INFLUENCE OF WEATHER ON LUCERNE HAY PRODUCTION AND QUALITY: 2020|21 PRODUCTION SEASON

INFLUENCE OF WEATHER ON LUCERNE HAY PRODUCTION AND QUALITY: 2020|21 PRODUCTION SEASON

1. INTRODUCTION

The extent of the reduction in yield and quality of lucerne hay depends on heat, irrigation, harvesting schedule, harvest management and weather patterns. Of these, harvest management has by far the greatest impact on forage quality and is under the direct control of the producer. Producing lucerne hay for maximum yield and quality requires an understanding of how environmental and management factors influence crop growth and development.

2. YIELD|QUALITY TRADEOFF

In order to understand the factors that influence lucerne hay quality and yield, it is firstly important to have a basic understanding of how the plant works (Figure 1). As the lucerne plant matures the stems become more lignified in order to support the plant in reproduction, as it becomes heavier due to flowering. The stems also become proportionally more, in comparison with leaves. This causes higher yield, but lower quality. The lucerne will also take longer to dry, due to thicker stems, which will in turn cause increased leaf loss to due to shattering (lucerne leaves dry out 3 to 5 times faster than the stems). Therefore, finding the perfect balance between yield and quality should be the main objective of lucerne hay production.

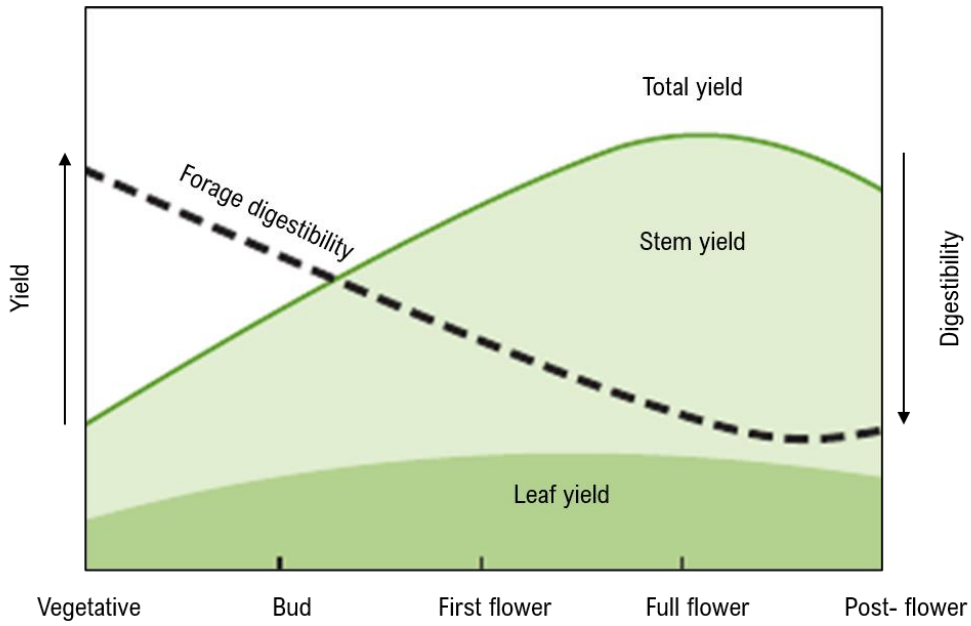


Figure 1: Forage yield relative to quality at different lucerne growth stages.

