Is it really worth growing F2 canola seed?

Maurie Street[1], Ben O'Brien[1] & Josiah May[1]

[1] Grain Orana Alliance

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Take home message

Using farmer retained hybrid canola seed (F2) as an alternative to commercial seed (F1) in 3 trials resulted in:

- Poorer crop establishment in some instances
- Lower rates of vegetative growth in most instances
- Lower yields in all instances; penalties in the range of 14–39% or 250–680 kg/ha
- Reduced net profit in all instances, even when considering the lower seed costs of farmer kept F2 hybrid canola seed

Background

The retention of grain from hybrid canola crops by grain growers and using it for seed the following year is not novel. Hybrid seed is often seen as an expensive crop input and with tightening margins, growers are often tempted to make some savings. However, there are additional challenges that have influenced growers to adopt this practice, particularly since the break of the 2020 drought.

Increases in the canola area because of higher grain prices, and an increasing realisation of the benefits of hybrid over open pollinated (OP) varieties in yield and profitability, has resulted in reported year-on-year increases in the demand for hybrid canola seed. The longer lead times required to produce hybrid canola seed has limited seed suppliers' ability to respond to these changes in demand. This has meant many growers have not been able to access adequate quantities of their desired choice of commercial hybrid canola seed.

Additionally, many suppliers/retailers are requesting seed orders to be placed well in advance, with growers faced to take delivery and pay for orders even when planting conditions fail to be realised.

Not only does this represent a large cost (particularly with hybrid seed) for growers to carry for up to 18 months, but the seed also losses viability in storage so the seed may not be suitable for planting in subsequent years. This scenario is common, particularly in the lower rainfall zones, and results in a reluctance by growers to commit to seed in the time frames needed. In this situation, growers have seen the alternative, retaining canola grain harvested from previous crops that can be graded and sown if needed, as a cheap and easy alternative.

However, seed harvested from a hybrid crop, referred to as F2 seed, often does not retain the full genetic traits of the F1 parent. These traits might affect productivity, and include pest or disease resistances, herbicide tolerances, flowering period, or simply yield potential. The degree to which the genetic traits of F2 seed, or 'hybrid vigour', deviates from the F1 seed is largely unknown by growers and advisors alike or dismissed as not significant or not real.

Much of the previous research conducted into the performance of F2 seed that clearly shows there are significant yield and quality penalties, has been conducted by commercial seed companies which may be seen as not independent or having 'cherry picked' the data to support seed sales.

Furthermore, many growers who have utilised F2 seed often report little difference, but this may not be based on robust methods of comparison and further complicated as some farmers blend F1 and F2 seed. In response to this situation, GOA initiated three trials with the aim to quantify the consequences of sowing farmer retained F2 canola seed instead of commercially supplied F1 hybrid seed. The trials are not a comprehensive study, rather are intended to offer an insight into the relative performance for the two seed generations.

What did we do?

Over the 2023 and 2024 winter crop seasons, GOA established 3 trials to compare the performance of F2 seed to their F1 contemporaries. In these trials only 4 main attributes were measured: crop establishment, crop growth as measured by Normalised Difference Vegetation Index (NDVI), grain yield, and grain quality.

These trials utilised a small plot, randomised, complete block design with 4 replicates. Results were analysed using ANOVA for the analysis of variance and results compared by using a least significant difference (LSD) method with a 95% confidence interval. Any references to differences between treatments should be assumed to be statistically different unless otherwise stated.

All trials were sown in commercial canola fields and managed under best practice for crop nutrition and disease management.

The canola varieties tested were influenced by the availability of the F2 seed at the time, and the varieties are commonly grown in the Orana Region. The use of these varieties in these trials is in no way a recommendation or criticism for their use or otherwise.

2023

In the 2023 trial the F2 was sourced from growers who were using their own retained F2 seed. All seed lots were professionally cleaned, graded, and treated with the standard seed treatments of Guacho®(600 g/L imidacloprid) and Fluquinconazole seed dressing (167 g/L), commonly known as Jockey® Stayer®. All seed lots had sowing rates adjusted to target a plant population of 30 plants/m^2.

Table 1. Site detail of the F1/F2 seed comparison at Wongarbon, 2023.

Sowing date	22/4/2023
Starter fertiliser	MAP: 25 kg/ha with seed, 50 kg/ha IBS
N fertiliser	100 kg/ha urea - IBS
Harvest date	13/11/2023
Rainfall	In crop 197 mm, fallow 234 mm

Table 2. Canola varieties tested, source of seed and generation in the F1/F2 seed comparison at Wongarbon, 2023.

