MAIZE SILAGE RESEARCH UPDATE 2022

PIONEER®
BRAND · PRODUCTS

CONTENTS

INTRODUCTION

Welcome to the Pioneer Maize Silage Research Update for 2022.

For many years we have produced Maize Silage Hybrid Performance Information which provides comprehensive hybrid yield data enabling growers to make informed decisions on which hybrid to plant. However, our research programme covers so much more than just hybrid evaluation. Every year we aim to deliver more value to growers by conducting a range of agronomic and environmental research. In this publication, we summarise some of the latest research which includes stress emergence and seed quality, nitrogen leaching, an update on plant populations and information on our new brown mid-rib (BMR) hybrid, Pioneer® brand P0284.

A Pioneer IMPACT™ trial at Gordonton, Waikato. IMPACT is the acronym for "intensively managed product advancement and characterisation trials".

Long term breeding delivers higher yields

The annual rate of silage yield gain in New Zealand is estimated to have been over 300 kilograms of drymatter per hectare per year over almost 60 years, as shown in the graph below. Crop management and the breeding of more defensive and higher yielding hybrids have both made significant contributions to yield increases over this time frame. As a result, a newly introduced Pioneer hybrid will usually have a considerable yield advantage over older hybrids.

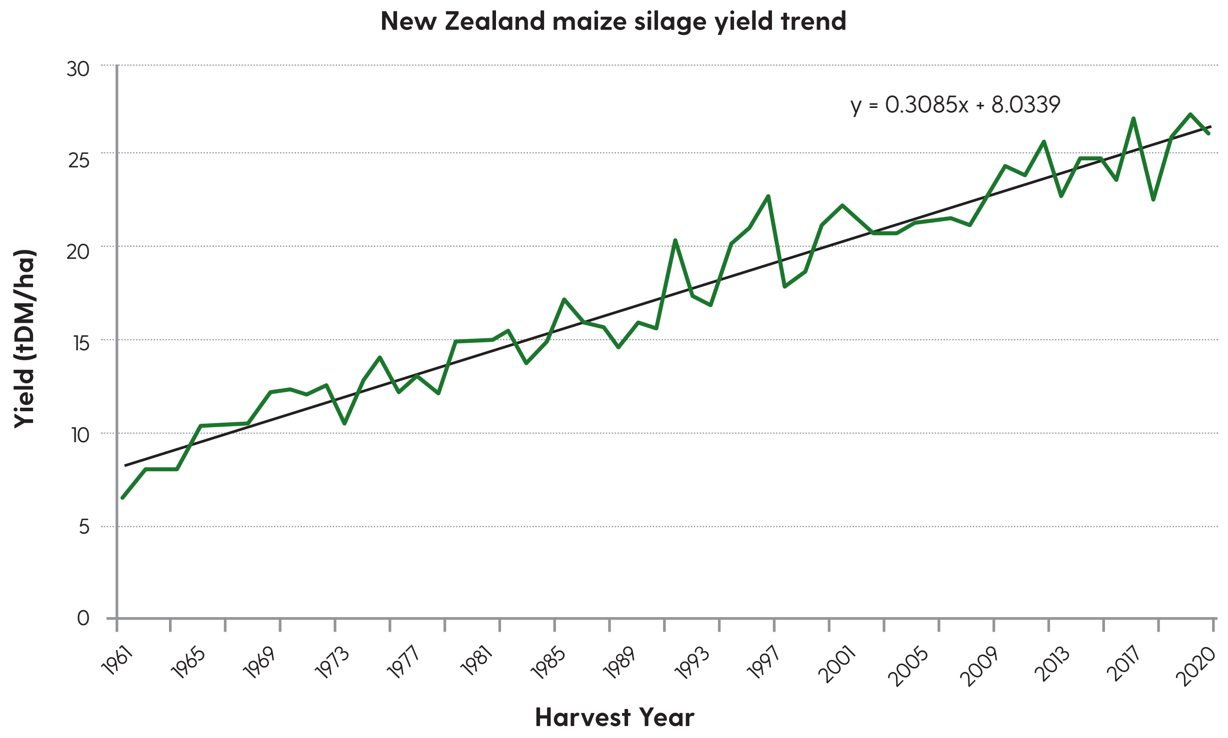
To maxmise their returns, silage growers should look to introduce new hybrids that are best suited to their farm system on a regular basis.

Desired harvest timing, soil type, cultivation methods and agronomic traits such as early growth, drought tolerance, stalk and root strength, disease resistances and silage quality are all important considerations to include in the hybrid selection process.

The most reliable way to select superior hybrids is to consider yield stability and quality performance information, gathered over several seasons and over a wide range of locations within a growing region. Individual on-farm trial results should not be used to select a hybrid because in isolation they are not a reliable predictor of hybrid performance in future seasons. A useful rule of thumb is that 20 locations over several seasons provide a reliable measure of comparative yield performance between two hybrids. This data should then be statistically analysed to establish the quality of the data and if there is a real yield difference between hybrids being compared. This publication provides a summary of the investment made to evaluate the silage yield performance of Pioneer® brand products and other brands of silage hybrids in five defined growing regions in New Zealand:

1. Northland and north Auckland
2. Waikato
3. Bay of Plenty, Gisborne and northern Hawke's Bay
4. Lower North Island and Taranaki
5. South Island

It is Pioneer's policy to only publish statistically significant results when comparing a Pioneer hybrid with that of another brand (see opposite page). As a result, we do not make any hybrid comparison inferences based on only a few trials. Consequently, comparisons involving new hybrids may take several seasons to generate sufficient data to publish.



Source: New Zealand Year Book (1961 to 1996) and Pioneer® brand products New Zealand Research Programme (1997 to 2020).

Interpreting the hybrid comparison t-test

The table below presents a summary of the possible t-test outcomes.

Understanding paired hybrid comparisons

Where stars (★) are shown beside each comparison, this indicates the level of confidence that a real yield difference exists between the two hybrids based on the yield data.

P value	Confidence level	Scientific designation	Level of significance	Yield advantage	Interpretation
<0.001	>99.9%	★★★	Very highly significant	YES	**Hybrid superiority for yield <u>can be claimed</u>.** Can confidently plant the winning hybrid providing no key agronomic traits are limiting. Check the trait ratings for any considerations.
<0.01	>99.0%	★★	Highly significant	YES	
<0.05	>95.0%	★	Significant	YES	
<0.10	>90.0%	CA	Commercially acceptable	YES	Not a significant result, but may be regarded as a commercially acceptable basis for a decision.
>0.10	<90.0%	NS	Not significant	NO	**Hybrid superiority for yield <u>cannot be claimed</u>.** Ignore the yield comparison and refer primarily to important trait ratings to select between the hybrids.

The more stars (★) present for the comparison, the more confident we can be that the measured average yield difference is due to an actual genetic yield difference between the two hybrids rather than just chance.

Where a result is commercially acceptable **(CA)**, the result is not designated as statistically significant, but it may be regarded as commercially acceptable.

