Seed Production of Prairie Grass. I. Effect of Spring Sowing Date, Seeding Rate and Defoliation

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ABSTRACT

Field trials were carried out in New Zealand over three years, 1984 to 1986, to measure seed yields and seed yield components of prairie grass (*Bromus willdenowii* Kunth; syn. *B. cartharticus* Vahl) cv. Grasslands Matua sown in spring on different sowing dates from early September to mid-October at three seeding rates (20, 40 and 60 kg ha^{-1}) and was harvested in the succeeding summer. In the first year, an additional defoliation treatment was imposed in December.

Seed yield each year was greatest from mid- to late-September and early October sowings. In the first year, sowing in the first week of September yielded 1540 kg ha^{-1} of seed compared with 2430 kg ha^{-1} from sowing four weeks later. In the second year, the seed yield from sowing in the first week of September was 590 kg ha^{-1} compared with 1600 kg ha^{-1} two and four weeks later. In the third year, sowing the third week of September yielded 3240 kg ha^{-1} of seed compared with 1670 kg ha^{-1} from sowing three weeks later.

Increasing the seeding rate increased seed yield each year, even though this effect was significant ($P<0.05$) only in 1985. At comparable seeding rates seed yields differed between years (e.g.. from 1090 kg ha^{-1} at the 20 kg ha^{-1} seeding rate in 1985 to 2180 kg ha^{-1} at the 20 kg ha^{-1} seeding rate in 1986).

Defoliation in December 1984 increased seed yields by 85% in early sown plots (first week of September) but had no effect on plots sown in the first week of October. Undefoliated plots in October out yielded defoliated September sown plots by 23%. Seed yield increases were caused primarily by increases in fertile tiller numbers and spikelets per tiller.

These studies have shown that hand harvested seed yields of 2000 kg ha^{-1} can be obtained in the first summer from Matua prairie grass established in mid-spring at high seeding rates.

Additional index words: **_Bromus willdenowii_, rescue grass, seed yield, fertile tillers, spikelets per tiller.**

INTRODUCTION

For seed production, most temperate grasses must pass through a short day and/or low temperature vernalization phase to induce flowering after an autumn or spring sowing. Prairie grass (or rescue grass) (*Bromus willdenowii*) Kunth (syn. *B. cartharticus* Vahl)), is one of the few temperate grasses grown for commercial seed production that does not have a vernalization requirement for flower induction (Evans, 1964). It can, therefore , be spring sown and a seed crop harvested four to five months later (Brown and Rolston, 1985). Hand harvested seed yields from spring-sown prairie grass are usually one-half to one-third less than yields from autumn-sown crops (Brown and Rolston, 1985) which range from 4000 to 8000 kg ha^{-1} (Hare et al., 1988).

In autumn-sown crops of Matua prairie grass it has been shown that time of sowing and seeding rate (Hare et al., 1988) and row spacing (Brown and Archie, 1986) have significant effects on seed yield. Late autumn sowing decreased seed yields by over 3000 kg ha^{-1}. Low seeding rates (5 kg ha^{-1}) gave equal seed yields to high seeding rates (20 kg ha^{-1}) if sown in early autumn, and wide row spacings (60 cm) produced less seed than narrow row spacings (15 cm). These factors have not been studied with spring sown crops. From previous experience with spring sown crops Hare and Rolston (unpublished) found that a defoliation in early summer appeared to increase fertile tillers. Field trials were designed to examine time of sowing, seeding rates and defoliation in 'Grasslands Mauta' prairie grass seed productivity.

MATERIALS AND METHODS

Trials were conducted over three years from 1984 to 1987 at the Grasslands Division, DSIR, Aorangi farm, Manawatu, New Zealand (40° S) on a poorly drained soil developed within a Holocene siliceous sand alluvium. Rainfall and soil temperatures (10 cm depth) were recorded at a meteorological station (N.Z. Meteorological Service, Kairanga) approximately 1000 m from the trial sites. Each trial was conducted on a new site from the previous year's trial.