Variety	Source	Generation
Pioneer® 44Y94-CL	Pioneer®	F1
	Grower1	F2
Pioneer® 45Y93-CL	Pioneer®	F1
	Grower2	F2
	Grower3	F2

2024

In the 2024 trials the seed was sourced from a GOA trial run in the 2023 season. F2 seed lots were treated with the same labelled seed dressings used on the commercial F1 hybrid seed used in the trial. Both the F1 and F2 seed was graded to the uniform size of 1.8–2.2 mm. All seed lots had sowing rates adjusted to target a population of 30 plants/m^2. By grading the seed to the same size, it removes the potential for seed sizes of the different lines to influence yield.

Table 3. Site detail of the F1/F2 seed comparisons at Ballimore and Parkes, 2024

	Ballimore site	**Parkes site**
Sowing date	8/5/2024	22/5/2024
Starter fertiliser	MAP: 24 kg/ha with seed, 48 kg/ha IBS	MAP: 25 kg/ha with seed, 50 kg/ha IBS
N fertiliser	200 L/ha UAN 25/6/2024	Nil
Harvest date	25/11/2024	11/11/2024
Rainfall	In crop 300 mm, fallow 285 mm	In crop 244 mm, fallow 280 mm

Table 4. Canola varieties tested, source of seed and generation in the F1/F2 seed comparison at Ballimore and Parkes, 2024

Variety	Source	Generation
Pioneer® 43Y92-CL	Pioneer®	F1
	GOA	F2
Pioneer® 45Y93-CL	Pioneer®	F1
	GOA	F2
Nuseed® Diamond	Nuseed®	F1
	GOA	F2
HyTTec® Trophy	Pioneer®	F1
	GOA	F2
HyTTec® Velocity	Pioneer®	F1
	GOA	F2

What did we find out?

Full details of the trials referenced in this paper can be found at: https://www.grainorana.com.au/

2023

The effects on crop establishment when using F2 seed was inconsistent. For the variety Pioneer® 44Y94-CL, F2 seed resulted in lower plant establishment when compared to the F1 line. There was no difference for Pioneer® 45Y93-CL.

By the mid vegetative stage, crop growth as measured by NDVI showed that both the F2 Pioneer® 45Y93-CL lines had lower vegetative index (VI) than the F1, while there was no difference in the Pioneer® 44Y94-CL.

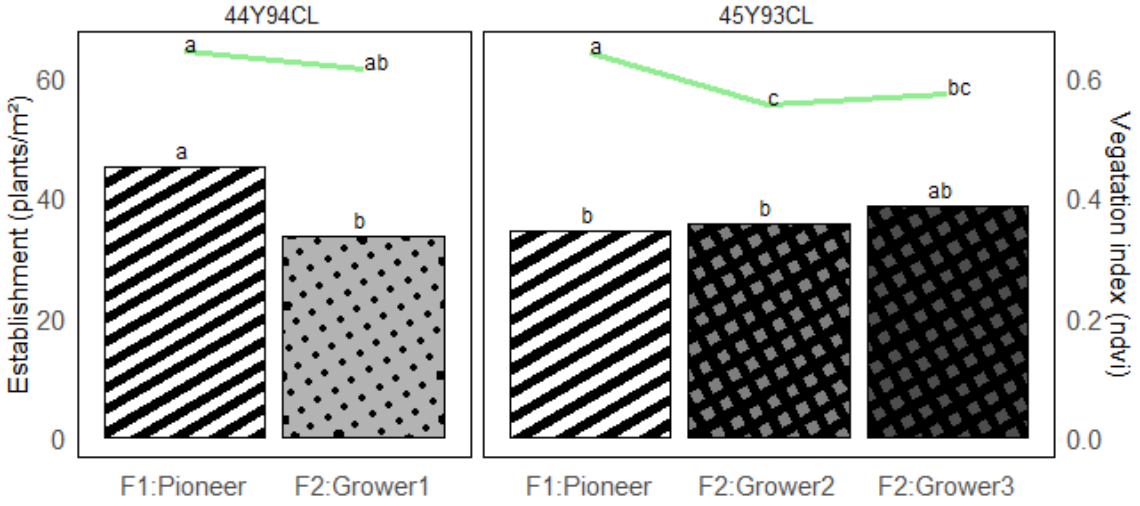

Figure 1. Impact of seed variety and generation on plant populations (bars) and vegetation index (VI, lines), in the F1/F2 seed comparison at Wongarbon, 2023

All F2 lines had lower yield than the F1 line of the same variety. For Pioneer® 44Y94-CL, F2 seed yielded 0.23 t/ha or 19% less than the F1 seed of the same variety. For Pioneer® 45Y93-CL, the two F2 seed lines yielded between 0.26–0.28 t/ha less than the F1 line or ~27%.

