Release Proposal for "ClearSkies Hybrid #102" Camelina

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Current line designation: 'CS Hy #102
Proposed Variety name: 'ClearSkies Hybrid #102'
Alternative proposed name: OG ' Hybrid #102'

Origin and breeding of the variety.

Private variety: Hybrid Camelina

Camelina is described as a plant species which is highly adaptable to low moisture and cold environments and typically are grown as dryland crops in limited rainfall environments (7-15 inches; 171-378 mm). It is a cool-season oilseed crop which is typically very competitive with weed species requiring less water, less fertilizer and less weed control than conventional crops. *Camelia sativa* involves flowers which are complete (containing sepals, petals, anthers and stamens) and are These traits contribute to its success in its near-arctic native environments.

ClearSkies, Inc. has discovered, and has patented, a chemical process for creating 100% male-sterile camelina. All varieties tested has shown similar results where plants chemically treated, produce viable flowers which are environmentally insensitive and receptive flowers ("female") open to random pollen from self-fertile camelina plants. Experimental protocols for pollination (2012,2013,2014) have shown pollination efficiency decreases with distance but economic seed yields are possible at 8-36 inches from the pollinator rows. Using a system of 2 rows male, 8 rows female, 2 rows male in the seed production rows, seed is produced as hybrid seed on the females. Females are created by applying Clopyralid, a common herbicide at a rate of 1 pint per acre. Male rows are shielded to prevent overspray.

ClearSkies Hybrid # 102

A cross between cv. 'Vantania' and cv. 'Orovada' has resulted in a hybrid expressing heterosis for yield and seed size. This hybrid is being called "ClearSkies Hybrid #102. ClearSkies Hybrid #102 is best adapted to highly variable, dryland environments typical of the High Plains of eastern Montana to northern New Mexico. Data are shown in Tables 1a-1d.

An application of clopyralid at the 4-8 leaf stage (1 pint/acre) results in plants which are male sterile for 30-40 days. Male sterility results in incomplete flowers lacking anthers (figure 2). An extensive flowering period observed in initial tests in Montana 2012 has shown reversion to full male fertile in terminal flowers. This is extremely rare and only in varieties with extreme flowering periods (Johnson, October, 2016, USPTO patent pending).

Frequently, sprayed plants will show chemical-induced effect on existing leaves resulting in curling and minor chlorophyll loss. Females will grow normally thereafter and initiate flowering normally based on female used. However, since no selfed seed is produced, females tend to continue to produce flowers longer than the untreated fertile ("female") parent. Consequently, varieties selected to be used as females, are earlier maturing varieties to provide better opportunity for pollination by later flowering males since females bloom longer.

Post-pollination (terminal flowering by females), male rows can be destroyed by an application of glyphosate using a covered sprayer or rope-wick or physical destruction. "Females" containing hybrid seed are harvested using a certified combine.

C. Botanical description of the variety.

A cross of Vantania (male) X Orovada (female) is designated as ClearSkies Hybrid # 102. ClearSkies Hybrid #102 under a significant difference in environments, has shown a real advantage under stress. Growing Degree Days (GDD_{2015}) have provided preliminary estimates for average environment conditions in California and Montana. Table 1a-d illustrates the botanical description of ClearSkies Hybrid #102, its parents and the check variety, Epequen in California (2015,2016) and Montana (2014,2015).

Table 1a. Botanical Description of ClearSkies Hybrid #102 (MT: 2014, CA: 2016)

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Variety	GDD Flowering	GDD Maturity	1,000 seed 2014 weight (gram)	MT Yield 2014 (tons/acre)	CA Yield 2016 (tons/acre)
ClearSkies Hybrid #102	2,213	3,745b	1.8a	1.9a	2.1a
Epequen	2,642	3,426a	1.7a	1.3b	1.4b
Vantania	2,442	3,513a	1.5b	1.0c	1.3b
Orovada	2,320	3,426a	1.6a	1.2bc	1.25b
Mean		3,528	1.65	1.3	1.5
LSD 0.05		125	0.14	0.5	0.4

[z] all plots flooded

Table 1b. Botanical Description of ClearSkies Hybrid #102 (Bigfork, Montana, 2014, 2015; Madera, California 2015,2016)

Variety	Plant $Ht_{flowering}$ inch 2015	Plant $Ht_{fmaturity}$ inches 2015	Shatter Resistance (2015)[X]:
ClearSkies Hybrid #102	16 c	38 a	1
Epequen	15 ab	36 b	1
Vantania	14 a	31 c	1.3
Orovada	15 b	38 a	1.5
Mean	15	35	1.2
LSD 0.05	1.87	2.15	n.s.

