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REGISTRATION

Cultivar

Registration of 'Successor' barley: A two-row, spring-habit, feed cultivar with tolerance to imidazolinone herbicides and adaptation to dryland production

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Abstract

'Successor' (Reg. no. CV-377, PI 702593), experimental designation DH190481, is a two-row spring barley (*Hordeum vulgare* L.) released by Oregon Agricultural Experiment Station in 2023. It is notable for tolerance to imidazolinone herbicides and can be planted in a rotation with crops that are treated with these chemicals. Successor is well adapted to dryland production in the Pacific Northwest and is being released as a feed cultivar. This assessment evaluated the cultivar in a multi-environment cultivar trial in eastern Oregon and Washington and in an on-farm trial at a commercial partner. It showed strong performance and matched or exceeded expectations set by the only other currently available imidazolinone-tolerant cultivar adapted to the target growing region, Survivor.

1 | INTRODUCTION

Eastern Oregon and Washington are major small grain production areas within the United States. These areas are primarily cultivated under dryland conditions, and many growers use conservation-till or no-till practices. Wheat (*Triticum aestivum* L.) is the dominant small grain crop in the region, with just over 1.2 million ha planted across both states (USDA-NASS, 2022). Although barley (*Hordeum vulgare* L.) is a smaller crop than wheat, it plays an important role in each state, with approximately 29,000 ha in Washington and 15,000 ha in Oregon harvested in 2022 (USDA-NASS, 2022). Barley has historically been part of a seasonal rotation of wheat, oil seed crops, and legumes and will commonly follow winter wheat (Schillinger et al., 2011). Barley produced in this region under dryland conditions is primarily grown for the feed market because the limited rainfall does not typically produce grain suitable for the malting stream.

Imidazolinone (IMI) herbicides are popular and effective broad-spectrum chemicals. They target an enzymatic pathway common in many plant species but show minimal to low animal toxicity (Hess et al., 2010). However, their mode of action does target many commodity crops. Wheat cultivars with genetic resistance to IMI herbicides were developed using mutagenesis and can confer complete tolerance to herbicide exposure (Pozniak & Hucl, 2004; Tan et al., 2005).

Abbreviations: CBARC, Columbia Basin Agricultural Research Center; DH, doubled haploid; IMI, imidazolinone; OSU, Oregon State University; TW, test weight.

These cultivars have since become part of the trademarked Clearfield system and thus allow for IMI application to control economically important grass weeds, such as cheatgrass (*Bromus tectorum* L.) and jointed goatgrass (*Aegilops cylindrica* Host), and a variety of broadleaf weeds. A challenge to the Clearfield system is herbicide residue in the soil and/or on stubble in no-till systems limiting rotation options with crops without any herbicide tolerance (Alister & Kogan, 2005). This has contributed to a steady decline in barley acreage in Oregon and Washington due to declining performance related to IMI residues (Rustgi, 2013). Development of suitable barley varieties with tolerance to herbicide residue is important to maintain a successful rotation and return barley to its valuable role in the regional agricultural system. Currently there is one barley cultivar on the market suitable for rotation into a Clearfield system: 'Survivor', a spring-habit, two-row cultivar with tolerance to IMI herbicides released by Washington State University (Murphy & Ullrich, 2018). A tolerance allele (AHAS) was identified on chromosome 6H, and this cultivar was developed via a back-crossing scheme with a mutant parent (Rustgi et al., 2014).

The aim of this germplasm development was to identify an agronomically successful, spring-planted cultivar that is well adapted to Oregon and Washington dryland environments and tolerant to soil residue from IMI herbicides while exhibiting suitable grain quality for the barley feed market.

Core Ideas

- 'Successor' is a novel spring-habit, feed barley cultivar evaluated in the Pacific Northwest.
- 'Successor' is tolerant to imidazolinone herbicide residue in soil and crop stubble.
- 'Successor' shows promise for growth in dryland environments and in no-till and conservation-till agriculture.