Where a result is not significant **(NS)**, we cannot conclude there is a yield difference between the hybrids. There are two principle explanations;

1. Where the yields are very similar and the comparison has been made over more than 20 locations, no significance indicates there is no measurable difference between the two hybrids or;
2. Where there appears to be a large yield difference, no significance likely indicates there are too few trial locations, or there have been inconsistent or fluctuating results. It is therefore not possible to indicate that the difference is real.

In both instances above, growers should use regionally important hybrid trait ratings to select which hybrid to plant.

In other comparisons, yield differences may appear to be relatively small but still achieve significance – this happens in cases where yield data quality is high and the number of trial locations is large.

A t-test analysis of statistical significance is carried out on all Pioneer hybrid comparisons and we take great care to base our product yield statements and recommendations on the outcome.

PIONEER P8000

VERSATILE STALWART. DELIVERS HIGH ENERGY SILAGE.

CRM 80

Feature hybrid	Comparison hybrid	Number of trials	Drymatter difference (%)[1]	Yield advantage (kgDM/ha)[2]	Statistical significance[3]
South Island					
P8000	P7524	35	-2.23	1,215	★★
P8000	P8333	27	1.80	-2,262	★★★
P8000	Titus	9	0.15	3,314	★★
Lower North Island and Taranaki					
P8000	P7524	79	0.01	837	★★
P8000	P8333	42	3.21	-2,010	★★★
P8000	Titus	13	0.27	1,729	★★

[1]Positive DM differences means the bolded hybrid was drier at harvest, negative DM differences mean it was wetter. [2]A positive yield advantage means the bolded hybrid produced more yield, a negative yield advantage means it produced less. [3]For information on interpreting hybrid comparison data and statistical significance see page 4.

Recommended growing regions

Recommended established plant populations (000's/ha)

Challenging yield environments	108
Medium yield environments	115
High yield environments	120

PIONEER P8500

YIELD LEADER WITH LOOKS TO MATCH.

CRM 85

Feature hybrid	Comparison hybrid	Number of trials	Drymatter difference (%)[1]	Yield advantage (kgDM/ha)[2]	Statistical significance[3]
National					
P8500	Booster	21	1.22	3,611	★★★
P8500	Comet	31	1.92	1,912	★★★
P8500	Delitop	30	-2.79	3,250	★★★
P8500	Obelix	7	0.41	719	CA
P8500	P8000	91	-2.58	2,317	★★★
P8500	P8333	98	-0.37	431	CA
P8500	P8666	106	0.44	-311	NS
P8500	P8805	94	0.77	1,339	★★★
Lower North Island & Taranaki					
P8500	Comet	6	2.98	3,095	★★★
P8500	P8000	52	-2.98	2,558	★★★
P8500	P8333	53	0.14	778	★★
P8500	P8666	48	0.72	28	NS
P8500	P8805	43	1.16	1,437	★★★
P8500	Titus	11	-0.50	5,038	★★★
South Island					
P8500	P8000	33	-2.04	2,218	★★★
P8500	P8333	26	-0.95	-713	CA
P8500	P8666	28	0.09	-573	NS
P8500	P8805	20	-0.21	1,171	★
P8500	Titus	8	-1.66	5,842	★★★

[1]Positive DM differences means the bolded hybrid was drier at harvest, negative DM differences mean it was wetter. [2]A positive yield advantage means the bolded hybrid produced more yield, a negative yield advantage means it produced less. [3]For information on interpreting hybrid comparison data and statistical significance see page 4.

Recommended growing regions

Recommended established plant populations (000's/ha)

Challenging yield environments	105
Medium yield environments	115
High yield environments	120

PRODUCTIVE HIGH ENERGY OPTION.

P8333

CRM 83

Feature hybrid	Comparison hybrid	Number of trials	Drymatter difference (%)[1]	Yield advantage (kgDM/ha)[2]	Statistical significance[3]
National					
P8333	Booster	19	2.03	2,158	★★★
P8333	Delitop	23	-3.03	2,252	★★★
P8333	P7524	32	-2.89	2,250	★★★
P8333	P8000	69	-2.66	2,109	★★★
P8333	P8500	98	0.37	-431	CA
P8333	P8666	66	0.83	-754	★★
P8333	P8805	50	1.04	821	★
P8333	Titus	11	-0.18	5,864	★★★
South Island					
P8333	Delitop	8	-1.74	2,696	CA
P8333	P8000	27	-1.80	2,262	★★★
P8333	P8500	26	0.95	713	CA
P8333	P8666	17	1.00	63	NS
P8333	P8805	11	-0.35	996	NS
Lower North Island & Taranaki					
P8333	Delitop	15	-3.71	2,015	★★
P8333	P7524	26	-2.89	2,407	★★★
P8333	P8000	42	-3.21	2,010	★★★
P8333	P8500	53	-0.14	-778	★★
P8333	P8666	32	0.69	-950	★
P8333	P8805	25	0.86	1,125	★

[1]Positive DM differences means the bolded hybrid was drier at harvest, negative DM differences mean it was wetter. [2]A positive yield advantage means the bolded hybrid produced more yield, a negative yield advantage means it produced less. [3]For information on interpreting hybrid comparison data and statistical significance see page 4.

Recommended growing regions

Recommended established plant populations (000's/ha)

Challenging yield environments	100
Medium yield environments	110
High yield environments	115

GROWS WELL, YIELDS VERY WELL AND FEEDS EVEN BETTER.

P8666

CRM 86

Feature hybrid	Comparison hybrid	Number of trials	Drymatter difference (%)[1]	Yield advantage (kgDM/ha)[2]	Statistical significance[3]
National					
P8666	Booster	21	0.52	3,639	★★★
P8666	Comet	35	1.39	2,246	★★★
P8666	Obelix	8	1.95	1,906	CA
P8666	P8333	66	-0.83	754	★★★
P8666	P8500	106	-0.44	311	NS
P8666	P8805	65	0.07	1,851	★★★
Waikato					
P8666	Booster	12	1.53	3,867	★★★
P8666	Comet	24	0.98	2,561	★★★
P8666	P8333	17	-0.93	1,201	★
P8666	P8500	30	-0.31	608	NS
P8666	P8805	25	0.77	1,886	★★
Lower North Island and Taranaki					
P8666	Booster	9	-0.82	3,335	★★★
P8666	P8333	32	-0.69	950	★★★
P8666	P8500	48	-0.72	-28	NS
P8666	P8805	31	-0.24	1,685	★★★
South Island					
P8666	P8000	19	-2.56	2,796	★★★
P8666	P8333	17	-1.00	-63	NS
P8666	P8500	28	-0.09	573	NS
P8666	P8805	9	-0.79	2,326	★★★
P8666	P9127	10	1.34	163	NS

[1]Positive DM differences means the bolded hybrid was drier at harvest, negative DM differences mean it was wetter. [2]A positive yield advantage means the bolded hybrid produced more yield, a negative yield advantage means it produced less. [3]For information on interpreting hybrid comparison data and statistical significance see page 4.