3. EFFECT OF TEMPERATURE AND RAIN ON LUCERNE HAY PRODUCTION

To begin with, the smallest amount of untimely rain can postpone the harvesting process causing your rapidly maturing lucerne to decline in quality very fast. Rain just before harvesting slows down drying after harvesting, because the soil remains moist despite sunshine and low humidity. However, rain pre-harvesting is just the tip of the iceberg. The mecca of problems starts when it rains post-harvesting. The first, and most obvious, reason is because rain increases the amount of time needed for lucerne to dry, it also increases the amount of times the lucerne is mechanically handled, which encourages further leaf loss. Rain on lucerne in the drying process, can decrease the amount of leaves retained from 62% to 38%. Partially dried lucerne that is exposed to rain loses much of its nutrients due to leaching, as most of the nutrients in lucerne hay are water soluble. Secondly, apart from physical rain, high humidity with no wind also poses a problem, as it hinders evaporation from the windrow by leaving no room for the replacement of saturated air with unsaturated air. Furthermore, the additional drying time caused by rain, causes damage to the regrowth of lucerne due to shading from the windrow (Figure 2).

Figure 2: Damage to regrowth from windrows that remained to long due to rain.

When looking at the influence of heat on the lucerne plant, it is important to note that lucerne that is grown in high heat produces high protein content, which is good, however when taking into account that this lucerne also has a high fiber content it becomes irrelevant. High temperature, which increases the rate of plant maturation and cell wall lignification, has a dominant effect. Therefore, the rate of decline in digestibility with time is faster in summer when temperatures are high than in spring or autumn when temperatures are low. Another problem is high night-time temperatures, as this causes respiration during the night and thus a decline in valuable nutrients and the plant is unable to store root carbohydrates under short harvesting schedules. The heat-driven growth rates not only deplete root reserves, but also increase fiber content, reduce soluble highly-digestible carbohydrates, and reduce quality. The higher level of soluble carbohydrates, coupled with slower lignification are thought to be the major reasons for the high quality of cool-season grown lucerne hay, regardless of where it's grown.

During the day, the inability of the plant canopy to cool itself is a problem. In Graph 4 and 5 the higher rainfall experienced in the current season combined with high humidity is an exacerbating problem, since evaporative cooling doesn't work as well. This, coupled with high respiration rates during the night, along with water and salt stress, is thought to cause early flowering, smaller leaf size and lower growth rates. Thus, even the traditional 21 day harvesting schedule does not help in ensuring a high-quality product (Graph 5).

Premature flowering is not only identified by lack of height in the plant but also by reduced stem numbers. This response may be due to water stress, or the combined effect of low root carbohydrates and high temperatures. From the literature it is evident that warm temperatures followed by a cold period decreases the growth rate of plants, the effect being more severe on lucerne as indicated in Table 1.

Cold injury, whether visible frost is present or not, may affect the growth of both established lucerne plants, as well as newly emerged seedlings. This not only negatively affects the yield, but also has a significant negative effect on quality

4. 2020|21 PRODUCTION SEASON

The current situation regarding lucerne hay production in South Africa can be seen and compared with previous years in Table 1 and 2. In Table 1 a clear decrease in NLQI values (and thus lucerne quality) over the past 3 years is visible. Table 2 gives a detailed distribution of the amount (%) of lucerne in each grade category over lucerne hay production periods (months) in the last 4 years. The production of prime quality lucerne normally takes place during September, October and November.

However, while looking at the weather data in Graphs 1- 5 there is a clear deviation from normal climatic patterns as from the 2019|20 production season until the current production season, while 2018|19 presented a more ideal lucerne production climate with night-time temperatures below 20˚C; these conditions give the plant an opportunity to translocate reserves to its roots. On the contrary, high night-time temperatures promotes respiration at night which burns away valuable carbohydrates and increases the fiber content of the plant while also having a negative effect on regrowth; and extremely low night-time temperatures such as the sporadic instances of frost in September 2020|21 (Figure 3, Graph 4 and 5) which caused severe cold damage. The ideal temperatures for lucerne growth are between 22-24 ˚C and when temperatures reach 1.5 ˚C and below, growth stops.

Figure 3: Lucerne plant with frost.

In the Octobers of 2018-2020 there was a fair amount of prime lucerne produced, however the temperatures varied greatly from day to day, and so did the gaps between maximum and minimum temperatures all through October 2019|20 to the end of November 2019|20, which caused the decline in prime lucerne production form 2018|19 to 2020|21 (Graph 3,4 and 5; Table 1). These fluctuations in temperature cause instability in the physiological development of the lucerne plant.

