DESICCATION OF STAY-GREEN AND CONVENTIONAL SUNFLOWER

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Abstract

Development of stay-green sunflower hybrids that exhibit delayed senescence requires determination of desiccant effectiveness in hastening harvest maturity. Stay-green and conventional sunflower hybrids were evaluated for plant drydown response to desiccant and control treatments in the 2000 and 2001 growing seasons in North Dakota. The experiment was a RCB in a split-split-plot design with desiccant treatment, hybrid, and harvest date representing main, sub, and subsub factors, respectively. Stay-green hybrid 6338 and conventional hybrid 63M91 were established in stands of 51,800 plants/hectare in four row plots with 0.76 m spaced rows 7.6 m in length. Desiccant treatments consisted of paraquat applied at labeled rates at approximately 50% achene moisture and a non-desiccated control treatment. Four harvest dates occurred at 7 d intervals following desiccant application where achene, receptacle, and stalk moisture were determined. Results indicated hybrid achene moisture response across harvest dates was similar for desiccated or control treatments, and desiccation hastened achene moisture loss to harvestable levels by 7 d. High receptacle moisture for the stay-green hybrid 6338 would prevent harvest even though achene moisture was at harvestable levels. Desiccation hastened hybrid 6338 receptacle drydown to harvestable levels by more than 5 d. Stalk moisture was also greater for the stay-green than for the conventional hybrid but this may not pose harvestability limitations since only part of the stalk enters the threshing process and the stalk does not break apart like receptacles. Receptacle and stalk moisture differences indicated greater receptacle moisture than stalk moisture differences between stay-green and conventional hybrids.

Introduction

Full season crops grown in regions with short growing seasons such as the northern Great Plains are often subject to fall frosts that terminate plant growth and initiate plant drydown. Delays in occurrence of killing fall frosts may prompt producers to apply chemical desiccants to hasten plant drydown. Recent development of stay-green sunflower hybrids may pose a greater need for desiccation than conventional hybrids. Stay-green hybrids senesce more slowly than conventional hybrids and leaves, stalks, and receptacles remain green after achenes reach physiological and harvest maturity. Consequently crop harvestability is determined by receptacle and stalk moisture rather than by achene moisture.

The study objective was to determine desiccation effects on plant moisture loss response for conventional and stay-green sunflower hybrids.

Materials and Methods

The study was conducted at three North Dakota locations during the 2000 and 2001 growing seasons. Locations were the Carrington Research Extension Center, Carrington (latitude 47^{o} 30' N, longitude 99^{o} 8', elevation 489 m), Agronomy Seed Farm, Casselton (latitude 46° 53′ N, longitude 97° 18′, elevation 288 m) and Prosper (latitude 47° 0′ N, 97° 7′, elevation 284 m), an off-station site associated with the North Dakota Agricultural Experiment Station at Fargo. The experimental design was a randomized complete block in a split-split-plot arrangement with four replicates. Desiccation was the main plot with two levels, application (desiccant) or non-application (control) of the herbicide paraquat (I, l'-dimethyl-4,4'bipyridinium dichloride). Desiccant was applied by ground application with a high-boy sprayer at labeled rates. Subplots consisted of a conventional NuSun hybrid, Pioneer 63M91 and a stay-green hybrid, Pioneer 6338. Moisture sampling dates were the sub-subplots. Achene, receptacle and stalk moisture sampling began on the date of desiccant application and occurred every seven days for four additional dates.

Plant stands were over-sown and thinned at growth stage V2 (Schneiter and Miller, 1981). Oilseed hybrids 63M91 and 6338 were thinned to 51,800 plants per ha. Plots consisted of four rows spaced 0.76 m apart and 7.6 m in length. Data were collected from the center two rows of each plot, with the two outside rows and several plants at row ends serving as border. Data were collected for achene, receptacle, and stalk moisture, achene yield, capitulum diameter, plant height, stalk and root lodging, achene loss due to white mold [*Sclerotinia sclerotiorum* (Lib) De Bary] and natural achene shatter, oil content, and sunflower midge (*Contarinia schulzi* Gagne) incidence. This paper will discuss only achene, receptacle and stalk moistures.