Trial 1: Matua was sown on two sowing dates (5 September and 5 October 1984) at two seeding rates (20 and 40 kg ha^{-1}). The defoliation treatment (3 cm from ground level) was imposed on 3 December 1984 to give a fully randomized trial design, replicated four times. Fungicide treated seed (benomyl at 5.0 g kg^{-1} seed, Benlate 50 WP) was hand sown in 15 cm spaced rows into

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cultivated plots, 3.6 x 4 m. Nitrogen at 20 kg ha^{-1} was applied at sowing and another 60 kg ha^{-1} was applied to all plots at the time of defoliation (3 December 1984). A herbicide mixture was applied on 24 October (2,4-D amine at 1 kg ha^{-1}, bromoxynil and ioxynil each at 200 g ha^{-1}) and again on 4 December 1984 (bromoxynil and ioxynil each at 300 g ha^{-1}).

Plants were counted six weeks after sowing. Seed harvesting dates varied according to time of sowing and defoliation. September sown plots were harvested on 31 December 1984 (undefoliated) and 19 January 1985 (defoliated); October sown plots were harvested on 4 February 1985 (undefoliated) and 7 February 1985 (defoliated). Two weeks before each harvest a one m row in each plot was cut to determine the number of fertile and vegetative tillers. At this time, 20 heads were selected randomly from each plot for spikelet and floret counts. These figures were used in conjunction with thousand seed weight (TSW) and seed yield at harvest to determine seed numbers following methods outlined in Hare et al. (1988). At seed harvest, 7 x 1 m rows were hand cut from each plot, air dried, threshed and cleaned prior to determination of seed yields (adjusted to 14% moisture).

Trial 2: 'Grasslands Matua' prairie grass was sown on three sowing dates (2, 16 and 30 September 1985) at three seeding rates (20 40 and 60 kg ha^{-1}) in a fully randomized design replicated six times. Fungicide treated seed (thiram + triadimenol + fuberidazole at 5 + 0.25 + 0.04 g kg^{-1} seed; "Thiram sow" + 'Baytan F17') was hand broadcast into cultivated plots measuring 20 x 3.6 m, and then harrowed and rolled. Nitrogen at 80 kg ha^{-1} was applied at sowing, herbicide (2,4-D amine at 1.2 kg ha^{-1}) was applied to all plots on 16 December November 1985.

Number of plants were counted in all plots on 26 November. During anthesis fertile tillers were counted in three 0.25 m^2 areas in each plot and 20 heads were selected randomly for spikelet and floret counts. Seed was harvested on 15 January (1 September sown plots), 21 January (16 September sown plots) and 29 January 1986 (30 September sown plots). At seed harvest, eight 0.25 m^2 samples were hand cut from each plot to determine seed yield (14% moisture) and other components of seed yield (Hare et al., 1988).

Trial 3: Matua was sown on two sowing dates (22 September and 15 October 1986 at three seeding rates (20, 40 and 60 kg ha^{-1}) with two seeding methods (hand broadcast and machine drilled in 15 cm spaced rows). Treatments were replicated three times in fully randomized trial. Fungicide treated seed (as for trial 2) was sown in plots measuring 15 x 3 m and harrowed after seeding. Nitrogen was applied twice (two weeks after sowing and across all plots on 24 November) at 40 kg ha^{-1} in each application.. A herbicide mixture (2,4-D amine 0.6 kg ha^{-1}; bromoxynil and ioxynil each at 200 g ha^{-1}) was applied to the first sown plots on 4 November and the second sown plots on 25 November 1986.

Plants were counted six weeks after sowing and tillers eight weeks after sowing. During anthesis, a 0.25 m^2 area in each plot was cut to determine fertile and vegetative tiller numbers;, fertile tillers were also counted in four additional uncut 0.25 m^2 areas in each plot. Seed yield components and seed yield were determined as in trials 1 and 2. The results of the method of sowing are presented (Hare et al., 1989).

RESULTS

Meteorological data

During the September and October establishment period, rainfall was adequate during 1984 and for the first sowing in 1986, but was below average with a prolonged dry spell in 1985 and during the second sowing in 1986. Soil temperatures were average in all years during this period except for 1986 which was slightly warmer (1 C) during October (Table 1).

During the November and December growth period, rainfall was heavy and well distributed during 1984 and 1985, but very low in 1986, especially in December. Temperatures during the growth period were warm in 1984, medium to warm in 1985, and cool in 1986.

Sowing date

Plant establishment: In 1984 and 1986, more plants established in the earlier sowing than the later sowing (Table 2). This result was reversed in 1985. Tillers were counted nine weeks after sowing in 1986 only, and plants sown on September 23 had 347 tillers m^{-2} (significantly ($P<0.01$) more than the 171 tillers m^{-2} from the October 15 sowing).

