PRECIPITATION AND GRASS SEED YIELD IN THE WILLAMETTE VALLEY

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The climate of the Willamette Valley is uniquely suited for the production of cool-season grass seed crops. Even in this ideal climate weather events can have substantive impacts on the yield of grass seed crops. Rainfall events and short-term rainfall patterns appear to have much greater influence on seed yield than do temperature events or patterns. Furthermore, the majority of the Willamette Valley's grass seed acreage is grown without the aid of irrigation. Among the most frequently asked questions pertains to how rainfall affects yield in grass seed crops yet there has not been a systematic investigation of seed yield responses to precipitation. This article reports the preliminary results of my investigation into weather effects on grass seed yield.

The average annual seed yield in the Willamette Valley for three major perennial grass seed crops during the past two and one-half decades is shown in Figure 1. Note that the average seed yield has risen markedly for perennial ryegrass and tall fescue, and to a lesser extent for Chewings fescue. These increases are the result of the development of better management practices and also result from grass seed variety improvement efforts by the seed industry. While there has been a significant overall increase in seed yields, major fluctuations have been recorded in several harvest years during the period. These fluctuations in yield more often involve losses in yield rather increases from the long-term trend line. Are these yield variations related to precipitation events and seasonal patterns? To answer to this question, I compared these seed yields to the precipitation data base of the Oregon Climate Service for Hyslop Farm at Corvallis and at the weather recording site at Silverton.

Figure 1. Willamette Valley seed yield averages for perennial ryegrass, tall fescue, and Chewings fescue during the 1976-1999 period.

The specific timing of the rainfall event or pattern is critical in determining the impact on grass seed yield. The overall or annual precipitation in a given year has virtually no effect on seed yield as some of our best seed yields have been harvested in very dry years (1985; 27.15 inches) or in very wet years (1996; 73.21 inches). Precipitation during the November through February period has little or no impact on yield unless the crop stand is lost due to flooding. The crop is usually dormant during this period and is not actively consuming much water. Rainfall during March and April may have minor effects on seed yield during a protracted drought.

The three major rainfall periods during the crop production cycle that affect seed yield of perennial grasses in the Willamette Valley are as follows:

1. September-October (Autumn Regrowth)
2. May-June (Flowering, Pollination, Early Seed Filling)
3. July-August (Late Seed Filling, and Harvest)

These periods are important because they occur during critical phases of the growth and development of the seed crop, or during harvest operations. These are listed in parentheses after each of the periods.

Low rainfall during September-October can result in the loss of plants in the stand (die-out) in perennial ryegrass. Furthermore, drought during this period reduces fall regrowth, which in turn, results in fewer fertile tillers produced in the following spring in both Chewings fescue and in tall fescue.

Drought during the May-June period can also result in lower fertile tiller numbers because fewer fail to fully develop. The number of spikelets and individual flowers are also reduced. If the crop is maturing early due to warm and dry conditions, then the seeds that are produced are often lighter in weight. High May-June rainfall often leads to poor conversion of flowers to seed as pollination is restricted. This situation is exacerbated by early lodging of the stand during high rainfall in this period which further restricts pollination and seed filling processes. Perennial ryegrass, Chewings fescue, and tall fescue yields are all adversely affected by either extreme in May-June rainfall.

High rainfall during July-August can cause reductions in the weight of late-maturing seed, but can also cause the premature sprouting of the seed in the windrow. Pollination of late-maturing varieties may also be restricted by rainfall events in this normally dry period. Harvest operations may be impeded directly by moisture in the crop or by regrowth stimulated in the windrows of wet fields. Removal of straw from fields after harvest by baling or by burning is often delayed by wet weather, which may affect seed yield in the following season. High rainfall events are infrequent during these months but when they do occur, problems often arise since field operations in the Willamette Valley are based on dry weather during July and August.

Nearly all the major fluctuations in grass seed yield depicted in Figure 1 may be explained by rainfall events and short-term rainfall patterns that have taken place during these three critical periods (Table 1). September-October rainfall was associated with seed yield only when the period was very dry. May-June rainfall caused low seed yields when the amounts were either high or low. High seed yields were recorded when rainfall during this period was normal to slightly below normal. Very high rainfall in July-August were associated with low seed yields. Chewings fescue and tall fescue were affected more by rainfall than was perennial ryegrass.

