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DIGGING INTO RESEARCH

Hybrid breeding could improve lentil yields

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New Australian research shows that lentil crop improvement through a combination of hybrids and hybrid mimics could be used to substantially boost yields as high as 50 per cent greater than commercial varieties. Hybrid vigour or heterosis can be generated in a wide variety of lentil hybrids, and hybrid mimic lines could be used to capture high yield traits into pure breeding stable lines.

One of the main barriers to yield increase in lentil breeding is thought to be the low genetic diversity in traditional breeding programs. With the success of large increases in yield in other crops through the use of hybrids, researchers in Australia wanted to examine the possibility of using hybrids in lentils.

For the study, researchers collected parental material from a wide range of genetic and geographic distances, including material from Pulse Breeding Australia, Australian Grains Genebank (AGG) and two local lentil lines. Three red lentil commercial lines with varying cotyledon sizes were selected from Pulse Breeding Australia, including Hurricane (small), Nugget (medium) and Jumbo2 (large), as well as one medium sized green lentil variety Greenfield. The AGG parental materials included both breeding collections and wild species (*L. orientalis*) from worldwide accessions.

Hybrids from a number of combinations including varieties from the same traditional breeding program and unrelated accessions from the global collections were initially made in a controlled

environment. High yielding hybrid combinations were used in the absence of male sterile lentil lines in a program of repeated selfing and selection to produce high yielding stable lines or Hybrid Mimics.

The grain yields of the hybrid mimics were similar to the F1 hybrids, avoiding the limitation of the hybrid advantage to the F1 generation. Based on seed weight per plant, the hybrid combinations with outstanding hybrid vigour or Better Parent Heterosis (BPH) were selected for further study. The seeds from 2 or 3 lines with the highest yielding plants were grown in cabinet or glasshouse conditions until the F4 generation. The F5 and subsequent generations were grown in a large field trial and selected based on yield per single plot.

Large yield gains realized

The results showed that of the 52 hybrids developed in the study, 15 of the combinations had seed yield hybrid vigour, with BPH gains ranging from 10.4% to 125%. The study indicated that plant height and pod stem length in hybrids may be useful traits to predict seed yield heterosis, however, there was no correlation between pod number per peduncle, seed number per pod and seed yield. Flowering time, seed size and branch number were important but not critical for the level of hybrid vigour in seed yield.

There was also an indication that cotyledon color may be important, as there was a greater chance of obtaining higher yielding hybrids when green selections were crossed with the red Jumbo2 than with the green Greenfield plants. A trend of increased seed yield, as high as 50% greater than the commercial varieties in 4 different independent experiments suggests a benefit of using hybrid mimics in lentil breeding.

Seed yield per plant is a complex trait, and along with genetic factors is also influenced by many different environmental factors, such as light, water and temperature. The study showed that hybrid vigour occurred at all stages of the life cycle, with observations as early as seed germination and in late vegetative growth. The data showed that in many of the hybrids, heterosis occurred in vegetative growth and/or seed yield, making both traits potentially important in lentil breeding programs. The results also indicated that although the heterosis values differed, seed yield heterosis was reproducible in different growing environments.

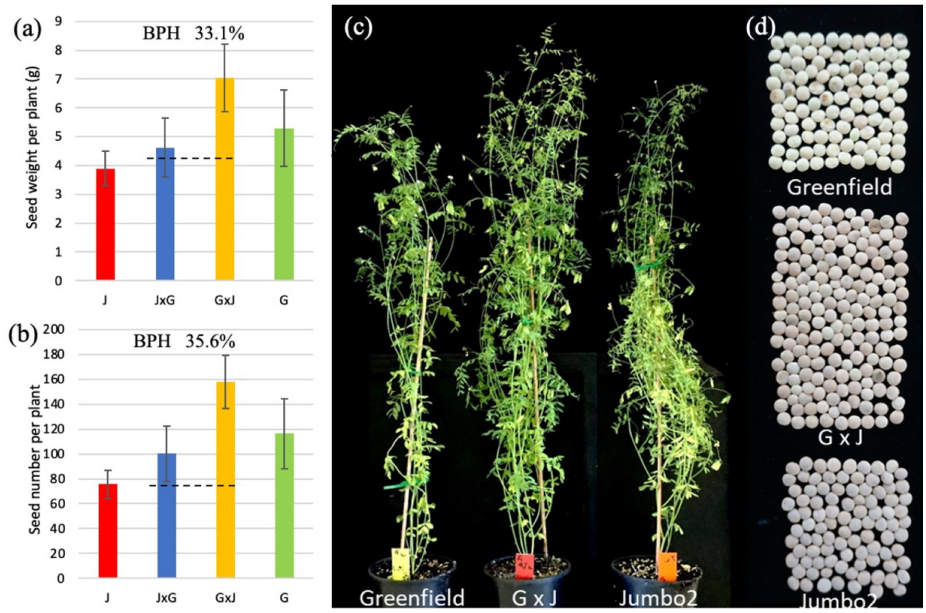

Figure 1. Hybrids between Australian red and green commercial varieties, Jumbo2 (J) and Greenfield (G). (a) Seed yield weight per plant. (b) seed number per plant. J, Jumbo2, n = 18; G, Greenfield, n = 15; JxG, n=9; GxJ, n= 8. Better Parent Heterosis (BPH) values were calculated on seed weight and number per plant. (c) phenotype of plants in the late flowering stage. (d) Seeds from typical individual plant of different material. Dashed line indicates middle parent value (MPV).

Overall, the research shows that lentil crop improvement through a combination of hybrids and hybrid mimics could be used to substantially boost yields. Heterosis can be generated in a wide variety of lentil hybrids. Hybrid mimic lines, which are stable and overcome the restriction of the hybrid advantage to the F1, could be used to capture high yield traits into pure breeding stable lines. This breeding strategy could be applied in a wider range of crops to enhance yields.

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Photo and graph by Elizabeth Dennis