Thirty-five to 45 capitula per plot were hand-harvested and threshed in the field with a Hege 125B plot combine at each moisture sampling date. A plastic tray was placed on the ground behind the discharge of the combine for collection of threshed receptacles. Threshed receptacles were collected in resealable 5-L plastic bags from the in-field threshed capitulum sample. Achene moisture samples (0.5 L) from the threshed capitula were transported to the lab in resealable plastic bags, weighed, and dried for 48 h at 110C. Achenes not used for moisture determination were collected in paper bags, dried at 60C, cleaned, and weighed for yield. Stalks were cut at ground level, grouped into bundles of ten, and transported to the lab for fresh weight determination, drying at 60C, and dry weight determination.

Desiccation, hybrid, and sampling date were considered fixed effects in the analysis of variance and location-year a random effect. Location-year was termed environment in the analysis. The regression procedure was performed on treatment means according to SAS (1999). Analysis of variance and regression probability level was $P \le 0.05$.

Results and Discussion

Analysis across environments showed significant effects for the desiccation by hybrid by moisture sampling date interaction for receptacle and stalk moisture, but not achene moisture (data not shown). This indicates moisture response across sampling dates for desiccated and control treatments and for receptacle and stalk moisture differed among the hybrids. The desiccation by sampling date interaction was significant for achene moisture. Achene moisture was lower for the desiccated than for the control treatment with differences increasing from day 7 to 16 and decreasing from day 16 to 28 (Table 1). A harvestable achene moisture of 15.5% occurred on dad 18 for the desiccated treatment, but the control treatment required 25 d to reach the same achene moisture. This represents a 7 d advantage for an earlier harvest when desiccated compared to not desiccating.

Before the advent of stay-green hybrids, growers based sunflower harvest primarily on achene moisture status, a common standard indicator of harvestability for many crops. Complete threshing of achenes from receptacles and proper combine function was possible at achene moisture levels from 13 to 19% if circumstances warranted; however, most producers generally delay harvest in an attempt to maximize natural drying to lower achene moisture to nearer storage levels of 10%. Although the conventional and stay-green hybrids in this study showed similar achene moisture loss across sampling dates for desiccated and control treatments, the limiting factor regarding harvestability of stay-green hybrids is receptacle moisture and not achene moisture.

At a given achene moisture level, receptacle moisture was higher for the stay-green hybrid 6338 than conventional hybrid 63M91 (Table 1). Maximum receptacle moisture levels reported for harvestability of sunflower were estimated by Johnson et al. (2002) between 37 and 43%. This was based on receptacle moisture of conventional hybrids 63M91 and Cargill 187 and their corresponding upper limit achene moisture at harvest of approximately 15.5% (Johnson and Henson, 2000; Johnson et al., 2002). When desiccated, the hybrids at day 18 showed achene moisture of 15.5% and receptacle moistures of 38.4 and 55.6% for 63M91 and 6338, respectively. Although achene moisture for both hybrids is at harvestable levels, hybrid 6338 shows high receptacle moisture that could prevent harvest. Receptacles at elevated moisture levels cause gumming and plugging of sieves and seed return clogging in the combine.

Control hybrid achene moisture for both hybrids reached 15.5% on day 25 with receptacle moistures of 41.5 and 53.6% for hybrids 63M91 and 6338, respectively. Hybrid 63M91 shows receptacle moisture within the estimated acceptable range but again harvestability of 6338 may be problematic because of high receptacle moisture. Receptacle moisture for the control treatment did not decrease to 43% for the stay-green hybrid 6338 by day 28, but when desiccated a receptacle moisture of 43.1% was observed on day 23. This shows more than a 5 d earlier harvest for 6338 when this hybrid was desiccated.

Table 1. Achene, receptacle, and stalk moisture levels (%) for control (ND) and desiccant (DS) treatments of conventional hybrid 63M91 and stay-green hybrid 6338 based on regression equations.

