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Oil Crop Potential for Biodiesel Production: Summary of Three Years of Spring Mustard Research—Methodologies, Results, and Recommendations

2000-2003

J. Brown
University of Idaho
Moscow, Idaho

Subcontract Report
NREL/SR-510-36309
July 2005

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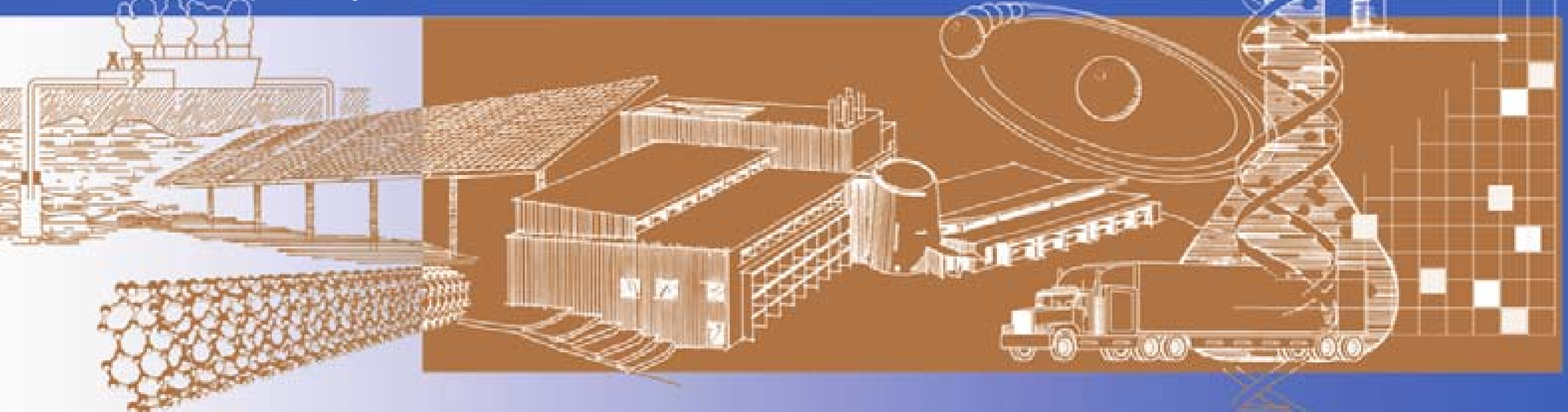

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Oil Crop Potential for Biodiesel Production

Summary of Three-years of Spring Mustard Hybrid Research: Methodologies, Results and Recommendations

Task 4

January 1, 2000 to March 31, 2003

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OBJECTIVE

The long-term goal of this project was to support R&D to develop an oil-seed crop that has the potential to reduce the *feedstock cost* of biodiesel to between 7 and 8 cents per pound of oil and expand supplies of biodiesel as demand for biodiesel grows. The key to this goal is that the non-oil fraction of the oil crop (the seed meal) must have a high value outside of the animal feed markets and produce oil that is not suitable for human consumption. To that end, a spring breeding program was developed to increase diversity of glucosinolate and the concentration of glucosinolates in the meal and to optimize the oil composition for biodiesel fuels.

This report presents the research on the spring planted hybrids. A companion report, *NREL Report: Winter Mustard Hybrid Research: Methodologies, Results and Recommendations* presents the progress made on winter planted hybrids.

The technical objectives of the program included the following:

- Increase the glucosinolate content of the meal by a factor of 3 or more with an emphasis on key types of glucosinolates known to have pesticide properties
- Increase seed yield per acre to the extent possible by identifying factors leading to robust hybrid establishment, insect resistance, drought tolerance, and other agronomic factors
- Maintain seed oil content at 40%
- Optimize the fatty acid content of the oil to minimize saturates and polyunsaturated oils and to ensure sufficient quantities of erucic acids to make the oils inedible but not high value for industrial use.

A high glucosinolate content oil seed crop can produce defatted meals with organic pesticide applications. A successful mustard pesticide must be as effective as the product it will substitute for, in terms of pest control, and must also be cost effective to use.

Often times the higher value of organic produce provides some cushioning effect that allows organic producers to use higher cost organic pesticides or organic pesticides with a slightly lower effectiveness that non-organic alternatives. Previous work with high glucosinolate meals *(Glucosinolate-Containing Seed Meal as a Soil Amendment to Control Pests)*[1] indicated that increasing the concentration of glucosinolates in the meal could increase their effectiveness as a pesticide and reduce the cost of field applications. This would be particularly true when the concentrations of specific glucosinolate types are increased.

Similarly, previous research indicated that the perfect oil composition for biodiesel is one that is low in saturates to reduce cold flow problems as well as low in polyunsaturates to reduce NO_x emissions.

Efforts to reduce the cost of vegetable oil used for biodiesel are limited by the economic constraints facing an oilseed crushing plant-seed and crushing costs must be allocated between two products: defatted meal and oil. Most oilseed crushers sell low-glucosinolate meals into the animal feed market at a price that frequently doesn't cover the cost of the seed inputs, and generally none of the crushing costs. This project was designed to develop an organic pesticide meal that could be sold at a higher value than animal feed meals, and thus, allow the crusher to allocate more of the crushing costs to the meal and less to the oil. By developing inedible oil, it also ensures that the oil will sell for less than most vegetable oils by eliminating high value markets.

In designing crops for broad regions of the U.S., both winter and spring planted varieties were developed to fit different crop rotation patterns. Mustard is a spring planted crop suitable for spring rotation schedules.

This project was not designed to answer many of the questions facing the development of mustard hybrid meals as organic pesticides. This project is limited to the brief (3 year) breeding program to determine the possibility of achieving the technical goals listed above.

METHODOLOGIES AND RESULTS

This report presents the activities on a year-by-year basis and discusses the methods used in this research. Materials examined and methods employed are presented on a year-by-year basis. Obviously, results from one generation have implications on the materials planted and evaluated in the next season.

Associated research examining non-genetic manipulation of glucosinolates by sulfur and nitrogen application and entomological studies are explained after the breeding section.

[1] J. Brown et al. July 2005. *Glucosinolate-Containing Seed Meal as a Soil Amendment to Control Pests,* NREL/SR-510-35254

2000 Growing Season

Material and Methods

The aim of developing spring interspecific hybrids was added after the first year of this project, and hence it was not possible to plant all lines in replicated yield field trials in spring of 2000. However, a large number of spring intergeneric hybrids (primarily from crosses between *B. napus* and *S. alba*) were planted in single replicate field trial. These materials fell into two category types:

- lines that we had sufficient seed to organize replicated field trials;
- others where we needed to increase seed in the glasshouse 1999/2000 to obtain sufficient seed to plant single plant plots in the field in the spring of 2000.

All previously lines with sufficient seed (88 hybrids) were planted in the field. Test plots were planted at the University of Idaho Plant Science farm, Moscow, Idaho (46^{o}44'N, 116^{o}57'W) Palouse Silt Loam (fine-silty, mixed, mesic Pachic Ultic Haploxerolls). Trials were planted into ground that had previously planted to spring barley, on May 2, 2000, using a six-row double disc opener plot drill and a seedling rate of 7 lb acre^{-1}. All fertilizer was applied pre-plant and incorporated prior to planting. The test area soil contained 2.4% organic matter and had a pH of 5.7. Prior to seeding, 233 kg ha^{-1} of Urea based 40-0-0-6 fertilizer was incorporated into the soil using a field cultivator to a depth of 8-10 cm. Prior to planting Treflon pre-plant herbicide was applied and incorporated. At the 5-6 leaf stage a spring application of sethoxydim {2-[1-(ethoxyimino) butyl-5-[2-(ethylthio) propyl]-3-hydroxy-2-cyclohexen-1-one} was applied to control volunteer grasses. The experimental design of this first year trial was a two replicate randomized block design. Plots consisted of two row 20 cm apart and 3 m long.

Control cultivars included in the first year trial were the *S. alba* lines 'IdaGold' 'UI.034535', 'UI.7012', Oriental mustard 'Pacific Gold', canola (*B. napus*) cultivars 'Cyclone', 'Hyola.401', and 'Helios', and *B. rapa* cultivars 'HySin.110' and 'Goldrush'.

General plant morphology and other pre-harvest characteristics (fall plant establishment, spring establishment and re-growth, Julian days to flow start, Julian days to flower ending, plant height at flower ending, visual preference, a visual estimation of commercial worth) were evaluated throughout the growing season. Plots were harvested using a Wintersteiger plot-combine on September 2, 2000. After harvest, seed weight from each plot was recorded and a sample of seed from each plot taken and used for quality determination.

Little is know about glucosinolate expression in the glasshouse, although we did complete fatty acid analyses (albeit after we had planted the spring crops) on the latter of the two groups of genetically different lines, bulked over family progenies. Fatty acid profiles were repeated after harvest. The majority of these lines had not been tested for glucosinolates, as they are segregating populations. In 2000, there were too many different lines to do a complete profile of glucosinolates (it takes two days to do 64 samples) so TesTape analyses were performed on all lines harvested.

Morphological characters (plant establishment, days to flower start, duration of flowering, days to flower end, and plant height after flowering), and yield potential were recorded throughout the growing season. At harvest, plots were individually combine harvested after single plant selections had been made. In addition, the genotypes were grouped according to whether they exhibited leaf, bud and pod types, which more resembled *B. napus* or *S. alba*.

Results and Selections

Hybrid lines showed a wide range of variability for oil fatty acid profile (Table 1 and Table 2). Only a few lines screened had an oil profile suitable for human consumption (i.e. less than 2% erucic acid content). Markedly more hybrid lines had medium to high erucic acid content, although none exhibited erucic acid content as high as the spring rapeseed cultivars 'Sterling', included in the fatty acid determination to indicate industrial rapeseed oil characteristics. All hybrids that had edible or industrial oil characteristics were eliminated from testing.

Similar variation in glucosinolate content between hybrids was observed (Table 3). None of the hybrid lines had glucosinolate content as low as the canola-quality cultivars 'Cascade', included as a canola standard in the testing. However, many hybrid lines showed intermediate glucosinolate content. A number of lines were, however, identified with glucosinolate content higher than 'Dwarf Essex', a high glucosinolate *B. napus* cultivar.

Most hybrid lines established well in the spring, and had plant stature similar to the control cultivars (Table 4). There was a general trend in that the hybrids were later to flower and had longer flower duration than the controls. Most control cultivars included in the field testing produced good to excellent seed yields, ranging from 35 to 137 g $plot^{-1}$ (Table 4). Hybrid seed yield was variable and ranged from 5 to 197 g $plot^{-1}$. Several hybrid lines produced significantly higher ($P<0.05$) seed yield than the highest yielding control cultivar (Goldrush).

There appeared to be little association between how the plant looked (i.e. like *B. napus* or *S. alba*) and either the fatty acid profile or the glucosinolate concentration. Few of the lines (in either group of genotypes) produced oil quality suitable for either edible or industrial purposes. A tremendous amount of variation was observed in glucosinolate concentration (assessed using TesTape), and fatty acid profile of control cultivars and interspecific spring-type hybrids grown in replicated yield trials 2000 (Table 5). More exciting results were obtained when the fatty acid profile of the spring-type hybrids was determined using gas chromatography techniques (Table 6a and Table 6b). Most hybrid combinations expressed glucosinolate types from both *S. alba* and *B. napus* parents. In addition, several of the glucosinolate types were greatly increased in concentration compared to the parental lines.

Selection of lines to be considered for evaluation in 2001 was based on a combination of field agronomic performance along with glucosinolate content and fatty acid profile.

2001 Growing Season

Material and Methods

In the spring of 2001, 89 *B. napus* x *S. alba* hybrid lines were selected based on seed yield, glucosinolate content, and oil characteristics assessed in 2000. These lines were grown in replicated field trials at two locations, University of Idaho Plant Science Park Farm, in Moscow, ID (46°44'N, 116°57'W), at an elevation of 793 m, approximately 65 cm precipitation annually, and with a Palouse silt loam soil type; and the University of Idaho Kambitsch Farm, near Genesee, ID (46°35'N, 116°57'W), with an elevation of 854 m, an average of 45 cm of precipitation annually, and also with Palouse silt loam soil type. Moscow trials were planted April 28, and Genesee trials planted on May 1, 2001. Both locations had been previously planted in spring barley. Included in these trials were the control cultivars 'IdaGold', yellow mustard (*S. alba*), 'Cyclone' canola (*B. napus*), 'Pacific Gold' Oriental mustard (*B. juncea*), and 'Goldrush canola (*B. rapa*).

Trials were planted using a six-row double disc opener plot drill and a seedling rate of 7 lb acre^{-1}. All fertilizer was applied pre-plant and incorporated prior to planting. The test area soil contained 2.4% organic matter and had a pH of 5.7. Prior to seeding, 233 kg ha^{-1} of Urea based 40-0-0-6 fertilizer was incorporated into the soil using a field cultivator to a depth of 8-10 cm. Prior to planting Treflon pre-plant herbicide was applied and incorporated. At the 5-6 leaf stage a spring application of sethoxydim {2-[1-(ethoxyimino) butyl-5-[2-(ethylthio) propyl]-3-hydroxy-2-cyclohexen-1-one} was applied to control volunteer grasses. The experimental design of this second year trial was a randomized complete block design with four replicates and a plot size of 1.5 m x 6 m.

Results and Selections

As in the previous year, wide variation was found in yield potential of the spring hybrids although some selected lines (Table 7) had yields comparable to the controls. Highest yielding control cultivar was Pacific Gold with over 2,000 kg ha^{-1} seed yield. Although no hybrid line evaluated was significantly higher yielding than Pacific Gold, the hybrid lines 95.HN.23105, 96.HN.123, F1.MMM.1F2.CMM4, and F3.MMM.18, each produced higher seed yield than Pacific Gold. Many more of the hybrid lines were significantly higher yielding compared to the other control checks. In general crop establishment in the hybrids was no different than the control cultivars, although several hybrid genotypes produced very tall plant heights (Table 7).

Selection was determined based the 2001 field performance and also on past fatty acid determination and glucosinolate concentration and profile. From the original 89 test lines, nineteen were selected and evaluated in multiple location trials in 2002.

2002 Growing Season

Original hybrid lines

Material and Methods

Glucosinolate content, oil content, and fatty acid profile on the most adapted spring hybrid selections from 2001 field trials were completed. Based on these data along with the field agronomic data, the 19 most adapted lines were selected for planting in the spring of 2002. These lines were tested for agronomic adaptability alongside 6 control cultivars ('IdaGold' and 'AC Pennant', yellow mustard; 'Cyclone' and 'Helios', canola; 'Pacific Gold', oriental mustard, and 'Goldrush', turnip rape), at four locations and under conventional and direct seed conditions. The four locations used were Moscow and Genesee (conventionally tilled) and Lewiston and Zenner Ranch (Direct seeded). Lewiston and Zenner Ranch are both low rainfall regions of Northern Idaho with average rainfall between 22 and 26 cm annually.

In addition to the field evaluation trials, seed increase multiplication plots were established to initiate seed increase if commercialization potential exists.

Results and Selections

The highest yielding control in the third year field trials was the yellow mustard cultivar IdaGold with 1,574 kg ha^{-1}. Only two hybrid lines produced yields that were significantly lower ($P<0.05$) than IdaGold, while the hybrid lines 95.HN.23105 and F2.CCM.4 produced significantly ($P<0.05$) higher yield than IdaGold. In general, the hybrid lines were later in flowering compared to the yellow mustard cultivar IdaGold (Table 9). Hybrids were of comparable stature (height) to the controls, and all hybrids had significantly greater oil content compared to IdaGold, and similar to Pacific Gold. Seed yield of Pacific Gold (oriental mustard) and IdaGold (yellow mustard) was significantly higher than all other controls and indeed higher than all hybrids under evaluation (Table 9). Several hybrids produced seed yields higher than the other canola and rapeseed cultivars in the trials.

New hybrid combinations developed in 2002

There has been some interest in developing a single hybrid line that contains both allyl and 3-hydroxybenzyl glucosinolate. In an attempt to achieve this goal, the University of Idaho breeding group successfully made two new hybrid cross combinations between *B. juncea* and *S. alba* and between *S. alba* and *B. nigra* in 2001. *B. juncea* (oriental mustard) and *B. nigra* (black mustard) were selected as parents that had highest concentrations of allyl glucosinolate and crossed these to *S. alba* lines with greatest concentrations of 3-hydroxybenzyl. Plants from these new hybrid combinations were transplanted *in vivo.* Over 90% of all plantlets survived transfer to *in* vivo. All hybrid plants produced were male sterile. Crosses were made, without the intervention of tissue culture to either (or both) of the original species parents and the initial indications are that some set will occur.

Attempts were made to make the haploid plants fertile by chromosome doubling. Cuttings from haploid sterile plants were treated with rooting powder and then allowed to develop into independent plants. After four weeks the cutting had reached the appropriate growth stage for treatment. Soil was washed from the roots and they were trimmed back to 3.0 cm. Cuttings were then immersed in 0.34% colchicine solution in water for 1.5 hours to induce chromosome doubling. Cuttings were rinsed in running tap water for 1.5 hours before being re-potted and transferred to the greenhouse.

After colchicine treatment fertile hybrid combinations were obtained from 18 *B. napus* x *B. juncea* hybrid combinations, 6 *B. carenata* x *B. juncea* hybrid combinations, and 2 *B. juncea* x *S. alba* cross combinations. Seed from these new hybrids were increased in the glasshouse over winter 2002-2003 and single-plant plot field trials are presently under evaluation.

Effect of S and N on glucosinolate content and profile

Material and Methods

A field study was planted to determine the effect of nitrogen and sulfur on seed meal glucosinolate type and quantity in spring mustard cultivars and hybrid genotypes.

Four *B. napus* x *S.* alba hybrids were selected, one with low glucosinolate content (<50 $\mu mol\ g^{-1}$), three with glucosinolate content (>100 $\mu mol\ g^{-1}$) These three lines, were planted along with their Canola parent ‘Cyclone’ and their yellow mustard parent ‘UI.534’ in a replicated field trial with five treatments: (1) low fertilization rate of 90 units of N and 15 units of sulfur; (2) normal fertilization rate of 120 units of N and 15 units of sulfur; (3) high fertilization rate of 150 units of N and 15 units of sulfur; (4) 120 units of N and 10 units of sulfur; (5) 120 units of N and 20 units of sulfur.

The fertility studies were planted at two locations, University of Idaho Plant Science Park Farm, in Moscow, ID (46°44’N, 116°57’W), at an elevation of 793 m, approximately 65 cm precipitation annually, and with a Palouse silt loam soil type; and the University of Idaho Kambitsch Farm, near Genesee, ID (46°35’N, 116°57’W), with an elevation of 854 m, an average of 45 cm of precipitation annually, and also with Palouse silt loam soil type. Moscow trials were planted April 29, and Genesee trials planted on May 1.