Seed yield: Date of sowing in spring had an effect on seed yield (Table 2); the highest yields (2430, 1600, 3240 kg ha^{-1} for 1984, 1985, 1986, respectively) came from sowings made between mid-September and early October. Sowing in the first week of September in 1984 and 1985 reduced seed yields to 63% and 37% respectively compared to seed yields from sowings delayed two to four weeks, while sowing in mid-October 1986, reduced seed yields to 51% of earlier sowings.

Components of seed yield

Tillers: Fewer fertile and vegetative tillers were produced from the early sowing 1985 than from sowing two and four weeks later (Table 2). The 1986 mid-October sowing produced fewer fertile and vegetative tillers than the sowing three weeks earlier. In 1984, sowing date had

Table 1. Weekly average soil temperature (10 cm) and rainfall records, August through December 1984, 1985, and 1986, Kairanga, N.Z.

		Rainfall (mm)			Temperature (C)		
Month	Week	1984	1985	1986	1984	1985	1986
Aug.	4	4.6	4.8[1]	0.2	8.6	8.2[1]	6.2
Sept.	1	1.0[1]	28.3	24.0	10.3[1]	7.5	8.5
	2	14.2	0.0[2]	22.6	9.4	9.0[2]	9.2
	3	3.3	0.0	0.1[1]	9.6	9.7	9.1[1]
	4	33.6	10.2[3]	7.6	11.3	11.2[3]	10.8
Oct.	1	6.4[2]	3.0	14.3	9.9[2]	12.3	12.6
	2	3.8	6.7	2.5	12.6	12.0	13.6
	3	7.0	11.6	20.0[2]	13.2	12.6	13.1[2]
	4	0.0	10.7	0.8	13.4	12.0	14.0
Nov.	1	23.1	23.7	2.5	15.7	12.5	15.3
	2	13.3	9.1	8.6	17.2	14.1	15.3
	3	22.8	38.4	0.0	14.8	16.3	14.4
	4	26.6	29.4	40.5	16.4	16.3	14.4
Dec.	1	21.2	23.4	0.1	19.2	17.4	14.3
	2	25.6	7.8	0.2	18.1	19.4	17.4
	3	41.9	2.3	14.7	17.7	19.3	19.4
	4	7.1	58.4	3.8	19.6	18.9	17.7

[1]Date of first sowing
[2]Date of second sowing
[3]Date of third sowing

no effect on fertile tillers; however, vegetative tillers were more numerous with the October sowing. Nearly twice the number of fertile tillers were produced in 1984 than from the best plots in 1985 and 1986.

In 1984, significantly ($P<0.001$) more dry matter (DM) was produced at harvest by sowing in October (725 g m^{-2}) than sowing in September (369 g m^{-2}). DM at harvest was not measured in other years.

Spikelets: Sowing early September in 1984 and 1985 reduced spikelets per tiller compared with sowing two and four weeks later.

Florets: Sowing date affected florets per spikelet only in 1984 when 21% more florets per spikelet were produced by sowing at the beginning of September than four weeks later.

Seeds: TSW's were greater with early September (1984) and mid-September sowings (1985 and 1986). Seeds m^{-2} were considerably lower in number with sowing at the beginning of September compared to sowing two to four weeks later in 1984 and 1985. Sowing in mid-October (1986) reduced seeds m^{-2} in comparison with sowings three weeks earlier but did not affect seeds per spikelet. Seed numbers were considerably higher (60 to 100%) in 1986 than in the previous two years.

Percentage floret site utilization (FSU) was affected by sowing date only in 1985, but in 1986 was over twice those of the previous two years.

Seeding rate

Plant establishment: The seeding rate of 20 kg ha^{-1} produced fewer plants at six weeks after sowing in all three years (Table 3). The highest seeding rate of 60 kg ha^{-1} produced 40 to 60% more plants than 40 kg ha^{-1} in 1985 and 1986.

In 1986, when tillers m^{-2} were measured nine weeks after sowing, the 20 kg ha^{-1} seeding rate produced 40% fewer tillers (195 tillers m^{-2}), than those produced at the 60 kg ha^{-1} rate (324 tillers m^{-2}). The 40 kg ha^{-1} rate produced 258 tillers m^{-2}, which was not significantly ($P<0.05$) different from the other two rates.

