

Release Proposal for “Bigfork DMR” Camelina

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Current line designation: ‘CS DMR 1412’

Proposed Variety name: ‘Bigfork DMR’

Alternative proposed name: ‘ Kalispell’

A. Camelina Disease Impact

The organism, as identified by the University of Nebraska, is *Hyaloperonospora camelinae* Gaum.) Goker, Voglmayr, Riethm.,M. Weiss & Oberw., 2003)¹. Control of *H. camelinae* is possible and use of *Tricoderma atroviride* as a seed treatment has been effective (Kandula, et al. 2015).This is a soil-borne pathogen and seed treatments have been effective in control (Harman, et al., 2011}

A serious issue in high rainfall or irrigated camelina is the development of indigenous downy mildew on stems and floral parts. Infections of 10% of plants can result in yield losses of 20% (MT observations) Infections; and infections of 20% of plants has resulted in yield losses of up to 32% in western Montana. This is supported by replicated trials in Bigfork/Creston, Montana (2014, 2015, 2016).Data from the University of Nebraska (2011) (Table 1) illustrate the impact of downy mildew.

Table 1. Downy mildew impact on High Plains camelina (Halverson, et al., 2011)

Cultivar	(Mean downy mildew rating (1-3) ^x	Mean seed yield (kg/ha) ^y
Blaine Creek	2c	972 abc
Cheyenne	2.25 bc	934 bc
Suneson	2.75ab	922 bc
Calena	2.75 ab	923 bc
Galena	2.75 bc	998ab
Celine	3 a	840 c
Ligena	3 a	1115 a
Trial Mean	2.64	957
LSD (0.05)	0.72	148

^xDisease ratings from each plot utilized a scale of 1 to 3 (1=no or little head distortion and 0 to 25% incidence, 2 = moderate head distortion and 26-50% incidence, and 3 = severe head distortion and >50%b incidence.

^ySeed yields on dry weight basis at 10% moisture using Proc ANOVA, mean separated by LSD (P<0.05)

¹ Harverson, et al.2011.

B. Importance of Downy Mildew Resistance

Camelina Downy mildew trials by ClearSkies, Inc. were conducted in fall, 2015 in Madera, California and 2016 in Creston, Montana. Indigenous populations of *H. camelinae* were collected in Madera in 2015 from early infections. The infected plant samples were placed in water and blended to produce spores in a water suspension. Filtration through cheesecloth provided a suspension which was sprayed on replicated trials in Madera, California. Madera represents a winter growth system for camelina. Seed was planted November 10, 2015. The winter environment provides effectively a cool (36-48F temperatures) with 45-63% fog or rain over 24 hours per day – a situation ideal for *H. camelinae* growth and infection.

Similar protocols were used in Bigfork (2015) and Creston (2016), Montana. Bigfork, 2015 was not effective (infection) due to drought but 2016 were highly effective. Results are shown in Table 2.

Table 2. Downy mildew impact on California/Montana camelina (2015, 2016)

Cultivar	(Mean downy mildew rating (1-3)) ^x <i>California</i>	Mean seed yield (kg/ha) ^y <i>California</i>	(Mean downy mildew rating (1-3)) ^x <i>Montana</i>	Mean seed yield (kg/ha) ^y <i>Montana</i>
Blaine Creek	2.45 bc	965 bc	2.25 bc	1,867 b
Suneson	2.65 c	934 c	2.45 c	1,005 c
Epequen	2.35 b	1027 a	2.0 b	2,135 b
Vantania	2.65 c	1,005 b	2.25 c	1,067 c
Epequen (treated)	1.1 a	1,123 ab	1 a	2,335 a
CS DMR 1412	1 a	1,225a	1 a	2,637 a
Location	2.55		2.30	
Trial Mean	2.21	1,035.4	1.97	1,742.6
LSD (0.05)	0.30	95	0.32	555

^xDisease ratings from each plot utilized a scale of 1 to 3 (1=no or little head distortion and 0 to 25% incidence, 2 = moderate head distortion and 26-50% incidence, and 3 = severe head distortion and >50% incidence. ^ySeed yields on dry weight basis at 10% moisture using Proc ANOVA, mean separated by LSD (P<0.05). 1. Locations in analysis: California 2015; Montana 2016

2. replications: 4 per location, 3 used in analysis (California); 4 replications (Montana)

C. Development of Bigfork DMR

The variety 'Epequen' was treated with the mutagen "ethyl methyl sulfonate" (EMS) to induce or simulate a natural mutational event.