Results and Discussion

Averaged over all genotypes, increased nitrogen resulted in increased seed yield (Table 10) although there was no yield response to increased sulfur. Neither nitrogen nor sulfur had a significant effect on total glucosinolate content (Table 11).

Field insect resistance screening of canola x yellow mustard hybrids

Material and Methods

Twenty lines consisting of two yellow mustard cultivars (UI.034534 and 'IdaGold') and two canola cultivars ('Helios' and 'Cyclone') along with 16 hybrids were planted in spring 2002 field trials. The hybrids in this study were all *B.* napus x *S. alba* hybrids with differing glucosinolate concentration and types (Table 12).

The experimental design used was a four replicate split plot design where main-plots were assigned to four different insecticide treatments and sub-plots were assigned to the twenty genotypes. The four insecticide treatments included; (1) a no treatment control; (2) chemical control of early season pests only; (3) chemical control of late season pests only; (4) chemical control of both early and late season pests. Trials were planted at two locations, University of Idaho Plant Science Park Farm, in Moscow, ID (46°44'N, 116°57'W), at an elevation of 793 m, approximately 65 cm precipitation annually, and with Palouse silt loam soil type; and the University of Idaho Kambitsch Farm, near Genesee, ID (46°35'N, 116°57'W), with an elevation of 854 m, an average of 45 cm of precipitation annually, and also with Palouse silt loam soil type. Moscow trials were planted April 29, and Genesee trials planted on May 3.

The early season control included granular Furidan® applied with the seed. In addition, at the 3-4 leaf stage of the plants a foliar application of Sevin® was applied for flea beetle control, allowing us to show yield loss due to late season pests only. For the late pests we applied Capture® to kill aphids and CSPW and diamond back moths. Late season insecticides were applied during late flowering or early pod development. The late season application treatment shows yield loss due to early season insect pests.

Data was collected for emergence (a count of seedlings established in a 2 meter row), establishment (rated on a scale of 1 to 9, with 9 being well established), flea beetle ratings (rated on a scale of 1 to 9, with 9 being unaffected plants), flower start dates (in days from planting), plant heights (cm), seed yield, and percentage oil content in the seed. Glucosinolate analysis was carried out on seed meal from all 240 plots (i.e. 20 genotypes x 4 insecticide treatments x 3 replicates).

Insect counts were made throughout the growing season for adult cabbage seedpod weevil, diamond back moth larvae, diamond back moth adults, lygus adults, lygus nymphs, chinch bugs and flea beetles. The primary method used in gathering data on insect infestation was bucket counts. A five-gallon bucket and clip-board were used to count insects by swatting the canola plants above the bucket. The bucket was placed low along the front edge and back edge of the trial and the clipboard was used to make two swats on each side of the plot. After two swats into the bucket, the insects were counted and species recorded. The aphid counts were done late in the season by randomly selecting 30 racemes from each plant and recording the number of racemes classified as (1) covered in aphids, (2) racemes that had aphids present and (3) racemes that had no aphids. From these frequency counts a weighted rating was calculated as: ([number of plants covered in aphids x 3.0] + [number of plants that had aphids present x 2.0] + [number of plants with no aphids x 1.0])/30.0. An aphid rating of 3.0 would indicate that all plants were covered in aphids, while a rating of 1.0 would indicate that there were no aphid observed on the plants. CSPW exit hole counts were made by randomly cutting 50 pods from each plot just prior to harvest, and storing them in paper bags. The number of CSPW exit holes per sample was counted later in the laboratory.

All data were first analyzed through analyses of variance general linear model. Only characteristics that showed significant differences between insecticide treatments or between genotypes were considered for further investigation. In further analyses of variance the effect of differences between insecticide treatments was partitioned, using orthogonal contrasts, into: T1 = effect of early season insect control; T2 = effect of late season insect control and T3 = the interaction between early and late insect control. Similarly, the effect due to differences between genotypes was partitioned, using orthogonal contrasts into: G1 = difference between the canola and yellow mustard parental species and the hybrids; G2 = difference between canola and yellow mustard; G3 = difference between the two yellow mustard cultivars; G4 = difference between the two canola cultivars; and G5 = difference within 16 hybrids lines. Other differences were examined using Duncan's multiple range tests. Tolerance to insect infestation was considered for seed yield and percentage oil content. Tolerance ratings were calculated as: [yield of no insecticide treatment/yield of full season insecticide treatment] * 100.

Results and Discussion

Mean squares from the analyses of variance of all variates which showed significant treatment or genotype effects are shown for flea beetle rating, diamondback moth, adult CSPW counts, aphid rating and CSPW exit holes, seed yield, and percentage oil content (Tables 13 to 18). Early season insecticide effects were significant for flea beetle rating at all locations, seed yield at three of the four locations, and percentage oil content at one site only. As would be expected early season insecticide application had no effect on any insects affecting the crops late in the season. In contrast, late season insecticide application was significant for the late season pests' aphids and CSPW exit holes, although there was no significant effect of late season insect application on adult CSPW or diamondback larvae counts. Late season insect application caused significant yield losses in half the trials and reduced oil content in two locations. Interaction effects between early and late season insect application was significant for flea beetle, oil content and CSPW exit holes at one of the four possible sites and it was obvious that the interaction effects were always small compared to the effect of either early or larvae season application.

Heavy insect pressure resulted in large differences for all characteristics measured between insecticide treatments (Table 19 and Table 20). Seed yield at Moscow with full season control being significantly higher than other treatments, no control significantly lower yielding than either early or late season control (Table 19). Late season insect damage resulted in shorter plants at both sites and adversely affected crop stands.

As previously noted, yellow mustard cultivars showed significantly greater resistance to flea beetle than the canola cultivars. Where flea beetle were not controlled (no insecticide treatment plus late season insecticide only), several hybrid lines showed significantly better flea beetle resistance than the canola cultivars. Hybrids with high resistance included IsHyb.5, IsHyb.8, Is.Hyb.10, IsHyb.11, IsHyb.13, and Is.Hyb.18. As increased hybrid number is related to increased glucosinolate content, it is obvious that the resistant hybrids cover the range of glucosinolate content found amongst the hybrids.

No significant variation was observed for diamondback moth or aphid infestation between the interspecific hybrids examined. However, large variation was observed for CSPW exit holes. As would have been expected, the yellow mustard cultivars were immune to CSPW egg laying and no exit holes were found in any pods. The canola cultivars Helios and Cyclone had an average of 7.5 and 11.5 exit holes, respectively per 50 pods. Most of the hybrid lines tested showed exit hole counts similar to the canola cultivars, although IsHyb.8 and Is.Hyb.9 appeared to be markedly more resistant to CSPW than the other lines. Both these hybrids had intermediate to low concentrations of seed meal glucosinolate content (28 and 24 μmol g^{-1} of glucosinolates in defatted seed meal, respectively).

On considering valuable insect resistance it is impossible not to consider the effect of insect infestation on seed yield and oil content. Severe yield losses were significant as a result of insect infestation (Table 21). Yellow mustard cultivars UI.034534 and IdaGold showed yield losses of 25% and 14%, respectively; while the canola cultivars Helios and Cyclone showed 58% and 45% yield reduction without insect control. Yield tolerance amongst the hybrids ranged from a low of 29% to 86%. Hybrid yield tolerance was therefore worst than canola up to the same as the better yellow mustard. The most tolerant hybrids were IsHyb.8 with 35% yield loss and IsHyb.18 with less than 15% yield loss due to insect infestation. It should be noted that IsHyb.8 was one of the two with high resistance to CSPW egg laying and IsHyb.18 appeared to have high flea beetle resistance.

Insect tolerance with respect to oil content was affected to a lesser degree compared to that for seed yield (Table 22). Hybrids were more sensitive than either yellow mustard or canola cultivars in oil content. The most yield tolerant hybrid (IsHyb.18) also showed the ‘better’ tolerance with respect to oil content compared to other hybrids. Inter-relationships between the various characters recorded were examined by correlation analyses. In the previous year of this study very few significant relationships were observed between insect ratings, counts, seed yield or plant glucosinolate concentrations. In 2001, the low insect levels were reflected in that the correlation between seed yield from full insect control and no insect control ($r = 0.92$) accounted for over 85% of the total variation between the treatment yields. In contrast, the similar relationship in 2002 ($r = 0.50$) accounted for only 25% of the variation that existed between the two treatment yields (Table 2.8). In addition, significant relationships were found between glucosinolate content and yield tolerance ($r = 0.62$) whereby high glucosinolate lines tended to have higher yield tolerance. In 2002, yield tolerance was also highly correlated to flea beetle rating ($r = 0.70$) and aphid rating ($r = 0.92$). Forward stepwise regression of seed yield tolerance onto other characters recorded resulted in a significant regression where:

$$\text{Tolerance} = 73.4 + 0.56 \times \text{exit holes} - 41.4 \text{ aphid rating} + 0.09 \text{ total glucosinolate}$$

Entry of aphid rating into the regression equation accounted for 85% of the variation in tolerance, while entry of exit holes, glucosinolate content and flea beetle added 4.3%, 3.5%, and 1%, respectively.

The 2002 growing season had ample insect infestation and confirmed many findings consistent with other published results. In 2002 fewer bucket counts were taken because higher populations of insects were found when the bucket counts were taken. The high-density insect populations enabled us to carry out the aphid scores and cabbage seedpod weevil exit hole counts. Effects of early season insect control in 2002 showed significant differences over Moscow and Genesee. Significant differences were seen between parents and hybrid, canola and yellow mustard, within yellow mustards, canola's and hybrids. As previously mentioned, aphid ratings were only done in 2002, when aphid populations were higher. Not surprising, significantly fewer aphids were observed when late season control was applied. Effects also were seen with late season insecticide application on CSPW populations. In 2002, IsHyb.18 and IsHyb.8 exhibited the highest yield tolerance. It is interesting to note that the most tolerant line, IsHyb.18, was among the most susceptible to CSPW, having a high number of CSPW exit holes. However, this hybrid exhibited high resistance to flea beetles with a score of 4.5, and was extremely resistant to aphids with a sore of 0.45, which is the second highest amongst hybrids. Similarly, IsHyb.8 was second most tolerant to yield loss and had high flea beetle resistance rating (4.20) and had the fewest number of CSPW exit holes among hybrids. Several other hybrids showed interest from an insect resistance standpoint. IsHyb.11 was most resistant to flea beetle and exhibited similar rating to the highly resistant yellow mustard cultivar IdaGold. IsHyb.5 had the second lowest CSPW exit hole counts (6.35) and had an extremely low aphid rating of 0.67.

Overall, the results found here are highly encouraging with regards to introgressing high levels of insect resistance from yellow mustard into a canola x yellow mustard hybrids (Table 23). There was a general trend that hybrid lines with high glucosinolate concentrations were most insect resistance, although this relation ship was not absolute and several lines were identified with high levels of resistance to one or more insect pests and yet had lower total glucosinolate content.

RECOMMENDATIONS

If Brassicaceae seed meal is to have high impact in the US as an alternative to highly toxic synthetic soil fumigants then demand for the product is likely to be high. To facilitate the demands will require large acreage of fumigation crops that fit into rotation in many regions of the country. This will require spring (and winter) types.

As different glucosinolate breakdown products have different allelopathic effects of different past organisms (see other reports in this project), it is likely that more than a single species (or hybrid) class will be needed for the many used in intensive agricultural conditions. Spring hybrid crops offer highest potential in many US growing regions when winter crops are not feasible. In addition, there are many more spring-type

Brassicaceae species (i.e. *B. nigra*) that have very high concentrations of allyl glucosinolate content that do not appear in nature in winter forms.

The surviving 19 lines under investigation in this study now have sufficiently larger quantities of seed available that we can begin allelopathic testing and perhaps also plant toxicity testing. This breeding group has recently purchased a small lab oil press capable of crushing small quantities of seed (1-2 kg) and produce relatively fat free seed meal. Glasshouse testing of pesticidal efficacy of these lines will begin in 2004.

Overall, information on biopesticidal activity of these hybrids will offer the opportunity to better understand the factors involved in the apparent allelopathy observed. The hybrids developed in this project are unique and are the only plants of their kind that express a combination of characteristics shared between the species involved.

PRESENTATIONS AND PUBLICATIONS

Ross, D.W., J. Brown, J. P. McCaffrey and Bradley Harmon, 2003. Cabbage seedpod weevil resistance in canola (*Brassica napus* L.), yellow mustard (*Sinapis alba* L.) and canola x yellow mustard hybrids. *Euphytica* (in review).

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Hetrick, A., J. Brown, J.D. Davis, L. Seip, and D.A. Erickson, 2002. Developing high-quality cost-effective biodiesel from *Brassica* crops. In proceedings of the Western Society of Crop Science Meeting, Hawaii, June 3, 2002.

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Brown, A.P., J. Brown & J.B. Davis, 1998. Developing alternative *Brassica* crops from interspecific hybrids. Cruciferae Newsletter Nr. 19, pp.

Table 1. Fatty acid profile of spring-type interspecific hybrids grown in glasshouse to increase seed for planting in field studies 2001.

Identifier	16:0§	18:0	18:1	18:2	18:3	20:1	22:1
	------------	------------	------------	%	------------	------------	------------
STERLING	2.9	1.3	11.2	11.2	6.0	10.8	50.7
CYCLONE	3.6	2.0	62.6	18.0	7.7	2.7	1.5
95HN.23104	3.5	2.0	59.8	14.0	6.0	5.1	7.4
95HN.41202	3.1	1.3	17.8	14.5	7.9	10.5	38.1
95HN.5161	3.8	1.6	53.3	17.2	6.8	5.8	9.4
95HN.23102	4.2	1.9	61.7	17.5	7.7	2.7	2.6
96HN.123	3.0	1.4	25.4	12.5	7.5	12.2	32.9
95HN.23102	3.4	1.5	45.3	15.3	8.1	8.5	14.7
95HN.2571	3.4	1.4	31.6	15.1	6.3	12.5	25.0
96HN.53	4.2	1.6	49.1	21.3	9.3	5.2	6.9
96HN.113	2.9	1.6	34.8	12.6	6.4	12.7	24.7
96HN.114	3.2	1.8	37.5	11.9	6.0	12.4	22.9
95HN.2243	3.7	2.0	54.8	16.7	6.9	5.2	8.4
95HN.5131	3.4	1.6	52.1	14.2	7.8	7.7	10.5
96HN.121	3.0	1.4	27.3	14.0	8.8	15.3	25.8
95HN.4112	3.1	1.2	23.4	13.9	6.7	12.3	34.1
95HN.41121	2.8	1.3	22.7	14.5	7.5	11.0	34.3
95HN.73	3.2	1.6	41.2	15.0	8.9	10.7	16.3
96HN.52	3.8	1.5	42.8	18.5	9.8	7.6	12.8
95HN.31121	3.8	1.7	32.0	17.3	6.1	12.3	21.8
95HN.4171	2.8	1.4	21.5	11.0	5.1	10.6	41.7
95HN.2573	3.6	1.3	29.2	15.2	7.9	13.0	25.4
95HN.4112	2.9	1.4	22.5	13.2	5.7	11.0	37.1
96HN.34	3.8	2.1	62.2	17.5	6.4	3.1	3.2
95HN.5131	3.7	1.8	60.9	16.0	8.1	3.4	4.4
95HN.5122	4.6	2.3	53.5	21.4	7.9	3.3	4.4
95HN.41171	2.8	1.1	20.8	12.4	5.5	10.3	40.8
95HN.23101	3.7	2.1	51.5	13.3	9.5	6.4	10.9
96HN.31	4.0	2.2	58.1	17.5	7.5	3.9	4.6
96HN.113	2.9	1.6	34.4	12.0	5.6	12.6	26.5
95HN.2572	3.6	1.2	16.3	17.1	7.8	8.6	37.2
95HN.41141	2.9	1.1	20.7	15.8	8.3	10.0	34.8

§ 16:1 = palmitic acid; 18:0 = stearic acid; 18:1 = oleic acid; 18:2 = linoleic acid; 18:3 = linolenic acid; 20:1 = eicosenoic acid; 22:1 = erucic acid.

Table 1. Fatty acid profile of spring-type interspecific hybrids grown in glasshouse to increase seed for planting in field studies 2001 (continued).

Identifier	16:0[§]	18:0	18:1	18:2	18:3	20:1	22:1
	%						
96HN.112	2.9	1.4	22.4	12.9	8.2	9.4	36.0
95HN.23101	3.8	1.9	48.0	14.3	10.8	6.1	12.0
96HN.122	3.4	1.7	36.1	14.3	6.3	13.0	24.3
95HN.23103	4.1	2.1	64.2	15.0	6.7	2.8	2.9
96HN.282	4.3	2.2	43.2	18.0	8.3	9.6	10.3
95HN.73	3.2	1.8	38.3	15.1	7.4	11.1	19.5
95HN.4114	3.1	1.4	23.2	13.8	5.1	11.3	36.5
96HN.114	3.3	1.8	40.1	12.8	7.2	11.7	19.3
95HN.23103	3.7	1.8	54.0	16.5	8.7	5.8	7.2
96HN.122	3.3	1.7	32.0	14.6	6.6	13.4	23.5
95HN.2573	3.5	1.1	22.3	15.5	8.1	11.6	31.9
95HN.41141	2.7	1.0	18.6	12.4	6.3	8.9	43.8
95HN.4113	3.0	1.2	19.7	12.9	4.9	9.6	42.5
96HN.34	4.0	2.4	61.0	18.4	6.8	2.6	2.6
95HN.2241	3.7	1.8	56.5	18.7	6.0	7.4	3.9
95HN.4171	3.0	1.3	24.6	12.9	6.0	12.0	34.7
95HN.5161	3.9	1.6	54.7	19.3	7.9	5.6	5.0
96HN.121	3.1	1.3	26.3	13.3	8.8	15.1	27.0
95HN.2572	3.2	1.0	14.5	15.4	8.0	8.2	41.9
95HN.4114	3.3	1.5	21.6	13.3	4.2	10.2	39.1
95HN.72	3.6	2.2	56.1	19.5	7.7	4.4	4.2
96HN.112	3.2	1.7	23.3	13.5	7.4	9.6	34.5
95HN.2571	3.6	1.4	25.3	14.9	5.6	11.5	31.5
95HN.41171	2.8	1.2	22.2	13.1	6.5	10.6	37.5
95HN.23104	3.6	2.0	62.3	15.5	6.9	3.5	4.3
96HN.282	3.8	1.8	41.7	16.4	8.6	11.1	12.8
96HN.111	2.9	1.7	28.6	10.9	7.1	12.7	31.0
95HN.72	4.0	2.4	56.7	21.4	7.8	2.9	2.7
95HN.4111	2.9	1.3	19.5	13.2	5.6	9.8	41.5
95HN.31141	3.9	1.6	33.0	17.9	8.2	11.1	20.0
96HN.111	3.0	2.0	41.3	11.8	6.1	11.1	20.9
95HN.4111	3.0	1.5	23.5	12.2	4.9	10.8	38.1
95HN.41121	2.6	1.4	23.3	14.1	6.1	10.9	35.6
96HN.53	4.3	1.8	50.6	20.3	7.6	4.7	8.1
95HN.4113	3.0	1.5	23.8	12.3	4.4	11.8	37.1
96HN.123	3.2	1.7	30.6	12.8	6.6	12.7	27.4

Table 1. Fatty acid profile of spring-type interspecific hybrids grown in glasshouse to increase seed for planting in field studies 2001.