November of 2020 presented much more rain in comparison with previous years (Graph 2- 4 and 5); the increased amounts of rain combined with the temperature fluctuations, as well as higher than normal temperatures, caused the significantly low amounts of prime lucerne produced in the 2020|21 (current) production season (Table 2). As previously mentioned, evaporative cooling isn't efficient when high rainfall combined with high humidity is experienced.

During December 2020 and January 2021 (though on fewer occasions) respiration at night due to high night-time temperatures was a common occurrence. This occurrence burns valuable nutrients instead of giving them an opportunity to translocate into the roots, as previously mentioned. It also has a negative effect on growth, presents a smaller leaf size and promotes early flowering.

Taking these affects into account, lower quality lucerne is naturally expected (Table 1 and 2).

5. CONCLUSION

For the purpose of simplicity, only data collected in the Douglas area is included in this report; however, the same tendencies are visible in other areas. There is a limited amount of research available on the influences of weather on lucerne in South Africa. The data used in this is report is unpublished data collected recently. Thus far, data like the data published in this article can merely help us understand production seasons such as the one we are currently experiencing, as it is quite unique and there has been no previous data collected to explain it.

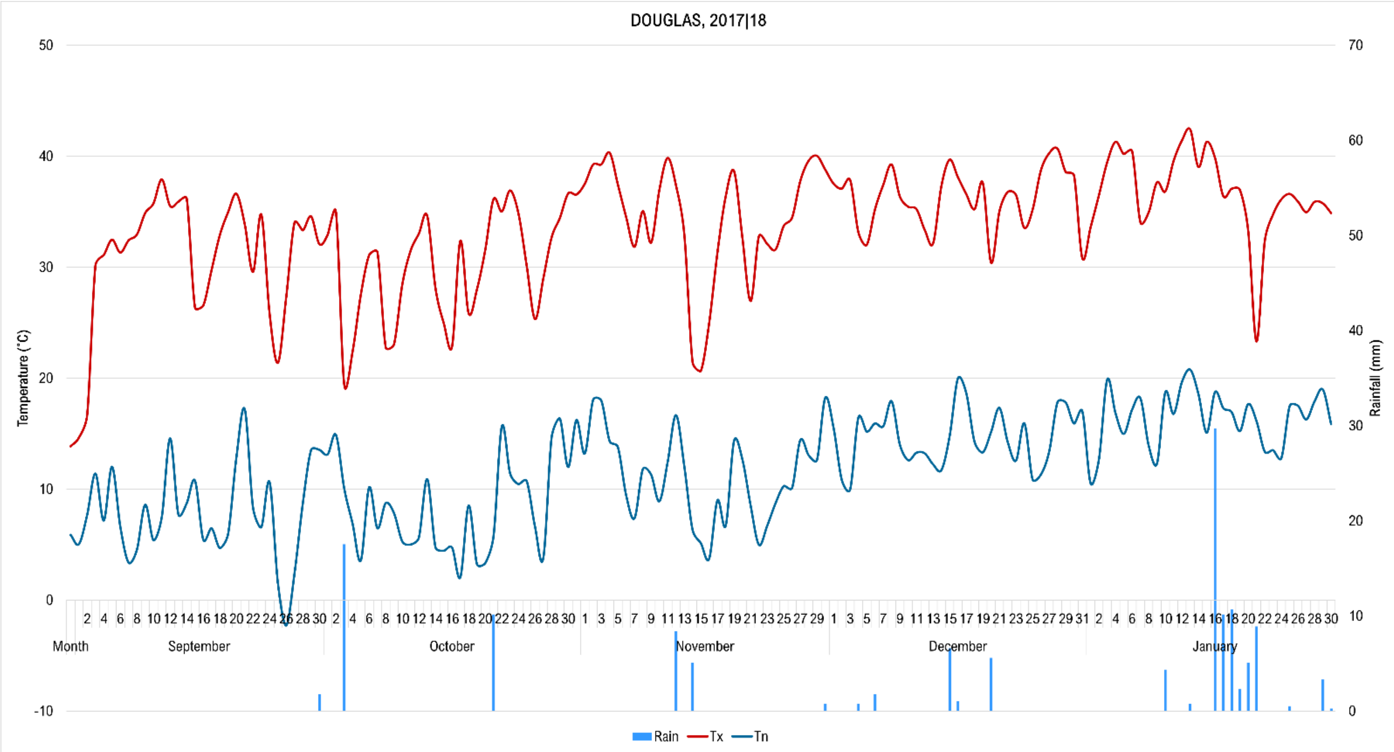
Table 1: Monthly average NLQI values between 2017 – 2021, September – January (NLQI = New Lucerne Quality Index)