2 | METHODS

2.1 | Breeding and selection

'Successor' (Reg. no. CV-377, PI 702593) was selected from a set of doubled haploids (DHs) developed for the purposes of introgressing IMI tolerance into Oregon State University (OSU) barley germplasm. The DHs were derived in 2018 from two crosses: Survivor/'Lightning' and RCS124/07WA201. Lightning [SHORT11-7 (TC6W265)/HERZ 29494/2991] is a facultative, two-row cultivar released by Oregon State University (Hayes et al., 2021). Survivor, a cultivar released from Washington State University, is an induced mutant in the cultivar 'Bob'. RCSL 124 is an introgression line developed from the cross of *H. vulgare* subsp. *spontaneum* × Harrington (Matus et al., 2003), and 07WA201 is a sister selection of Survivor. From these F_1 crosses, a population of 411 DHs was produced in 2019 via anther culture following the methods of Cistué et al. (2003). This population of germplasm is herein referred to as the Successor population. These DHs were screened for IMI tolerance in the greenhouse by spraying the foliage of plants at the two-leaf stage with the IMI herbicide imazamox at 79 g a.i. ha^{-1} (1.5× the highest recommended dose) with 0.25% (v/v) non-ionic surfactant and 1% (v/v) ammonium sulfate. Plants that were actively growing after the herbicide application were considered tolerant and were advanced to field trials.

From the original 411 lines, 174 were found to be IMI tolerant, and 171 were advanced to an off-season seed increase in New Zealand and then to field trials in 2020 (3 of the 174 had limited seed production). For the 2021 trials, 20 lines were selected based on agronomic performance for a multi-environment trial in Oregon. Finally, two selections (both from the cross of Lightning/Survivor)—DH190346 and DH190481 (Successor)—were selected for an additional round of off-season increase in Chile and into another multi-environment trial as well as commercial scale trial, both in 2022.

2.2 | Field trials

The 171 IMI-tolerant lines were evaluated in 2020 in field trials conducted at the OSU Hyslop Crop Science Field Research Lab (Corvallis, OR) and at the OSU-Columbia Basin Agricultural Research Center (CBARC) (Pendleton, OR). At Hyslop, IMI herbicide tolerance was confirmed with a post-planting, pre-emergence application of imazamox at 53 g a.i. ha^{-1} (1× the highest recommended dose) with 0.25% (v/v) non-ionic surfactant and 1% (v/v) ammonium sulfate. In both locations, the 171 lines were planted in an augmented randomized block design and were screened for several agronomic characteristics.

Of the 171 lines, 20 advanced on to replicated trials in 2021 at Hyslop, OSU-CBARC, and on-farm sites near Ione, OR, and Kent, OR. The OSU-CBARC, Ione, and Kent sites were dryland, whereas the Hyslop site was irrigated. Four replicates of each experimental line were grown at Hyslop, and two replicates of each experimental line were grown at each of the dryland locations. One of the two replicates at the site near Ione was discarded due to herbicide damage from a neighboring field. At Hyslop, IMI herbicide tolerance was again confirmed with a post-planting, pre-emergence application of imazamox as described for the 2020 field trial.

In 2022 Successor (DH190481), Survivor, and DH190346 were included in the OSU Cereal Variety Trials in six

TABLE 1 Disease screening and agronomic data from a subset of the initial Successor population from 2020 at the Corvallis, OR, field site.