Recommended growing regions

Recommended established plant populations (000's/ha)

Challenging yield environments	100
Medium yield environments	110
High yield environments	115

BRED TO YIELD, DESTINED TO IMPRESS.

PIONEER P9127

CRM 91

Optimum AQUAmax

Feature hybrid	Comparison hybrid	Number of trials	Drymatter difference (%)[1]	Yield advantage (kgDM/ha)[2]	Statistical significance[3]
Waikato					
P9127	Booster	14	-2.23	4,549	★★★
P9127	Obelix	8	-0.20	1,720	★
P9127	P8666	29	-3.55	-373	NS
P9127	P8805	50	-3.24	1,737	★★★
P9127	P9400	77	-0.13	318	NS
P9127	P9721	34	2.80	-227	NS
P9127	PAC249	19	2.00	3,152	★★★
P9127	Velocity	10	1.68	1,144	CA
Lower North Island & Taranaki					
P9127	C29-A1	12	1.05	1,453	★
P9127	P8666	30	-3.71	-972	★★
P9127	P9400	49	-0.75	875	★
P9127	P9721	18	1.24	812	CA
P9127	PAC249	11	2.11	2,309	★★
South Island					
P9127	Obelix	8	-3.56	1,938	★
P9127	P8666	10	-1.34	-163	NS
P9127	P8805	23	-3.03	1,022	★
P9127	P9400	13	0.14	1,123	★

[1]Positive DM differences means the bolded hybrid was drier at harvest, negative DM differences mean it was wetter. [2]A positive yield advantage means the bolded hybrid produced more yield, a negative yield advantage means it produced less. [3]For information on interpreting hybrid comparison data and statistical significance see page 4.

Recommended growing regions

Recommended established plant populations (000's/ha)

Challenging yield environments	95
Medium yield environments	108
High yield environments	115

TOP YIELDING, DROUGHT BUSTER.

PIONEER P9911

CRM 99

Optimum AQUAmax

Feature hybrid	Comparison hybrid	Number of trials	Drymatter difference (%)[1]	Yield advantage (kgDM/ha)[2]	Statistical significance[3]
Waikato					
P9911	C29-A1	47	-1.18	2,312	★★★
P9911	G49-T9	66	0.05	2,420	★★★
P9911	N39-Q1	82	-2.45	2,414	★★★
P9911	P0021	109	-1.34	1,476	★★★
P9911	P0362	59	1.39	583	★
P9911	P9721	102	-1.08	1,581	★★★
P9911	P9978	24	-1.03	-124	NS
P9911	PAC314	10	0.65	1,936	★
P9911	PAC343	16	2.33	1,752	★★
P9911	PAC432	26	2.47	987	★
P9911	Plenitude	22	1.97	1,340	★
P9911	Velocity	16	-2.49	3,804	★★★
Lower North Island & Taranaki					
P9911	Afinity	23	-2.65	2,521	★★★
P9911	C29-A1	42	-2.13	3,128	★★★
P9911	G49-T9	23	-1.33	2,151	★★
P9911	P0021	131	-2.17	961	★★★
P9911	P0362	33	0.30	513	NS
P9911	P0640	21	1.51	1,945	★★
P9911	P9721	120	-2.27	1,379	★★★
P9911	P9978	18	-1.84	-460	NS
P9911	PAC249	31	-1.94	3,605	★★★
P9911	PAC314	8	-0.60	3,030	★
P9911	PAC343	6	0.34	4,534	★★
P9911	Plenitude	6	0.73	1,847	★

[1]Positive DM differences means the bolded hybrid was drier at harvest, negative DM differences mean it was wetter. [2]A positive yield advantage means the bolded hybrid produced more yield, a negative yield advantage means it produced less. [3]For information on interpreting hybrid comparison data and statistical significance see page 4.

Recommended growing regions

Recommended established plant populations (000's/ha)

Challenging yield environments	100
Medium yield environments	108
High yield environments	115

VERY PRODUCTIVE. VERY STABLE. VERY DEFENSIVE.

P9978

CRM 99

Feature hybrid	Comparison hybrid	Number of trials	Drymatter difference (%)[1]	Yield advantage (kgDM/ha)[2]	Statistical significance[3]
National					
P9978	Afinity	15	-1.28	2,953	★★★
P9978	N39-Q1	26	-1.16	2,286	★★★
P9978	P0021	27	-0.36	1,591	★★
P9978	P9721	30	0.02	1,886	★★★
P9978	P9911	46	1.47	300	NS
P9978	PAC249	21	-1.03	2,381	★★★
P9978	PAC314	16	1.38	2,422	★★
P9978	Velocity	22	-1.56	2,803	★★★
Waikato					
P9978	Afinity	9	-1.91	2,489	★
P9978	N39-Q1	15	-0.57	2,339	★★
P9978	P9874	9	-0.73	3,008	★★
P9978	P9911	24	1.03	124	NS
P9978	PAC249	9	-1.55	2,192	★★★
P9978	Velocity	11	-1.34	2,596	★★
Lower North Island & Taranaki					
P9978	C29-A1	11	-0.72	3,512	★★★
P9978	N39-Q1	11	-1.96	2,214	CA
P9978	P0021	12	-0.24	1,867	★
P9978	P9721	13	-0.02	3,044	★★★
P9978	P9911	18	1.84	460	NS
P9978	PAC249	11	-0.84	2,493	★
P9978	Velocity	11	-1.79	3,009	★★

[1]Positive DM differences means the bolded hybrid was drier at harvest, negative DM differences mean it was wetter. [2]A positive yield advantage means the bolded hybrid produced more yield, a negative yield advantage means it produced less. [3]For information on interpreting hybrid comparison data and statistical significance see page 4.

Recommended growing regions

Recommended established plant populations (000's/ha)

Challenging yield environments	95
Medium yield environments	110
High yield environments	120

LEAF DISEASE CHAMPION DELIVERING SILAGE YIELD STABILITY.

P0640

CRM 106

Feature hybrid	Comparison hybrid	Number of trials	Drymatter difference (%)[1]	Yield advantage (kgDM/ha)[2]	Statistical significance[3]
National					
P0640	Brutus	11	-0.36	3,572	★★★
P0640	G49-T9	61	-1.93	2,629	★★★
P0640	Maximus	27	-1.09	2,328	★★★
P0640	P0362	39	-1.34	871	★
P0640	P0725	143	0.92	-918	★★★
P0640	P0891	124	-1.59	-119	NS
P0640	P9911	93	-1.78	-143	NS
P0640	PAC343	33	-0.25	1,725	★★★
P0640	PAC432	42	0.41	891	★
Northland and South Auckland					
P0640	P0725	26	-0.32	-272	NS
P0640	P0791	21	-1.06	-271	NS
P0640	P0891	28	-2.78	-377	NS
Waikato					
P0640	Brutus	11	-0.36	3,572	★★★
P0640	G49-T9	52	-1.81	2,774	★★★
P0640	Maximus	24	-0.96	2,320	★★★
P0640	P0021	15	-2.86	1,444	★
P0640	P0362	27	-1.15	1,454	★★
P0640	P0891	89	-1.26	120	NS
P0640	P9911	51	-1.67	299	NS
P0640	PAC343	24	-0.37	1,865	★★★
P0640	PAC432	40	0.40	945	★
P0640	Plenitude	29	1.21	1,164	★

[1]Positive DM differences means the bolded hybrid was drier at harvest, negative DM differences mean it was wetter. [2]A positive yield advantage means the bolded hybrid produced more yield, a negative yield advantage means it produced less. [3]For information on interpreting hybrid comparison data and statistical significance see page 4.