There was no impact on oil concentration (%) in this trial.

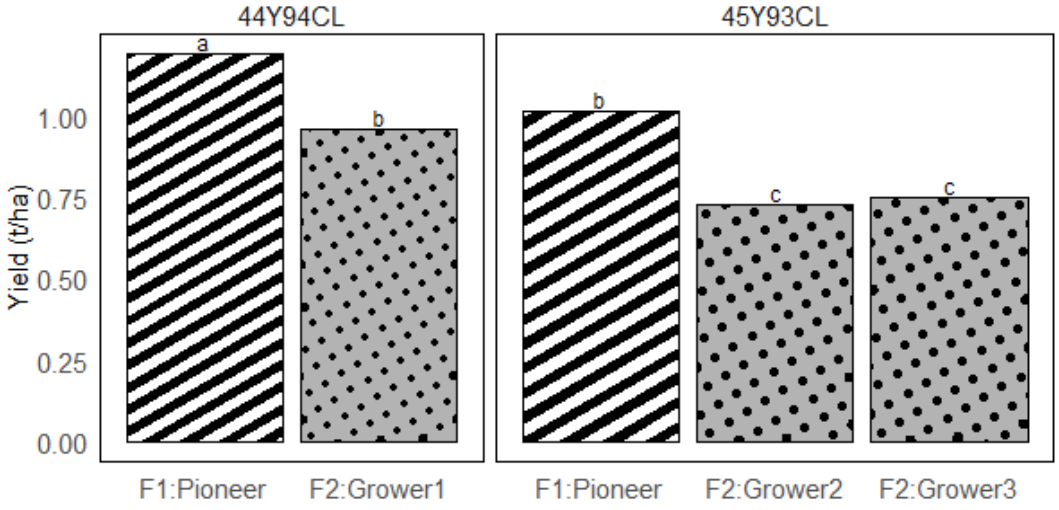

Figure 2. Impact of variety and generation on grain yield in the F1/F2 seed comparison at Wongarbon, 2023.

2024

Ballimore trial

At this site for 3 of 5 varieties tested, F2 lines resulted in lower plant establishments when compared with F1 lines of the same variety. Reductions of 57% were measured in the variety

Pioneer® 43Y92-CL. F2 lines of Nuseed® Diamond and HyTTec® Velocity were not different to the F1 lines.

Crop growth (NDVI) 89 days after sowing was lower for F2 seed compared with F1 for all but one variety- HyTTec® Velocity. Notably, Pioneer® 43Y92-CL was 32% lower in the F2 line compared to using F1 seed.