[X]1 = no shatter; 2= 5-10%; 3= > 10% at harvest

Table 1c. Botanical Description of ClearSkies Hybrid #102 (Bigfork, Montana, 2014,2015; Madera, California 2015,2016)

Variety	GDD Flowering	GDD Maturity	1,000 seed 2014 weight (gram)	Yield 2014 (tons/acre)	Yield 2015 (tons/acre)[z]
ClearSkies Hybrid #102	2,405	3,425	1.8a	2.6a	0.58
Epequen	2,534	3,628	1.6b	1.8b	0.48
Vantania	2,123	3,212	1.4b	1.9b	0.47
Orovada	2,425	3,321	1.7b	1.7b	0.43
Mean			0.4	2.0	
LSD 0.05			0.15	0.4	n.s.

[z]2015 was a severe drought year and no significant differences were observed.

Table 1d. Botanical Description of ClearSkies Hybrid #102 (Bigfork, Montana, 2014; Madera, California 2015,2016)

Variety	Plant $Ht_{flowering}$ inch 2014	Plant $Ht_{fmaturity}$ inches 2014	Shatter Resistance (2014[x]:
ClearSkies Hybrid #102	12 c	36	1
Epequen	13 ab	37	1
Vantania	12 a	36	1
Orovada	11 b	35	1
Mean	12	36	1
LSD 0.05	1.45	n.s.	n.s.

[X]1 = no shatter; 2= 5-10%; 3= > 10% at harvest

D. Objective description of the variety.

ClearSkies Hybrid #102 was selected from twenty-five preliminary hybrids produced in Bigfork, Montana in 2013. ClearSkies Hybrid #102 was planted in Bigfork, Montana, April 2, 2014 and harvested August 22, 2014. Trials were planted November 10, 2014 in Madera, California and harvested April, 10, 2015. Montana yield trial was planted May 1, 2015 but failed due to drought

to yield significant differences. The Madera, California yield trial was repeated in November, 2015 and harvested in May,2016. Crosses were one-way hybrids as maternal effects were not expected. Hybrid yield trials were conducted in Madera, California in 2015 and 2016 and in Montana in 2014 and 2015 under dryland conditions.

ClearSkies Hybrid #102 is an medium-late maturity variety with well above average yield, average oil content and general characteristics common to its parent varieties, Vantania as male and Orovada as female. Robust hybrids tended to delay harvest date by up to 5-6 days. PVP will likely be applied for within the year after approval by CCIA.

E. Evidence to support identity of variety.

Data from Table 1. illustrates that ClearSkies Hybrid #102 has a 46% to 71% yield advantage in yield trials. The environments in each year were significantly different. The California trials in 2015 were dryland with a 5-inch rainfall in 2015 and an 8.25-inch rainfall in 2016. Yields in 2016 were highly variable as irregular flooding caused replications one and three to be flooded significantly, reducing yield and stands.These replications were discarded. Replications 2 and 4 in 2016 were used to calculate yields under variable conditions. Hybrids significantly out-yielded parents and standard varieties. This heterotic effect appears to allow ClearSkies Hybrid #102 to adapt to a wide range of stressful, full season environments. Drought conditions in Montana in 2015, while non-significant show a trend toward higher hybrid yields. Yields under high yield environments, such as Montana 2014, (example: rainfall of 18 inches in 2014; soil fertility exceeding 50 lbs/acre nitrogen) showed a 48% yield advantage. In 2015, an extremely dry spring (2 inches preplant moisture: April) followed by a prolonged drought reduced stands and yields so while the hybids did out-yield one parent and the check variety, differences were non-significant and CVs were 38%.

F. Variety Maintenance

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

<u>Foundation Seed</u>: 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.

<u>Registered and Certified Seed</u> 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 Omega Grains' 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.

<u>Release Recommendation</u>

ClearSkies Grains, LLC, (dba ClearSkies, Inc.), recommends release of ClearSkies Hybrid# 102 for PVP.

References

Blank, Timothy. June 26, 2014. Letter. Certification of Epequen (CS0921), Vantania (CS 0964) and Orovada (CS 0905) camelina varieties. California Crop Improvement Association.

Johnson, D.L. 2016. Hybrid Production systems in camelina. USPTO provisional patent.

Johnson, Duane L. 2016. Camelina oil as a food. Food and Drug Administration approved.

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Duane L. Johnson, PhD **date**

ClearSkies, Inc. (Montana Corporated)
Madera Experiment Station, LLC
ClearSkies Grains, LLC