Recommended growing regions

Recommended established plant populations (000's/ha)

Challenging yield environments	95
Medium yield environments	105
High yield environments	110

PIONEER P0725

GREAT PERFORMANCE WITH EXTRAORDINARY CONSISTENCY.

CRM 107

Optimum AQUAmax

Feature hybrid	Comparison hybrid	Number of trials	Drymatter difference (%)[1]	Yield advantage (kgDM/ha)[2]	Statistical significance[3]
National					
P0725	Brutus	11	-0.88	3,965	★★★
P0725	G49-T9	60	-2.64	3,355	★★★
P0725	Maximus	37	-1.66	2,490	★★★
P0725	P0362	28	-1.77	1,506	★★
P0725	P0640	143	-0.92	918	★★★
P0725	P0891	253	-2.21	324	CA
P0725	P0900	27	-0.94	82	NS
P0725	P1636	72	2.49	-611	CA
P0725	PAC343	32	-1.43	2,650	★★★
P0725	PAC432	45	-0.81	1,290	★★
P0725	PAC456	62	1.15	613	CA
P0725	Plenitude	33	-0.23	1,969	★★★
Waikato					
P0725	Brutus	11	-0.88	3,965	★★★
P0725	Maximus	35	-1.78	2,375	★★★
P0725	P0640	100	-1.12	862	★★★
P0725	P0891	168	-2.15	677	★★
P0725	P0900	16	-0.94	435	NS
P0725	P1636	55	2.39	-833	★
P0725	PAC343	25	-1.62	2,466	★★★
P0725	PAC432	43	-0.82	1,371	★★
P0725	PAC456	56	1.12	725	CA
P0725	Plenitude	29	-0.18	1,990	★★★
Bay of Plenty					
P0725	P0900	6	-1.34	-670	NA

[1]Positive DM differences means the bolded hybrid was drier at harvest, negative DM differences mean it was wetter. [2]A positive yield advantage means the bolded hybrid produced more yield, a negative yield advantage means it produced less. [3]For information on interpreting hybrid comparison data and statistical significance see page 4.

Recommended growing regions

Recommended established plant populations (000's/ha)

Challenging yield environments	95
Medium yield environments	104
High yield environments	108

PIONEER P0900

HARD TO FAULT, STABLE, ALL-ROUND HYBRID.

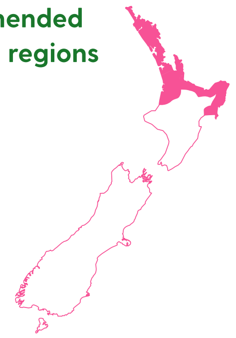
CRM 109

Optimum AQUAmax

Feature hybrid	Comparison hybrid	Number of trials	Drymatter difference (%)[1]	Yield advantage (kgDM/ha)[2]	Statistical significance[3]
National					
P0900	P0891	54	-2.42	562	NS
P0900	P0937	52	0.98	789	★
P0900	P1253	28	-0.48	979	★
P0900	P1315	16	0.03	-619	NS
P0900	P1636	17	1.85	-359	NS
P0900	PAC343	8	-2.10	2,571	★
P0900	PAC430	10	1.13	3,256	★★
P0900	PAC432	11	-0.64	1,724	★
P0900	PAC456	22	2.23	953	CA
P0900	Plenitude	9	1.52	874	★
Northland					
P0900	P0937	9	1.06	763	NS
Waikato					
P0900	P0891	33	-2.64	1,166	★
P0900	P0937	34	0.29	1,001	★
P0900	P1253	28	-0.48	979	★
P0900	P1315	16	0.03	-619	NS
P0900	PAC343	8	-2.10	2,571	★
P0900	PAC430	10	1.13	3,256	★★
P0900	PAC432	11	-0.64	1,724	★
P0900	PAC456	22	2.23	953	CA
Bay of Plenty					
P0900	P0725	6	1.34	670	NS
P0900	P0937	9	3.53	15	NS

[1]Positive DM differences means the bolded hybrid was drier at harvest, negative DM differences mean it was wetter. [2]A positive yield advantage means the bolded hybrid produced more yield, a negative yield advantage means it produced less. [3]For information on interpreting hybrid comparison data and statistical significance see page 4.

Recommended growing regions



Recommended established plant populations (000's/ha)

Challenging yield environments	85
Medium yield environments	95
High yield environments	115

PIONEER® P1315

DESIRABLE AND DEFENSIVE FROM NORTHLAND TO HAWKE'S BAY.

CRM 110

Feature hybrid	Comparison hybrid	Number of trials	Drymatter difference (%)[1]	Yield advantage (kgDM/ha)[2]	Statistical significance[3]
National					
P1315	P1253	51	-0.20	996	★
P1315	P1613	51	2.04	201	NS
P1315	P1636	51	1.96	-308	NS
P1315	Pelota	8	1.55	693	CA
Waikato					
P1315	P0900	16	-0.03	619	NS
P1315	P0937	17	-0.26	1,343	NS
P1315	P1253	23	-0.21	1,369	★
P1315	P1636	24	2.11	213	NS
Bay of Plenty					
P1315	P1253	14	0.08	650	NS

[1]Positive DM differences means the bolded hybrid was drier at harvest, negative DM differences mean it was wetter. [2]A positive yield advantage means the bolded hybrid produced more yield, a negative yield advantage means it produced less. [3]For information on interpreting hybrid comparison data and statistical significance see page 4.

Recommended growing regions

Recommended established plant populations (000's/ha)

Environment	Population
Challenging yield environments	85
Medium yield environments	95
High yield environments	105

PIONEER® P1636

ENJOY THE AGRONOMICS OF THIS TOP YIELDING HYBRID.