Identifier	16:0§	18:0	18:1	18:2	18:3	20:1	22:1
				%			
95HN.41174	3.0	1.3	22.5	13.7	6.8	11.7	34.9
95HN.41174	2.9	1.2	20.7	11.9	5.0	9.9	42.4
95HN.2242	3.4	2.2	61.7	17.6	7.5	2.8	2.8
95HN.3141	3.2	1.6	30.4	15.0	7.0	12.4	25.3
95HN.5122	3.8	2.2	61.0	16.7	7.4	3.4	3.3
95HN.31141	3.4	1.7	34.8	17.4	8.8	11.2	18.6
95HN.2242	3.5	2.0	62.7	18.6	8.5	1.8	1.2
95HN.2243	3.7	2.0	60.7	18.2	8.5	2.6	2.2
95HN.2241	3.7	1.8	54.3	21.1	7.0	6.7	3.3

Table 2. Fatty acid profile of spring-type interspecific hybrids grown in the field 2000.

Identifier	16:0	18:0	18:1	18:2	18:3	20:1	22:1
	------------	------------	------------	%	------------	------------	------------
95HN.2371	3.3	1.9	42.2	14.3	8.8	12.7	12.9
95HN.2372	3.2	1.9	38.9	13.3	9.0	14.4	15.9
95HN.2373	3.1	2.1	44.7	13.6	7.9	12.6	12.4
95HN.2374	3.5	2.5	46.9	13.2	10.8	4.3	6.2
95HN.2375	3.0	1.9	33.7	13.9	7.4	14.2	21.4
95HN.2376	3.3	2.1	47.0	14.9	8.1	11.7	9.6
95HN.2377	2.9	1.8	32.7	10.9	8.7	16.6	22.7
95HN.2378	3.1	1.7	34.5	12.9	9.4	13.4	20.7
95HN.41161	2.5	1.0	13.2	11.7	7.8	6.3	50.4
95HN.41162	2.6	1.2	18.7	11.2	7.3	1.3	43.9
95HN.41163	2.4	1.2	18.1	10.4	7.3	8.2	46.1
95HN.41164	2.5	1.1	17.7	10.9	7.1	8.4	46.5
95HN.41165	2.6	1.0	15.4	12.0	8.4	7.8	46.5
95HN.41166	2.6	1.1	17.6	11.4	6.8	8.6	45.7
95HN.41167	2.6	1.2	17.9	10.7	6.6	8.4	46.9
95HN.41168	2.5	1.0	16.6	12.3	7.8	8.4	45.3
95HN.41169	2.4	1.2	19.1	10.4	6.5	10.1	44.5
95HN.411610	2.5	1.0	15.4	12.2	7.9	6.8	46.6
95HN.2241	3.6	2.2	54.3	16.9	8.5	4.5	6.9
95HN.2242	3.5	1.9	60.0	20.1	9.2	2.2	1.1
95HN.2243	3.6	2.2	53.7	18.9	8.9	4.6	5.4
95HN.2244	3.5	2.1	59.3	16.3	8.3	4.1	4.3
95HN.2245	3.7	2.0	61.3	16.9	8.4	2.8	2.7
95HN.2246	3.3	1.9	52.1	16.8	8.8	5.6	8.7
95HN.2247	3.3	1.8	43.5	18.6	9.8	6.6	12.7
95HN.2248	3.2	1.9	43.0	17.1	8.7	8.1	14.1
95HN.2249	3.9	1.9	44.9	19.6	9.1	6.4	10.7
95HN.22410	4.0	2.1	54.8	22.0	9.9	2.4	2.4
95HN.41111	2.5	1.2	16.4	10.8	7.1	8.4	47.8
95HN.41112	2.6	1.1	17.2	12.0	7.4	7.2	45.6
95HN.41113	2.8	1.1	14.6	11.9	7.4	8.0	47.3
95HN.41114	2.3	1.1	16.5	11.1	6.9	8.0	48.3
95HN.41115	2.7	1.3	16.4	11.6	6.2	8.5	47.1
95HN.41116	2.3	1.3	18.9	10.4	6.0	8.1	46.2
95HN.41117	2.7	1.2	15.5	12.3	6.8	7.7	46.8
95HN.41118	2.5	1.2	17.2	11.2	6.3	9.0	46.8
95HN.41119	2.4	1.4	17.4	10.7	5.9	8.5	46.7

Table 2. Fatty acid profile of spring-type interspecific hybrids grown in the field 2000 (continued).

Identifier	16:0	18:0	18:1	18:2	18:3	20:1	22:1
	%						
95HN.411110	2.7	1.3	15.1	11.1	7.1	8.0	48.3
95HN.4141	3.2	1.3	14.8	13.8	6.5	7.8	45.9
95HN.4142	2.6	1.1	14.5	11.7	7.4	7.4	49.3
95HN.4143	2.5	1.0	15.2	10.8	8.2	8.2	48.2
95HN.4144	2.4	0.9	13.7	11.6	7.5	6.2	51.6
95HN.4145	2.9	1.2	13.6	12.7	8.1	8.5	46.6
95HN.4146	2.8	1.1	15.3	11.8	7.0	7.8	48.8
95HN.4147	2.5	1.0	16.2	11.6	7.4	9.2	46.4
95HN.4148	2.5	1.0	14.4	11.0	8.3	7.8	49.0
95HN.4149	2.7	1.3	19.6	11.5	6.8	11.1	41.7
95HN.41410	2.3	1.3	18.9	11.9	6.7	10.6	41.7
95HN.2351	3.3	1.6	32.1	13.1	8.8	13.3	23.6
95HN.2352	3.3	1.6	28.9	11.2	8.8	14.6	26.3
95HN.2353	3.1	2.0	36.7	11.3	7.8	13.1	21.5
95HN.2354	3.2	1.4	30.4	13.7	7.4	14.5	24.9
95HN.2355	3.5	1.6	41.3	15.2	7.2	11.7	15.8
95HN.2356	3.4	1.9	46.3	13.6	7.6	12.1	11.7
95HN.2357	3.9	1.8	54.7	18.2	8.5	4.9	5.2
95HN.2358	3.2	2.8	37.4	11.3	6.0	12.9	20.9
95HN.2359	3.6	1.7	49.6	16.4	8.9	7.5	9.1
95HN.23510	3.2	1.8	32.0	13.5	8.1	14.2	21.8
96HN.121	3.3	2.2	40.3	11.7	5.7	13.3	19.2
96HN.122	3.0	1.4	24.3	12.0	5.6	11.6	35.9
96HN.123	3.5	1.9	44.0	15.8	8.5	9.3	13.5
96HN.124	2.9	1.5	31.5	12.7	8.1	13.4	25.2
96HN.125	3.4	1.7	40.0	15.8	7.1	10.9	17.0
96HN.126	2.7	1.2	23.3	13.0	7.6	11.9	34.5
96HN.127	3.1	1.6	37.1	13.8	8.0	12.5	19.3
96HN.128	2.9	1.5	30.1	12.1	7.6	12.2	28.3
96HN.129	3.1	1.3	25.2	14.6	7.7	11.8	30.5
96HN.1210	3.0	1.9	35.4	15.3	6.4	11.9	21.8
95HN.4111	2.9	1.5	24.1	14.0	6.9	12.6	32.3
95HN.4112	2.8	1.2	21.5	13.7	7.6	12.1	35.3
95HN.4113	2.7	1.4	18.7	10.3	7.5	9.5	43.1
95HN.4114	2.9	1.6	23.2	11.7	5.7	12.6	36.5
95HN.4115	2.7	1.1	17.6	13.3	7.1	10.2	42.4

Table 2. Fatty acid profile of spring-type interspecific hybrids grown in the field 2000 (continued).

Identifier	16:0	18:0	18:1	18:2	18:3	20:1	22:1
	------------	------------	------------	%	------------	------------	------------
95HN.4116	2.8	1.0	13.3	14.2	8.1	6.8	45.2
95HN.4117	2.6	1.2	18.8	13.3	7.4	8.9	41.3
95HN.4118	2.5	0.9	13.1	13.8	8.2	6.2	46.9
95HN.4119	2.6	1.0	14.6	13.9	7.9	7.1	45.2
95HN.41110	2.7	1.1	15.9	13.5	6.6	9.5	44.1
95HN.41151	2.7	1.2	16.0	10.8	8.0	8.7	45.9
95HN.41152	2.9	1.4	17.4	9.8	7.7	9.3	45.3
95HN.41153	3.0	1.1	15.0	12.9	7.9	8.1	43.9
95HN.41154	2.7	1.3	18.1	9.8	7.2	9.9	45.1
95HN.41155	3.1	1.2	16.4	11.2	6.7	9.0	45.4
95HN.41156	3.0	1.1	15.2	11.3	7.9	8.1	46.0
95HN.41157	2.6	1.4	17.0	11.2	6.5	9.6	44.9
95HN.41158	3.0	1.2	16.4	11.0	6.7	8.6	45.8
95HN.41159	3.0	1.2	16.7	11.4	7.3	8.7	44.5
95HN.411510	2.7	1.2	17.7	10.6	7.5	10.0	44.7
95HN.2391	3.1	1.5	31.6	12.0	6.4	17.6	23.6
95HN.2392	3.2	1.9	48.0	11.3	6.8	12.7	12.6
95HN.2393	3.3	1.7	44.8	13.4	7.1	13.5	12.7
95HN.2394	3.5	1.9	64.0	16.1	8.6	2.3	1.4
95HN.2395	3.6	1.9	44.3	15.0	7.0	14.0	10.8
95HN.2396	3.1	1.7	34.2	12.9	5.9	17.4	20.9
95HN.2397	3.5	1.8	48.5	13.4	7.4	11.5	10.4
95HN.2398	3.7	2.0	63.6	15.9	7.3	3.1	2.3
95HN.2399	3.4	1.9	46.0	13.5	6.6	12.6	12.6
95HN.23910	3.3	2.2	57.0	12.4	7.3	8.7	6.6
95HN.4181	2.5	1.4	22.2	10.2	5.9	8.8	42.4
95HN.4182	2.7	1.2	19.5	10.4	7.1	9.6	43.2
95HN.4183	3.0	1.8	56.4	9.2	4.0	10.1	38.2
95HN.4184	2.8	1.6	20.1	10.2	6.5	9.1	42.5
95HN.4185	2.5	1.6	22.7	9.2	5.7	9.3	42.1
95HN.4186	2.8	1.2	18.8	11.2	8.0	10.2	41.9
95HN.4187	3.0	1.5	19.7	10.9	7.1	9.5	41.2
95HN.4188	3.1	1.3	20.0	11.3	6.9	10.4	40.2
95HN.4189	2.7	1.2	20.8	10.9	8.1	9.8	39.9
95HN.41810	2.7	1.4	19.7	10.7	7.6	9.4	41.7
95HN.41101	2.6	1.2	16.2	11.5	6.6	8.5	47.6

Table 2. Fatty acid profile of spring-type interspecific hybrids grown in the field 2000 (continued).

Identifier	16:0	18:0	18:1	18:2	18:3	20:1	22:1
				%			
95HN.41102	2.5	1.1	16.3	12.1	6.1	8.9	46.6
95HN.41103	2.4	1.0	15.7	11.5	6.9	8.5	48.2
95HN.2121	3.1	1.2	20.5	11.7	7.7	12.8	37.2
95HN.2122	4.1	1.7	56.8	16.4	9.4	3.7	5.4
95HN.2123	3.5	1.4	23.0	13.2	8.3	13.4	31.8
95HN.2124	3.3	1.6	32.9	13.5	8.6	11.7	24.0
95HN.2125	3.0	1.1	19.0	11.8	8.1	10.4	40.1
95HN.2126	3.5	1.3	18.5	11.1	9.0	10.9	39.0
95HN.2127	3.3	1.2	23.3	12.7	9.2	11.2	33.5
95HN.2128	3.9	1.5	45.5	16.1	10.4	8.3	11.0
95HN.2129	3.4	1.1	18.8	12.6	8.3	10.8	38.4
95HN.21210	3.7	1.1	31.8	15.6	10.2	12.0	20.8
95HN.2271	3.5	1.8	48.9	17.1	7.2	7.5	10.7
95HN.2272	3.1	1.4	32.9	17.3	9.0	10.7	21.0
95HN.2273	2.7	1.5	32.1	14.2	8.4	12.3	24.2
95HN.2274	3.4	1.4	39.2	16.3	8.5	10.9	16.6
95HN.2275	3.3	1.8	44.7	16.5	8.2	9.5	12.4
95HN.2276	3.1	1.6	30.6	13.5	8.2	11.0	27.2
95HN.2277	2.9	1.3	26.5	13.4	8.1	10.9	31.1
95HN.2278	3.2	1.2	34.3	15.1	8.9	10.3	22.8
95HN.2279	3.0	1.3	28.5	14.2	8.7	9.9	29.6
95HN.22710	3.0	1.5	26.5	14.2	9.4	10.4	29.3
95HN.2141	3.7	1.5	29.9	17.1	7.6	11.7	23.7
95HN.2142	2.8	1.2	20.4	14.4	8.0	11.1	35.6
95HN.2143	2.9	1.0	17.1	15.6	7.7	9.6	39.0
95HN.2144	3.6	1.7	35.4	17.7	7.9	10.2	19.0
95HN.2145	2.9	1.9	26.5	12.5	5.0	13.6	32.0
95HN.2146	3.3	1.5	25.1	14.7	6.9	13.0	29.7
95HN.2147	3.3	1.4	17.8	14.9	7.6	11.2	36.2
95HN.2148	3.4	1.4	27.7	15.5	7.7	14.0	25.1
95HN.2149	3.3	1.3	29.4	15.3	8.7	12.4	24.7
95HN.21410	3.2	1.4	24.3	13.9	8.9	14.8	28.1
95HN.4151	2.8	1.1	15.4	12.3	7.6	7.3	46.0
95HN.4152	2.6	1.1	14.4	12.0	6.7	7.1	49.4
95HN.4153	2.7	1.3	14.9	12.1	7.3	7.9	46.9
95HN.4154	2.7	1.3	18.8	11.8	6.4	10.0	42.8

Table 2. Fatty acid profile of spring-type interspecific hybrids grown in the field 2000 (continued).

Identifier	16:0	18:0	18:1	18:2	18:3	20:1	22:1
	----	----	----	%	----	----	----
95HN.4155	2.6	1.3	16.1	11.2	6.9	8.9	46.3
95HN.4156	2.5	1.2	17.5	11.6	6.6	9.5	44.9
95HN.4157	2.7	1.2	16.6	11.6	6.1	8.9	46.1
95HN.4158	2.7	1.2	16.4	11.2	7.0	9.4	45.7
95HN.4159	2.6	1.4	19.2	10.6	5.4	9.9	44.8
95HN.41510	2.5	1.0	16.3	11.5	7.1	7.6	47.4
95HN.2171	4.0	1.8	53.8	21.0	8.7	3.7	4.6
95HN.2172	3.9	1.7	52.6	17.1	10.5	6.0	5.6
95HN.2173	3.6	1.5	42.3	14.9	8.8	12.5	13.1
95HN.2174	3.4	1.4	35.0	15.0	9.5	13.8	17.7
95HN.2175	3.2	1.4	33.7	15.5	8.8	13.1	20.1
95HN.2176	3.4	1.3	24.8	13.9	8.4	16.0	26.9
95HN.2177	3.9	1.6	54.3	20.0	9.4	4.9	3.7
95HN.2178	3.6	1.7	52.4	17.3	7.9	7.0	7.4
95HN.2179	3.5	1.7	40.6	15.3	7.2	13.5	14.8
95HN.21710	4.3	1.7	54.6	20.1	8.6	4.0	4.1
95HN.4131	2.6	1.1	16.3	10.4	7.9	8.3	46.6
95HN.4132	2.6	1.1	16.9	10.5	7.7	8.8	45.7
95HN.4133	2.4	1.1	16.8	10.3	8.2	9.1	45.7
95HN.4134	2.5	1.3	17.2	10.6	6.9	9.2	45.9
95HN.4135	2.6	1.1	16.6	10.9	7.8	9.3	45.8
95HN.4136	2.5	1.1	15.5	10.5	8.3	8.0	47.8
95HN.4137	2.6	1.1	15.8	11.0	8.0	8.1	46.2
95HN.4138	2.6	1.2	16.4	11.2	7.7	8.6	45.4
95HN.4139	2.6	1.0	14.5	11.8	7.4	7.9	47.8
95HN.41310	2.4	1.0	13.8	11.1	9.0	7.5	48.9
94HN.231	3.3	2.0	34.0	13.2	6.7	12.7	23.2
94HN.232	2.8	2.3	34.9	10.3	5.2	14.1	25.5
94HN.233	3.1	2.2	32.9	11.6	5.9	14.4	25.0
94HN.234	2.8	1.8	31.1	11.1	5.7	13.7	28.0
94HN.235	2.9	2.0	30.2	11.5	6.7	12.9	28.0
94HN.236	2.7	2.1	30.0	10.8	6.1	13.8	28.6
94HN.237	2.9	2.4	30.6	11.0	5.7	13.9	27.2
94HN.238	2.9	2.2	33.6	10.9	6.0	14.2	24.8
94HN.239	2.7	1.6	26.9	11.1	7.0	14.0	31.1
94HN.2310	2.9	2.1	31.9	11.6	6.1	14.1	25.7

Table 2. Fatty acid profile of spring-type interspecific hybrids grown in the field 2000 (continued).