Seed yield: Seed yield was increased by seeding rate only in 1985 at the highest rate (Table 3). In 1986, the 60 kg ha^{-1} seeding rate yielded 36% more seed that at 20 and 40 kg ha^{-1}, but because of large variations (cv. 48%) in plot yields, the difference was not significant. Yields in 1985 were lower than in the other two years.

Table 2. Effect of spring sowing date on plant numbers, seed yield and components of seed yield of Matua prairie grass at various sowing dates.

	1984		1985		1986		
	2/9[1]	5/10	2/9	16/9	30/9	22/9	15/10
Plant no. (m^{-2})	143	131	32	48	67	107	72
LSD 0.05	11		16			21	
Seed yield (kg ha^{-1})	1540	2430	590	1600	1600	3240	1670
LSD 0.05	370		230			820	
Fertile tillers (m^{-2})	403	416	142	204	215	274	117
LSD 0.05	NS		39			48	
Veg. tillers (m^{-2})	276	354	--	--	--	264	169
LSD 0.05	58		--			59	
Spikelets $tiller^{-1}$	19	30	22	28	28	24	24
LSD 0.05	1.8		2.0			NS	
Florets $spikelet^{-1}$	6.65	5.50	6.68	6.73	6.65	6.03	5.83
LSD 0.05	0.34		NS			NS	
TSW (g)	10.90	10.46	10.61	11.26	10.70	11.54	10.94
LSD 0.05	0.30		0.31			0.46	
Seeds $spikelet^{-1}$	2.02	1.88	1.85	2.68	2.68	4.7	5.08
LSD 0.05	NS		0.48			NS	
Seeds (m^{-2})	14392	22147	5541	14171	15074	29185	14538
LSD 0.05	3908		2043			7195	
FSU (%)	31.4	35.6	27.8	39.7	40.4	78.8	87.5
LSD 0.05	NS		7.3			NS	

[1]Day/month

Components of seed yield

Tillers: The lowest seeding rate produced the fewest fertile and vegetative tillers (Table 3). In 1986 fertile tillers from the 20 kg ha^{-1} seeding rate were significantly heavier ($P<0.05$) (2.0 g per tiller) than tillers from the 60 and 40 kg seeding rates (1.6 and 1.4 g $tiller^{-1}$, respectively). In 1984, DM at harvest for the higher seeding rate (607 m^{-2}) was significantly higher ($P<0.05$) than for the lower seeding rate (484 m^{-2}).

Spikelets: Spikelets per tiller at the 20 kg ha^{-1} seeding rate were greater than 40 and 60 kg ha^{-1} in 1984 and 1986. In 1985, spikelets per tiller did not differ among seeding rates.

Florets: Seeding rate did not affect florets per spikelet in any year.

Seeds: TSW was affected by seeding rate only in 1984 when the 40 kg ha^{-1} rate produced heavier seed than 20 kg ha^{-1}. TSW in 1986 was heavier than those in 1984 and 1985. Number of seeds per spikelet in 1985 was higher at the 20 kg ha^{-1} seeding rate than the two higher seeding rates. Seeds m^{-2} were affected by sowing rate only in 1985 when the 60 kg ha^{-1} rate increased numbers by more than 30% above the other rates.

FSU was affected by seeding rate only in 1985 when the 20 kg ha^{-1} rate had the highest FSU, but FSU in 1986 was more than double that of the previous two seasons.

Defoliation

Seed yield: Matua defoliated in December increased seed yield by 24% compared with plots undefoliated (Table 4). Defoliation had a large effect on early sown Matua; seed yields were 85% greater than those of undefoliated plots. However, with late sown Matua there was no affect on seed yields with a December defoliation.

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In 1984, rainfall was sufficient during the establishment period of September and October. The early September sowing produced more plants m^{-2} than the sowing four weeks later, but by anthesis both sowings had an equal number of fertile tillers m^{-2}. The early October sowing produced 890 kg ha^{-1} more seed than the September sowing owing to the 57% increase in spikelets per tiller compared with the first sowing (Table 2). This seed yield component was the most important influence on seed yield. Spikelets per tiller were greater probably because the plants from the October sowing had more space initially (Hare et al., 1988) and more time for development subsequently (Langer, 1972). Spikelets developed later than the September sown plants under good December rainfall (harvested in February rather than December-January) and became larger (tiller weights were not measured, but there was significantly ($P<0.001$) more DM at harvest). More nutritional support to the fertile tillers was therefore available and they were able to develop more spikelets per tiller (Hare et al., 1988).