CRM 112

Feature hybrid	Comparison hybrid	Number of trials	Drymatter difference (%)[1]	Yield advantage (kgDM/ha)[2]	Statistical significance[3]
National					
P1636	Olympiad	31	0.23	2,486	★★★
P1636	P0725	72	-2.49	611	CA
P1636	P0900	17	-1.85	359	NS
P1636	P0937	32	-1.04	1,439	★
P1636	P1253	197	-1.98	764	★★
P1636	P1315	51	-1.96	308	NS
P1636	P1477W	108	0.95	-441	NS
P1636	PAC430	6	-1.65	3,240	★
P1636	PAC456	44	-0.96	1,217	★★
P1636	PAC624	63	3.46	932	CA
P1636	Z71-F1	86	0.40	1,546	★★★
Northland and South Auckland					
P1636	P1315	13	-1.46	685	NS
P1636	P1477W	30	0.36	-1,071	CA
P1636	P1613	26	-0.40	-898	NS
P1636	Z71-F1	15	-0.69	1,659	★
Waikato					
P1636	Olympiad	19	0.63	2,327	★
P1636	P0725	55	-2.39	833	★
P1636	P0900	16	-1.93	713	NS
P1636	P0937	24	-1.54	911	NS
P1636	P1315	24	-2.11	-213	NS
P1636	P1477W	50	1.55	37	NS
P1636	PAC456	42	-0.94	1,201	★★
P1636	Z71-F1	65	0.80	1,576	★★★
Bay of Plenty, Gisborne and Hawke's Bay					
P1636	P0725	10	-2.31	-348	NS
P1636	P1253	36	-1.92	121	NS
P1636	P1315	14	-2.15	850	NS
P1636	P1477W	28	0.52	-622	NS

[1]Positive DM differences means the bolded hybrid was drier at harvest, negative DM differences mean it was wetter. [2]A positive yield advantage means the bolded hybrid produced more yield, a negative yield advantage means it produced less. [3]For information on interpreting hybrid comparison data and statistical significance see page 4.

Recommended growing regions

Recommended established plant populations (000's/ha)

Environment	Population
Challenging yield environments	90
Medium yield environments	105
High yield environments	110

BMR MAIZE HYBRID RESEARCH

What is BMR maize?

Brown mid-rib (BMR) is a naturally occurring variant of maize which was first discovered in Minnesota, USA in 1924. BMR maize hybrids have a distinctive brown mid-rib on the leaves and the stover (leaf plus stem) contains less lignin than conventional maize hybrids.

Lignin is a key structural component in plant cell walls, which impacts silage quality for the following reasons:

- Rumen microorganisms cannot breakdown lignin.
- Lignin hinders fibre digestion as it obstructs enzyme access to the digestible fibre fractions of cellulose and hemicellulose.
- Less lignin improves performance associated with reduced gut fill and greater feed passage rate.

Traditional BMR maize hybrids had a significant yield drag and a number of agronomic disadvantages when compared to conventional hybrids. To address these challenges, Pioneer® brand maize breeders used traditional breeding methods to incorporate the BMR gene into elite conventional germplasm. The result is the development of BMR hybrids which combine the BMR fibre digestibility advantage with more competitive yields, high starch content, strong drought tolerance and a robust disease resistance package.

Yield results

The NZ Pioneer Research Program began evaluating a number of pre-commercial BMR hybrids more than four years ago. The first commercial release is P0284, a 102 CRM hybrid suitable for North Island growers wanting high digestibility silage.

Waikato yield data shows that P0284 yields 3-11% less than conventional Pioneer® brand maize silage hybrids of a similar maturity. It is important that this yield drag is considered when evaluating whether BMR hybrids will be the most profitable for your dairy farm system.

Feature hybrid	Comparison hybrid	Number of trials	Drymatter difference (%)[1]	Yield advantage (kgDM/ha)[2]	Statistical significance[3]
Waikato					
P0284	P0021	10	-2.42	-666	★
P0284	P0362	23	0.48	-2,183	★★★
P0284	P9911	13	-0.86	-2,691	★★

[1]Positive DM differences means the bolded hybrid was drier at harvest, negative DM differences mean it was wetter. [2]A positive yield advantage means the bolded hybrid produced more yield; a negative yield advantage means it produced less. [3]For information on statistical significance see page 4.

Who should consider growing BMR hybrids?

Overseas research data shows that the greatest benefit and best payback for BMR maize hybrids comes from high producing dairy cows in early lactation and transition cows. These top-end dairy producers require the highest energy levels. Typically, their production is limited by intake, and this is where the higher passage rates of BMR maize silage can deliver an advantage in additional energy.

If you have a high producing herd (> 1 kgMS/kg liveweight), feed a large amount of maize silage in early lactation and can store your BMR maize silage separately consider:

- Planting up to 20-30% of your silage area in P0284.
- Feeding it to transition cows three to four weeks pre-calving.
- Using BMR maize silage for the first four to five weeks in early lactation and then transition to conventional maize silage.

Feeding BMR maize silage

A smooth transition to the new maize silage crop is important for maintaining ration consistency and preventing nutritional imbalance problems.

When feeding BMR maize silage:

- Ensure that your nutritionist or consultant understands how the BMR product will perform differently in the ration compared to a ration containing large amounts of conventional maize silage.
- Always conduct a laboratory feed analysis prior to feeding and adjust the ration to take into account the lower fibre and higher intake rates of BMR maize silage.
- The transition from a conventional maize silage-based ration to BMR maize silage should be made in several steps, over seven to ten days.
- Be sure to watch for fibre effectiveness with BMR maize silage rations. BMR fibre tends to be fragile, and forage particle length can quickly be reduced to unacceptable levels during handling and mixing. For this reason you may want to consider a slightly longer chop length (20-30 mm) for BMR hybrids.
- As BMR maize silage-containing rations are fed, feed consumption likely will increase, compared with feeding non-BMR maize silage. Milk production also likely will increase when correctly managed.

To help determine whether BMR maize silage is the right option for you, or for feeding advice, please contact your local Pioneer Farm Systems Specialist at **pioneer.co.nz**.

Young plants showing the distinctive brown mid-rib.

Normal stalk (left), BMR stalk (right).

NITROGEN LEACHING IN MAIZE SYSTEMS

Introduction

Over the past four seasons the Pioneer Research Team have conducted a number of experiments to quantify and mitigate nitrogen losses from maize systems.

Waikato N-leaching trial

A two-year replicated plot trial in the Waikato aimed to quantify nitrogen (N) uptake and nitrate-N losses over a 12-month cropping cycle in a maize silage (P1253) and catch crop (fallow control or Hogan annual ryegrass) cropping system.

Maize was precision planted on 27th October 2018 and 29th October 2019 at 110,000 plants/ha in eight four-row plots (11.5 m x 3 m). Prior to planting, composite soil samples were taken to determine fertiliser requirements. Other than N, nutrient requirements were based on the soil test result and paddock yield potential. To increase the chance of measuring N-leaching losses, nitrogen was applied at a rate that allowed about 200 kg N/ha surplus after maize harvest.

Nitrogen leaching losses from under the maize and winter crops were measured using a series of 120 cm deep barrel lysimeters (to measure drainage volume) and ceramic sampling suction cups (to measure N concentration of the drainage).