Line	Heading date (DOY)	Scald	Stripe rust	Height	Yield	Protein	Plump (>6/64″)	TW
		——%——		cm	kg ha^{-1}	%		g L^{-1}
Survivor	148	22	0	87	5,477.4	12.6	87.5	700.2
Successor	140	0	5	77	5,703.9	11.9	88.8	710.6
Lightning	151	0	0	80	3,347.3	14.0	87.4	680.1
DH190675	146	5	60	90	3,993.1	13.2	62.6	589.8
DH190674	140	5	70	90	3,370.7	13.6	41.2	574.6
DH190634	142	0	0	80	5,250.5	14.5	95.2	703.8
DH190575	142	0	0	95	6,045.3	12.6	95.4	727.1
DH190541	139	0	0	85	6,141.0	12.4	93.2	729.0
DH190526	146	0	0	80	4,671.9	13.0	91.3	700.0
DH190523	150	1	13	100	5,691.2	13.6	88.7	719.5
DH190495	148	0	0	85	5,383.1	13.4	87.9	684.3
DH190435	148	0	1	95	5,891.1	12.8	91.5	714.5
DH190424	148	0	1	90	6,167.0	13.3	88.0	680.6
DH190417	146	2	0	93	5,462.7	13.2	89.0	696.7
DH190404	145	2	1	85	5,235.7	11.9	90.6	680.9
DH190366	140	5	10	85	5,209.7	13.5	93.1	708.2
DH190358	150	0	2	90	5,139.7	12.7	76.2	627.8
DH190346	138	0	5	83	5,736.3	11.4	91.8	695.0
DH190319	142	1	1	90	5,050.5	14.3	92.8	707.0
DH190317	153	0	0	90	4,302.4	13.4	78.5	672.0
DH190305	142	10	0	85	6,204.2	12.2	90.6	722.2
DH190287	146	0	5	80	5,035.1	12.1	88.9	677.6

Abbreviations: DOY, day of year; TW, test weight.

locations: Ione, OR; Kent, OR; Klamath Falls, OR; La Grande, OR; Pendleton, OR (OSU-CBARC); and Tulelake, CA. The Ione, Kent, and Pendleton sites were dryland; the La Grande, Klamath Falls, and Tulelake sites were irrigated. The 2022 Kent trial was not harvested due to severe elk damage in the trial. All field sites were managed according to local agricultural practices.

2.3 | Commercial trial

The top two accessions from the Successor population, DH190346 and DH190481 (Successor), and Survivor were evaluated in a large-scale field trial at Emerson Dell Farm, The Dalles, OR (45.54°N, 120.98°W) in 2022. Grain was planted in approximately 0.40-ha strips, with the experimental lines planted as a single replicate and Survivor planted in two strips on each side of the experimental lines, respectively: two for sample evaluation and two as borders to mitigate border effect. Prior to this trial, the field had been planted to sunflower (*Helianthus annuus* L.) in 2021, left as no-till fallow in 2020, and planted to soft white winter wheat in 2019. Weeds were managed with two applications using a tank mix of Affinity at 51 mL ha^{-1} (active ingredient: carfentrazone-ethyl) and Huskie at 1096 mL ha^{-1} (active ingredients: pyrasulfotole, bromoxynil octanoate, and bromoxynil heptanoate). A propiconazole fungicide was added to the tank mix at 292 mL ha^{-1} for disease control. Grain was harvested on August 27 using the farm's equipment.

2.4 | Statistical analysis

Data were assessed using ANOVA, and mean comparisons were performed using Fisher's LSD. Data for the multi-environment trials presented herein are subsets of the complete trials, and statistical analysis incorporates the entire dataset. Access to data from the 2022 OSU Cereal Variety trials is available at https://cropandsoil.oregonstate.edu/wheat/osu-wheat-variety-trials.

3 | CHARACTERISTICS

The cross between Survivor and Lightning was made to combine the IMI tolerance and yield potential of Survivor with the

TABLE 2 Spring yield trials from 2021 at the Corvallis, OR, field site.