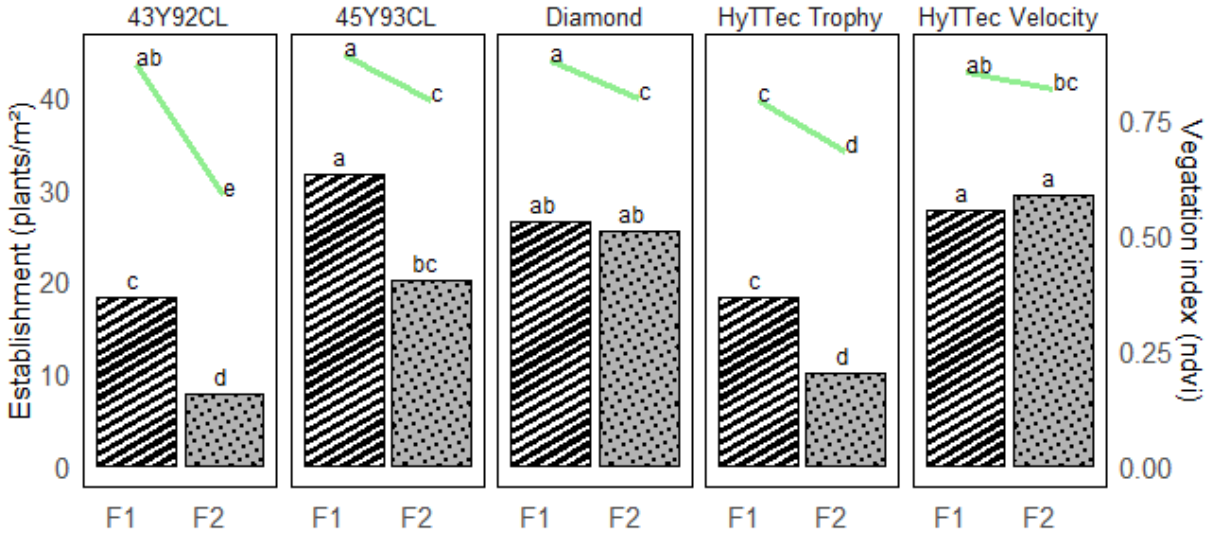

Figure 3. Impact of seed variety and generation on plant population (bars) and vegetation index (VI, lines), in the F1/F2 seed comparison at Ballimore, 2024

For all the varieties tested, F2 seed resulted in lower yield with reductions ranging from 18% to 39% or 0.35 t/ha up to 0.69 t/ha. However, there was no impact on oil concentration (%) between F1 and F2 lines of the same variety (results not shown).

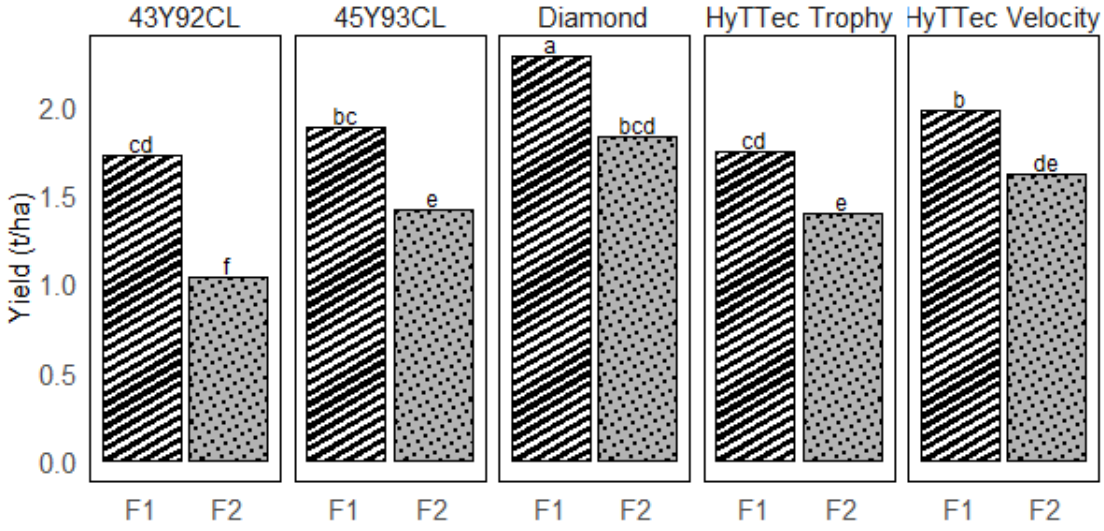

Figure 4. Impact of seed variety and generation on grain yield in the F1/F2 seed comparison at Ballimore, 2024

Parkes trial

At this site, the use of F2 seed resulted in a 60% reduction in establishment in one variety: Pioneer® 43Y92-CL. There was no impact on establishment in any other varieties tested.

Crop growth 79 days after sowing was reduced in 3 out of 5 varieties tested. The largest reduction between generations was 26% in Pioneer® 43Y92-CL, followed by 18% and 17% in Pioneer® 45Y93-CL and Nuseed® Diamond, respectively.