Identifier	16:0	18:0	18:1	18:2	18:3	20:1	22:1
	%						
92HC.622	3.5	2.0	36.1	30.2	18.0	3.4	4.0
95HN.2311	3.8	1.6	35.7	16.6	9.0	12.8	16.6
95HN.2312	4.1	1.8	41.7	18.6	12.9	8.8	9.0
95HN.2313	2.8	1.6	30.2	11.6	7.7	16.9	24.7
95HN.2314	3.4	1.6	41.6	13.6	8.4	14.6	13.6
95HN.2315	3.0	1.5	27.5	10.5	7.5	17.8	27.2
95HN.2316	3.8	1.7	39.7	14.8	7.3	14.5	14.3
95HN.2317	3.9	1.6	38.3	16.5	8.0	13.1	14.7
95HN.2318	3.4	1.9	41.2	14.7	6.1	14.6	14.4
95HN.2319	3.3	1.4	25.9	14.0	7.8	17.5	25.1
95HN.23110	4.0	2.2	60.8	15.7	10.3	2.7	1.9
95HN.4191	2.4	1.1	15.8	10.6	7.5	8.3	47.7
95HN.4192	2.5	1.0	13.5	12.9	7.7	6.9	49.9
95HN.4193	2.6	1.2	17.2	11.1	6.5	10.0	45.6
95HN.4194	2.4	0.9	15.2	11.0	7.6	6.5	49.7
95HN.4195	2.7	1.5	19.4	10.0	7.3	10.9	42.3
95HN.4196	2.5	1.7	24.5	8.3	5.8	10.8	40.4
95HN.4197	2.6	1.1	18.2	11.2	7.3	8.7	44.5
95HN.4198	2.6	1.1	16.9	11.5	7.9	9.2	44.2
95HN.4199	2.7	1.0	13.9	11.7	8.7	8.0	47.3
95HN.41910	2.7	1.1	16.1	10.9	7.6	9.3	46.1
95HN.2321	2.7	1.3	24.8	13.5	6.4	13.6	32.4
95HN.2322	2.9	1.8	34.2	13.7	7.1	12.7	23.3
95HN.2323	2.9	1.5	26.6	12.1	7.3	14.8	29.5
95HN.2324	2.9	1.7	26.3	12.3	6.0	16.1	30.0
95HN.2325	3.0	1.4	25.3	12.3	7.2	16.8	28.9
95HN.2326	3.5	2.0	55.7	17.8	11.9	3.3	3.5
95HN.2327	*	*	*	*	*	*	*
95HN.2328	3.2	1.8	34.4	15.6	8.0	12.7	19.7
95HN.2329	3.6	1.6	43.4	18.1	8.4	8.1	12.9
95HN.23210	2.9	1.8	31.5	15.5	7.8	12.8	22.9
95HN.41101	2.5	1.1	15.8	11.4	6.7	8.3	47.9
95HN.41102	2.6	1.2	17.3	12.3	6.0	9.6	44.9
95HN.41103	*	*	*	*	*	*	*
95HN.41104	2.6	1.2	17.8	12.0	5.9	9.2	45.2
95HN.41105	2.5	1.2	17.4	11.4	6.3	9.5	45.5

Table 2. Fatty acid profile of spring-type interspecific hybrids grown in the field 2000 (continued).

Identifier	16:0	18:0	18:1	18:2	18:3	20:1	22:1
	----------	----------	----------	%	----------	----------	----------
95HN.41106	2.7	1.5	19.4	11.8	5.3	9.7	43.7
95HN.41107	2.6	1.4	18.2	11.2	5.9	10.3	44.8
95HN.41108	2.5	1.2	17.2	11.0	6.8	10.1	44.9
95HN.41109	2.6	1.3	17.3	11.3	7.0	10.5	44.0
95HN.411010	2.6	1.3	17.7	12.0	6.6	9.9	43.7
95HN.23101	3.9	2.4	59.8	14.9	8.0	3.7	4.3
95HN.23102	3.7	2.4	67.1	13.9	8.6	1.4	0.4
95HN.23103	3.6	2.2	62.6	14.5	8.3	3.0	3.3
95HN.23104	3.6	2.0	50.9	17.9	8.1	5.8	8.9
95HN.23105	3.5	2.0	60.4	14.3	8.1	4.0	5.2
95HN.23106	3.9	3.0	67.8	10.5	8.7	2.0	1.6
95HN.23107	4.0	2.1	60.1	15.9	11.0	2.4	2.1
95HN.23108	3.7	2.2	64.2	13.8	7.8	3.1	2.8
95HN.23109	4.1	2.2	64.4	16.1	9.0	1.5	0.8
95HN.231010	3.8	1.9	63.6	15.1	8.2	2.6	2.7
95HN.41181	2.5	1.5	18.3	11.3	4.9	9.5	45.5
95HN.41182	2.4	1.3	15.6	11.5	6.1	9.0	47.4
95HN.41183	2.5	1.3	16.2	11.9	6.3	10.1	45.8
95HN.41184	2.3	1.3	17.2	11.2	8.6	8.7	47.8
95HN.41185	2.6	1.1	15.0	12.5	6.5	9.2	47.1
95HN.41186	2.5	1.1	13.7	12.4	6.8	7.9	48.7
95HN.41187	2.5	1.3	15.3	11.7	6.2	8.5	47.4
95HN.41188	2.4	1.2	15.4	11.6	6.8	8.6	47.9
95HN.41189	2.5	1.1	14.8	12.4	6.1	8.3	48.0
95HN.411810	2.5	1.3	15.9	11.7	6.2	9.7	46.1
96HN.111	2.7	1.5	24.7	12.8	8.0	11.9	33.5
96HN.112	3.0	1.8	30.1	12.6	6.4	14.2	27.5
96HN.113	2.4	1.4	18.6	11.1	7.8	9.7	42.5
96HN.114	2.8	1.2	20.5	12.1	8.3	12.0	37.0
96HN.115	3.1	2.1	38.4	12.2	6.9	14.6	18.5
96HN.116	3.1	2.6	35.6	10.4	4.8	13.3	25.0
96HN.117	2.7	1.5	24.2	12.1	6.5	11.6	35.9
96HN.118	2.7	2.0	35.3	11.9	6.8	13.3	23.5
96HN.119	2.7	1.6	23.4	12.5	7.5	10.8	35.2
96HN.1110	3.3	2.4	38.0	14.5	8.2	11.9	17.5
95HN.41191	2.7	1.4	16.5	11.2	6.2	8.7	46.4

Table 2. Fatty acid profile of spring-type interspecific hybrids grown in the field 2000 (continued).

Identifier	16:0	18:0	18:1	18:2	18:3	20:1	22:1
				%			
95HN.41192	2.8	1.5	20.7	12.0	4.6	10.0	41.5
95HN.41193	2.7	1.2	15.3	12.9	5.9	8.2	46.3
95HN.41194	2.8	1.2	17.2	12.8	5.4	8.9	44.8
95HN.41195	2.7	1.2	16.2	12.6	5.6	8.7	46.0
95HN.41196	2.7	1.3	17.5	11.9	6.0	9.8	44.4
95HN.41197	2.7	1.4	18.3	11.5	5.4	9.9	44.1
95HN.41198	2.6	1.4	18.4	40.8	6.4	10.3	43.4
95HN.41199	2.7	1.4	17.3	11.8	6.4	10.0	44.6
95HN.411910	2.8	1.1	16.9	13.0	7.4	8.8	42.8
95HN4161	2.5	1.3	17.8	10.8	7.2	8.7	44.9
95HN4162	2.5	1.3	18.4	9.5	7.2	9.1	45.3
95HN4163	3.1	1.1	14.9	11.7	9.6	6.9	44.0
95HN4164	2.8	1.1	18.4	13.0	5.7	8.4	43.3
95HN4165	2.9	1.2	15.7	11.4	7.2	7.8	46.2
95HN4166	2.9	1.0	16.7	11.7	8.6	7.8	44.3
95HN4167	3.2	1.5	17.5	13.4	6.9	7.5	40.9
95HN4168	2.5	1.0	16.7	11.7	8.6	7.8	44.3
95HN4169	2.9	1.3	15.2	12.8	6.7	7.7	44.9
95HN41610	2.8	1.2	15.7	10.9	7.8	8.3	46.0
95HN.5161	*	*	*	*	*	*	*
95HN.5162	3.7	1.9	50.7	16.5	8.1	7.4	8.7
95HN.5163	3.6	1.6	50.0	16.1	7.5	7.6	10.6
95HN.5164	*	*	*	*	*	*	*
95HN.5165	3.2	1.4	40.8	16.4	9.0	12.1	14.3
95HN.5166	3.3	1.6	47.2	17.0	8.1	7.9	11.4
95HN.5167	3.2	2.4	60.2	14.4	7.6	4.9	4.7
95HN.5168	*	*	*	*	*	*	*
95HN.5169	*	*	*	*	*	*	*
95HN.51610	*	*	*	*	*	*	*
93HN.11	3.1	1.7	62.3	18.4	8.2	2.2	1.9
93HN.12	3.7	2.3	66.6	15.7	5.4	2.3	1.7
93HN.13	3.7	2.2	63.7	16.5	7.4	2.2	1.8
93HN.14	3.6	1.9	66.2	16.5	6.8	1.8	1.1
93HN.15	3.1	2.0	61.6	15.9	7.1	3.8	4.1
93HN.16	3.7	2.3	62.1	18.1	6.5	2.3	2.6
93HN.17	3.6	2.3	64.5	18.1	7.3	1.4	0.6

Table 2. Fatty acid profile of spring-type interspecific hybrids grown in the field 2000 (continued).

Identifier	16:0	18:0	18:1	18:2	18:3	20:1	22:1
	------------------	------------------	------------------	%	------------------	------------------	------------------
93HN.18	3.4	2.7	65.5	16.6	6.5	1.9	1.2
93HN.19	3.6	2.3	65.5	17.2	6.4	1.9	1.0
93HN.110	3.7	2.4	55.2	17.7	7.2	4.9	5.6
95HN.2571	2.8	1.1	16.2	14.4	6.6	7.9	43.9
95HN.2572	3.1	1.0	15.2	15.0	8.0	7.9	42.0
95HN.2573	2.8	0.9	15.1	13.4	8.2	8.5	43.9
95HN.2574	2.8	1.2	18.2	13.3	7.1	9.6	41.6
95HN.2575	2.6	1.2	16.0	11.6	6.8	7.8	47.6
95HN.2576	3.2	1.3	23.0	14.7	6.6	12.3	33.3
95HN.2577	2.9	1.2	21.3	13.8	7.5	11.2	36.4
95HN.2578	2.8	1.0	17.7	15.2	7.3	9.7	39.5
95HN.2579	2.8	1.2	20.2	14.9	5.7	10.1	38.9
95HN.25710	3.1	1.2	19.7	14.2	7.1	11.3	37.1
95HN.41131	2.5	1.3	18.5	10.7	5.9	9.6	45.4
95HN.41132	2.6	1.2	18.2	12.5	6.7	10.1	42.2
95HN.41133	2.8	1.1	14.5	12.8	7.2	7.9	46.4
95HN.41134	2.8	1.3	15.4	12.5	6.6	8.4	46.0
95HN.41135	2.4	1.1	17.9	11.4	6.4	9.6	45.2
95HN.41136	2.4	1.2	20.1	10.6	6.6	9.4	44.4
95HN.41137	2.6	1.1	14.6	11.6	7.5	7.5	47.9
95HN.41138	2.6	1.1	15.1	11.7	8.3	8.8	45.5
95HN.41139	2.5	1.1	16.1	11.5	8.1	9.3	45.1
95HN.411310	2.5	1.3	17.9	11.5	6.5	9.8	44.3
95HN.2111	3.6	1.3	24.5	14.3	6.7	13.8	30.6
95HN.2112	3.8	1.6	34.5	16.9	7.5	12.5	18.6
95HN.2113	3.7	1.4	28.3	15.3	6.2	14.3	26.4
95HN.2114	3.4	1.3	27.0	13.2	7.6	13.3	28.7
95HN.2115	3.5	1.2	20.5	13.5	6.9	13.3	35.3
95HN.2116	4.0	1.6	50.7	18.6	7.9	6.4	8.1
95HN.2117	3.3	1.3	21.4	13.6	5.5	12.8	36.0
95HN.2118	3.5	1.5	29.7	13.6	6.0	12.8	28.3
95HN.2119	3.7	1.6	33.9	15.8	7.8	12.5	20.5
95HN.21110	3.4	1.4	22.1	15.1	4.7	11.3	35.6

Table 3. Glucosinolate concentration in seed meal of spring-type interspecific hybrids 1999/2000, estimated using the Testape procedure, where high rating relates to glucosinolate content.

Identifier	Gluc. content (0-5, 5 = high)	Identifier	Gluc. content (0-5, 5 = high)	Identifier	Gluc content (0-5, 5 = high)
Cascade	0.5	Bridger	2	Dwarf Essex	4
95HN.237.1	3	95HN.237.2	4	95HN.237.3	4
95HN.237.4	3	95HN.237.5	3	95HN.237.6	3
95HN.237.7	4	95HN.237.8	4	95HN.414.1	1
95HN.414.2	2	95HN.414.3	2	95HN.414.4	2
95HN.414.5	1.5	95HN.414.6	1.5	95HN.414.7	2
95HN.414.8	2	95HN.414.9	2	95HN.414.10	2
95HN.4111.1	3	95HN.4111.2	2.5	95HN.4111.3	3
95HN.4111.4	2	95HN.4111.5	1.5	95HN.4111.6	3
95HN.4111.7	2	95HN.4111.8	3	95HN.4111.9	3
95HN.4111.10	3	95HN.224.1	3	95HN.224.2	3
95HN.224.3	3	95HN.224.4	3	95HN.224.5	3
95HN.224.6	3	95HN.224.7	3	95HN.224.8	3
95HN.224.9	3	95HN.224.10	3	95HN.4116.1	2
95HN.4116.2	2	95HN.4116.3	2	95HN.4116.4	2.5
95HN.4116.5	3	95HN.4116.6	2.5	95HN.4116.7	3
95HN.4116.8	2.5	95HN.4116.9	3	95HN.4116.10	4
95HN.4115.1	2.5	95HN.4115.2	3	95HN.4115.3	3
95HN.4115.4	3	95HN.4115.5	2	95HN.4115.6	2.5
95HN.4115.7	2	95HN.4115.8	2.5	95HN.4115.9	3
95HN.4115.10	3	95HN.239.1	2.5	95HN.239.2	3
95HN.239.3	2.5	95HN.239.4	3	95HN.239.5	2.5
95HN.239.6	2.5	95HN.239.7	3	95HN.239.8	2.5
95HN.239.9	2.5	95HN.239.10	2.5	95HN.418.1	2.5
95HN.418.2	3	95HN.418.4	2	95HN.418.5	2.5
95HN.418.6	2.5	95HN.418.7	1.5	95HN.418.8	1.5
95HN.418.9	2.5	95HN.418.10	2.5	95HN.217.1	4
95HN.217.2	4.5	95HN.217.3	5	95HN.217.4	4
95HN.217.5	4	95HN.217.6	4	95HN.217.7	4
95HN.217.8	4.5	95HN.217.9	4.5	95HN.217.10	4
95HN.415.1	3	95HN.415.2	2	95HN.415.3	2
95HN.415.4	2	95HN.415.5	2	95HN.415.6	2.5
95HN.415.7	2.5	95HN.415.8	2.5	95HN.415.9	2.5
95HN.415.10	2	95HN.214.1	4.5	95HN.214.2	5

Table 3. Glucosinolate concentration in seed meal of spring-type interspecific hybrids 1999/2000, estimated using the Testape procedure, where high rating relates to glucosinolate content (continued).

Identifier	Gluc. content (0-5, 5 = high)	Identifier	Gluc. content (0-5, 5 = high)	Identifier	Gluc content (0-5, 5 = high)
95HN.214.3	5	95HN.214.4	5	95HN.214.5	4.5
95HN.214.6	5	95HN.214.7	5	95HN.214.8	4.5
95HN.214.9	4.5	95HN.214.10	4.5	95HN.227.1	4
95HN.227.2	4	95HN.227.3	3	95HN.227.4	4.5
95HN.227.5	4.5	95HN.227.6	5	95HN.227.7	5
95HN.227.8	3	95HN.227.9	4	95HN.227.10	4
95HN.212.1	5	95HN.212.2	5	95HN.212.3	4
95HN.212.4	4.5	95HN.212.5	5	95HN.212.6	5
95HN.212.7	5	95HN.212.8	4.5	95HN.212.9	4.5
95HN.212.10	4.5	95HN411.1	2	Infill	*
95HN411.2	2.5	95HN411.3	2	95HN411.4	2.5
95HN411.5	2	95HN411.6	3	95HN411.7	2.5
95HN411.8	2.5	95HN411.9	2.5	95HN411.10	1.5
95HN12.1	3	95HN12.2	3	95HN12.3	3
95HN12.4	4	95HN12.5	2.5	95HN12.6	5
95HN12.7	5	95HN12.8	5	95HN12.9	3
95HN12.10	3	95HN235.1	3	95HN235.2	3
95HN235.3	3	95HN235.4	3	95HN235.5	3
95HN235.6	3	95HN235.7	3	95HN235.8	4.5
95HN235.9	3	95HN235.10	4	95HN4110.1	2
95HN4110.2	2	95HN4110.3	2	95HN4110.4	2
95HN4110.5	2	95HN4110.6	5	95HN4110.7	1.5
95HN4110.8	2	95HN4110.9	2	95HN4110.10	1.5
95HN232.1	2	95HN232.2	2	95HN232.3	2
95HN232.4	2	95HN232.5	4	95HN232.6	3
95HN232.7	4	95HN232.8	2	95HN232.9	2
95HN232.10	3	95HN419.1	3	95HN419.2	3
95HN419.3	2.5	95HN419.4	3	95HN419.5	2.5
95HN419.6	3	95HN419.7	3.5	95HN419.8	3
95HN419.9	4	95HN419.10	4	95HN231.1	3
95HN231.2	3	95HN231.3	3	95HN231.4	4
95HN231.5	3	95HN231.6	2	95HN231.7	2
95HN231.8	2	95HN231.9	4	95HN231.10	3
94HN23.1	5	94HN23.2	5	94HN23.3	5
94HN23.4	5	94HN23.5	5	94HN23.6	5

Table 3. Glucosinolate concentration in seed meal of spring-type interspecific hybrids 1999/2000, estimated using the Testape procedure, where high rating relates to glucosinolate content (continued).