Line	Yield	Protein	Plump (>6/64″)	TW
	kg ha^{-1}	%		g L^{-1}
Survivor	4,452.0a	11.39ab	88.0bcd	674.5defg
Successor	4,117.4ab	11.33a	88.1bcd	682.9fg
Lightning	3,028.3ab	14.44g	92.2cde	649.4bc
DH190675	3,911.2ab	12.46abcde	82.1b	643.3ab
DH190674	3,576.6ab	11.81ab	73.2a	625.6a
DH190634	3,384.1ab	13.77fg	93.6cde	655.8bcde
DH190575	3,685.1ab	12.42abcde	96.2e	682.5fg
DH190541	4,106.8ab	12.12abcd	93.2cde	685.7g
DH190526	2,960.2ab	13.24defg	95.5de	655.8bcde
DH190523	3,631.3ab	12.59bcdef	92.0cde	685.1g
DH190495	3,866.1ab	12.51abcde	93.1cde	661.0bcdef
DH190435	3,695.7ab	12.23abcd	92.9cde	674.5defg
DH190424	4,056.9ab	11.92abc	91.7cde	653.6bcd
DH190417	3,298.9ab	12.48abcde	92.0cde	651.0bc
DH190404	3,789.3ab	11.37a	93.3cde	657.1bcde
DH190366	3,432.6ab	13.10cdef	93.8cde	670.9cdefg
DH190358	3,738.0ab	12.19abcd	93.2cde	642.3ab
DH190346	4,136.2ab	11.67ab	89.6bcde	652.9bcd
DH190319	3,227.8ab	13.46efg	86.0bc	650.0bc
DH190317	2,579.9b	14.37g	89.0bcde	642.3ab
DH190305	4,069.5ab	11.63ab	88.0bcd	676.4efg
DH190287	3,822.1ab	11.69ab	94.1de	659.7bcde

Note. This assessment includes 20 lines selected from the original Successor population and the two parents (Survivor and Lightning). Significant differences for each metric were found at the <0.05 level. Letters annotate mean separation within groups; entries with the same letter are not significantly different using LSD.
Abbreviation: TW, test weight.

superior disease resistance qualities of Lightning. Although Survivor displays resistance to IMI via a similar molecular mechanism to fully resistant wheat cultivars, it does not confer complete tolerance to IMI exposure; rather, Survivor is suitable for growth in soil and/or stubble with residual IMI herbicide (Rustgi et al., 2014). Successor gains its AHAS allele from Survivor and thus has similar tolerance. Greenhouse screening for IMI tolerance was performed on the complete population of 411 DHs at a rate above the recommend application dosage. Herbicide screening found that 174 lines were IMI tolerant, and 171 were advanced to further evaluation trials in two locations in Oregon in 2020.

Initial agronomic evaluation of selections was performed in 2020 in Corvallis and Pendleton, OR, for yield, grain quality, and disease resistance. A subset of the complete 171 selection dataset from Corvallis is shown in Table 1 (the complete dataset is available upon request) and includes the 20 selections advanced to 2021 and the two parents. The data are not reported for the 2020 Pendleton field trial because a field effect negatively affected a large portion of the trial, including nearly half of the 20 lines selected for advancement. At

TABLE 3 2021 results from field trials at three locations: Ione, OR; Kent, OR; and Pendleton, OR.

Location	Line	Yield	Protein	TW
		kg ha^{-1}	%	g L^{-1}
Ione	DH190346	1,442	15.3	686.1
	Successor	1,697	14.3	696.4
	Survivor	1,550	15.1	677.1
Kent	DH190346	1,194	14.4	576.7
	Successor	1,690	12.1	620.4
	Survivor	1,175	13.3	567.7
Pendleton	DH190346	2,711	8.9	708.0a
	Successor	2,541	8.8	718.3a
	Survivor	2,464	8.4	665.5b

Note. Mean separation was performed at each location and annotated results for metrics at locations were found to be significant at the <0.05 level. Letters annotate mean separation within groups; entries with the same letter are not significantly different using LSD. Significant differences were found only for test weight at the Pendleton location.
Abbreviation: TW, test weight.

TABLE 4 2022 results from field trials at five locations: Ione, OR; Pendleton, OR; La Grande, OR; Klamath Falls, OR; and Tulelake, CA.