The very dry September-October establishment period in 1985 reduced plant numbers considerably compared with numbers in 1984 and 1986. This was particularly the case with the early sown plants (Table 2). These plants (sown September 2) developed under very cool (7.5-9.0 C) and extremely dry conditions (Table 1). They were never able to catch up to later sown plants which established under warmer and moisture conditions. By harvest, the fewer fertile tillers of the September plants had fewer spikelets per tiller and seed yields decreased to 36% of later sown prairie grass (Table 2). In 1986, the prairie grass sown in the middle of October established under high soil temperatures (13-15 C) and met with a very dry period in late October and the first three weeks of November. Consequently, plant numbers m^{-1} were lower than September sown prairie grass and fertile tillers m^{-2} were fewer. Thus seed yield was only 51% of that produced by September sown prairie grass. A crop sown in the last week of October completely failed to establish owing to dry soil conditions (Brown, pers. comm.).

Falloon and Rolston (1991) suggested that the best seed production from spring sown Matua prairie grass is from early to mid-spring sowings, September 7 to October 5, rather than from sowings after that time. We would agree that Matua sown from the middle of October onwards will not give good seed yields, but also suggest that Matua sown in the first two weeks of September is unlikely to give good seed yields.

The seeding rate results were less clear. In 1984 and 1986 when the establishment period was moist, there were no significant differences ($P<0.05$) in seed yields. The trend, however, was for the highest seeding rate to produce the highest seed yield. (In the dry year, 1985, the highest seed yield came from the highest seeding rate (Table 3)).

Fewer fertile tillers were produced at the 20 kg ha^{-1} seeding rate compared to the higher rates. Although there were no significant differences ($P<0.05$) in seed yields between seeding rates in 1984 and 1986, fertile tillers produced more spikelets per tiller and compensated for low fertile tiller numbers at the 20 kg ha^{-1} rate. In 1986 when fertile tiller weights were measured the lower seeding rate had the heaviest tillers, (2.0 g per tiller).

Seed yield of defoliated early sown Matua was greater than that of undefoliated early sown but still less than that of undefoliated later sown October crops. The greater seed yield was associated primarily with the increase in spikelets per tiller. Defoliation increased the amount of DM at harvest in the defoliated treatments. As there were no significant ($P<0.05$) increases in fertile tiller numbers and as vegetative tiller numbers were reduced by defoliation, the extra dry weight came from increased tiller size.

The heavier tillers were associated with Matua regrowing and becoming fertile in the warm, wet December conditions. Undefoliated plots were harvested at the end of December and defoliated plots which grew in December were harvested at the end of January. There was no increase in seed yield with defoliation in the October sown plots because plants had not grown substantially by the time of defoliation. This meant that tillers from both treatments developed and became fertile under the same weather conditions in December and January and were harvested together in the first week of February.

Results from these trials show that Matua prairie grass can be sown in the spring and produce a seed crop four to five months later. Early September sowing and sowing after the middle of October reduce seed yields. Seeding rates must be substantially higher than those for autumn sown crops (Hare et al., 1988): a seeding rate of 60 kg ha^{-1} gives consistently higher yields than lower rates and eliminates the risk of lower seed yields from lower rates. Defoliation in early summer is an advantage only if Matua is sown very early in the spring.

Even though in two years out of three there were no significant differences in seed yields between seeding rates, the highest seeding rate always produced the highest seed yield. For this reason and taking into account the possibility of a dry spring, we would recommend a spring seeding rate of over 40 kg ha^{-1}.

ACKNOWLEDGEMENTS

Mr. Randall Kimura and Mr. Sam Gordon assisted with crop management and harvesting, and Dr. Siri Wewala gave advice on statistics. Dr. John Hampton offered constructive criticism of this paper.

Table 3. Effect of spring sowing rate (kg ha^{-1}) on plant numbers, seed yield and components of seed yield of Matua prairie grass.