Jabeen and Mirza (2004) found all concentrations of EMS were effective in bell pepper. ClearSkies selected a rate of 0.1% solution with a soaking of approximately 1.5 million

camelina seed, variety Epequen, for 6 hours in 2012 in Bigfork, Montana. The mutigenized seeds were then planted to the field using row-planter in Bigfork, Montana. Germination was reduced to 80% of seed planted. Albino plants were observed (0.4%) and effective mutation was assumed. The first generation (M_1) were grown to seed maturity without treatment. Since the seed source was CCIA certified 'Epequen', the M_2 generation was bulk planted in Bigfork in 2013 and sprayed with a solution of wild-type *H. camelinae* selected from frozen 2012 downy mildew infections of camelina. The treated plants were planted over ¼ acre and sprayed with a 25-gallon towable sprayer containing a solution of indigenous *H. camelinae* spores at the eight leaf stage. Plants exhibiting no downy mildew symptoms (twisted racemes, white stems or pods) were selected and regrown in California (winter, 2014). Plants were resprayed with California-collected wild-type downy mildew and selected plants were collected as individual plants. Seed were planted as "line-rows" in Bigfork, Montana. Two plants met both DM Resistance (DMR) and the agronomic yield and quality potential of the parent 'Epequen'. Plants in the M_4 generation were planted as head-rows in 2016 in Creston, Montana and selected for uniformity in flowering, maturity, oil percentage, seed size and plant height when compared to parent, Epequen.

D. Proposed release of Bigfork DMR

Bigfork DMR (CS DMR 1412) is proposed for release as a DMR variety for use in the United States, Europe, South America and Australia. ClearSkies is a subsidiary of Omega Grains, LLC and Bigfork DMR is expected to be of great value in replacing either lower yields from untreated camelina or significantly reduced cost by treating camelina for *H. camelinae*. Comparative data from Epequen (treated with *T. atroviride*) with CS DMR 1412 and Blaine Creek (treated) in Table 3.

Table 3. Comparative data of Epequen, Blaine Creek and CS DMR 1412 (Montana, 2016)

Variety / Line	Days to Flower	Days to Maturity	Growing Degree Days (flowering)	Oil Content %	Omega 3 %	Protein %
Blaine Creek (treated)	88	105b	2,480b	34	25	33
Epequen (treated)	88	107a	2,622a	34	27	33
CS DMR 1412	88	107a	2,615a	33	n/a	n/a
LSD (p=0.05) ^x	0.12	1.35	4.56	n.s.	n.s.	n.s

^x ANOVA using a randomized complete design.

E. Variety maintenance

Breeders seed: Breeders seed will be maintained by ClearSkies, Inc. Breeders seed will be regrown by the breeder, Duane Johnson.

Foundation Seed: Foundation generation will be grown when seed supplies of Breeder Seed drop below 100 pounds. Foundation seed can be grown by ClearSkies, Inc. under inspection by either

the University of California (CCIA) or Montana State University (MSU, Foundation) under direction of ClearSkies, Inc..

Registered and Certified Seed will be grown as needed to supply demand and maintain an inventory of 2,000 pounds minimum. Registered and Certified class seed will be inspected and approved by either the California Crop Improvement Association or Montana Seed Growers Association and will be maintained by Madera Experiment Station, LLC.

All seed, in any generation, is owned by Omega Grains, LLC., parent company of ClearSkies, Inc. and Madera Experiment Station, LLC.

Release Recommendation

Omega Grains, LLC, (dba ClearSkies, Inc.), recommends release of CS DMR 1412 as “Bigfork DMR” to represent not only its origin but the environment typical of the need for downy mildew resistance.

F. References

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Harverson, Robert M., Dipak K. Santra, Melanie L. Putnam, Marc Curtis, Alexander D. Pavlista. 2011. A new report for downy mildew [(*Hyaloperonospora camelinae* Gaum.) Goker, Voglmayr, Riethm.,M. Weiss & Oberw., 2003] of camelina [*Camelina sativa* (L.) Crantz] in the High Plains of the United States. Online. Plant Health Progress doi:10.1094/PHP-2011-1014-01-BR.

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date

ClearSkies, Inc. (Montana Corporated)
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