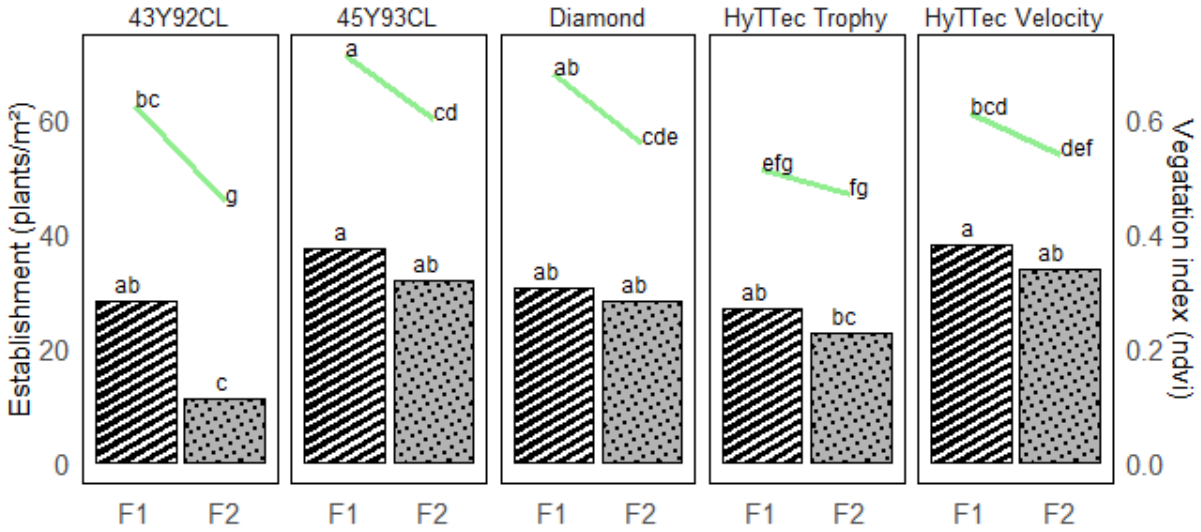

Figure 5. Impact of seed variety and generation on plant populations (bars) and vegetation index (VI, lines), in the F1/F2 seed comparison at Parkes, 2024

The use of F2 seed resulted in lower yield in all varieties tested when compared with their F1 counterparts. Yield reductions ranged from 14% to 21% which equated to a reduction in yields of 0.25 to 0.47 t/ha. Oil concentration was only impacted in Nuseed® Diamond with a 0.75% lower oil content in the F2 seed line.

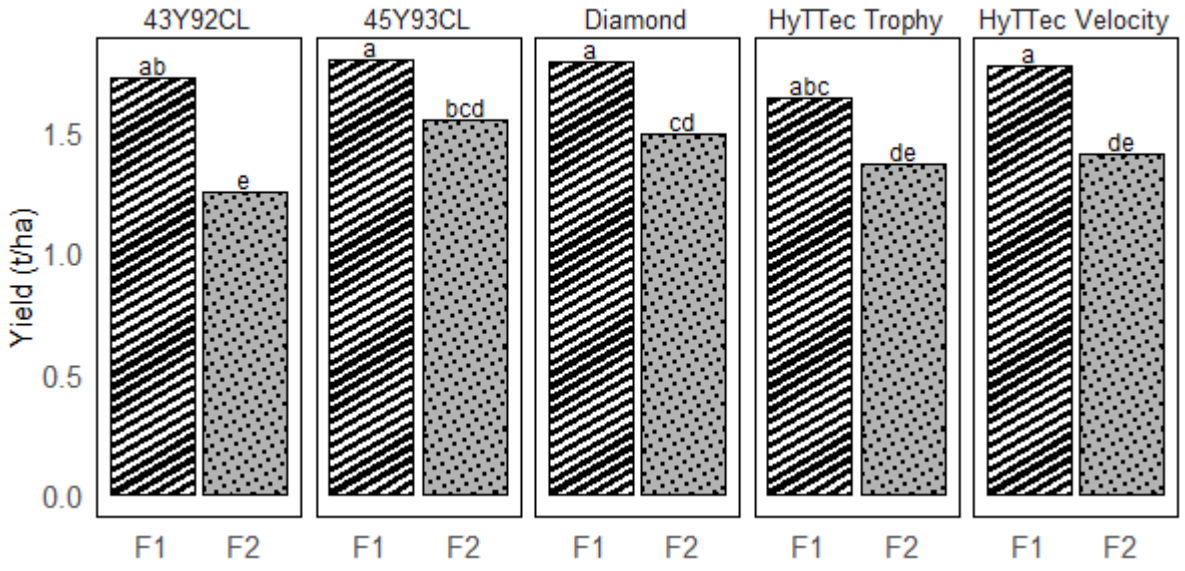

Figure 6. Impact of seed variety and generation on grain yield in the F1/F2 seed comparison at Parkes, 2024

If it isn't obvious, what does this all mean?

The use of F2 seed in some cases negatively impacted crop establishment but not always. The reduction recorded can be substantial with up to 60% lower establishment and is consistent

with research from WA (Agronomic and financial outcomes associated with retaining seed across Spring and Winter canola hybrids - GRDC) which showed consistent reductions in plant establishment across a range of varieties and environments. One solution to this might be to increase sowing rates to easily compensate for the lower establishments; due to the lower seed cost of F2 seed seems a simple fix. But a doubling of the seeding rate will double the seed cost per hectare, which will start to erode some of the perceived savings when using F2 seed in the first place.