Location	Line	Yield	Protein	TW	Height
		kg ha^{-1}	%	g L^{-1}	cm
Ione	DH190346	3,436b	10.4	691.2b	62.7
	Successor	3,759b	10.4	710.5a	64.0
	Survivor	4,582a	10.1	702.8ab	66.8
Klamath Falls	DH190346	2,628	14.7	643.6	74.7
	Successor	3,099	14.4	644.9	79.0
	Survivor	2,742	15.9	637.2	80.8
La Grande	DH190346	5,553b	11.8	705.4b	77.2c
	Successor	6,680a	11.5	728.5a	82.3b
	Survivor	5,877ab	11.5	728.5a	92.5a
Pendleton	DH190346	5,568b	9.7	727.3b	79.2
	Successor	6,141a	9.6	751.7a	87.6
	Survivor	5,810ab	9.7	746.6a	90.9
Tulelake	DH190346	8,159	11.4	634.6b	95.5b
	Successor	8,245	10.4	673.2a	104.4a
	Survivor	7,622	11.1	673.2a	109.5a

Note. Mean separation was performed at each location and annotated results for metrics at locations were found to be significant at the <0.05 level. Letters annotate mean separation within locations; entries with the same letter are not significantly different using LSD. Data from Kent, OR, were not included in 2022 due to elk damage at the field site.

Corvallis, Successor showed strong overall agronomics, with moderate yields, high test weight (TW), and minimal susceptibility to scald (caused by *Rhynchosporium commune*) and barley stripe rust (caused by *Puccinia striiformis* f. sp. *hordei*). Although scald impact was minimal across the experiment as a whole, Successor outperformed the trial average for barley stripe rust susceptibility (30.2%). Successor had an earlier heading date than Survivor and overall was 8 days earlier than the trial mean.

In the 2021 Corvallis yield trials, Successor performed well, with an average yield of over 4000 kg ha^{-1}. However, there was minimal separation in yield between all entries, with all but two entries falling into one group (Table 2), and Successor, Lightning, Survivor, and 18 of the other DHs did not yield significantly different from each other. Successor had moderately plump grain (88.1%) but did have the second highest overall TW (682.9 g L^{-1}). It also had the lowest protein (11.33%) in the trial. There is no premium paid for grain protein in the feed barley market, so this is not an issue. It should be noted that Corvallis, a high-rainfall environment with available spring irrigation, is not a target environment for this cultivar in particular or for spring feed barley in general.

A multi-environment trial was performed in 2021 and 2022 to evaluate the cultivar in a selection of locations within the current growing region under dryland conditions. Results for the 2021 and 2022 trials are shown in Tables 3 and 4, respectively. In the 2021 trials, Successor performed similar to Survivor for most metrics at all locations. The exception was TW at Pendleton, where Successor and DH190346 were both significantly higher than Survivor. In 2022, Successor saw the highest yield of the three lines in Pendleton, La Grande, Klamath Falls, and Tulelake, but the difference between Successor and Survivor was not statistically significant. Yields were much lower in Ione than the other locations, and Survivor yielded significantly greater there than both Successor and DH190346. Successor had the highest TW of the three entries in three locations and was matched for the highest TW with Survivor at two locations, but again the differences between Successor and Survivor were not statistically significant. Successor appeared to be shorter than Survivor and taller than DH190346, but the difference between the three was only significant in La Grande. The height difference between Successor and DH190346 was also significant in Tulelake. Grain protein did not differ significantly between entries at any location, which indicates that protein synthesis in these lines may be driven primarily by environmental conditions such as water availability (Gous et al., 2015).

The commercial trial in 2022 was performed to evaluate the final two accessions against Survivor in a larger-scale field setting as well as to assess grower interest in the new cultivar. Results from this trial are shown in Table 5. The two experimental lines were only planted as single replicates, and thus no statistical analysis was performed. At this location, Successor had the earliest heading date of the three entries but was similar to DH190346 (data not shown), which aligns with the Corvallis field trial. Successor was the highest-yielding entry, outyielding Survivor by 300 kg ha^{-1}. Protein was similar between Successor and DH190346, which were

TABLE 5 Results of on farm trials at Emerson Dell Farm, The Dalles, OR.

Line	Yield	Protein	Plump (>6/64″)	Thin (<5/64″)	TW	Moisture
	kg ha^{-1}	%			g L^{-1}	%
DH190346	3,921.3	12.8	98.2	2.25	654.5	10.6
Successor	3,926.7	12.9	85.6	5.4	652.6	10.5
Survivor	3,501.3	13.4	92.4	4.85	647.5	10.5

Note. Data are the mean of two subsamples from the same strip.
Abbreviation: TW, test weight.