Identifier	Gluc. content (0-5, 5 = high)	Identifier	Gluc. content (0-5, 5 = high)	Identifier	Gluc content (0-5, 5 = high)
94HN23.7	5	94HN23.8	5	94HN23.9	5
94HN23.10	5	95HN413.1	3	95HN413.2	3
95HN413.3	3.5	95HN413.4	2	95HN413.5	2.5
95HN413.6	2	95HN413.7	2	95HN413.8	1.5
95HN413.9	1.5	95HN413.10	2.5	95HN257.1	3
95HN257.2	3	95HN257.3	4.5	95HN257.4	2
95HN257.5	3	95HN257.6	2	95HN257.7	4
95HN257.8	4	95HN257.9	2	95HN257.10	4
93HN1.1	4	93HN1.2	1.5	93HN1.3	2
93HN1.4	1.5	93HN1.5	2	93HN1.6	2.5
93HN1.7	2	93HN1.8	1.5	93HN1.9	1.5
93HN1.10	5	95HN516.1	3	95HN516.2	2
95HN516.3	3.5	95HN516.4	3	95HN516.5	*
95HN516.6	*	95HN516.7	*	95HN516.8	*
95HN516.9	*	95HN516.10	*	95HN416.1	2
95HN416.2	3	95HN416.3	2.5	95HN416.4	2
95HN416.5	1.5	95HN416.6	3	95HN416.7	2
95HN416.8	2.5	95HN416.9	1.5	95HN416.10	3
95HN4119.1	1	95HN4119.2	1	95HN4119.3	1
95HN4119.4	1.5	95HN4119.5	1	95HN4119.6	2.5
95HN4119.7	2	95HN4119.8	2	95HN4119.9	2
95HN4119.10	2	96HN1.1	2.5	96HN1.2	2.5
96HN1.3	3	96HN1.4	3	96HN1.5	3
96HN1.6	1.5	96HN1.7	3	96HN1.8	3
96HN1.9	2	96HN1.10	1.5	95HN211.1	3
95HN211.2	4.5	95HN211.3	4.5	95HN211.4	2.5
95HN211.5	4	95HN211.6	4.5	95HN211.7	4
95HN211.8	4	95HN211.9	4.5	95HN211.10	4
95HN4118.1	2	95HN4118.2	2	95HN4118.3	1.5
95HN4118.4	2.5	95HN4118.5	3	95HN4118.6	2.5
95HN4118.7	2.5	95HN4118.8	3	95HN4118.9	3
95HN4118.10	2	95HN2310.1	2	95HN2310.2	3
95HN2310.3	3.5	95HN2310.4	1.5	95HN2310.5	3
95HN2310.6	2.5	95HN2310.7	3	95HN2310.8	2.5
95HN2310.9	3	95HN2310.10	3	95HN4113.1	3

Table 3. Glucosinolate concentration in seed meal of spring-type interspecific hybrids 1999/2000, estimated using the Testape procedure, where high rating relates to glucosinolate content (continued).

Identifier	Gluc. content (0-5, 5 = high)	Identifier	Gluc. content (0-5, 5 = high)	Identifier	Gluc content (0-5, 5 = high)
95HN4113.2	1.5	95HN4113.3	3	95HN4113.4	2
95HN4113.5	3	95HN4113.6	3.5	95HN4113.7	3
95HN4113.8	3.5	95HN4113.9	3	95HN4113.10	3

Table 4. Plant morphology and seed yield of spring-type interspecific hybrids in 2000.

Identifier	Seed Yield (g/plot)	Plant Estab. (1-9)	Flower Start (days)	Flower Duration (days)	Flower End (days)	Plant Height (cm)	Leaf[1] Type (1-9)	Bud[1] Type (1-9)	Pod[2] Type (1-9)	Harvest[3] Type (1-3)
O34535	79.05	7.50	32.00	30.50	62.50	120.00	9.00	9.00	1.00	3.00
O34535	75.16	7.00	33.00	30.50	63.50	110.00	9.00	9.00	1.00	3.00
CYCLONE	55.70	4.50	43.00	23.00	66.00	125.00	2.50	1.00	9.00	1.00
CYCLONE	97.08	5.50	43.00	24.00	67.00	120.00	2.00	1.00	9.00	1.00
IDAGOLD	90.18	6.50	33.00	30.50	63.50	110.00	9.00	9.00	1.00	3.00
UI.7012	71.01	6.50	33.00	28.00	61.00	110.00	9.00	9.00	1.00	3.00
HYOLA.401	58.74	5.50	35.00	27.00	62.00	90.00	3.00	1.00	8.00	1.00
HELIOS	35.77	5.50	47.00	19.00	66.00	135.00	1.00	5.00	9.00	1.00
P.GOLD	90.83	5.50	35.00	29.50	64.50	125.00	8.50	9.00	7.00	2.00
HYSYN.110	59.26	5.00	32.00	28.50	60.50	105.00	6.50	*	7.00	1.00
GOLDRUSH	137.29	6.50	31.00	28.00	59.00	115.00	8.50	*	7.00	1.00
F1.MMM.1	5.14	3.00	40.00	26.00	66.00	110.00	8.00	8.00	7.00	3.00
F1.MMM.2	30.70	5.00	40.00	28.00	68.00	145.00	6.00	6.50	6.00	3.00
F1.MMM.3	18.37	5.00	39.00	29.00	68.00	150.00	8.50	6.50	6.00	3.00
F1.MMM.4	6.67	3.00	40.00	28.00	68.00	120.00	9.00	5.00	5.00	3.00
F1.MMM.5	15.00	5.00	38.00	30.00	68.00	120.00	9.00	7.00	3.00	3.00
F1.MMM.6	12.75	5.50	36.00	32.00	68.00	115.00	8.00	6.00	6.00	3.00
F1.MMM.7	23.33	5.50	39.00	28.00	67.00	130.00	8.50	7.00	7.00	2.50
F1.MMM.8	13.78	5.00	40.00	28.00	68.00	130.00	7.00	5.00	5.00	2.00
F2.CCC.1	117.48	6.50	41.00	26.00	67.00	115.00	1.00	2.50	9.00	1.00
F2.CCC.2	65.28	6.50	42.00	25.00	67.00	125.00	1.00	3.00	9.00	1.00
F2.CCC.3	49.67	6.00	42.00	25.00	67.00	136.50	1.00	2.50	8.00	1.00
F2.CCC.4	80.11	6.00	40.00	26.00	66.00	125.00	1.00	2.50	9.00	1.00
F2.CCC.5	197.07	7.00	43.00	24.00	67.00	130.00	1.00	2.50	9.00	1.00
F2.CCM.1	40.85	6.50	46.00	21.00	67.00	110.00	1.00	4.50	8.00	1.00
F2.CCM.2	62.45	5.00	45.00	22.00	67.00	115.00	1.00	3.00	8.00	1.00
F2.CCM.3	59.57	5.50	42.00	24.00	66.00	110.00	3.00	4.50	7.00	1.00
F2.CCM.4	67.59	6.00	43.00	23.00	66.00	130.00	1.00	4.00	8.00	1.00
F2.CCM.5	66.09	5.50	43.00	23.00	66.00	130.00	1.50	2.50	9.00	1.00
F2.CMM.1	18.66	6.00	39.00	30.00	69.00	150.00	3.50	5.50	6.00	3.00
F2.CMM.2	19.58	1.00	44.00	22.00	66.00	110.00	1.00	1.00	7.00	1.00
F2.CMM.3	29.47	2.00	50.00	21.00	71.00	150.00	4.00	7.00	7.00	1.00
F2.MCM.1	42.99	6.00	44.00	24.00	68.00	135.00	2.00	3.00	8.00	1.00
F2.MMM.9	10.95	4.00	41.00	27.00	68.00	120.00	9.00	6.50	5.00	3.00
F2.MMM.10	10.58	3.50	41.00	28.50	69.50	145.00	6.50	7.50	6.00	2.00
F2.MMM.11	11.85	4.00	41.00	27.00	68.00	130.00	8.00	6.00	3.50	3.00
F2.MMM.12	24.17	5.00	41.00	28.00	69.00	145.00	8.50	5.00	6.00	3.00
F2.MMM.13	22.50	6.50	39.00	28.00	67.00	135.00	8.00	7.00	4.00	3.00
F3.CCC.6	49.30	4.50	43.00	25.00	68.00	120.00	1.00	2.00	9.00	1.00
F3.CCC.7	85.71	6.00	43.00	21.50	64.50	135.00	2.50	2.50	8.00	1.00
F3.CCC.8	89.36	6.50	41.00	25.00	66.00	130.00	2.00	4.00	9.00	1.00
F3.CCC.9	107.06	6.50	41.00	23.50	64.50	120.00	1.00	3.00	9.00	1.00
F3.CCC.10	51.30	5.00	43.00	23.00	66.00	110.00	1.00	3.00	9.00	1.00
F3.CCM.6	49.33	2.00	48.00	20.00	68.00	130.00	1.00	2.00	9.00	1.00
F3.CCM.7	77.07	5.50	42.00	22.00	64.00	110.00	1.00	3.50	9.00	1.00

[1] 1 = like canola; 9 = like mustard, [2] 1 = like mustard; 9 = like canola, [3] 1 = like mustard; 3 = like canola.

Table 4. Plant morphology and seed yield of spring-type interspecific hybrids in 2000 (continued).

Identifier	Seed Yield (g/plot)	Plant Estab. (1-9)	Flower Start (days)	Flower Duration (days)	Flower End (days)	Plant Height (cm)	Leaf[1] Type (1-9)	Bud[1] Type (1-9)	Pod[2] Type (1-9)	Harvest[3] Type (1-3)
F3.CCM.8	28.93	5.00	43.00	23.00	66.00	105.00	3.00	5.00	8.00	1.50
F3.CCM.9	51.26	6.00	45.00	22.00	67.00	140.00	2.00	3.50	7.00	2.00
F3.CCM.10	47.92	6.00	41.00	25.00	66.00	140.00	4.00	5.00	7.00	1.50
F3.CMM.14	23.19	2.00	39.00	27.00	66.00	115.00	8.50	6.00	6.00	2.50
F3.CMM.15	16.45	4.00	40.00	27.00	67.00	125.00	9.00	6.50	5.00	2.50
F3.CMM.4	23.40	5.00	38.00	28.00	66.00	125.00	9.00	6.00	6.00	2.50
F3.CMM.5	27.08	4.50	40.00	27.00	67.00	125.00	2.50	5.00	7.00	2.00
F3.CMM.6	67.91	6.00	42.00	26.00	68.00	140.00	4.50	5.00	7.00	2.00
F3.CMM.7	61.18	5.00	41.00	26.00	67.00	125.00	4.00	6.00	7.00	1.50
F3.CMM.8	93.66	6.50	42.00	25.00	67.00	145.00	5.00	5.50	6.00	2.00
F3.CMM.9	48.15	4.00	43.00	25.00	68.00	135.00	3.50	5.50	7.00	1.50
F3.CMM.10	51.11	5.50	44.00	22.00	66.00	130.00	2.00	6.00	8.00	1.50
F3.CMM.11	60.62	5.50	41.00	24.00	65.00	120.00	3.00	3.50	8.00	1.50
F3.CMM.12	15.18	4.00	41.00	29.00	70.00	155.00	6.00	6.00	7.00	3.00
F3.CMM.13	31.86	3.00	40.00	28.00	68.00	150.00	7.50	6.00	6.00	2.00
F3.MCM.2	41.20	6.00	43.00	23.00	66.00	130.00	5.00	5.00	8.00	1.50
F3.MCM.3	44.64	5.50	45.00	23.00	68.00	125.00	3.00	5.00	7.00	1.00
F3.MMM.14	12.50	3.00	38.00	30.00	68.00	120.00	1.00	7.00	5.00	2.00
F3.MMM.15	7.50	4.00	40.00	28.00	68.00	120.00	9.00	5.00	5.00	3.00
F3.MMM.16	10.42	3.00	38.00	30.00	68.00	120.00	9.00	5.00	5.00	3.00
F3.MMM.17	26.25	5.00	40.00	30.00	70.00	140.00	9.00	7.00	7.00	3.00
F3.MMM.18	30.83	5.00	40.00	27.00	67.00	140.00	9.00	6.50	5.00	3.00
F4.CCC.11	76.87	4.50	44.00	24.00	68.00	150.00	1.00	3.50	7.00	1.50
F4.CCC.12	39.72	6.00	47.00	20.00	67.00	125.00	1.00	2.50	9.00	1.50
F4.CCC.13	82.50	6.50	43.00	21.50	64.50	125.00	1.00	3.00	8.00	1.00
F4.CCC.14	110.83	5.50	44.00	21.00	65.00	115.00	2.50	3.00	8.00	1.00
F4.CCC.15	67.89	6.00	42.00	21.50	63.50	110.00	1.00	2.00	9.00	1.00
F4.CCM.10	63.91	4.00	42.00	24.00	66.00	130.00	2.00	5.00	9.00	1.00
F4.CMC.4	103.75	6.00	42.00	20.50	62.50	115.00	1.00	5.00	9.00	1.00
F4.CMC.1	84.75	5.50	42.00	23.50	65.50	120.00	1.00	3.00	9.00	1.00
F4.CMC.2	66.67	5.00	44.00	22.00	66.00	125.00	3.00	6.00	8.00	1.00
F4.CMC.3	41.30	5.00	44.00	24.00	68.00	135.00	3.00	3.50	8.00	1.00
F4.CMM.16	77.38	5.00	42.00	25.00	67.00	135.00	3.00	4.50	8.00	1.50
F4.CMM.17	74.81	6.00	40.00	26.00	66.00	130.00	3.00	5.50	7.00	1.50
F4.CMM.18	20.17	3.50	41.00	25.00	66.00	115.00	4.00	6.50	6.00	2.00
F4.CMM.19	37.73	5.00	42.00	25.00	67.00	150.00	1.00	4.00	7.00	1.50
F4.MCM.4	71.33	6.50	43.00	24.00	67.00	135.00	1.00	5.00	9.00	1.00
F4.MMM.19	24.87	5.00	42.00	24.00	66.00	135.00	4.00	5.00	5.00	2.00
F4.MMM.20	25.31	5.00	42.00	26.00	68.00	160.00	7.00	6.00	5.00	3.00
F4.MMM.21	11.67	4.50	41.00	27.00	68.00	160.00	8.00	7.00	4.00	3.00
F4.MMM.22	15.00	5.00	40.00	28.00	68.00	135.00	7.00	7.00	5.00	3.00
F4.MMM.23	*	*	*	*	*	*	*	*	*	*
F5.CCC.16	52.00	6.00	47.00	22.00	69.00	125.00	1.00	2.00	8.00	1.00
F5.CCC.17	106.31	6.00	39.00	26.00	65.00	115.00	2.00	2.50	9.00	1.00
F5.CCC.18	79.18	6.00	44.00	24.00	68.00	140.00	1.00	3.00	9.00	1.00
F5.CCC.19	46.88	6.00	46.00	22.00	68.00	120.00	1.00	2.50	9.00	4.00

[1] 1 = like canola; 9 = like mustard, [2] 1 = like mustard; 9 = like canola, [3] 1 = like mustard; 3 = like canola.

Table 4. Plant morphology and seed yield of spring-type interspecific hybrids in 2000 (continued).

Identifier	Seed Yield (g/plot)	Plant Estab. (1-9)	Flower Start (days)	Flower Duration (days)	Flower End (days)	Plant Height (cm)	Leaf[1] Type (1-9)	Bud[1] Type (1-9)	Pod[2] Type (1-9)	Harvest[3] Type (1-3)
F5.CCC.20	56.44	6.50	42.00	25.00	67.00	110.00	2.00	2.50	9.00	1.00
F5.CCM.11	95.54	7.00	42.00	24.00	66.00	135.00	1.50	3.50	9.00	1.00
F5.CCM.12	69.19	6.00	41.00	23.00	64.00	130.00	1.50	4.00	9.00	1.00
F5.CCM.13	67.50	5.50	42.00	23.00	65.00	115.00	1.00	4.50	8.00	1.00
F5.CMC.5	67.47	5.00	45.00	21.00	66.00	140.00	1.00	4.00	7.00	1.00
F5.CMC.6	51.53	6.00	42.00	24.00	66.00	140.00	1.00	5.00	9.00	1.00
F5.CMM.20	50.52	5.00	40.00	26.00	66.00	125.00	2.00	4.00	6.00	1.50
F5.CMM.22	58.32	6.00	43.00	24.00	67.00	125.00	3.50	5.00	7.00	1.50
F5.CMM.23	65.45	6.00	39.00	25.00	64.00	125.00	4.00	3.50	9.00	1.00
Standard Error	24.95	0.51	0.86	-	0.92	8.82	1.16	0.81	0.63	0.44

[1] 1 = like canola; 9 = like mustard, [2] 1 = like mustard; 9 = like canola, [3] 1 = like mustard; 3 = like canola.

Table A5. Glucosinolate concentration (TesTape) and fatty acid profile of control cultivars and interspecific spring-type hybrids grown in replicated yield trials 2000.

Identifier	Glucs. (TTape) (0-5)	16:0§	18:0	18:1	18:2	18:3	20:1	22:1
			-------------------	%	------------------------			
O34535	4.50	2.25	1.05	26.75	8.45	9.10	10.80	36.35
O34535	5.00	2.35	1.05	26.90	9.15	9.10	10.15	35.75
CYCLONE	2.00	3.55	1.75	61.75	19.55	9.70	1.55	0.30
CYCLONE	2.25	3.65	1.75	61.00	19.65	9.90	1.75	1.10
IDAGOLD	5.00	2.20	1.00	25.05	8.90	9.05	9.95	37.95
UI.7012	3.75	2.35	1.15	35.00	9.10	10.55	10.90	26.45
HYOLA.401	2.00	3.50	2.70	66.10	15.70	7.65	1.75	1.20
HELIOS	2.50	3.75	1.75	63.35	19.95	8.55	1.20	*
P.GOLD	5.00	2.45	1.55	22.60	18.70	11.30	12.75	24.70
HYSYN.110	*	3.20	1.70	57.80	21.80	11.50	1.50	0.80
GOLDRUSH	*	3.10	1.85	60.50	20.50	10.50	1.25	0.80
F1.MMM.1	5.00	2.90	2.00	42.40	14.60	8.60	11.40	14.60
F1.MMM.2	5.00	3.30	2.20	43.05	16.20	8.70	9.45	13.60
F1.MMM.3	5.00	3.10	2.00	38.75	15.65	8.80	11.35	16.55
F1.MMM.4	4.50	3.30	2.00	40.90	14.80	8.50	11.00	15.80
F1.MMM.5	5.00	3.10	2.10	38.70	14.00	8.00	12.30	18.30
F1.MMM.6	5.00	3.10	2.15	36.50	14.55	8.30	12.60	18.60
F1.MMM.7	4.75	3.00	1.95	35.55	14.80	8.45	12.20	19.60
F1.MMM.8	5.00	3.00	2.40	39.10	14.00	7.30	12.80	17.00
F2.CCC.1	2.50	3.10	2.15	63.25	18.75	8.30	1.60	0.80
F2.CCC.2	1.75	3.50	2.25	62.40	19.00	8.50	1.65	1.20
F2.CCC.3	2.75	3.30	2.20	61.70	18.00	9.45	2.10	1.00
F2.CCC.4	2.50	3.55	2.20	61.70	19.10	8.25	2.15	0.80
F2.CCC.5	2.50	3.80	2.20	65.05	17.35	7.95	1.45	0.20
F2.CCM.1	3.25	3.35	1.95	63.50	16.55	7.65	3.10	1.90
F2.CCM.2	2.50	3.50	2.05	63.70	17.70	8.20	1.80	2.00
F2.CCM.3	2.50	3.25	1.95	57.90	19.40	8.65	3.40	3.30
F2.CCM.4	3.00	3.30	1.95	64.10	18.60	8.05	1.70	0.80
F2.CCM.5	2.75	3.20	2.25	60.25	18.10	8.35	3.05	2.55
F2.CMM.1	5.00	3.10	1.90	37.55	15.05	8.15	11.60	18.45
F2.CMM.2	4.00	3.40	1.80	48.70	20.60	10.80	5.80	6.50
F2.CMM.3	5.00	3.50	1.70	29.40	18.30	9.30	3.50	2.50

§ 16:1 = palmitic acid; 18:0 = stearic acid; 18:1 = oleic acid; 18:2 = linoleic acid; 18:3 = linolenic acid; 20:1 = eicosenoic acid; 22:1 = erucic acid.