MONTH	2017|18	2018|19	2019|20	2020|21
September	104	107	104	101
October	104	107	104	104
November	103	105	102	100
December	102	104	101	100
January	102	103	99	99
Average NLQI	**103**	**105**	**102**	**101**

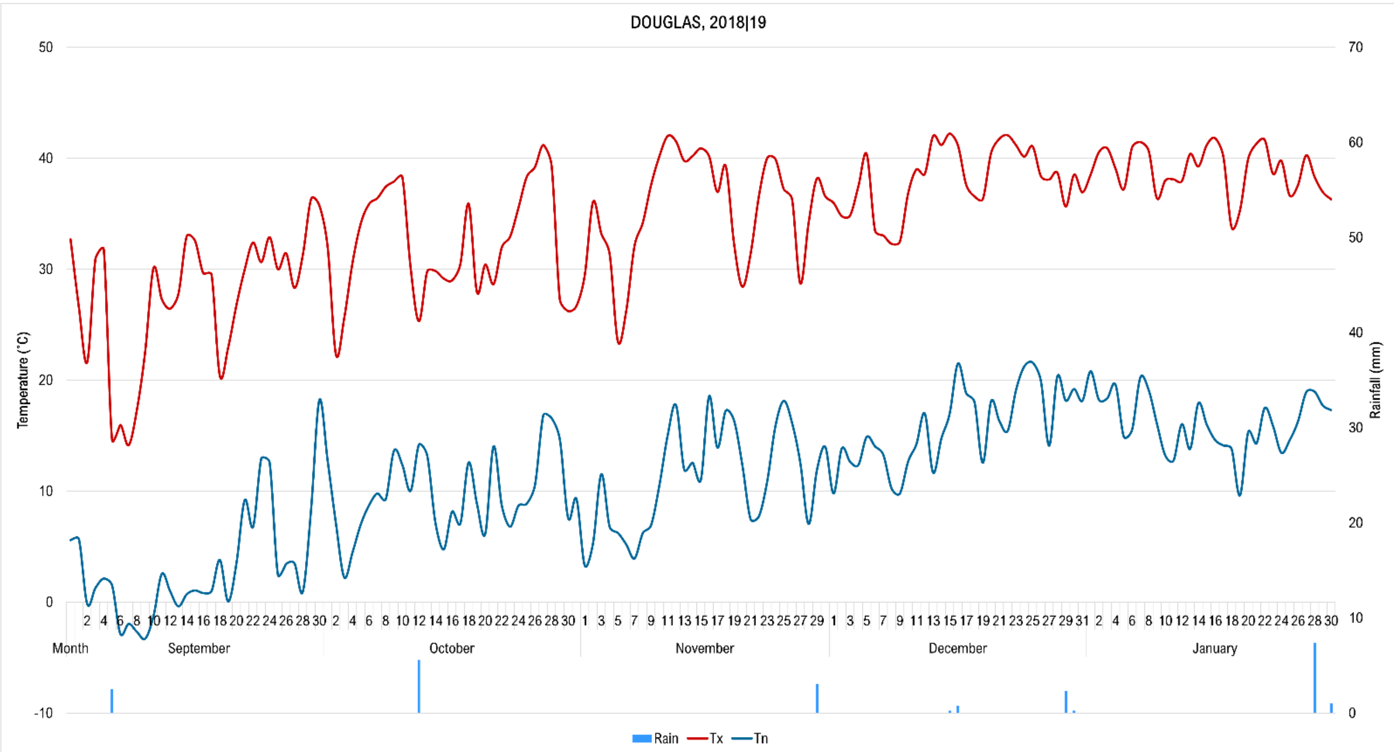
NLQI values: Prime | 104 and higher; Grade 1 | 97 – 103; Grade 2 | 93 – 96; Grade 3 | 92 and less.