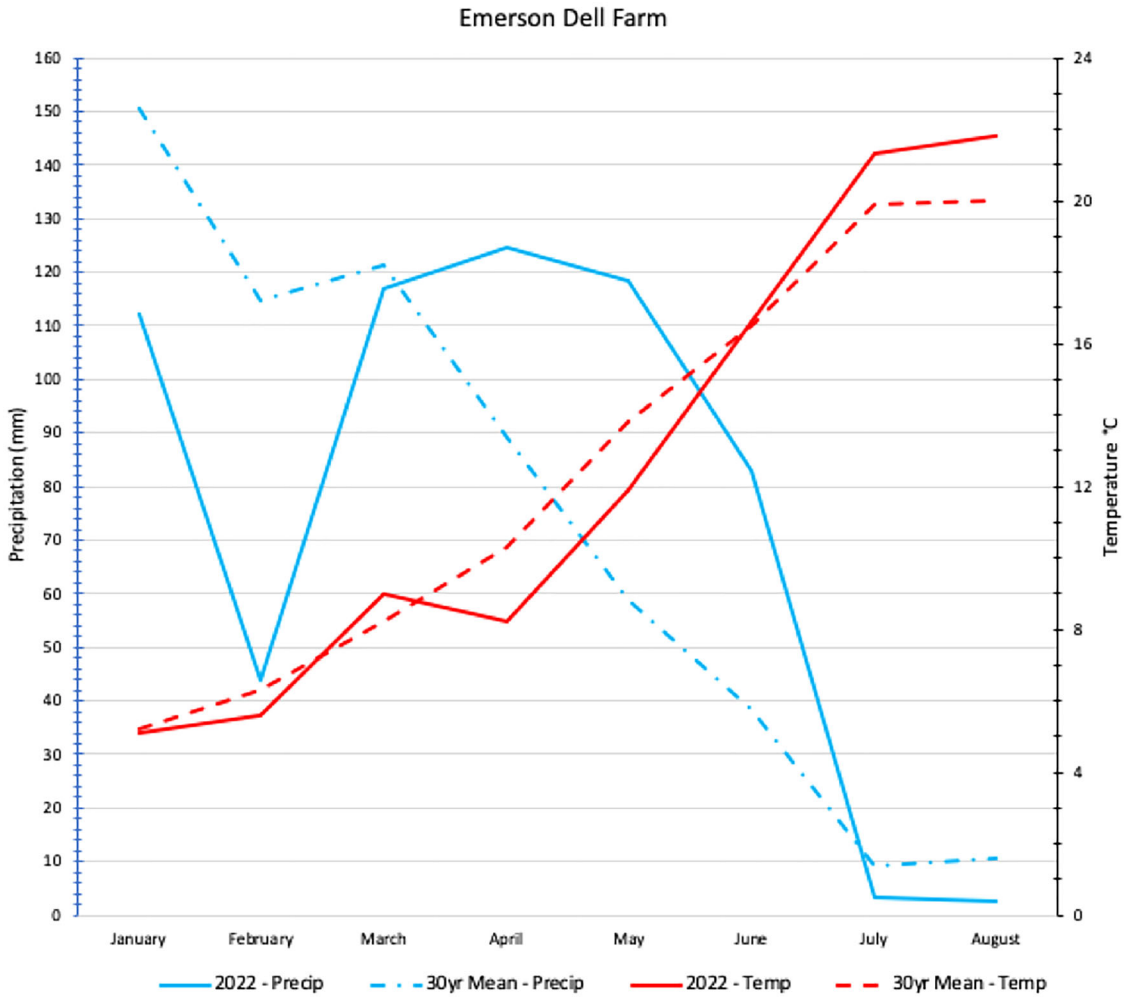

FIGURE 1 Weather data for Emerson Dell Farm comparing 2022 with the 30-year average rainfall and temperature. Data were aggregated using the Prism Climate Group tool available at https://www.prism.oregonstate.edu/ (PRISM Climate Group, 2022).