Table A5. Glucosinolate concentration (TesTape) and fatty acid profile of control cultivars and interspecific spring-type hybrids grown in replicated yield trials 2000 (continued).

Identifier	Glucs. (TTape) (0-5)	16:0[§]	18:0	18:1	18:2	18:3	20:1	22:1
			------------------- % ------------------------					
F2.MCM.1	2.75	3.30	2.05	63.50	18.55	8.85	1.50	0.20
F2.MMM.9	4.50	3.10	1.75	41.25	15.70	9.80	10.35	14.65
F2.MMM.10	5.00	3.05	2.00	36.20	15.70	8.45	11.35	18.85
F2.MMM.11	5.00	2.95	2.05	38.10	14.60	7.80	11.50	18.90
F2.MMM.12	5.00	3.25	1.95	35.65	15.15	8.70	12.00	18.85
F2.MMM.13	4.75	2.95	1.75	32.75	14.25	8.90	12.85	21.90
F3.CCC.6	2.50	3.45	2.20	62.10	19.10	8.70	1.70	0.90
F3.CCC.7	2.25	3.55	2.35	66.40	16.60	6.90	1.75	0.65
F3.CCC.8	2.00	3.70	2.40	60.95	20.75	8.65	1.40	*
F3.CCC.9	2.25	3.35	1.70	60.70	20.15	8.95	2.00	1.05
F3.CCC.10	2.25	3.45	1.80	61.50	20.70	8.55	1.70	0.40
F3.CCM.6	4.00	3.40	1.60	61.10	20.50	10.10	1.40	*
F3.CCM.7	2.50	3.45	2.05	64.25	15.80	6.90	3.45	2.20
F3.CCM.8	3.00	3.80	2.55	58.30	21.60	8.55	1.85	1.15
F3.CCM.9	2.75	3.70	1.85	61.75	17.65	8.80	2.65	1.65
F3.CCM.10	3.50	3.30	2.20	55.95	17.15	7.70	5.70	5.70
F3.CMM.14	5.00	3.25	2.00	35.00	15.90	8.10	12.10	19.20
F3.CMM.15	4.50	3.10	1.85	40.75	15.45	8.15	10.80	16.00
F3.CMM.4	5.00	2.95	2.00	37.70	15.00	8.70	11.95	17.80
F3.CMM.5	3.75	3.35	1.90	46.90	16.95	8.70	8.50	10.70
F3.CMM.6	4.25	3.30	1.85	53.70	17.45	9.65	5.15	6.55
F3.CMM.7	4.00	3.55	1.65	36.35	15.90	8.75	10.30	19.15
F3.CMM.8	3.50	3.40	2.05	56.45	16.95	8.45	4.95	5.70
F3.CMM.9	3.50	3.80	2.20	58.10	18.80	8.60	3.45	2.75
F3.CMM.10	2.75	4.00	2.20	54.95	18.70	8.85	4.15	5.00
F3.CMM.11	4.00	3.30	2.05	57.25	17.35	8.45	4.80	4.60
F3.CMM.12	4.50	3.00	1.80	33.80	14.35	9.00	12.15	21.40
F3.CMM.13	4.50	3.55	2.25	42.50	16.00	8.75	10.75	12.45
F3.MCM.2	3.75	3.45	2.05	57.70	17.45	8.50	4.65	4.15
F3.MCM.3	4.00	3.35	1.75	49.00	17.15	8.85	8.35	8.95
F3.MMM.14	5.00	3.40	1.90	43.30	18.10	9.80	9.20	11.00
F3.MMM.15	4.50	3.20	2.10	36.00	13.90	7.80	13.20	19.60
F3.MMM.16	5.00	3.10	1.90	41.00	15.60	8.80	11.40	14.80
F3.MMM.17	4.50	3.10	1.80	34.50	14.70	8.50	12.50	20.10

Table A5. Glucosinolate concentration (TesTape) and fatty acid profile of control cultivars and interspecific spring-type hybrids grown in replicated yield trials 2000 (continued).

Identifier	Glucs. (TTape) (0-5)	16:0§	18:0	18:1	18:2	18:3	20:1	22:1
			------------------- % ------------------------					
F3.MMM.18	4.75	3.20	1.70	45.25	17.25	9.35	8.55	11.70
F4.CCC.11	2.50	3.90	1.90	60.40	18.90	9.65	2.05	1.35
F4.CCC.12	2.75	3.15	1.95	61.35	18.00	9.35	2.55	1.70
F4.CCC.13	2.75	3.65	2.20	66.70	17.25	6.70	1.40	0.30
F4.CCC.14	2.00	3.60	2.00	65.75	17.60	7.55	1.35	0.40
F4.CCC.15	2.75	3.60	2.15	66.85	17.05	7.05	1.30	0.20
F4.CCM.10	3.25	3.65	2.15	61.85	18.65	8.30	2.00	1.05
F4.CMC.4	2.25	3.05	1.75	46.60	14.80	7.35	12.55	11.35
F4.CMC.1	2.75	3.40	2.05	60.60	18.75	8.65	2.85	1.50
F4.CMC.2	3.00	3.30	1.80	57.10	18.30	8.80	4.70	3.90
F4.CMC.3	2.50	3.50	2.05	56.40	18.25	8.65	4.50	4.60
F4.CMM.16	3.75	3.40	1.85	53.30	18.25	9.35	5.40	6.05
F4.CMM.17	3.25	3.60	2.10	52.70	17.45	8.50	6.30	6.70
F4.CMM.18	3.50	3.30	2.00	52.60	18.05	9.45	5.65	6.40
F4.CMM.19	2.75	3.45	3.50	56.35	17.50	9.80	4.50	4.10
F4.MCM.4	2.50	3.60	1.95	63.75	18.15	8.25	1.60	1.00
F4.MMM.19	4.50	3.15	1.80	42.45	16.80	8.60	9.85	14.30
F4.MMM.20	5.00	3.50	2.00	43.50	14.10	8.40	9.30	15.30
F4.MMM.21	4.50	3.20	1.90	35.25	15.50	9.10	11.95	18.85
F4.MMM.22	5.00	3.30	2.00	40.85	15.70	8.30	26.95	15.70
F4.MMM.23	*	*	*	*	*	*	*	*
F5.CCC.16	2.50	3.20	1.75	61.70	19.50	9.50	1.85	0.45
F5.CCC.17	2.25	3.55	1.95	63.15	18.10	8.75	2.00	1.00
F5.CCC.18	2.50	3.70	2.60	62.65	18.05	7.90	2.05	0.90
F5.CCC.19	2.00	3.60	2.10	62.05	19.00	8.50	1.95	1.50
F5.CCC.20	2.50	3.50	2.00	63.00	18.35	8.80	1.80	0.65
F5.CCM.11	2.75	3.35	2.05	63.75	16.20	8.10	2.30	2.25
F5.CCM.12	2.25	3.75	2.45	62.10	19.00	8.45	1.70	0.40
F5.CCM.13	2.75	3.55	1.95	62.40	19.45	7.90	2.00	0.80
F5.CMC.5	2.50	3.35	1.90	59.05	18.50	9.00	3.60	2.70
F5.CMC.6	2.25	3.00	2.20	60.15	17.85	8.35	3.55	2.80

Table A5. Glucosinolate concentration (TesTape) and fatty acid profile of control cultivars and interspecific spring-type hybrids grown in replicated yield trials 2000 (continued).

Identifier	Glucs. (TTape) (0-5)	16:0§	18:0	18:1	18:2	18:3	20:1	22:1
			-------------------	%	------------------------			
F5.CMM.20	4.00	2.95	1.80	40.65	15.90	9.05	10.25	16.00
F5.CMM.22	2.75	3.35	1.80	61.55	16.55	8.40	3.75	2.65
F5.CMM.23	2.75	3.00	1.55	35.65	14.90	8.60	12.70	19.90
Standard Error	0.34	0.12	0.20	2.12	0.77	0.45	2.09	1.91

Table 6a. Glucosinolate profile of spring interspecific hybid lines.

Identifier	ALLYL[§]	3-BUT	4-PENT	2HY3-BU	2HY4-PE	4-MTB
O34535	0.15	0.00	0.00	8.35	0.00	0.00
O34535	0.00	0.00	0.00	7.65	0.00	0.00
CYCLONE	0.00	2.00	0.30	3.35	0.10	0.10
CYCLONE	0.00	2.70	0.40	5.55	0.10	0.10
IDAGOLD	0.00	0.00	0.00	8.15	0.00	0.00
UI.7012	0.00	0.35	0.00	20.05	0.00	0.00
HYOLA.401	0.00	2.45	0.45	6.85	0.20	0.00
HELIOS	0.05	3.30	0.35	9.80	0.05	0.40
P.GOLD	107.85	0.75	0.20	0.60	0.10	0.00
HYSYN.110	0.05	9.10	4.85	16.80	1.75	1.50
GOLDRUSH	5.95	12.60	6.85	11.85	1.50	3.70
F1.MMM.1	0.00	3.20	1.70	7.50	1.10	0.60
F1.MMM.2	0.10	7.50	0.80	24.30	0.35	0.20
F1.MMM.3	0.10	4.60	0.60	21.05	0.35	0.10
F1.MMM.4	3.05	6.20	1.15	19.55	0.55	0.10
F1.MMM.5	0.05	3.90	1.20	14.25	0.50	0.40
F1.MMM.6	0.10	3.75	0.55	19.70	0.35	0.10
F1.MMM.7	0.10	4.40	0.50	19.20	0.30	0.10
F1.MMM.8	0.05	4.55	2.15	15.80	0.90	0.10
F2.CCC.1	0.00	3.95	0.30	8.75	0.15	0.10
F2.CCC.2	0.00	3.50	0.30	5.25	0.00	0.05
F2.CCC.3	0.00	6.30	0.90	14.90	0.30	0.20
F2.CCC.4	0.00	5.05	0.65	10.15	0.05	0.00
F2.CCC.5	0.10	4.10	0.55	8.30	0.10	0.10
F2.CCM.1	0.05	10.25	2.40	25.05	0.60	0.00
F2.CCM.2	0.00	3.30	0.30	6.75	0.10	0.10
F2.CCM.3	0.10	3.50	0.30	8.50	0.10	0.00
F2.CCM.4	0.05	4.05	0.55	8.60	0.10	0.10
F2.CCM.5	0.05	4.40	0.30	9.90	0.10	0.10
F2.CMM.1	0.10	6.90	1.00	25.10	0.50	0.10
F2.CMM.2	0.00	8.40	2.25	15.00	0.65	0.60
F2.CMM.3	0.10	16.90	3.05	18.65	0.70	0.20
F2.MCM.1	0.00	3.30	0.20	6.65	0.10	0.10
F2.MMM.9	0.00	3.60	0.70	18.10	0.40	0.10
F2.MMM.10	0.10	3.15	0.30	18.55	0.25	0.15
F2.MMM.11	0.05	4.80	0.75	18.65	0.35	0.10

[§] ALLYL = 2-propenyl glucosinolate; 3-BUT = 3-butenyl glucosinolate; 4-PENT = 4-pentenyl glucosinolate; 2HY3BUT = 2-hydroxy-3-butenyl glucosinolate; 2HY4-PE = 2-hydroxy-4-pentenyl glucosinolate

Table 6a. Glucosinolate profile of spring interspecific hybid lines (continued).

Identifier	ALLYL§	3-BUT	4-PENT	2HY3-BU	2HY4-PE	4-MTB
F2.MMM.12	0.10	5.40	0.70	21.40	0.30	0.10
F2.MMM.13	0.10	5.45	0.85	23.85	0.40	0.10
F3.CCC.6	0.00	2.75	0.15	3.95	0.00	0.15
F3.CCC.7	0.00	2.55	0.20	4.25	0.05	0.10
F3.CCC.8	0.00	1.85	0.15	2.75	0.00	0.10
F3.CCC.9	0.00	2.95	0.25	5.60	0.00	0.25
F3.CCC.10	0.00	2.45	0.15	4.75	0.05	0.15
F3.CCM.6	0.05	8.60	2.10	18.30	0.95	0.25
F3.CCM.7	0.05	6.55	0.40	13.95	0.05	0.20
F3.CCM.8	0.00	4.95	0.45	12.85	0.15	0.25
F3.CCM.9	0.05	5.20	0.95	11.80	0.35	0.10
F3.CCM.10	0.70	5.50	0.65	10.15	0.15	0.15
F3.CMM.14	0.05	6.15	0.85	31.10	0.50	0.05
F3.CMM.15	0.00	9.60	1.30	35.50	0.60	0.00
F3.CMM.4	0.15	8.95	1.25	22.45	0.45	0.10
F3.CMM.5	0.05	7.95	0.85	20.05	0.25	0.10
F3.CMM.6	0.10	6.85	1.00	16.45	0.30	0.20
F3.CMM.7	0.10	7.10	0.90	11.90	0.20	0.20
F3.CMM.8	0.10	8.20	1.10	14.10	0.20	0.20
F3.CMM.9	0.05	6.30	0.75	14.50	0.25	0.20
F3.CMM.10	0.00	3.60	0.45	6.55	0.10	0.10
F3.CMM.11	0.05	10.45	1.25	18.60	0.35	0.40
F3.CMM.12	0.20	6.60	0.80	20.50	0.35	0.15
F3.CMM.13	0.15	8.50	0.95	26.10	0.50	0.20
F3.MCM.2	0.05	4.85	0.65	12.45	0.25	0.15
F3.MCM.3	0.05	12.15	1.30	18.80	0.30	0.35
F3.MMM.14	0.05	9.90	2.60	21.15	0.70	0.25
F3.MMM.15	0.05	5.50	2.05	23.70	1.15	0.40
F3.MMM.16	0.00	6.85	1.65	22.90	0.80	0.00
F3.MMM.17	0.00	5.50	2.80	6.00	0.60	0.00
F3.MMM.18	0.20	6.80	0.60	21.70	0.30	0.20
F4.CCC.11	0.00	3.35	0.40	5.80	0.10	0.15
F4.CCC.12	0.05	5.80	0.85	14.65	0.25	0.05
F4.CCC.13	0.05	2.50	0.25	6.00	0.05	0.10
F4.CCC.14	0.00	1.80	0.20	4.00	0.10	0.10
F4.CCC.15	0.05	4.45	0.30	9.35	0.05	0.05
F4.CCM.10	0.05	3.80	0.60	9.15	0.20	0.15
F4.CMC.4	0.02	4.75	0.35	9.00	0.05	0.05

Table 6a. Glucosinolate profile of spring interspecific hybid lines (continued).

Identifier	ALLYL§	3-BUT	4-PENT	2HY3-BU	2HY4-PE	4-MTB
F4.CMC.1	0.00	2.90	0.70	6.45	0.20	0.15
F4.CMC.2	0.00	4.10	0.90	10.80	0.30	0.10
F4.CMC.3	0.10	4.40	1.35	11.50	0.45	0.10
F4.CMM.16	0.05	5.65	0.65	10.30	0.15	0.20
F4.CMM.17	0.10	5.65	0.55	11.35	0.15	0.20
F4.CMM.18	0.10	4.80	0.50	8.90	0.10	0.10
F4.CMM.19	0.10	6.00	0.90	10.70	0.20	0.20
F4.MCM.4	0.00	1.65	0.25	4.15	0.10	0.10
F4.MMM.19	0.10	26.90	5.75	34.95	1.10	0.35
F4.MMM.20	*	*	*	*	*	*
F4.MMM.21	0.20	4.20	0.50	19.60	0.30	0.10
F4.MMM.22	0.10	3.75	0.50	18.40	0.35	0.10
F4.MMM.23	0.00	6.10	2.80	10.75	1.25	1.65
F5.CCC.16	0.10	3.65	0.50	11.10	0.30	0.10
F5.CCC.17	0.00	3.30	0.45	4.20	0.05	0.10
F5.CCC.18	0.00	3.60	0.30	5.50	0.00	0.10
F5.CCC.19	0.00	1.90	0.10	2.50	0.00	0.10
F5.CCC.20	0.05	4.70	0.50	10.55	0.20	0.10
F5.CCM.11	0.00	3.60	0.40	6.55	0.10	0.20
F5.CCM.12	0.00	2.95	0.15	7.05	0.10	0.10
F5.CCM.13	0.05	3.00	0.20	9.30	0.10	0.10
F5.CMC.5	0.00	3.55	0.25	6.00	0.10	0.15
F5.CMC.6	0.00	2.55	0.20	4.75	0.05	0.10
F5.CMM.20	0.05	12.05	1.90	21.40	0.60	0.30
F5.CMM.22	0.10	2.80	0.20	5.30	0.10	0.10
F5.CMM.23	0.00	4.40	0.50	9.80	0.10	0.20
Standard Error	0.73	1.51	0.48	3.89	0.15	0.21

Table 6b. Glucosinolate profile of spring interspecific hybid lines.