Relationships between rainfall in the September-October and May-June periods outlined in this article and seed yield have been identified and are similar to the one shown here for tall fescue (Figure 2). It is interesting to note that grass seed yields have gotten more sensitive to rainfall than they have in the past (Figure 2). It is unclear whether the varieties themselves are more sensitive to rainfall or that the farming practices employed today make the crops more sensitive to rainfall. One possible explanation is that modern varieties of these crops generally are later maturing than older varieties. Late maturing varieties flower and produce seed during periods with lower probability of precipitation than do varieties that mature earlier in the season.

Figue 2. Effect of September-October rainfall at Corvallis on seed yield in tall fescue in the Willamette Valley.

Maximum seed yield in Chewings fescue was attained when May-July rainfall at Silverton was about six inches in older varieties and about seven inches in modern varieties (Figure 3). Rainfall higher or lower than these amounts resulted in lower seed yields. One major exception among these relationships is that perennial ryegrass seed yields do not seem to be influenced by rainfall in the previous September-October period. However, the manifestation of stand die-out in older fields of perennial ryegrass is likely to be dependent on early autumn drought conditions. This progressive loss of stand might contribute to lower yields in older stands.

Figure 3. Effect of May-July rainfall at Silverton on seed yield of Chewings fescue in the Willamette Valley.

Forecasting seed yields based on rainfall in one or more prior critical periods may benefit those interested in future seed supply considerations. This knowledge may also be useful in modifying management practices for the purpose of better matching inputs to yield potential in dry or wet seasons. The principle relationships between critical rainfall periods (September-October, May-June) and seed yield in tall fescue outlined earlier in this article have been enumerated (Table 2). Average seed yields in the Willamette Valley have been converted to percentages of the average or base yield under the conditions depicted in the table. This approach obviously ignores variability in yield responses among varieties (one variety may be more drought tolerant than another); however, yield data for individual varieties is not available. Also, the responses of tall fescue seed crops on different soil types cannot be considered in this approach. Users of this table can determine rainfall effects on tall fescue seed yield by calculating the percentage gain or loss given the seasonal rainfall level indicated in the table. For example, suppose that September-October rainfall is 4 inches and May-June rainfall is 2 inches, then the available rainfall would reduce seed yield to 92% of normal. If the average yield is for your field is 1000 lbs./acre, then the expected seed yield would be 920 lbs./acre.

Information on rainfall effects in other grass seed crop species will be presented in future reports.

Table 1. Precipitation involvement in selected fluctuations in seed yield of Willamette Valley grass seed crops. Precipitation values in bold are related to the seed yield response for a given crop year in bold.

Crop Year	Precipitation (% of normal) Sept.-Oct.	May-June	July-Aug.	Seed yield response Perennial ryegrass	Chewings fescue	fescue
1978	54	118	**191**	Normal	**Low**	Normal
1980	94	**83**	18	**High**	Normal	**High**
1981	201	**144**	8	Normal	Low	Low
1983	185	75	**344**	Normal	**Low**	Normal
1984	119	**207**	14	Normal	**Low**	Normal
1985	34	**82**	74	Normal	High	High
1989	**7**	68	87	Normal	Normal	Low
1992	116	**30**	117	Low	Low	Low
1993	59	**171**	80	Normal	Low	Normal
1995	**25**	98	97	Low	Low	Low
1998	162	**175**	7	Low	Low	Low

Table 2. September-October and May-June rainfall effects on tall fescue seed yield in the Willamette Valley. To use: find the point where the two rainfall periods intersect and multiply the percent gain or loss by your average seed yield.

Sept.-Oct. rainfall (inches)	May-June rainfall (inches) 0	1	2	3	4	5	6	7
0	68	73	78	83	89	94	99	104
1	72	77	82	87	93	98	103	114
2	75	80	85	90	96	101	106	117
3	79	84	89	94	100	105	110	121
4	82	87	92	97	103	108	113	124
5	85	90	95	100	106	111	116	127
6	89	94	99	104	110	115	120	131
7	92	97	102	107	113	118	123	134
8	96	101	106	111	117	122	127	138
9	99	104	109	114	120	125	130	141
10	102	107	112	117	123	128	133	144