both 0.5%–0.6% lower than Survivor. The largest range was found for plump grains; Successor was the lowest of the three but had similar thin kernels to Survivor. Weather data for the location are shown in Figure 1 and show that, whereas temperature followed close to the 30-year mean, rainfall came in a much different pattern. The area saw much lower winter precipitation, receiving 109 mm less than average over January and February. However, the spring was quite wet, with 139 mm more rain than average throughout April, May, and June. Because it appears Successor heads and matures earlier than Survivor, this may indicate that Successor would be even better suited for the environment during a normal rainfall year because it would be more apt to take advantage of the residual winter soil moisture during the typical precipitation patterns.

4 | CONCLUSION

Successor barley is a novel cultivar that exhibits tolerance to residual IMI herbicide in soil and crop residue. It is well suited

to dryland and conservation/no-tillage agricultural systems in eastern Oregon and Washington. In a multi-environment trial, Successor met or exceeded the yield of Survivor in all years in all but one location year. Additionally, it had similar protein levels and test weights as Survivor. A commercial trial showed its potential under standard management conditions in a rotation including oil seed crops and winter wheat and was perceived favorably by the grower. Successor's early maturity suggests it may perform best relative to other varieties in environments with late-season water stress, as is often the case in low-rainfall environments and fields with shallow soil. Successor provides a new option for growers to add barley to a rotation with Clearfield crops, being only the second released variety with known tolerance to IMI residues.

5 | AVAILABILITY

The production of certified classes of seed is proceeding as follows. Breeder seed was produced from head row purification blocks at Hyslop Farm, near Corvallis, OR, in 2021. Approximately one-quarter of an acre of this seed was harvested in summer of 2022 in Othello, WA, by Washington State Crop Improvement Association to produce breeder seed. Seed for 1 acre (~50 kg) will be saved for planting approximately 1–2 acres of foundation seed increase in the spring of 2023. Orders for foundation seed (to be harvested summer 2023) will be taken 1 year in advance (in spring 2023) for planting spring of 2024.

Successor is proposed for release with a non-exclusive license, per previous OSU malting barley cultivars. There will be a one-time application fee of $250 for each non-exclusive license. Those interested in a license should contact Denis Sather at the OSU Office of Commercialization and Corporate Development (denis.d.sather@oregonstate.edu). Successor seed, for planting purposes, can only be sold as a class of certified seed with a royalty of $0.02 lb^{-1} (approximately $0.067 kg^{-1}). The $0.02/lb royalty will be paid on sale of this seed. All grain harvested from the certified production must be disposed of by malting or feeding, unless permission is obtained—in writing—from OSU to use the seed for other purposes, including re-planting. Seed of Successor has also been deposited into the USDA-ARS National Laboratory for Genetic Resources, where it will be available immediately upon publication.

Plant Variety Protection will not be sought for Successor because this cultivar will meet an immediate short-term need for IMI-tolerant barley. Long-term, the reduced use of IMI herbicides, and generally low price for feed barley do not justify the cost of PVP. The cultivar will be protected by Federal Seed Law and OSU recognized as the owner of the cultivar. Furthermore, Oregon, Idaho, and Washington state trademarks will specify that the cultivar can only be sold under the name of "Successor."

AUTHOR CONTRIBUTIONS

Campbell P. Morrissy: Data curation; investigation; writing—original draft; writing—review and editing. **Daniela Carrijo**: Data curation; formal analysis; investigation; methodology; writing—review and editing. **Tanya P. Filichkin**: Investigation. **Scott P. Fisk**: Investigation; methodology; writing—review and editing. **Laura Helgerson**: Investigation. **Ryan Graebner**: Data curation; investigation; methodology; writing—review and editing. **David Brewer**: Investigation; methodology. **Patrick M. Hayes**: Conceptualization; investigation; methodology; resources; supervision; writing—original draft; writing—review and editing.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