Identifier	2-PEN	5-MTB	3-HYBEN	INDO-3ME	4-HI3-M
O34535	0.00	0.00	65.70	0.35	0.45
O34535	0.00	0.00	62.80	0.30	0.35
CYCLONE	0.55	0.15	0.15	0.30	4.80
CYCLONE	0.50	0.20	1.85	0.35	5.65
IDAGOLD	0.00	0.00	78.85	0.30	0.20
UI.7012	0.60	0.00	38.30	1.25	1.00
HYOLA.401	0.45	0.10	0.20	0.65	5.65
HELIOS	0.30	0.05	0.40	0.50	8.30
P.GOLD	0.80	0.00	0.05	0.15	2.85
HYSYN.110	0.80	1.10	0.05	0.35	8.25
GOLDRUSH	1.15	3.40	0.05	0.20	3.55
F1.MMM.1	0.30	0.30	0.00	0.30	5.30
F1.MMM.2	0.35	0.70	69.95	0.20	2.75
F1.MMM.3	0.30	0.65	100.40	0.25	2.60
F1.MMM.4	0.30	0.40	31.00	0.60	4.05
F1.MMM.5	0.25	0.40	50.05	0.20	3.40
F1.MMM.6	0.25	0.40	105.60	0.35	3.15
F1.MMM.7	0.20	0.60	80.80	0.10	3.40
F1.MMM.8	0.30	0.40	47.80	0.20	3.75
F2.CCC.1	0.30	0.10	0.10	1.15	7.30
F2.CCC.2	0.45	0.20	0.55	0.95	11.10
F2.CCC.3	0.85	0.35	0.00	1.20	11.00
F2.CCC.4	0.15	0.40	0.15	1.15	9.90
F2.CCC.5	0.55	0.20	0.10	0.90	5.50
F2.CCM.1	1.60	0.25	0.05	0.65	10.65
F2.CCM.2	0.60	0.05	0.20	0.45	6.00
F2.CCM.3	0.30	0.00	0.10	0.80	5.00
F2.CCM.4	0.45	0.20	3.35	0.85	5.80
F2.CCM.5	0.30	0.05	0.05	0.80	7.50
F2.CMM.1	0.50	1.00	93.00	0.30	2.50
F2.CMM.2	0.65	0.45	17.05	1.05	6.55
F2.CMM.3	0.55	0.35	11.40	0.45	5.95
F2.MCM.1	0.30	0.00	0.25	0.75	6.65
F2.MMM.9	0.10	0.30	92.30	0.70	2.60
F2.MMM.10	0.25	0.40	96.40	0.25	4.00
F2.MMM.11	0.35	0.60	86.05	0.45	2.30
F2.MMM.12	0.40	0.70	110.80	0.60	5.50

Table 6b. **Glucosinolate profile of spring interspecific hybid lines.**

Identifier	2-PEN	5-MTB	3-HYBEN	INDO-3ME	4-HI3-M
F2.MMM.13	0.25	0.50	93.90	0.20	2.95
F3.CCC.6	0.20	0.05	0.00	1.00	10.00
F3.CCC.7	0.20	0.00	0.00	0.50	5.75
F3.CCC.8	0.15	0.05	0.85	0.75	7.25
F3.CCC.9	0.35	0.00	0.30	1.35	9.10
F3.CCC.10	0.25	0.05	0.05	0.85	5.75
F3.CCM.6	1.15	0.50	14.45	0.55	8.90
F3.CCM.7	0.50	0.00	0.05	0.85	8.85
F3.CCM.8	0.25	0.15	0.10	1.00	5.60
F3.CCM.9	0.45	0.30	0.00	0.45	5.30
F3.CCM.10	0.40	0.20	10.95	0.40	4.85
F3.CMM.14	0.30	0.55	143.65	1.10	4.75
F3.CMM.15	0.60	1.20	158.80	1.30	10.90
F3.CMM.4	0.40	0.65	96.00	0.40	3.35
F3.CMM.5	0.45	0.65	92.30	0.35	5.55
F3.CMM.6	0.55	0.45	21.95	0.65	5.75
F3.CMM.7	0.70	0.65	30.45	1.00	5.60
F3.CMM.8	0.70	0.70	24.60	0.40	4.60
F3.CMM.9	0.55	0.35	14.30	0.25	4.35
F3.CMM.10	0.30	0.20	8.55	0.40	4.90
F3.CMM.11	0.90	0.75	30.40	0.55	7.90
F3.CMM.12	0.45	0.75	86.45	0.35	3.85
F3.CMM.13	0.40	0.75	80.05	0.10	2.00
F3.MCM.2	0.50	0.35	17.40	0.30	4.70
F3.MCM.3	1.10	0.60	19.45	0.80	8.85
F3.MMM.14	0.45	0.95	74.80	0.55	7.75
F3.MMM.15	0.45	0.90	86.80	0.20	4.60
F3.MMM.16	0.35	0.50	75.70	0.40	5.55
F3.MMM.17	0.40	0.20	0.10	0.30	6.50
F3.MMM.18	0.30	0.70	95.30	0.10	1.70
F4.CCC.11	0.20	0.20	0.25	0.55	6.85
F4.CCC.12	0.65	0.25	1.10	0.45	7.40
F4.CCC.13	0.20	0.00	0.05	0.45	6.65
F4.CCC.14	0.15	0.00	0.20	0.25	4.15
F4.CCC.15	0.50	0.00	0.00	1.15	10.25
F4.CCM.10	0.40	0.45	20.70	0.40	4.95
F4.CMC.4	0.35	0.00	0.15	0.95	9.50

Table 6b. Glucosinolate profile of spring interspecific hybid lines.

Identifier	2-PEN	5-MTB	3-HYBEN	INDO-3ME	4-HI3-M
F4.CMC.1	0.40	0.20	0.45	0.50	6.10
F4.CMC.2	0.40	0.20	1.10	0.80	5.80
F4.CMC.3	0.45	0.25	0.30	0.35	5.35
F4.CMM.16	0.40	0.40	16.95	0.50	5.65
F4.CMM.17	0.45	0.30	16.80	0.55	5.55
F4.CMM.18	0.30	0.20	16.80	0.30	4.30
F4.CMM.19	0.70	0.45	15.75	0.40	4.85
F4.MCM.4	0.20	0.10	0.30	0.30	4.35
F4.MMM.19	1.45	2.10	27.55	0.30	7.35
F4.MMM.20	*	*	*	*	*
F4.MMM.21	0.20	0.50	90.80	0.10	2.30
F4.MMM.22	0.25	0.60	75.55	0.10	2.25
F4.MMM.23	0.50	0.65	0.30	0.20	5.90
F5.CCC.16	0.55	0.10	0.05	1.05	6.30
F5.CCC.17	0.25	0.15	0.30	0.80	7.65
F5.CCC.18	0.20	0.10	0.00	0.80	8.10
F5.CCC.19	0.10	0.00	0.20	0.60	7.50
F5.CCC.20	0.55	0.10	0.00	0.75	5.65
F5.CCM.11	0.35	0.20	8.85	0.70	5.75
F5.CCM.12	0.30	0.05	0.10	0.65	6.55
F5.CCM.13	0.20	0.10	0.00	0.30	4.20
F5.CMC.5	0.35	0.10	0.00	0.45	4.50
F5.CMC.6	0.15	0.10	0.30	0.55	5.25
F5.CMM.20	1.15	0.55	33.30	1.70	8.70
F5.CMM.22	0.30	0.10	10.40	0.60	6.80
F5.CMM.23	0.30	0.20	0.00	0.50	5.40
Standard Error	0.18	0.18	21.55	0.18	1.65

Table 7. Seed yield, seedling establishment and plant height of 2001 spring hybrid trial.

Identifier	Seed yield --- lb/acre --	Establishment --- 1 to 9 ---	Plant Height --- inches ---
IdaGold	1574	6.75	135.00
Cyclone	1466	7.50	135.00
Pacific Gold	2010	7.00	142.50
Goldrush	1752	7.25	127.50
93HN.1.5	1402	7.00	137.50
94HN.2.3.3	1063	7.25	145.00
94HN.2.3.4	1573	6.75	142.50
94HN.2.3.7	1363	6.75	135.00
94HN.2.3.8	1603	7.00	142.50
95HN.2.2.4.6	1998	7.00	142.50
95HN.2.3.10.5	1248	6.25	142.50
95HN.2.3.10.8	1264	6.50	137.50
95HN.2.1.1.10	1136	6.75	140.00
95HN.2.1.2.5	1297	7.00	120.00
95HN.2.1.2.5	1430	7.00	130.00
95HN.2.1.4.3	883	6.75	125.00
95HN.2.1.7.7	764	7.25	130.00
95HN.2.3.1.6	1700	6.25	140.00
95HN.2.3.5.2	1560	7.00	135.00
95HN.2.3.7.2	903	6.25	132.50
95HN.2.3.7.8	1372	6.25	132.50
95HN.2.3.9.2	1369	6.00	135.00
96HN.1.1.2	1065	5.50	145.00
96HN.1.1.5	1456	6.25	140.00
96HN.1.2.1	1729	6.50	147.50
96HN.1.2.2	1479	6.50	145.00
95HN.2.3.10.5	2169	6.50	145.00
96HN.1.2.3	2124	6.00	145.00
96HN.1.2.1	1288	5.75	142.50
96HN.1.2.2	1066	6.25	140.00
96HN.1.1.1	1268	6.50	145.00
95HN.2.5.7.1	1361	6.50	145.00
96HN.5.3	1567	6.75	137.50
96HN.2.8.2	727	7.00	132.50
95HN.7.3	12.84	6.50	145.00

Table 7. Seed yield, seedling establishment and plant height of 2001 spring hybrid trial (continued).

Identifier	Seed yield --- lb/acre --	Establishment --- 1 to 9 ---	Plant Height --- inches ---
95HN.7.2	13.88	6.50	132.50
96HN.3.4	14.36	7.25	140.00
96HN.3.1	11.75	6.75	147.50
F1.MMM.1	23.91	6.50	147.50
F1.MMM.2	12.56	6.25	142.50
F1.MMM.3	693	7.00	140.00
F1.MMM.4	759	6.75	140.00
F1.MMM.5	307	7.00	140.00
F1.MMM.6	311	7.00	145.00
F1.MMM.7	570	7.00	142.50
F2.CCM.3	1875	7.50	140.00
F2.CCM.4	2196	7.25	137.50
F2.CMM.1	386	6.75	140.00
F2.CMM.2	961	7.50	137.50
F2.CMM.3	965	7.00	137.50
F2.MCM.1	1524	6.50	142.50
F2.MMM.9	737	6.50	142.50
F2.MMM.10	755	6.50	137.50
F2.MMM.11	316	6.00	142.50
F2.MMM.12	235	6.25	140.00
F2.MMM.13	410	5.75	135.00
F3.CCM.6	1473	6.00	142.50
F3.CCM.10	1399	7.00	137.50
F3.CMM.14	327	6.75	147.50
F3.CMM.15	1347	7.50	150.00
F3.CMM.4	344	7.00	147.50
F3.CMM.5	320	7.25	140.00
F3.CMM.6	986	7.25	145.00
F3.CMM.7	1631	7.00	135.00
F3.CMM.8	1975	7.00	132.50
F3.CMM.9	1096	5.75	147.50
F3.CMM.10	771	5.50	142.50
F3.CMM.11	1389	5.50	152.50
F3.CMM.12	145	6.25	152.50
F3.CMM.13	427	6.50	140.00

Table 7. Seed yield, seedling establishment and plant height of 2001 spring hybrid trial (continued).

Identifier	Seed yield --- lb/acre --	Establishment --- 1 to 9 ---	Plant Height --- inches ---
F3.MCM.2	1907	6.25	140.00
F3.MCM.3	1730	6.25	140.00
F3.MMM.14	399	6.50	140.00
F3.MMM.15	197	5.75	142.50
F3.MMM.16	393	6.50	140.00
F3.MMM.17	450	5.00	137.50
F3.MMM.18	2010	5.00	140.00
F4.CCM.10	1430	6.25	135.00
F4.CMC.2	1372	5.75	135.00
F4.CMM.16	1260	6.00	137.50
F4.CMM.17	1458	6.00	137.50
F4.CMM.18	951	5.75	145.00
F4.CMM.19	1720	6.50	147.50
F4.MMM.19	1228	7.00	140.00
F4.MMM.20	824	6.75	137.50
F4.MMM.21	293	6.25	142.50
F4.MMM.22	509	6.00	145.00
F5.CCM.11	1365	5.75	137.50
F5.CMM.20	1244	7.00	140.00
F5.CMM.22	1188	6.25	132.50
F5.CMM.23	1147	6.50	132.50
Standard Error	99	0.49	5.80

Table 8. Seed yield, erucic acid content, Tes-tape rating and total glucosinolate content of 19 spring hybrid lines selected for planting in 2002 field trials.

Identifier	Seed Yield	Erucic acid	Tes-tape	Total Glucosinolate
	----- lb/acre ---	----- % -----	--- 1 to 5 ---	--- µmol g^{-1} ---
IdaGold	1574	28.3	4.0	100.15
Cyclone	1466	0.1	1.5	11.8
94.HN.1	1354	25.0	5.0	325.4
94.HN.2.3.3	1063	8.7	4.0	183.7
95.HN.2.2.4.6	1998	19.3	4.0	193.6
95.HN.2.1.1.10	1136	39.0	4.0	210.8
95.HN.2.1.4.3	1883	26.3	4.0	199.2
95.HN.2.3.5.2	1560	20.7	3.0	110.4
95.HN.2.3.7.8	1372	18.3	2.5	88.3
95.HN.2.3.10.5	2169	5.2	2.5	76.3
F1.MMM.2	1256	13.6	4.0	229.5
F1.MMM.4	759	15.8	4.5	227.3
F2.CCM.4	2196	0.8	2.5	25.7
F2.MCM.1	1524	20.6	2.0	18.5
F3.MCM.2	1907	4.2	4.5	199.1
F3.CCM.6	1473	20.1	4.5	185.5
F3.CCM.10	1399	5.0	3.5	134.0
F3.CMM.15	1347	19.6	4.0	219.8
F3.CMM.8	1997	5.7	3.5	88.7
F4.CMM.18	1720	11.7	3.5	119.0
F4.MMM.20	824	15.3	4.5	101.6
LSD 5%	274	3.5	0.33	43.6

Table 9. Seed yield, days to 50% flower, plant height and oil content of 2002 spring interspecific hybrids.

Cultivar	Seed Yield Average	Moscow	Genesee	Zenner	Flower start	Plant height	Oil content
	-------------------- kg/ha			------------------	- days -	-- cm --	-- % --
IdaGold	1715	1798	2250	1098	95	122	28.3
AC.Pennant	1266	1010	1779	1008	96	114	28.4
Sunrise	1646	1098	2616	1223	102	116	36.7
Cyclone	1621	1215	2536	1112	102	119	35.9
Pacific Gold	2023	2239	2673	1158	99	132	34.2
Goldrush	1287	1125	1744	992	95	119	27.4
UI-Hullihan	1001	815	1581	607	98	124	30.8
94HN.2.3.3	1264	924	1774	1095	101	111	36.7
95HN.2.2.4.6	1507	1803	1696	1021	100	128	34.6
95HN.2.1.1.10	1174	655	1981	885	103	113	35.4
95.HN.2.1.4.3	1499	1140	2313	1044	102	120	36.3
95HN.2.3.5.2	1730	1252	2378	1561	103	108	38.1
95HN.2.3.7.8	1419	948	2170	1140	100	116	36.4
95HN.2.3.10.5	1512	1176	2352	1007	101	115	35.9
F1.MMM.2	981	465	1603	875	102	127	34.8
F1.MMM.4	1221	1578	992	1092	100	125	35.5
F2.CCM.4	1620	1318	2561	982	101	119	37.1
F2.MCM.1	1592	983	2319	1473	103	112	36.9
F3.MCM.2	1613	1270	2398	1172	101	117	36.0
F3.CCM.6	1059	955	1258	964	101	114	33.6
F3.CCM.10	1496	1146	1951	1392	101	114	37.0
F3.CMM.15	1405	1427	1696	1093	101	124	34.8
F3.CMM.8	1546	1007	2537	1094	103	116	36.4
F4.CMM.18	1510	1054	2070	1416	102	107	35.7
F4.MMM.20	1170	589	2078	844	101	120	35.2
SE mean	222	201	276	189	0.44	3.02	0.88
LSD 5%	577	589	806	552	0.86	5.92	2.58

Table 10. Seed yield of spring lines grown with variable nitrogen and sulfur levels.

Cultivar		Nitrogen			Sulfur	
	Low	Medium	High	Low	Medium	High
	---------------- kg/ha ----------------					
Cyclone	1352	1692	1543	1482	1692	1770
UI.534	942	1536	1375	1207	1536	1152
F4.CCM.3	1208	1233	1435	1392	1233	1187
F4.CMM.19	1543	1352	1432	1432	1352	1301
F2.CMM.3	1183	1150	1052	1532	1150	1179
F3.CMM.10	1274	1100	1381	1270	1100	1100
Mean	1250	1344	1370	1386	1344	1281
LSD 5%		166			166	

Table 11. Total seed meal glucosinolate content of spring lines grown with variable nitrogen and sulfur levels.

Cultivar		Nitrogen			Sulfur	
	Low	Medium	High	Low	Medium	High
	---------------- μmol g^{-1} ----------------					
Cyclone	16.6	33.0	15.9	20.6	33.0	31.9
UI.534	147.6	180.1	80.4	172.8	180.1	164.6
F4.CCM.3	23.4	18.3	27.6	64.0	18.3	16.9
F4.CMM.19	13.3	23.7	66.9	24.2	23.3	10.3
F2.CMM.3	139.8	126.4	147.4	151.1	126.4	155.7
F3.CMM.10	113.1	148.9	119.6	119.4	148.9	129.8
Mean	75.6	88.4	76.3	92.0	88.3	84.9
LSD 5%		n.s.			n.s.	

Table 12. Glucosinolate profiles of selected parental and hybrid lines. The hybrid lines in bold were selected for follow up choice tests based on total glucosinolates and results from the first choice test.

			Parents		
Identifier	3-Butenyl	4-Pentenyl	2-OH 3-But †	3-HyBenz††	Total
	--------------------	--------------------	μ mol g^{-1}	--------------------	
AC Pennant	0.00	0.00	2.70	186.30	189.00
Tilney	0.00	0.00	3.20	152.50	155.70
IdaGold	0.00	0.00	5.40	182.70	188.10
UI.034534	0.00	0.00	3.80	160.70	164.50
Hyola 401	3.00	0.40	11.80	0.00	15.20
Helios	3.40	0.00	8.10	1.10	12.60
Sunrise	2.30	0.50	5.70	0.00	8.50

			Hybrids		
Identifier	3-Butenyl	4-Pentenyl	2-OH 3-But	3-HyBenz	Total
	--------------------	--------------------	μ mol g^{-1}	--------------------	
IsHyb.1	4.60	0.60	21.05	100.40	126.65
IsHyb.2	6.90	1.00	25.10	93.00	126.00
IsHyb.3	6.90	1.00	25.10	93.00	126.00
IsHyb.4	5.50	2.05	23.70	86.80	118.05
IsHyb.5	9.90	2.60	21.15	74.80	108.45
IsHyb.6	26.90	5.75	34.95	27.55	95.15
IsHyb.7	16.90	3.05	18.65	11.40	50.00
IsHyb.8	8.60	2.10	18.30	14.45	43.45
IsHyb.9	6.30	0.75	14.50	14.30	35.85
IsHyb.10	4.85	0.65	12.45	17.40	35.35
IsHyb.11	3.80	0.60	9.15	20.70	34.25
IsHyb.12	5.50	0.65	10.15	10.95	27.25
IsHyb.13	3.60	0.40	6.55	8.85	19.40
IsHyb.14	4.40	1.35	11.50	0.30	17.55
IsHyb.15	4.05	0.55	8.60	3.35	16.55
IsHyb.16	4.40	0.50	9.80	0.00	14.70
IsHyb.17	3.50	0.30	8.50	0.10	12.40
IsHyb.18	3.20	1.70	7.50	0.00	12.40
IsHyb.19	2.55	0.20	4.75	0.30	7.80

† 2-Hydroxy 3-Butenyl
†† 3 Hydroxybenzyl

Table 13. Mean squares from the analyses of variance of flea beetle ratings in 2001 and 2002 grown at Moscow and Genesee.