Table 2: Percentage (%) of different grades of lucerne hay certified between 2017 – 2021, September - January

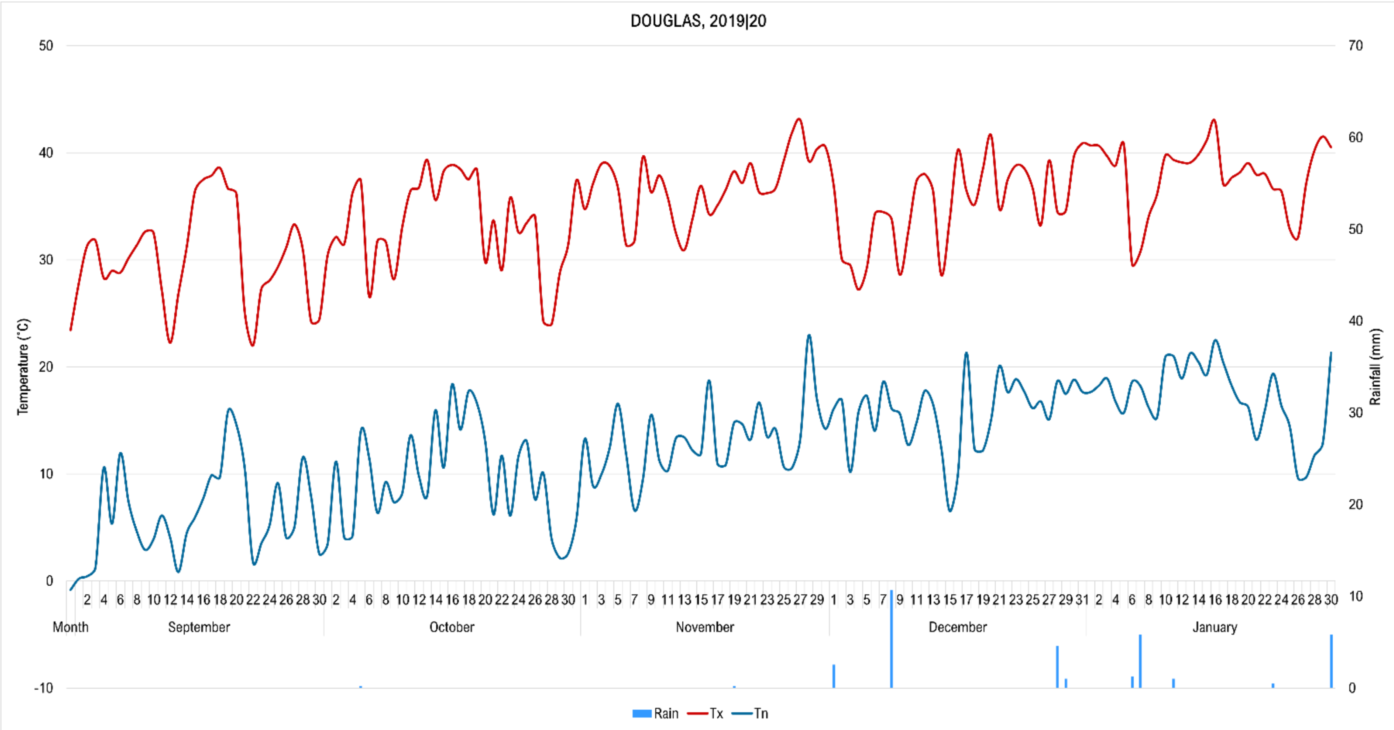
MONTH	2017|18	2018|19	2019|20	2020|21
SEPTEMBER				
Prime	63,64	76,90	61,44	43,47
Grade 1	29,97	15,49	31,33	37,54
Grade 2	3,70	4,89	5,44	13,83
Grade 3	2,69	2,72	1,78	5,15
Total analysis	**297**	**368**	**900**	**1 417**
OCTOBER				
Prime	63,40	82,78	57,36	60,27
Grade 1	34,12	16,13	39,25	34,97
Grade 2	2,23	0,89	2,63	2,75
Grade 3	0,25	0,21	0,76	2,00
Total analysis	**806**	**1 463**	**1 977**	**1 747**
NOVEMBER				
Prime	60,14	71,44	39,73	23,36
Grade 1	37,34	26,36	54,00	59,22
Grade 2	2,33	2,14	4,99	13,47
Grade 3	0,18	0,05	1,28	3,94
Total analysis	**1 114**	**1 821**	**2 026**	**1 952**
DECEMBER				
Prime	43,14	58,74	32,71	19,37
Grade 1	50,17	35,69	53,86	62,54
Grade 2	5,24	4,91	7,34	14,52
Grade 3	1,45	0,65	6,09	3,57
Total analysis	**897**	**1 384**	**1 281**	**1 735**
JANUARY				
Prime	40,51	52,45	16,45	11,06
Grade 1	51,95	40,19	54,79	62,92
Grade 2	6,48	6,13	16,03	17,66
Grade 3	1,05	1,23	12,73	8,36
Total analysis	**1 049**	**2 854**	**2 152**	**1 591**