One might argue that the reduced populations in the F2 lines may have lead to the yield reductions. However, robust populations were targeted, and despite reductions in plant populations following the use of F2 seed, most plant populations where still above 20 plants/ m^2 which is the accepted population to achieve potential yields in the trialling environments. Therefore, it is suggested the lower plant populations alone did not fully account for the reduced yields observed in F2 generations detailed further below.

The use of F2 seed often resulted in poorer crop growth as measured by NDVI. This could be in response to lower plant populations, which as explained above, could be addressed by increased sowing rates. However, NDVI was also reduced in lines where plant establishment was not impacted. Additionally, the NDVI measurement detailed in this report was 80 to 90 days post sowing. A period of time that would be generally accepted that poorer plant establishment would have been compensated for by crop biomass. As such it is likely that the reductions in crop growth are caused by additional effects than population alone.

The final crop performance indicator, yield, was consistently lower for F2 seed compared to using F1. Yield differences were substantial and reductions ranged from14% to 39% or 0.25 to 0.68 t/ha. The reasons behind the lower yields are likely to vary depending on the hybrid, but also the growing environment in the year in which the F2 seed is planted. The reduction in hybrid vigour is also likely to contribute to yield reductions; research suggests that F2 seed will 'segregate', taking on parental characteristics with effects on herbicide tolerance and disease resistance. Note that these were not factors in our trials (conventional herbicide package and full disease control was applied) and yield effects are likely to be greater when using hybrid specific herbicide packages or under disease pressure using F2 seed.

Interestingly, despite significant yield reductions, oil% was either unaffected or reduced. Often, where yields are reduced oil% increase as the oil grown is condensed into a smaller volume of seed. In these trials, this did not occur. This would indicate that F2 seed may be also less efficient in producing oil which is consistent with other research, suggesting a 0.5 to 2.5% decrease in grain oil% (https://www.pacificseeds.com.au/wp-content/uploads/2021/09/2021-Pacific-Seeds-Hyola-F1-Hybrid-vs-Retained-F2-Seed-Technote-FINAL.pdf) by using F2 seed.

Retaining seed from hybrid crops, cleaning, grading and treating will vary in the cost to the grower and is suggested to be around $4/kg (including cost of grain, grading, and seed treatment). However, to avoid complexity in working out cost savings in the use of F2 seed we can simply assess the yield and gross income advantages gained from the use of F1 seed as opposed to F2.

The minimum yield advantage of F1 seed over F2 seed in these trials was 0.25t/ha. Based on a conservative price of $600/t, that would equate to an advantage of $150/ha. If hybrid F1 seed was priced at $40/kg and assuming a sowing rate of 2 kg/ha and no cost (which will never be the case in reality) if F2 seed was used as an alternate, growers would still be $70/ha better off. If we considered the maximum yield advantage of F1 seed of 0.68t/ha with the same assumptions,

growers would be $328 better off. Additionally, the yields achieved in these sites and years were only moderate at 1.2–2.3 t/ha. In higher yielding environments, the advantages would likely be much higher.

Summary

Across three trials spanning two growing seasons, GOA compared the performance of several F2 seed lines when planted next to commercially available F1 lines. The use of the F2 seed sometimes resulted in differences in crop establishment, often resulted in poorer crop growth and vigour, but always resulted in lower yield.

The impacts on grain yield could be described as moderate to high with financial penalties of $70 to $328/ha.

Historically, some growers utilised F2 seed when F1 seed was not available and, despite the yield penalties associated, this practice may be seen as acceptable. But if there is an opportunity to use F1 seed over F2, these trials show there is a strong case to do so. But it is worth noting that the yield penalties are such that if the F1 hybrid seed of your choice is not available, non-hybrid options may well outyield the F2 alternatives and are worthy of consideration.

References

Agronomic and financial outcomes associated with retaining seed across Spring and Winter canola hybrids - GRDC

https://www.pacificseeds.com.au/wp-content/uploads/2021/09/2021-Pacific-Seeds-Hyola-F1-Hybrid-vs-Retained-F2-Seed-Technote-FINAL.pdf

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Contact details

Maurie Street
Ph. 0400 066 201
Grain Orana Alliance
PO Box 2880, Dubbo NSW 2830

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