* x *G. barbadense* were observed to show excessive vigour in plant size. (Jenkins, Hall and Ware, 1939). Kelkar *et al* (1946) recorded heterotic effects in yield and lint length in inter-specific crosses. Balasubramaniam and Narayanan (1948) noticed vigour in staple length, fibre weight, and spinning value in two inter- specific hybrids and in yield of seed cotton in the other. Experiments conducted at Coimbatore (Santhanam 1951 a) showed that the direct and reciprocal crosses involving Co. 2 (Madras Cambodia) and Sea Island V. 135 (West Indies) exhibited heterosis in productivity and seed index. Cambodia-2 x Tanguis hybrids showed vigour in yield of seed cotton and lint length (Santhanam, 1951). Experiments conducted by Christidis (1955) revealed that Inter-specific New World cross expressed vigour in respect of yield, earliness and possibly boll weight. Kesava Iyengar and Ramachandran (1956) found that the F_1 *G. hirsutum* x *G. barbadense* maintained its heterosis for yield of seed cotton and halo length in the third year of planting. Pandya and Patel (1957) studied a number of combinations out of which Co. 2 x Sea Island hybrid was found to be highly expressive of hybrid vigour with high degree of fruitfulness and producing extra-long, fine and silky cotton of 1·20" to 1·40" mean fibre length and capable of spinning 70's to 80's H. S. W. C. Gursham Singh and Avtar Singh (1957) and Joshi *et al* (1957) noticed hybrid vigour in *G. hirsutum* x *G. barbadense* crosses and indicated the possibility of commercial exploitation.

Mehbub Ali and Lewis (1962) studied the effects of reciprocal crossing on cytological and morphological features of interspecific hybrids of *G. hirsutum* and *G. barbadense* and observed heterosis in plant height, seed index, lint length, strength and extensibility. The hybrids with *G. hirsutum* cytoplasm had a significantly larger seed index, reduced fibre extensibility and increased yield of seed cotton when compared to the reciprocal combination.

Semenova (1963) observed no heterosis for earliness in the hybrids of *G. hirsutum* x *G. barbadense*. The hybrids excelled *G. hirsutum* in yield of *kapas* and lint length.

Interspecific crosses between *G. hirsutum* and *G. barbadense* at Rehovot, Israel exhibited a large heterotic effect for plant height, number of flowers and percentage of boll retention. Studies on general and specific combining ability in these interspecific crosses indicated that it would be advantageous in breeding hybrid cotton varieties to select the parents on the basis of their general combining ability for shorter plants, production of more flowers and a high percentage of boll retention (Mavani, 1964).

Interspecific hybrid involving Giza-12 as one of the parents showed heterosis in respect of halo length, while in yield of seed cotton, ginning percentage, lint index and seed index, a negative trend (Gursham Singh *et al*, 1964) was observed.

Studies on the expression of hybrid vigour in *G. hirsutum* x *G. barbadense* conducted by Vaman Bhat (1965) revealed that hybrids involving Andrews with either DPL. 15 or P. 216 F recorded maximum vigour and among them the hybrid between Andrews and P. 216 F combined also alround superiority in fibre length and indicated its scope for practical exploitation.

Of the characteristics studied by Young and Murray (1966), yield showed most pronounced heterosis in the teraploid *G. hirsutum* and the diploid *G. arboreum*. The *G. hirsutum* hybrid combinations exhibited less heterosis than the *G. arboreum* hybrids and were less sensitive to breeding.

Practical utilisation of heterosis in cotton: In a predominantly self-fertilised crop like cotton, which produces only a few seeds per flower, the snag in the proposition of commercial cultivation of first generation hybrids lies, among other things, in the discovery of cheap method for the large scale production of crossed seeds. To reduce the cost and labour involved in emasculation and cross-pollination in cotton and to tide over the difficulty of supplying hybrid seeds afresh every year, various techniques, such as dusting pollen

in the bud stage (Kaiwar and Kubsad, 1957), utilising honey bees as pollinating agents (Richmond, 1951), allowing for natural cross-pollination in regions where natural out crossing is rather high (Simpson, 1954, Stephens, 1950), development of male sterile lines by breeding (Loden and Richmond, 1951, Meyer and Meyer, (1963), by the use of selective gametocides to prevent pollen development (Eaton, 1957), by radiation-induced pollen sterility (Constantin, 1964) and by the adoption of the sieve method of producing partial hybrids (Justus, 1964), vegetative propagation of stem cuttings (Balasubramaniam and Narayanan, 1948, Balasubramaniam and Kanniyan, 1952; Patel and Patel, 1952; Stroman, 1961) and ratooning of the crop (Kesava Iyengar and Ramasamy, 1958) have been advocated.

In India, successful attempts have been made to grow on a bulk scale, the *hirsutum-barbadense* hybrids both in Bombay State (Patel and Patel, 1952) and in the Malabar tract (Kesava Iyengar and Ramaswamy, 1956).

Such an attempt will go a long way in the large scale production of long staple cotton in India and thus to save the enormous drain on foreign exchange.

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Anion Exchange Capacity and Crop Responses

by

F. L. DANIEL,[1] P. P. RAMASWAMI,[2] and
T. P. MAHADEVAN[3]

.....oduction: The purpose of the present investigation is to study the phenomena of anion exchange capacity on the lateritic soils of Nanjanad (The Nilgiris). When the study of response of crops to application of different nutrients began, it was discovered that many soils were deficient in supplies of available phosphorus. In most of the soils the total quantity of the phosphorus was low being less than about 0·0075 per cent. When phosphorus in the form of superphosphate was applied on the surface of these soils, about 80 to 90 per cent of added phosphate was fixed and the rest turned to unavailable form.

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[1] Retired Agricultural Chemist and Associate Professor of Soil Science, [2] and [3] Assistants in Chemistry, Agricultural College and Research Institute Coimbatore-3.

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