Maize silage was harvested around 35% whole plant drymatter (DM) and tetraploid annual ryegrass was direct drilled in four plots at 30 kg/ha. The remaining four plots were left fallow throughout the winter period. No additional N fertiliser was added to the ryegrass because the purpose of the experiment was to measure its efficiency in taking up left-over nitrogen after maize. When the ryegrass reached 30 cm in height, two 0.5 m x 10 m strips were cut from each plot. The material was weighed , subsampled and analysed for N and DM.

Twelve-month nitrate-N-leaching losses were much higher for maize-fallow than maize-ryegrass catch crop plots in both seasons (Table 1).

Table 1: Nitrate-N-leaching losses in a maize/ryegrass and maize fallow rotation

	N-leaching (kg/ha)	
	Control (fallow)	Ryegrass
2018/19	59.6 ± 11.65	8.8 ± 2.96
2019/20	88.4 ± 9.10	0.31 ± 0.04
	Statistical significance	
Season	NS	
Catch crop	*	

NS = not significant; * means significantly different at P<0.05

N-leaching at 70 cm vs 120 cm

This experiment was designed to compare N-leaching losses at 70 cm (standard depth generally used to measure N-leaching) and 120 cm (assumed effective rooting depth of maize across a range of environments). Twelve additional pairs of suction cups were installed in four plots consisting of fallow and ryegrass treatments. Six barrel lysimeters were installed to measure drainage.

For both seasons, leaching losses and average N concentration were significantly greater when collected at 70 cm than 120 cm, but only in the maize-fallow rotation plots (Table 2).

Table 2: Total nitrate-N-leaching losses and concentration when measured at 70 cm and 120 cm below the soil surface in the 2018/19 and 2019/20 seasons.

	Leaching losses (kgN/ha)		N concentration (mg/l)	
	Control (fallow)	Ryegrass	Control (fallow)	Ryegrass
70 cm	119.2a	5.93c	51.92a	2.88c
120 cm	41.6b	2.18c	21.74b	1.49c

Values with a different letter are statistically different (P≤0.05)

Efficacy of N uptake at depth

A maize study using ^{15}N, a natural isotope of nitrogen was conducted in spring 2020 to determine the effectiveness of N uptake by maize roots at depth. The experiment consisted of three ^{15}N enriched treatments and a control. Each plot area consisted of three rows, sized 2.3 m wide x 2 m long. Each row consisted of 15-16 evenly spaced maize plants sown at a density of 100,000 plants/ha.

At planting, 40 kg N/ha was applied as starter fertiliser in the form of diammonium phosphate (17.6% N). At approximately V6 maize development stage, urea (46% N) was broadcast at a rate of 75 kg N/ha. Within a week of urea application, 30 kg N/ha in the form of liquid KNO_3 enriched with ^{15}N, was injected via a modified 8 mm diameter stainless steel pipe to a depth of 60 cm, 90 cm or 120 cm under each plant within the centre row of each treatment. Urea at an equivalence of 30 kg N/ha was broadcast on the centre row of the control plots at the same time.

Ten consecutive buffered plants within the 2 m plot were marked for future sampling to trace ^{15}N uptake. At grain harvest (approximately two to four weeks after physiological maturity or black layer), individual plant components (leaf, stalk and grain) were sampled, dried and ground and sent to the University of California Davis Stable Isotope Lab Facility for total N and isotopic N analysis. These results show that maize was capable of extracting N at 120 cm depth (Table 3). While the leaf component had less ^{15}N at the 90 cm and 120 cm depths than at 60 cm, there was no difference in both maize stalks and grain.

Table 3: Percentage of ^{15}N recovered in maize leaves, stalks and grain from labelled KNO_3 applied at 60 cm, 90 cm and 120 cm soil depth compared to control during the 2019/20 season.

	% of ^{15}N recovered in:		
Depth (cm)	Leaf	Stalks	Grain
0 (control)	0.37a	0.37a	0.37a
60	0.72b	0.82b	1.07b
90	0.71bc	0.92b	1.31b
120	0.54c	0.96b	1.21b

Values with a different letter within the table are statistically different (P≤0.05)

Conclusions

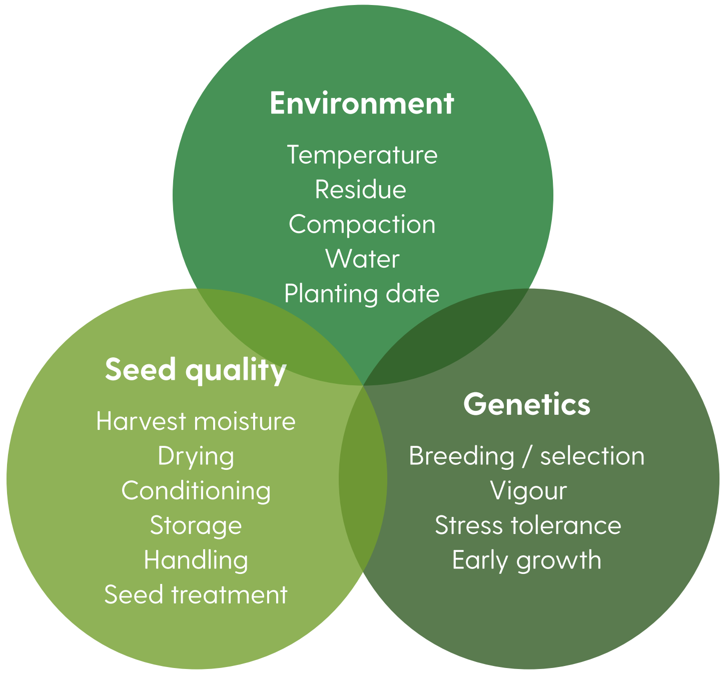
Despite fertiliser rate having a direct influence on N leaching, actual losses can be reduced by better crop management.

- Establishing a catch crop after maize mitigates N-leaching through increased N and soil water uptake, resulting in a reduction of soil N concentrations and soil water drainage volumes.
- When reporting N-leaching losses in maize, it is critical that the correct measuring depth is used, otherwise losses are likely to be overstated.
- The ^{15}N isotope trial showed maize is capable of extracting N at 120 cm depth.
- This research was published in the Journal of NZ Grasslands 83:163-170.

PIONEER STRESS EMERGENCE RATINGS

Introduction

Research shows that the highest maize yields come from uniform stands of plants which emerge at the same time and grow to produce even plants. Three factors interact during germination and emergence and together determine how well a maize crop establishes. These are seed quality, hybrid genetics and the growing environment.



While it is possible to influence some environmental factors (e.g., soil compaction and planting date) others are virtually impossible to control. In New Zealand, spring growing conditions can be challenging with fluctuating temperatures and saturated soils.

For the past three seasons, the quest for more uniform maize seed emergence has led to increased seed quality research to help characterise the performance of individual Pioneer hybrids under cold, wet emergence conditions. As a result of this work, Stress Emergence ratings have been included in the 2022 Pioneer Maize Silage Catalogue (see page 62).

Seed quality and emergence

A number of tests can be used to quantify maize seed quality.