Moisture			Receptacle				Stalk			
sampling	Achene		63M91		6338		63M91		6338	
Day	ND	DS	ND	DS	ND	DS	ND	DS	ND	DS
0	51.3	51.3	82.9	82.9	82.0	82.0	82.3	82.3	81.9	81.9
7	44.6	41.2	82.8	80.5	82.4	83.0	82.0	81.4	82.0	82.2
8	41.5	37.8	80.5	75.8	81.8	80.6	80.3	79.5	80.7	81.5
9	38.6	34.7	78.2	71.2	81.0	78.1	78.7	77.5	79.5	80.7
10	35.9	31.8	75.9	66.8	80.2	75.6	77.1	75.6	78.2	79.7
11	33.3	29.0	73.6	62.6	79.2	73.1	75.5	73.7	77.0	78.6
12	30.9	26.5	71.2	58.6	78.2	70.6	73.9	71.7	75.7	77.4
13	28.7	24.1	69.0	54.7	77.0	68.1	72.3	69.8	74.6	76.1
14	26.6	22.0	66.1	51.1	75.7	65.6	70.7	67.8	73.2	74.6
15	24.8	20.1	64.4	47.6	74.2	63.1	69.1	65.9	71.9	73.0
16	23.1	18.4	62.1	44.4	72.7	60.6	67.4	64.0	70.7	71.3
17	21.6	16.9	59.9	41.3	71.0	58.1	65.8	62.0	69.5	69.5
18	20.2	15.5	57.6	38.4	69.3	55.6	64.2	60.1	68.2	67.5
19	19.1	14.4	55.3	35.7	67.4	53.1	62.6	58.1	67.0	65.4
20	18.1	13.5	53.0	33.2	65.4	50.6	61.0	56.2	65.7	63.2
21	17.2	12.8	50.6	30.9	63.2	48.1	59.4	54.3	64.6	60.7
22	16.6	12.7	48.4	28.8	61.0	45.6	57.8	52.3	63.2	58.4
23	16.1	12.0	46.1	26.9	58.7	43.1	56.2	50.4	62.0	55.8
24	15.8	11.9	43.8	25.2	56.2	40.6	54.6	48.4	60.7	53.1
25	15.5	12.0	41.5	23.6	53.6	38.1	53.0	46.5	59.5	50.3
26	15.7	12.4	39.2	22.3	50.9	35.7	51.3	44.6	58.2	47.4
27	16.0	12.9	36.9	21.1	48.1	33.2	49.7	42.6	57.0	44.3
28	16.4	13.6	34.6	20.1	45.1	30.7	48.1	40.7	55.7	41.1

Although receptacle moisture determines harvestability of stay-green hybrids, stalk moisture could be important since the upper part of the stalk passes through the combine during threshing. Desiccant influence on stalk moisture response varied among hybrids (Table 1). Stalk moisture reduction increased for the desiccant treatment compared to the control as sampling date advanced for conventional hybrid 63M91. For stay-green hybrid 6338 desiccant effectiveness did not become apparent until sampling day 18 after which stalk moisture reduction increased for the desiccated treatment compared to the control as sampling date advanced. Stalk moisture reductions for 6338 from day 17 to day 28 were 13.8 and 28.4% for control and desiccated treatments, respectively. This indicates an approximately twofold greater moisture loss for the desiccated treatment compared to the control during this interval. The delayed stalk moisture response to desiccation for 6338 is difficult to explain. Perhaps the stay-green characteristic and a stem exhibiting sharp to 15% curvature with less surface exposed to direct desiccant contact are associated with this response.

The decision to desiccate is multifaceted and involves consideration of many factors besides achene, receptacle, and stalk moisture levels. Growers must also consider acreages to harvest and time required, availability of equipment and labor, storage and drying facilities, calendar date, weather forecast, crop standability, potential bird damage, incidence of disease and insect damage, and possible early harvest crop value incentives. These factors are all involved in estimating the possible economic benefits of desiccation and earlier harvest.

Acknowledgements

Appreciation is extended to Pioneer and Seeds 2000 for providing seed to conduct the study. Thanks also to the New Crops and Carrington Research Extension Center field crews for performing many of the hand-on activities required with the field and lab aspects of the study. Their assistance was integral to the success of the study and is greatly appreciated.

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