		2001		2002	
Source		Moscow	Genesee	Moscow	Genesee
Treatment †	(T1)	985.66 ***	553.64 ***	80.5 ***	64.1 ***
	(T2)	0.94 n.s.	0.51 n.s.	4.5 *	11.3 **
	(T3)	0.26 n.s.	1.81 n.s.	387.6 ***	0.2 n.s.
Genotype ‡	(G1)	1.78 n.s.	0.30 n.s.	3.6 *	0.3 n.s.
	(G2)	0.00 n.s.	4.08 n.s.	12.0 ***	35.0 ***
	(G3)	0.04 n.s.	2.04 n.s.	2.0 n.s.	4.2 n.s.
	(G4)	0.05 n.s.	2.04 n.s.	2.0 n.s.	7.0 n.s.
	(G5)	25.08 **	22.29 n.s.	31.2 ***	74 ***
G x T		0.62 n.s.	0.88 n.s.	0.71 n.s.	1.3 n.s.
Error		0.62	1.32	0.65	1.4

Table 14. Mean squares from the analyses of variance of Diamond back moth bucket counts in 2001 and 2002 grown at Moscow and Genesee.

		2002		2002	
Source		Moscow	Genesee	Moscow	Genesee
Treatment †	(T1)	14.67 n.s.	2.92 n.s.	0.0 n.s.	0.0 n.s.
	(T2)	18.22 n.s.	0.09 n.s.	0.06 n.s.	0.0 n.s.
	(T3)	6.55 n.s.	0.01 n.s.	0.0 n.s.	0.0 n.s.
Genotype ‡	(G1)	143.2 n.s.	5.47 n.s.	0.0 n.s.	0.02 n.s.
	(G2)	98.8 n.s.	6.02 n.s.	0.0 n.s.	0.02 n.s.
	(G3)	876.0 ***	3.38 n.s.	0.0 n.s.	0.04 **
	(G4)	45.9 n.s.	4.12 n.s.	0.04 n.s.	0.0 n.s.
	(G5)	1233.7 n.s.	204.27 n.s.	0.01 n.s.	0.0 n.s.
G x T		35.2 n.s.	7.14 n.s.	.01 n.s.	0.0 n.s.
Error		41.5	10.31	0.02	0.00

† Effect of treatment was partitioned, using orthogonal contrasts into T1 = effect of early season insect control; T2 = effect of late season insect control and T3 = the interaction between early and late insect control.

‡ Effect of Genotypes was partitioned using G1 = Parent vs. Hybrid; G2= Canola vs. Must; G3 = with Mustard; G4 = with Canola and G5 = within Hybrids.

Table 15. Mean squares from the analyses of variance of CSPW bucket counts in 2002 grown at Moscow and Genesee.

		2001		2002	
Source		Moscow	Genesee	Moscow	Genesee
Treatment †	(T1)	0.01 n.s.	0.76 n.s.	6.02 *	0.04 n.s.
	(T2)	0.33 n.s.	0.29 n.s.	0.15 n.s.	0.04 n.s.
	(T3)	0.04 n.s.	0.05 n.s.	0.82 n.s.	0.20 n.s.
Genotype ‡	(G1)	0.50 n.s.	0.63 n.s.	3.75 n.s.	0.17 n.s.
	(G2)	0.02 n.s.	0.02 n.s.	4.08 n.s.	0.00 n.s.
	(G3)	0.38 n.s.	0.00 n.s.	10.7 ***	0.00 n.s.
	(G4)	0.00 n.s.	0.04 n.s.	0.67 n.s.	0.00 n.s.
	(G5)	5.06 n.s.	5.67 n.s.	3.08 n.s.	3.70 n.s.
G x T		.28 n.s.	0.22 n.s.	1.49 n.s.	0.10 n.s.
Error		0.28	0.24	1.44	0.13

Table 16. Mean squares from the analysis of variance of aphid scores and CSPW exit holes in 2002 grown at Moscow and Genesee.

		2002 Aphids		2002 CSPW	
Source		Moscow	Genesee	Moscow	Genesee
Treatment †	(T1)	0.00 n.s.	0.39 *	64.1 n.s.	0 n.s.
	(T2)	26.35 ***	32.05 ***	5226.7 ***	2248 ***
	(T3)	0.10 n.s.	0.03 n.s.	224.3 *	12 n.s.
Genotype ‡	(G1)	1.16 ***	0.71 ***	714.2 ***	318 *
	(G2)	.40 n.s.	0.74 ***	800.3 ***	320 *
	(G3)	0.02 *	0.02 n.s.	73.5 n.s.	267 *
	(G4)	0.02 *	0.00 n.s.	0.95 n.s.	113 n.s.
	(G5)	4.05 ***	3.7 ***	772.4 ***	4640 ***
G x T		0.09 **	0.00 **	51.7 n.s.	99 **
Error		0.05	0.06	42.4	57

† Effect of treatment was partitioned, using orthogonal contrasts into T1 = effect of early season insect control; T2 = effect of late season insect control and T3 = the interaction between early and late insect control.

‡ Effect of Genotypes was partitioned using G1 = Parent vs. Hybrid; G2= Canola vs. Must; G3 = with Mustard; G4 = with Canola and G5 = within Hybrids.

Table 17. Mean squares from the analyses of variance of yield in 2001 and 2002 grown at Moscow and Genesee.

		2002		2002	
Source		Moscow	Genesee	Moscow	Genesee
Treatment †	(T1)	147479 n.s.	2169087 ***	2403422 ***	9619826 ***
	(T2)	1447527 ***	94045 n.s.	318036 n.s.	62738201 ***
	(T3)	27252 n.s.	238611 n.s.	236676 n.s.	211160 n.s.
Genotype ‡	(G1)	179479 n.s.	939527 **	1428506 ***	69257 n.s.
	(G2)	192335 n.s.	86164 n.s.	382685 n.s.	17197 n.s.
	(G3)	112694 n.s.	163037 n.s.	168774 n.s.	3444 n.s.
	(G4)	2796 n.s.	77386 n.s.	1227762 **	111646 n.s.
	(G5)	21957481 ***	28423956 ***	2440882 ***	29900359 ***
G x T		44317 n.s.	88718 n.s.	108246 n.s.	268035 n.s.
Error		59288	105582	194553	184857

Table 18. Mean squares from the analyses of variance of % Oil in 2001 and 2002 grown at Moscow and Genesee.

		2001		2002	
Source		Moscow	Genesee	Moscow	Genesee
Treatment †	(T1)	1.35 n.s.	1.55 n.s.	256.68 ***	1.51 n.s.
	(T2)	.47 n.s.	60.63 ***	8.66 n.s.	119.26 ***
	(T3)	.00 n.s.	5.73 n.s.	15.91 *	0.05 n.s.
Genotype ‡	(G1)	117.85 ***	71.55 ***	341.77 ***	294.75 ***
	(G2)	167.71 ***	178.79 ***	901.33 ***	483.78 ***
	(G3)	527.34 ***	531.94 ***	140.17 ***	297.6 ***
	(G4)	2.14 n.s.	0.96 n.s.	4.0 n.s.	0.27 n.s.
	(G5)	1205.85 ***	1096.15 ***	1454.01 ***	1527.5 ***
G x T		1.67 n.s.	0.87 n.s.	3.88 n.s.	3.09 n.s.
Error		1.91	1.06	3.45	2.95

† Effect of treatment was partitioned, using orthogonal contrasts into T1 = effect of early season insect control; T2 = effect of late season insect control and T3 = the interaction between early and late insect control.

‡ Effect of Genotypes was partitioned using G1 = Parent vs. Hybrid; G2= Canola vs. Must; G3 = with Mustard; G4 = with Canola and G5 = within Hybrids.

Table 19. Seed yield (lb/acre), number of seedlings emerged in 2 m, crop establishment (1 to 9, 9 = well established), days to flower opening and plant height (cm) of cultivars from the 2002 Moscow site.

	2002 Moscow Site			
Character	No Insecticide	Early Season	Late Season	Full
Yield (lb/a)	1139[c]	1632[b]	1769[b]	2116[a]
Oil content	35.6[b]	37.2[ab]	35.5[b]	38.1[a]
Emergence (#/2m row)	34.2	33.9	36.4	34.2
Establish (1 to 9)	6.4[b]	7.3[a]	6.3[b]	7.4[a]
Days to flower	51.4[ab]	50.7[bc]	51.7[a]	50.5[c]
Plant height (inches)	128[c]	133[b]	128[c]	138[a]
Flea beetle rating	3.4[c]	7.5[a]	3.8[b]	7.4[a]
Adult CSPW counts	0.3[ab]	0.1[ab]	0.5[a]	0.0[b]
CSPW exit holes	15.4[a]	12.5[b]	4.2[c]	5.1[c]
Diamondback moth counts	2.3[a]	1.6[b]	0.5[c]	0.6[c]
Aphid rating	0.8[a]	0.7[a]	0.1[b]	0.1[b]

Means within rows with different superscrip letters are significant at the 5% level.

Table 20. Seed yield (lb/acre), number of seedlings emerged in 2 m, crop establishment (1 to 9, 9 = 23ll established), days to flower opening and plant height (cm) of cultivars from the 2002 Genesee site.

	2002 Genesee Site			
Character	No Insecticide	Early Season	Late Season	Full
Yield (lb/a)	1340[d]	1681[c]	2303[b]	2764[a]
Oil content	35.6[b]	37.2[a]	35.5[b]	38.1[a]
Emergence (#/2m row)	41[b]	41[b]	49[a]	38[b]
Establish (1 to 9)	5.8[c]	6.7[b]	6.5[b]	7.2[a]
Days to flower	60.8	60.2	60.6	60.2
Plant height (inches)	121[b]	126[a]	123[b]	129[a]
Flea beetle	4.5[c]	5.4[b]	4.8[c]	5.9[a]
Adult CSPW counts	0.05	0.08	0.08	0.00
CSPW exit holes	9.9[a]	11.5[a]	4.2[b]	4.9[b]
Diamondback moth counts	1.7[a]	1.4[a]	0.5[b]	0.4[b]
Aphid rating	0.90[a]	0.79[b]	0.14[c]	0.08[c]

Means within rows with different superscrip letters are significant at the 5% level.

Table 21. Yield averages over Moscow and Genesee for 2001 and 2002 along with tolerance ratings calculated using no insecticide control/full insecticide control *100.

	2001					2002				
Genotypes	Both	Early	Late	None	Tolerance	Both	Early	Late	None	Tolerance
O34534	2204	2134.6	2170.7	2049.7	93.0	2195.3	1753.2	1992.8	1647.8	75.1
IDAGOLD	2145.8	1941.7	1966.9	2072.7	96.6	1873.6	2058.3	1908.8	1615.5	86.2
HELIOS	2596.6	2503	2448.7	2092.5	80.6	2282.2	1742.7	1813.9	952.0	41.7
CYCLONE	2537.5	2344.2	2459.5	2268.2	89.4	3088.9	1835.3	2431.7	1700.8	55.1
IsHyb.1	1634	1408.8	1419.4	1214	74.3	1660.2	903.1	1408.8	646.3	38.9
IsHyb.4	2133.4	2058	1834.7	1883	88.3	1368.9	771.8	897.0	394.5	28.8
IsHyb.5	2179.4	1962.5	2130.5	2073	95.1	2939.4	2115.5	2631.4	1637.2	55.7
IsHyb.7	2004.6	2115.2	2020.6	1962.8	97.9	2595.9	1465.4	1916.1	786.2	30.3
IsHyb.8	1945.2	2059.9	2090.9	1859.3	95.6	2202.7	1797.6	1782.0	1423.5	64.6
IsHyb.9	2131.4	2255.7	2046.8	1770.1	83.0	2778.7	1942.0	2496.6	1201.8	43.3
IsHyb.10	1979.1	1951	2418	1980	100.0	2671.3	1690.6	2181.3	1268.3	47.5
IsHyb.11	2185.1	2290.5	2146.1	2008.8	91.9	2926.9	2042.0	2630.8	1638.2	56.0
IsHyb.12	2178.4	2232.4	2013.9	2049.3	94.1	2482.2	1467.3	2028.3	1263.8	50.9
IsHyb.13	2308.1	2342	2195.7	2160.5	93.6	2760.8	1735.3	2122.8	1058.4	38.3
IsHyb.14	2224.7	2221.2	1924.8	1837.5	82.6	2694.7	1923.8	2164.4	1132.5	42.0
IsHyb.15	2296.3	2241.7	2335.9	2217.4	96.6	3323.7	1601.8	2509.7	1506.9	45.3
IsHyb.16	1296.7	1311.4	1119.4	1069.2	82.5	2240.4	1247.2	1473.4	1057.7	47.2
IsHyb.17	1512.3	1272.1	1474	1148.5	75.9	2192.5	1485.2	1750.6	860.0	39.2
IsHyb.18	1632.1	1638.2	1562.5	1489.6	91.3	1864.1	1750.6	1923.2	1593.2	85.5
IsHyb.19	2288.3	2055.1	2090.2	1917.4	83.8	2655.4	1807.5	2667.5	1415.2	53.3
LSD 5%			122					362.0		

Table 22. % Oil content averages over Moscow and Genesee for 2001 and 2002 along with tolerance ratings calculated using no insecticide control/full insecticide control *100.

	2001					2002				
Genotypes	Both	Early	Late	None	Tolerance	Both	Early	Late	None	Tolerance
O34534	28.3	28.3	28.3	27.5	97.2	27.1	26.8	27.3	26.6	98.2
IDAGOLD	27.9	27.1	28.3	28.4	101.8	26.8	27.1	26.9	26.3	98.1
HELIOS	37.0	37.0	37.8	37.8	102.2	39.7	36.8	37.1	38.0	95.7
CYCLONE	37.8	37.2	38.1	38.0	100.5	37.8	37.7	39.5	37.8	100.0
IsHyb.1	36.0	34.4	35.1	33.8	93.9	37.0	34.7	37.0	35.5	95.9
IsHyb.4	35.9	35.5	36.3	36.8	102.5	36.1	35.6	37.5	35.3	97.8
IsHyb.5	37.6	37.5	37.8	37.9	100.8	37.8	36.4	38.2	37.0	97.9
IsHyb.7	36.4	36.8	36.2	36.2	99.5	38.2	36.3	38.3	35.8	93.7
IsHyb.8	39.0	36.6	37.7	37.2	95.4	35.2	32.4	34.3	30.4	86.4
IsHyb.9	36.9	36.6	37.6	36.6	99.2	38.3	36.8	39.5	36.8	96.1
IsHyb.10	37.0	36.8	36.6	37.2	100.5	38.4	35.6	38.8	36.7	95.6
IsHyb.11	39.2	38.1	38.3	38.3	97.7	40.1	37.4	40.3	39.2	97.8
IsHyb.12	37.2	36.5	37.4	35.9	96.5	37.0	37.0	39.1	37.3	100.8
IsHyb.13	38.8	38.8	39.1	39.1	100.8	39.3	37.9	38.8	37.2	94.7
IsHyb.14	37.9	38.3	38.1	38.5	101.6	39.2	38.0	39.7	37.2	94.9
IsHyb.15	38.5	38.3	38.7	38.4	99.7	39.6	36.6	40.2	36.9	93.2
IsHyb.16	34.8	34.3	33.8	33.6	96.6	36.3	34.9	38.1	35.6	98.1
IsHyb.17	35.8	34.4	35.9	35.5	99.2	38.8	36.4	39.4	35.0	90.2
IsHyb.18	36.3	36.0	36.1	35.8	98.6	36.1	36.2	36.8	36.6	101.4
IsHyb.19	37.1	35.6	37.7	36.7	98.9	38.7	36.8	39.1	35.8	92.5
LSD 5%		30.08					1.15			

Table 23. Yield differences of treatments averaged over Moscow and Genesee in 2002 onto cultivars with no insecticide and full insecticide shown along with flea beetle ratings, cabbage seedpod weevil exit holes, diamond back moth bucket counts and aphid scores.

Cultivar	No Insecticide	Full Insectice	Difference	Tolerance	Flea Beetles	CSPW Exit Holes	Diamond Back Moths	Aphids
IDAGOLD	1616	1874	258	86	5.00	0.00	1.50	0.24
O34534	1648	2195	548	75	5.80	0.00	1.17	0.37
HELIOS	952	2282	1330	42	2.50	8.65	0.34	0.89
CYCLONE	1701	3089	1388	55	3.70	12.00	1.67	0.85
IsHyb.1	1424	2203	779	65	4.20	4.35	1.17	0.38
IsHyb.4	1637	2939	1302	56	4.00	6.35	1.83	0.67
IsHyb.5	1058	2240	1183	47	4.00	13.00	1.84	1.03
IsHyb.7	646	1660	1014	39	3.80	13.30	2.67	1.14
IsHyb.8	1264	2482	1218	51	3.15	12.65	0.83	0.70
IsHyb.9	1638	2927	1289	56	5.00	11.70	0.83	0.69
IsHyb.10	1415	2655	1240	53	4.00	16.35	3.00	0.99
IsHyb.11	1202	2779	1577	43	4.00	11.00	3.00	0.86
IsHyb.12	860	2193	1333	39	3.35	18.65	3.83	1.14
IsHyb.13	1507	3324	1817	45	3.65	17.00	1.17	1.02
IsHyb.14	1133	2695	1562	42	3.50	14.35	2.34	0.86
IsHyb.15	395	1369	974	29	3.65	13.70	1.67	1.33
IsHyb.16	1058	2761	1702	38	4.00	12.65	3.84	1.06
IsHyb.17	1268	2671	1403	47	3.50	13.00	2.17	0.85
IsHyb.18	1593	1864	271	85	4.50	50.65	2.67	0.45
IsHyb.19	786	2596	1810	30	3.35	20.35	1.84	1.18

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14. ABSTRACT *(Maximum 200 Words)*
This report summarizes a project whose goal was to support R&D to develop an oil-seed crop that has the potential to reduce the feedstock cost of biodiesel to between 7 and 8 cents per pound of oil and expand supplies of biodiesel as demand for biodiesel grows. The key to this goal is that the non-oil fraction of the oil crop (the seed meal) must have a high value outside of the animal feed markets and produce oil that is not suitable for human consumption. To that end, a spring breeding program was developed to increase diversity of glucosinolate and the concentration of glucosinolates in the meal and to optimize the oil composition for biodiesel fuels. This report presents the research on the spring planted hybrids.

15. SUBJECT TERMS
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