Grain Yield Lost of Canola Using Hyola 401 as Seed for Planting

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ABSTRACT

Canola production area has increased in Northeastern Mexico over the last five yr. Cultivars has been inbred lines although recently new introduced cultivars are hybrids. Because growers need import hybrid seed at higher cost, they are looking for other seed options to produce canola. This study examined the performance of the F_2 seed from Hyola 401 to determine the potential disadvantage if it is used as seed for planting. Four cultivars were grown in Nov. 2004: Hyola 401 F_1, Hyola 401 F_2, IMC-205 (inbred cultivar) and IMC-205 F_2 (inbred). Field trial was conducted at one location to compare F_1 hybrid and F_2 progeny. High inbred depression was found for yield, but not for oil and protein content, with highest degree of inbred depression in Hyola 401 F_2. Hyola 401 F_1 and IMC-205 produced higher yield than its respective F_2 progeny. As expected, the magnitude of inbred depression observed varied between Hyola 401 and IMC-205, with minor effects in latest because is an inbred cultivar. However, average oil and protein content showed heterosis in F_2 in the trial, Hyola 401 F_1 had yield advantage compared with the inbred cultivar IMC-205. However, difference in oil and protein content between two cultivars was not significantly different. F_2 progeny in both cultivars tended to have higher oil and protein content with higher plant height in Hyola 401 F_2. Results shows that F_2 seed from Hyola 401 hybrid is not appropriate for commercial production, but as expected F_2 seed from inbred cultivar IMC-205 can be planted without risk of grain yield lost. So, farmers have to consider buying hybrids each year to expect highest yields.

INTRODUCTION

Mexico imports around five millions tons of oil seeds, of which about 20% is canola seed (1). Canola production began a few years ago in Central and Northwestern Mexico, and now total planted area is about ten thousand hectares annually. There are other potential areas for canola production such as Northeastern, but it is needed technology production before planting extensive areas there. Seed for planting is one of the most important bottle necks, because it is imported from Canada. Hyola 401 has been planted as appropriate hybrid for commercial production by most of farmers, but they are not agreeing to depend of seed imports each year, so they are looking for options of seed availability. One option they have put their eyes, is use recycled seed (F_2) from hybrid plant harvested. Objective of this work was determinate if

grain of Hyola 401 harvested (F_2) from a commercial field hybrid (F_1) can be used as seed for planting without significantly yielding lost.

MATERIALS AND METHODS

One hybrid (Hyola 401) and one inbred cultivar (IMC-205) and its inbred F_2 seed were used for this study. These materilas were chosen to represent inbreds and hybrids in yield potential, plant height, and time of maturity, grain weight, oil and protein content under Northeastern Mexico. In 2004, the four cultivars were grown and evaluated in an eight replicate randomized complete block design, and a plot size of 0.76 m by 5 m.

F_2 seed was produced by self-pollination of F_1 plants from a trial grown in 1993. Seeding rates were equivalent to 2.5 kg/ha and planting depth was approximately 2.5 cm. The trial was planted on 26 Nov. at Southern Tamaulipas Mexico near Cuauhtémoc, Tam. This site (22°34'N, 98°09'W) is located at an elevation of 40 m. Average annual rainfall is 90 cm.

The previous crop was corn (*Zea mays* L.), and besed on soil sample analyses, 120 kg anhydrous ammonia/ha was applied prior to planting. Seed was pre-plant treated with 6 mg (a.i.) of the fungicide benomyl [methyl 1-(butylcarbamoyl)-2 benzimidazolecarbamate] per gram of seed and mixed with granular cabofuran (2,3-dihydro-2-2-dimethyl-7-benzofuramul-methylcarbamate) at a rate of 0.6 kg a.i./ha just prior to planting to protect seedlings from soil insects. Because of heavy infestations of green bugs (*Myzus persiscae* L.), two applications of Dimethoate at a rate of 0.5 kg a.i./ha were required during the growing season.

The following traits were recorded from the trials: date of maturity (when approximately 90% of pods were dry); plant height (height of mature plants, in cm, at the center of each plot). grain weight (a liter of grain weight expressed in grams). Grain yield were estimated from the field trial. All mature plants in two row were removed from each plot. Field trial were harvested by hand on a plot-by-plot bases. Trials was harvested on 16 March 2005 (120 growing days). Weights of a liter-seed were also recorded. Oil content was determined following the procedure out-lined by Hammond (1991) with a Nuclear Magnetic Resonance (NMR) Analyser calibrated with a single reference sample of known oil content. Oil and protein content were determinated only in one sample of the mixture of all replicates.

Analysis of variance was carried out for each trait. Significant difference among cultivars was detected by significant *F* values from their respective mean square.