- Pioneer Stress Test (PST) – a proprietary vigour test which imposes extreme chilling and anaerobic stresses, beyond that of the industry standard saturated cold test.
- Saturated cold test – seed is planted into saturated trays which are kept at 10°C for seven days.
- Cold germination test – seed is planted into trays which are kept at 10°C for seven days.
- Warm germination test – seed is planted into trays which are kept at 25°C for seven days.

While warm germination tests - carried out according to International Seed Testing Association (ISTA) protocols - provide a good indication of paddock germination under ideal conditions, the proprietary Pioneer Stress Test (PST):

- Applies the highest level of vigour stress testing by providing a low temperature, waterlogged germination environment.
- Helps to further differentiate the quality of individual seed lines.
- Quantifies the impact of seed treatments on seed quality.
- Helps characterise the genetic stress tolerance of individual Pioneer maize hybrids.

Laboratory seed quality testing

Over the winter of 2019 and 2020 a total of 894 samples of New Zealand produced, commercial Pioneer maize hybrids (treated and untreated) were tested for physical purity, genetic purity, warm germination and through the Pioneer Stress Test (PST). This allowed us to characterise the relative vigour of individual hybrids under the toughest germination conditions.

Field stress emergence trials

In spring 2019, 24 hybrids were planted ultra-early at twice the normal planting depth (8.5 cm) into cold wet soils. There were a total of three Waikato and three lower North Island sites giving a total of 36 replicates per hybrid.

The Pioneer Research Team monitored the sites and measured the rate of emergence as well as final plant stand count. Due to the challenging establishment conditions, the mean established plant population was 82% of the planting rate. There were, however, significant differences between hybrids with an established population range of 70-90%.

Pioneer stress emergence ratings

All Pioneer seed supplied to the market is expected to establish excellent plant stands if planted well and under normal germination conditions. Data collected from the laboratory seed quality testing exercise and the field stress emergence trials, referred to above, were used to develop the Pioneer Stress Emergence Ratings. These ratings indicate each hybrids ability to establish under challenging cold, wet growing conditions. The table below groups hybrids into three classes as a result of this research.

Stress emergence rating	Commentary	Hybrids
7-9	Very good potential to establish normal stands under stressful environmental conditions of cold, wet soils.	P7124, 38V12, P9721, P9911, P9978, P0021, P0900, P0937.
5-6	Good potential to establish normal stands under stressful conditions of cold, wet soils.	P7524, P8000, P8333, P8500, P8666, P8805, P9127, P0284, P0362, P0640, P0725, P1315, P1613 P1636, P1477W.
1-4	Below average potential to establish normal stands under stressful conditions of cold, wet soils. Should not be used if severe wet and cold conditions are expected after planting.	P9400, P0891.

Growers can be confident that every bag of Pioneer® brand maize seed they plant has been thoroughly tested in this extensive screening program and meets Pioneer's industry-leading standards.

MAIZE RESPONSE TO PLANT POPULATION

Introduction

Maximising maize silage yield requires matching the right maize hybrid with the optimal plant population.

- If plant density is too low, silage yield is low because the maize plant is not capable of "flexing" sufficiently to compensate for the reduction in plant density.
- If plant density is too high, the reduction in plant and ear size or grain fill due to extreme competition among plants may result in a drop in yield per plant that is not offset by the increase in the number of plants.

A major genetic contribution to the lift in maize yields in recent years can be attributed to an increase in "crowding stress" tolerance. Although maize yield per plant declines with increased population, the overall yield per hectare increases, provided soil moisture and nutrition are not limiting.

Optimum plant population density varies depending on a range of factors such as growing environment, yield level, soil moisture, hybrid choice and planting date. High yield environments (including high fertility soils straight out of long-term pasture) have higher recommended established plant populations than challenging yield environments including light, sandy or shallow soils with low fertility and/or drought risk. Short season hybrids (<100 CRM) are usually smaller and usually require more plants per unit area to achieve the optimum density needed to maximise silage yields.

Leaf area index

While Pioneer's earlier plant population research gathered agronomic and yield data from replicated plant density studies, current research is focusing on determining the plant population that optimises leaf area index (LAI).

- Maize yields are largely influenced by the amount of light intercepted by leaves during grain fill.
- Leaf area index is the amount of leaf area in a crop canopy relative to ground area and is directly related to the amount of light intercepted by the crop.
- When measured at or around silking, LAI can be considered a reliable parameter for estimating maize yield due to its strong relationship with radiation interception.
- Achieving a greater leaf canopy helps maximise photosynthesis allowing the plant to convert more sunlight into stored energy.
- Optimum LAI may vary by hybrid and environment but a range of 5-6 appears adequate to maximise NZ maize silage yields in moderate to high yielding environments, but research is ongoing.
- Earlier maturing hybrids tend to be smaller or shorter than longer season hybrids and hence require a higher plant density to optimise LAI. The same also applies to cooler growing areas (e.g., Canterbury) where plants can be of smaller stature.

Trial method

Over the past three seasons, the Pioneer Research Team has conducted maize plant density trials to assess the impact of plant population on LAI for a range of new Pioneer® brand maize silage hybrids. In this example we present a summary of field trial results for P9978, P0640 and P0900.

Maize was planted using a conventional Wintersteiger precision planter in plots sized four rows x 76.2 cm x 5.3 m at a slightly higher planting density than required. At around V2 – V4 maize development stage, plots were thinned to achieve established populations of 10,000, 45,000, 75,000, 100,000, 125,000 and 150,000 plants per hectare. Throughout the season, a range of records were collected. These included measurements of LAI around flowering time on a sunny day, close to solar noon (the time when the sun is highest in the sky) using an Accupar LP-80 Plant Canopy Analyser. At approximately 35% whole plant drymatter (DM), two centre rows of each plot were harvested using a Kemper silage harvester.

Results

While individual plant DM yield decreased with increased plant population, DM yield per hectare increased (Table 1). This research showed that for every 10,000 plants/ha increase:

- Individual plant weight (DM) decreased by 9 gDM/plant.
- Silage DM yield increased by 210 kgDM/ha.