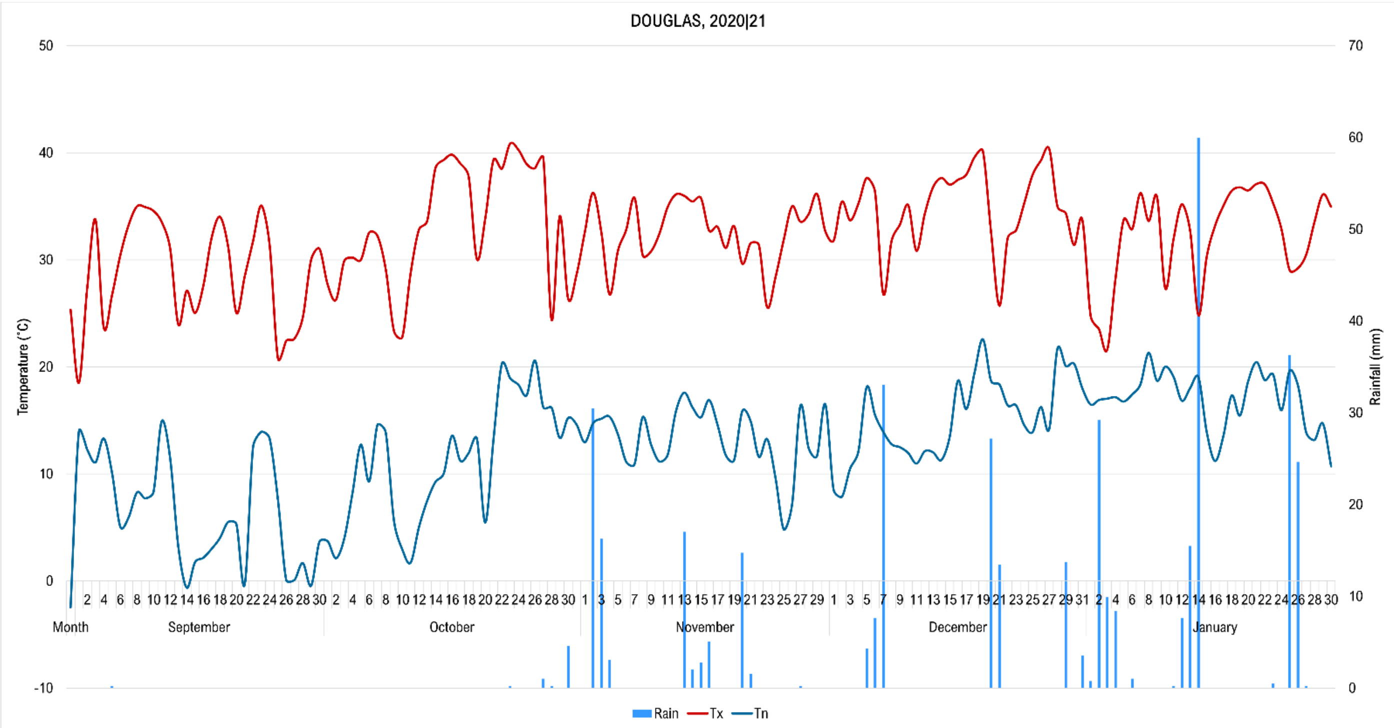
Graph 1: Average of minimum and maximum daily temperature, total daily rainfall during September, October, November, December, and January for 2017|18.