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REFERENCES

Alister, C., & Kogan, M. (2005). Efficacy of imidazolinone herbicides applied to imidazolinone-resistant maize and their carryover effect on rotational crops. *Crop Protection*, *24*(4), 375–379. https://doi.org/10.1016/j.cropro.2004.09.011

Cistué, L., Vallés, M., Echávarri, B., Sanz, J., & Castillo, A. (2003). Barley anther culture. In I. Maluszynski, M., Kasha, K. J., Forster, & B. P., Szarejko (Eds.), *Barley anther culture*. Springer Science & Business Media. https://doi.org/10.1007/978-94-017-1293-4_5

Gous, P. W., Gilbert, R. G., & Fox, G. P. (2015). Drought-proofing barley (*Hordeum vulgare*) and its impact on grain quality: A review. *Journal of the Institute of Brewing*, *121*(1), 19–27. https://doi.org/10.1002/jib.187

Hayes, P., Carrijo, D. R., Filichkin, T., Fisk, S., Helgerson, L., Hernandez, J., Meints, B., & Sorrells, M. E. (2021). Registration of 'Lightning' barley. *Journal of Plant Registrations*, *15*(3), 407–414. https://doi.org/10.1002/plr2.20129

Hess, F., Harris, J., Pendino, K., & Ponnock, K. (2010). Imidazolinones. In R. Krieger (Ed.), *Hayes' handbook of pesticide toxicology* (3rd ed., pp. 1853–1863). Academic Press.

Matus, I., Corey, A., Filichkin, T., Hayes, P. M., Vales, M. I., Kling, J., Riera-Lizarazu, O., Sato, K., Powell, W., & Waugh, R. (2003). Development and characterization of recombinant chromosome substitution lines (RCSLs) using *Hordeum vulgare* subsp. spontaneum as a source of donor alleles in a *Hordeum vulgare* subsp. vulgare background. *Genome*, *46*, 1010–1023. https://doi.org/10.1139/g03-080

Murphy, K., & Ullrich, S. E. (2018). *Barley variety 'Survivor' (07M-203), two-row spring barley*. Washington State University. https://wsu.technologypublisher.com/technology/35141#:~:text=Survivor%20is%20a%20two%2Drow,a%20high%20yielding%20genetic%20background

Pozniak, C. J., & Hucl, P. J. (2004). Genetic analysis of imidazolinone resistance in mutation-derived lines of common wheat. *Crop Science*, *44*(1), 23–30. https://doi.org/10.2135/cropsci2004.2300

PRISM Climate Group. (2022). *Time series values for individual locations*. Oregon State University. https://www.prism.oregonstate.edu/

Rustgi, S. (2013). Bringing barley back in crop rotation by breeding for imidazolinone resistance. *Medicinal & Aromatic Plants*, *02*(06), https://doi.org/10.4172/2167-0412.1000e148

Rustgi, S., Matanguihan, J., Mejías, J. H., Gemini, R., Brew-Appiah, R. A. T., Wen, N., Osorio, C., Ankrah, N., Murphy, K. M., & Von Wettstein, D. (2014). Assessment of genetic diversity among barley cultivars and breeding lines adapted to the US Pacific Northwest, and its implications in breeding barley for imidazolinone-resistance. *PLOS ONE*, *9*(6), 1–13. https://doi.org/10.1371/journal.pone.0100998

Schillinger, W., McKenzie, R. H., & Tanaka, D. (2011). Cultural practices: Focus on major barley-producing regions - North America. In S. E. Ullrich (Ed.), *Barley: Production, improvement, and uses* (pp. 221–281). Wiley. https://doi.org/10.1002/9780470958636.ch9

Tan, S., Evans, R. R., Dahmer, M. L., Singh, B. K., & Shaner, D. L. (2005). Imidazolinone-tolerant crops: History, current status and future. *Pest Management Science*, *61*(3), 246–257. https://doi.org/10.1002/ps.993

USDA National Agricultural Statistics Service (USDA-NASS). (2022). *Small grains summary - September 2022*. https://downloads.usda.library.cornell.edu/usda-esmis/files/5t34sj573/h128pr261/5138kq83p/smgr0922.pdf

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