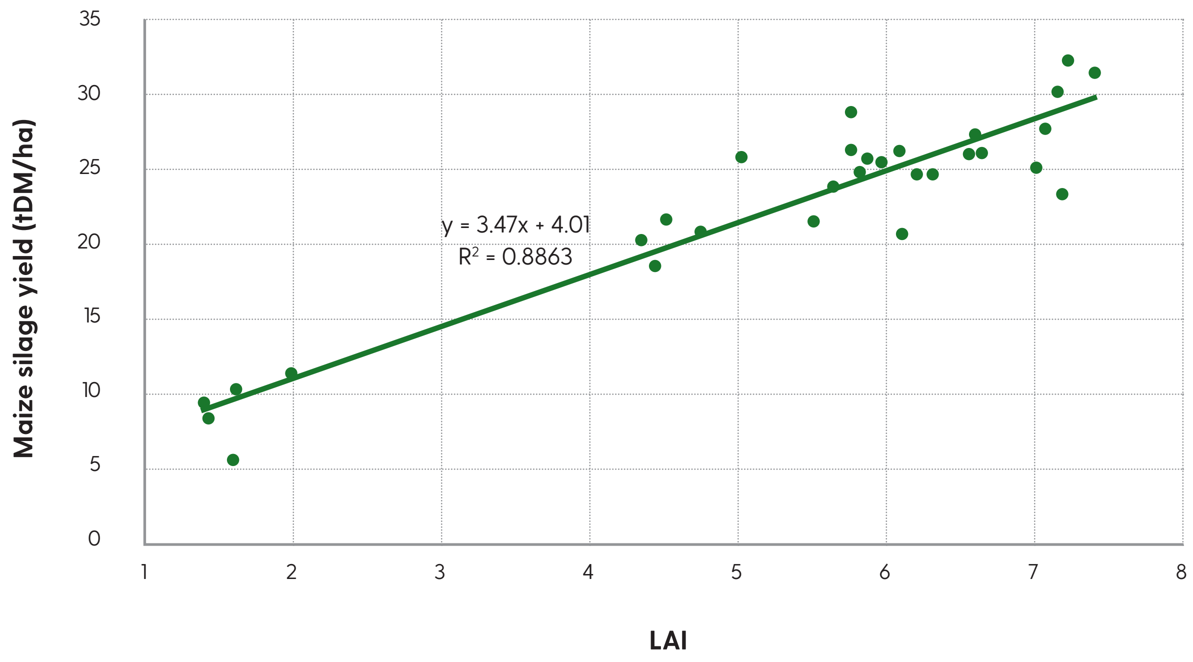
Table 1: Relationship between established maize plant population and leaf area index, individual plant weight and maize silage DM yield at three sites over three seasons (2020-2022).

Plant population/ha	LAI	Individual plant weight, gDM/plant	Maize silage yield, tDM/ha
45,000	4.8a	462a	21.4a
75,000	5.8b	326b	23.5a
100,000	6.3c	270c	26.2b
125,000	6.5c	227d	27.8b
150,000	6.9c	182e	26.3b

Values within the same column with the same letter are not statistically different.

For each unit increase in LAI value, maize silage yield increased at a rate of 3 tDM/ha (Figure 1). At 125,000 plants/ha or greater, despite a continued increase in LAI, silage DM yield gain diminished due to increased plant competition for light, nutrients and/ or water.

Figure 1: Relationship between leaf area index at flowering time and maize silage drymatter yield at three Waikato sites over three seasons (2020-2022).



Conclusions

- While maize silage crops planted at a lower population can sometimes look impressive, the maize plant cannot flex sufficiently to compensate for the reduced yield due to a decreased plant population.
- By using LAI growers can adjust seeding rates depending on time of planting, environment, hybrid choice etc. For instance, when planting early in cooler climates, plant size is likely to be smaller and a higher plant density will be required to achieve the optimum LAI required to maximise yield.
- Our current data indicates that in medium to high yield environments yields are maximised at LAI values around 6. Limited data indicates optimum values on light, drought-prone soils could be lower than 6 but more research is needed.
- Once the desired plant population to maximise yield is determined, downward population adjustments can be made to account for less favourable growing conditions such as soils with low water holding capacity or high lodging risk.
- To evaluate the adequacy of light interception during grain fill observe light penetration under the crop canopy at solar noon on a calm, sunny day. A paddock considered to be at an optimal plant population density should have very little sunlight hitting the soil surface with very few to no plants without an ear or an ear filled to the tip.
- Pioneer® brand recommended plant populations are for established stands. Plant 5-10% more seed than the recommended rates to allow for seedling mortality.

THANK YOU TO THE 2020-2021 TRIAL CO-OPERATORS

The results of the extensive research programme in this publication are only made possible with the willing assistance and co-operation of both farmers and contractors. Our special thanks go to all those involved with planting and harvesting silage trials across New Zealand.

Northland

Alexander, Greig
Alexander, Kevin
Barfoote, Barry & Elaine
Josper Farms
Kaycee Farms Ltd (K & C Tucker)
Kidd, Roger & Rachel
King, Logan
Mangakahia Dairies
McDermott, Scott
North Star Dairies
Pāmu - Sweetwater
Porteous, Neville
Rock Solid Ltd (Wiegersma, R & J)
Scott, Dave
Slade, Peter
Wilson, Steve

Waikato

Addison, Dayne
Arnold, Bruce
Bain, Richard
Balle Brothers (Eamon Balle)
Baytown Investments - Iron Clover
Bennett, Jeremy
Bill Webb Feed Solutions
Buckley, Matt
Butterworth, Rex
Cunningham, Ben
Dean, Murray
Edwards, Pat & Luke
Feather Holdings
Fonterra Farms Ltd Cambridge
Gavin, Ian
Harlow Ltd (Glen Crafar)
Henderson, Graeme
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Laing, Brian
Lane, Peter & Ro
Laurich, Gavin
Pāmu - Wairakei Estate
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Roden, Gavin
S D Nicholson Contracting Ltd (Scott Nicholson)
Singh, Arjun
Smith, Paul
Stobie, Donald & Craig
Strang, Richard
Takapau Trust (Bruce Putt)
Waikiwi Farms Limited (David Jefferis)
Walling Contracting
Wilcox AS & Sons
Wymer, Lewis

Bay of Plenty, Gisborne and northern Hawke's Bay

Bill Webb Feed Solutions Ltd (Bill Webb)
Feather Holdings
Fell Farms Ltd (Dan & Jono Fell)
Grant Farms Ltd (Tom Grant)
Greenwell Farms Ltd (Paul Looney)
J L Murray & Sons Ltd
Jordaan Contracting Ltd (Japie Jordaan)
Mullins, Paul & Keryn
Pāmu - Wairakei Estate
PJ Brogden Contracting Ltd
Takapau Trust (Bruce Putt)
Te Tiringa Farms Ltd (Matthew Barr)

Central Hawke's Bay, lower North Island and Taranaki

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Argyle, Paul
Burke, Eddie
England, Dave
Fonterra Taranaki
Funnell, Kristian
Gray Brothers
Harris, Tim
Kearins, Grant
Kissick, Bede
Knight, Gary
Knowles, Chris & Amy
Lawrence, Hayden
Major, Kirk
Manning, Kesty
McCarty, John
Mead Farming Feeds
O'Sullivan, Simon
Pratt, Malcolm
Stewart, James
Te Whanake Joint Venture
Trewithen Partnership
Weir, John & Roslyn
Westtown Ag
Whittfield, Jared
Whittington, John

South Island

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Riley, Brent
Sheppard, Dan
Smythe, Todd
Tod, Derek
Van Leeuwen Dairy Group (Aad van Leeuwen)
Wai-iti Fresh (Peter McCracken)
Watson, Dave
Wilson, Gary

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