	1984		1985			1986		
	20[1]	40	20	40	60	20	40	60
Plant no. (m^{-2})	103	170	34	46	66	48	85	136
LSD 0.05	11			16			25	
Seed yield (kg ha^{-1})	1830	2140	1090	1170	1540	2180	2200	2975
LSD 0.05	NS			230			NS	
Fertile tillers (m^{-2})	355	464	139	191	230	147	204	236
LSD 0.05	61			30.9			59	
Veg. tillers (m^{-2})	250	379	--	--	--	175	225	250
LSD 0.05	59			--			72	
Spikelets tiller^{-1}	25.8	23.4	25.2	26.3	26.1	26.2	22.9	22.3
LSD 0.05	1.72			NS			2.32	
Florets spikelet^{-1}	6.09	6.07	6.66	6.75	6.65	5.99	5.77	6.04
LSD 0.05	NS			NS			NS	
TSW (g)	10.52	10.84	10.92	10.69	10.97	11.16	11.52	11.11
LSD 0.05	0.30			NS			NS	
Seeds spikelet^{-1}	2.08	1.83	2.71	2.18	2.31	5.00	4.56	5.18
LSD 0.05	NS			0.48			NS	
Seeds (m^{-2})	17608	18930	9886	10869	14031	19731	19159	26694
LSD 0.05	NS			2043			NS	
FSU (%)	34.9	32.1	40.7	32.3	34.9	83.1	79.2	87.2
LSD 0.05	NS			7.3			NS	

[1]Seeding rate (kg ha^{-1})

Components of seed yield

Tillers: Defoliation did not affect fertile tiller numbers, but did decrease vegetative tillers (Table 4). Defoliation increased the amount of DM at harvest significantly ($P<0.05$) (616 vs 478 g m^{-2}).

Spikelets: Defoliation increased the number of spikelets per tiller at both sowing dates and sowing rates.

Florets: Defoliation decreased florets per spikelet at the two sowing dates and the two sowing rates.

Seeds: Defoliation decreased TSW by 6% and increased seed numbers m^{-2}. The latter was particularly noticeable at the early sowing date (10% increase).

DISCUSSION

These studies have shown that Matua prairie grass can produce seed crops four to five months after spring sowing. Although the seed yields are one-third of autumn sown crops or equal to second harvest autumn sown seed yields (Hare et al., 1988), the crop is in the ground for a shorter period (five vs. eight or nine months). Farmers may choose between an autumn or a spring sowing.

The main factors studied in these trials were sowing date and seeding rate, the former having considerable more influence on seed yields than seeding rate.

Seed yields from sowings in the first week of September were 37% (1984) and 64% (1985) lower than from sowings delayed two to four weeks (Table 2). Low soil temperatures (<10 C) have been shown to reduce the germination and tiller growth rates of prairie grass (Culleton and McCarthy, 1983; Hill et al., 1985); late autumn sowing reduced seed yields by 40-50% of early autumn sowings (Hare et al., 1988). In these spring studies, low soil temperatures probably affected the first sowing only in 1985 (low plant numbers). In 1985 and 1986, soil moisture limited seed production from the early September sowing (1985) and the mid-October sowing (1986).

Table 4. Effect of defoliation in early December on seed yields, components of seed yield of Matua prairie grass sown at two seeding rates on two sowing dates.

Component Defoliation method	Seeding rate[1] 20	Seeding rate[1] 40		Sowing date 5/9[2]	Sowing date 5/10
Seed yield (kg ha^{-1})					
ND[3]	1650	1896		1076	2468
D[4]	20134	2380		2000	2395
LSD 0.05			370		
Fertile tillers (m^{-2})					
ND	349	451		452	348
D	362	476		353	485
LSD 0.05			NS		
Veg. tillers (m^{-2})					
ND	253	450		315	387
D	247	308		236	318
LSD 0.05			58		
Spikelets tiller^{-1}					
ND	24.7	20.4		16.8	28.3
D	27.0	26.2		21.2	31.9
LSD 0.05			1.72		
Florets spikelet^{-1}					
ND	6.42	6.37		7.07	5.71
D	5.76	5.76		6.23	5.29
LSD 0.05			0.34		
TSW (g)					
ND	10.69	11.23		11.41	10.52
D	10.34	10.46		10.39	10.40
LSD 0.05			0.30		
Seeds spikelet^{-1}					
ND	1.82	1.68		1.26	2.23
D	2.33	1.98		2.77	1.54
LSD 0.05			NS		
Seeds (m^{-2})					
ND	15695	15093		9414	21374
D	19521	22768		19369	22920
LSD 0.05			13908		
FSU (%)					
ND	29.3	30.0		18.06	41.25
D	40.6	34.2		44.80	29.95
LSD 0.05			NS		

[1]Kg ha^{-1}
[2]Date/month
[3]ND = no defoliation
[4]D = defoliation