Heterosis in F1 Arabica hybrids and its use under different agronomic conditions

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Rationale:
Heterosis is defined as the superiority of the hybrid over the best of its parents. This phenomenon affects especially complex traits such as biomass and seed yield. F1 hybrid cultivars of Arabica coffee have been developed in Latin America by crossing dwarf pure lines 'American varieties' (A.V) x tall 'Ethiopian accessions (E.A)' or A.V x A.V. We have more than 30 years of hindsight on these varieties. How do F1 hybrids behave as a function of altitude (i.e. average temperatures), light intensity, and low-input conditions? Does this type of variety have a future to face the climate change?
Methods:
We present the main results of articles published between 2005 and 2022 from research started from 1991, where F1 are compared to A.V. Evaluations have been carried out by comparing F1 with the two parents in experimental trials or comparing F1 with A.V (G x E networks), in different altitudes, light intensity, and input conditions.
Main Results:
Basis of heterosis in Arabica: In experimental trials, E.A crossed by A.V produced high yielding F1 hybrids. F1 hybrids produced 75–80% more than A.V and 40–50% more than E.A, suggesting two heterotic groups. We did not observed heterosis between A.V x A.V.
Heterosis varies according to the characters : F1 hybrids produced a larger number of internodes over the same time lapse. The rust tolerance of susceptible F1 is superior to the rust tolerance of parents. Other characters of interest (i.e. seed size, sensory quality) are not altered by heterosis. For seed size and shape we suspect a maternal inheritance.
Heterosis & G x E: Heterosis is higher at low and medium altitudes (i.e.T°) and are stronger in sub-optimal conditions. There are no clear conclusions about light intensity. F1 Hybrids are more stable over environments than A.V for biomass and yield traits.
Conclusions:
The performance of the F1 are far beyond exceed the productivity of the best A.V. The absence of heterosis in AVxAV is probably due to the very small genetic distance between the A.V. Homeostasis appears as an important and essential component of heterosis in Arabica F1.
F1 hybrids always appear superior to A.V in low/medium altitude and in low/high-input or sun/shade conditions. Finding heterosis in an allopolyploid, autogamous and as low polymorphic species as Arabica is a great opportunity to increase the productivity and address the challenge of climate change. Farmers adopt the F1 varieties because they offer higher yields and fewer risks than other coffee varieties. However, the production cost of a hybrid seed is a major deterrent. The control of male sterility is a strategic element of any Arabica breeding program focused on F1 hybrids.

References:
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