Inbred depression (ID) is expressed as a percentage and is calculated using the formula:

$$ID = [(P_2-P_1)/P_1] \times 100,$$

were P2 is the performance of the F_2 progeny, for the character of interest and *P*1 is the equivalent value for the F_1 hybrid or inbred cultivar. Heterosis (H) was calculated in the same way:

$$H=(P_1-P_2)/P_2 \times 100,$$

Were P1 is the performance of the F1 hybrid or inbred cultivar for the character of interest and P2 is the equivalent value of F2 progeny.

RESULTS AND DISCUSSION

ANOVA shows statistical significant for grain yield, days to maturity and plant heights (Table 1). Hyola hybrid and IMC-205 produced higher average seed yield than their respective F_2 progeny (Table 2), although the difference was only significant for Hyola 401. Highest inbred depression for yield was observed from Hyola 401 F_2 (22.2%), while inbred depression for yield in IMC-205 was only 4.9%. However oil and protein content also showed heterotic advantage, although a lesser degree F_2 of Hyola 401 showed heterosis of 13.3% and produced higher oil content (38.2%) and higher protein (3.6% heterosis and 28.4% content, respectively).

Table 1. Mean square values of four agronomic characters in four canola cultivars.

Source	L.G.	Grain yield kg ha^{-1}	Grain weight	DM	Plant height
Reps.	7	35557	479.2	2.4	266.5**
Cultivars	3	208717**	374.4	16.5**	446.9**
Error	21	45192	277.6	2.0	40.7
C.V.		13.6	2.52	1.2	4.6
Mean		1552	659.9	117	137.0

**, * = Statistical significance with P = 0.01 and 0.05, respectively. DM = Days to maturity;

The same oil and protein performance were found in IMC-205 F_2. Its oil and protein content were 35.3 and 27.9%, respectively, that were 7.1 and 10.7% of heterosis, respectively. Plant height and grain weight were not significantly different from cultivars, although Hyola 401 hybrid was earliest and weightiest (Table 1).

Table 2. Grain yield (kg ha-1) mean and characteristics of canola cultivars.

Cultivars	Kg ha^{-1}	ID	Grain weight	DM	Plant height	Oil		Protein	
						%	H	%	H
Hyola 401 (F_1 hybrid)	1,721 a	-	668 a	115 a	126 b	33.7	-	27.4	-
Hyola 401 F2 (F2 hybrid)	1,338 b	22.2	653 a	117 a	136 a	38.2	11.7	28.4	3.5
IMC-205 (Inbred cultivar)	1,615 ab	-	655 a	118 a	143 a	32.8	-	24.9	-
	1,536 ab	4.9	662 a	118 a	141 a	35.3	7.1	27.9	10.7

IMC-205 (F2 inbred)

ID=Inbred Depression; DM=Days to maturity; H=Heterosis.

The degree of inbred depression differed between cultivars. As expected, inbred depression in F_2 progeny of IMC-205 (4.9%) was lower for yield, only a fourth part of the Hyola 401 F_1 hybrid (22.2%).

The range of heterosis for oil and protein found in F_2 cultivars indicates that hybrid canola development is of utmost importance and that heterosis is an occurrence which does not always work in favor of improvement (2).

CONCLUSIONS

Disadvantageous inbred depression was observed in Hyola 401 F_2 that may offer lower yield potential, but more desirable oil and protein quantity. But as expected, the degree of inbred depression observed in IMC-205 F_2 was lower than in Hyola 401 F_2, because is an inbred cultivar.

Yield advantage of hybrid was confirmed in the Northeastern Mexico, but it performed lower oil and protein content than its F_2. This might reflect the emphasis on total yield rather than oil content in breeding programs. Higher heterosis for oil and protein content, found in F_2 progeny suggest an additional opportunity for improvement in developing hybrid canola for these traits. Hyola 401 hybrid tended to be earlier, that, suggesting no relationship exists between hybrids and late maturity.

Heterotic advantage of hybrids over its inbred cultivars must be sufficiently large to justify increased cost of hybrid seed production. In this study, Hyola 401 hybrid was not to much higher in yield than inbred cultivar IMC-205; so, perhaps seed F_2 from hybrid may be not a good choice to supply seed for planting, but inbred cultivars can use without serious risk of lost yielding.

Hybrid canola shows heterotic advantage for seed yield, over inbred cultivars Northeastern Mexico; However, the hybrid has have reduced oil and protein content. It is therefore essential that hybrid cultivars are selected for oil content and quality along with adaptability for specific production environments. Potential for increased productivity and quality from hybrid canola offers opportunities for higher production and increased acreage of this crop in Northeastern Mexico region.

REFERENCES

1. FAOSTAT 2005. www.fao.org
2. Kathleen P. Starmer, Jack Brown, and Jim B. Davis. 1998. Heterosis in spring canola hybrids grown in northern Idaho. Crop Sci: 38:376-380.