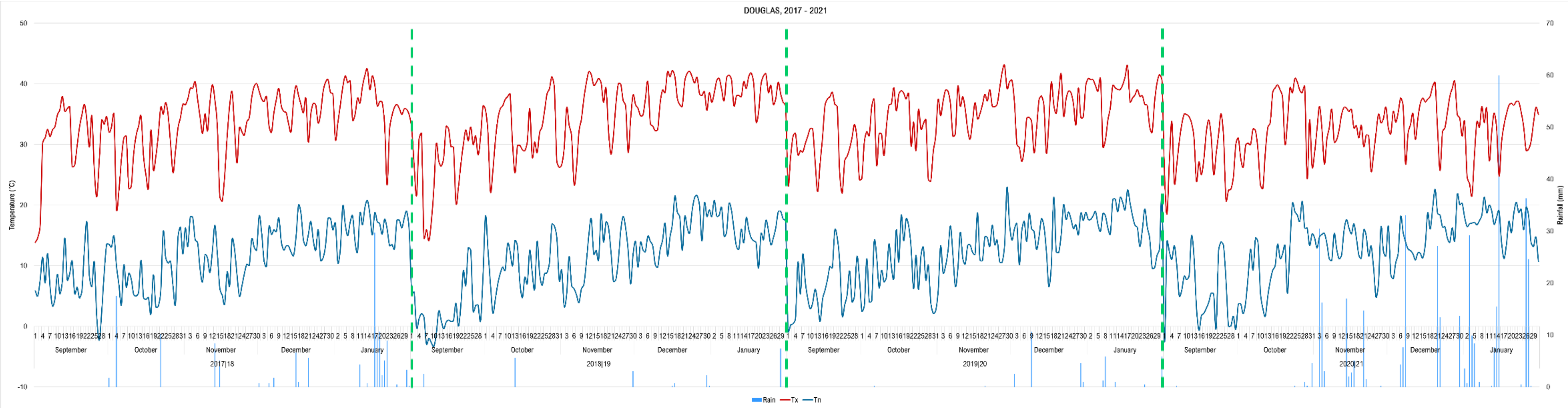
Graph 2: Average of minimum and maximum daily temperature, total daily rainfall during September, October, November, December, and January for 2018|19.



Graph 3: Average of minimum and maximum daily temperature, total daily rainfall during September, October, November, December, and January for 2019|20.



Graph 4: Average of minimum and maximum daily temperature, total daily rainfall during September, October, November, December, and January for 2020|21.



Graph 5: Average of minimum and maximum daily temperature, total daily rainfall between 2017 – 2021 (Sept – Jan)