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Delayed N re-application after grass harvest: effects on yield, N uptake and root biomass

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Abstract
The effects of delayed N re-application after grass harvest on yield, N uptake and root biomass were investigated in a field experiment

Keywords
Delayed N application, grassland, yield, N uptake, root biomass

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Uitstel van N-bemesting na grasoogst: effecten op opbrengst, N-opname en wortelmassa

Herman de Boer
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November 2012

Summary

The effects of delaying N re-application after grass harvest were investigated under field conditions in the Netherlands in the year 2011. The hypothesis was that delaying N re-application increases root biomass and rooting depth, resulting in increased N uptake efficiency and dry matter yield. In the field experiment, N re-application after harvest (mowing) was delayed with 0, 3, 6, 9 or 12 days. Treatments were replicated six times on six different permanent grassland fields on drought-sensitive sandy soil. Grass was fertilized and harvested six times and all treatments were harvested at the same date. N application rate with CAN was 320 kg N ha^{-1}, split in rates of 80, 60, 60, 50, 40 and 30 kg N ha^{-1} for the six consecutive growth periods, respectively. Results show that delaying N application with 0 to 12 days significantly ($p = 0.01$) increased N uptake of the fourth harvest from 46 to 59 kg N ha^{-1} and significantly ($p = 0.009$) increased N uptake of the fifth harvest from 39 to 50 kg N ha^{-1}. Delay in N application did, however, not significantly affect root biomass in soil layers 10 – 20, 20 – 30 and 30 – 40 cm (determined on September 27); the increases in N uptake can entirely be explained by the pattern and amounts of rainfall. For example, heavy rainfall (29 mm) on the second day of the fifth growth period reduced N uptake of the fifth harvest with 10 kg N ha^{-1} (or 25% of N applied) when N was applied immediately after the fourth harvest, but not when N was applied three days later. Total N uptake over the six growth periods was not significantly ($p = 0.649$) affected by a delay in N application; N uptake with no delay was 224 kg N ha^{-1} and N uptake with 12 days of delay was 241 kg N ha^{-1}. Of the dry matter yield, only the yield of the third harvest was significantly ($p = 0.018$) affected by a delay in N application and decreased from 2.2 Mg dm ha^{-1} (0 days of delay) to 1.7 Mg dm ha^{-1} (12 days of delay). Yield tended to decrease as a result of delay in N application at second harvest and tended to increase at fourth harvest. Results were less consistent for the first, fifth and sixth harvest. Total dry matter yield over the six growth periods tended to be lower when N application was delayed with more than three days; yield with no delay was 11.1 Mg dm ha^{-1} and yield with 12 days of delay was 10.5 Mg dm ha^{-1}. In conclusion: the results provide no evidence that delaying N application can increase N uptake efficiency through an increased root biomass, but they do show that rainfall events shortly after N application can considerably reduce N uptake and yield of grassland, likely because of N leaching. Management practices to reduce this leaching can therefore increase N use efficiency and yield of grassland. Based on the results of this experiment (one year), it can be concluded that Dutch dairy farmers can delay the (re-)application of N fertilizer on grassland with a week, without experiencing negative impacts on dry matter yield or N uptake (≈ protein yield). A delay up to 12 days can have a negative impact on dry matter yield.

Samenvatting

De effecten van uitstel van de N-bemesting na de oogst van grasland werden in 2011 onderzocht in een veldexperiment. De veronderstelling was dat uitstel van de N-bemesting de wortelmassa en bewortelingsdiepte kan verhogen, leidend tot een hogere N-opname en opbrengst. In de veldproef werd de N-bemesting na grasoogst (alleen maaien) uitgesteld met 0, 3, 6, 9 of 12 dagen. De behandelingen werden zes keer herhaald op zes verschillende permanente graslanden op droogtegevoelige zandgrond. Het grasland werd zes keer bemest en geoogst en alle behandelingen werden op dezelfde dag geoogst. De jaargift N was 320 kg N ha^{-1} met KAS, met een N-gift per snede van 80, 60, 60, 50, 40 en 30 kg N ha^{-1} voor respectievelijk de 1^{e} t/m de 6^{e} snede. De resultaten laten zien dat uitstel van de N-bemesting van 0 tot 12 dagen de N-opname van de vierde snede significant ($p = 0,01$) verhoogde van 46 tot 59 kg N ha^{-1} en de opname van de vijfde snede significant ($p = 0,009$) verhoogde van 39 tot 50 kg N ha^{-1}. Uitstel van de N-gift had echter geen significant effect op de wortelmassa in bodemlagen 10 tot 20, 20 tot 30 en 30 tot 40 cm (bepaald op 27 september); de toename van de N-opname kan volledig worden verklaard vanuit de hoeveelheden en het patroon van neerslag. Bijvoorbeeld, zware regenval (29 mm) op de tweede dag van de groei van de vijfde snede verlaagde de N-opname van de vijfde oogst met 10 kg N ha^{-1} (of 25% van de gegeven N) wanneer de N meteen na oogst van de vierde snede werd toegediend, maar niet als de N-gift drie dagen werd uitgesteld. De totale N-opname van de zes sneden was niet significant ($p = 0,649$) verschillend bij een langere uitstel van de N-gift; de N-opname bij geen uitstel was 224 kg N ha^{-1} en de N-opname bij uitstel met 12 dagen was 241 kg N ha^{-1}. Bij de opbrengst was alleen de opbrengst van de derde snede significant ($p = 0.018$) verschillend bij uitstel van de N-gift; deze opbrengst nam af van 2.2 ton ds ha^{-1} (0 dagen uitstel) tot 1.7 ton ds ha^{-1} (12 dagen uitstel). De opbrengst van de tweede snede neigde naar lager als gevolg van uitstel van de N-gift en de opbrengst van de vierde snede neigde naar hoger. De resultaten waren minder consistent voor de eerste, vijfde en zesde snede. De totale opbrengst van de zes sneden neigde naar lager wanneer de N-bemesting met meer dan drie dagen werd uitgesteld; de opbrengst zonder uitstel was 11,1 ton ds ha^{-1} en de opbrengst bij 12 dagen uitstel was 10,5 ton ds ha^{-1}. Geconcludeerd kan worden dat de resultaten geen bewijs leveren dat uitstel van de N-gift de efficiëntie van N-opname kan verhogen als gevolg van een hogere wortelmassa. De resultaten laten echter wel zien dat regenbuien vlak na N-bemesting de N-opname en opbrengst van grasland duidelijk kunnen verlagen, waarschijnlijk als gevolg van uitspoeling. Maatregelen waardoor het risico op N-uitspoeling verlaagd kan worden kunnen hierdoor de efficiëntie van N-opname en de opbrengst van grasland verhogen. Gebaseerd op deze resultaten (één jaar) kan geconcludeerd worden dat Nederlandse melkveehouders de N-bemesting van een volgende snede gras met een week kunnen uitstellen zonder dat dit negatieve gevolgen heeft voor de drogestofopbrengst en N-opname (≈ eiwitopbrengst. Uitstel tot 12 dagen kan een negatief effect hebben op de drogestofopbrengst.

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1 Introduction

When production grassland is harvested, usually N fertilizer is (re-)applied for the next growth period. Grassland is harvested by mowing or grazing. The time that lapses between harvest and N application is often determined by necessary activities. After mowing for silage, grass is often left on the field to wilt for several days. After grazing, the grazing residues have to be removed. Apart from these activities, the fertilization event itself has to be fitted into the farmer's time schedule. As a result of these activities and planning, the re-application of N is often delayed by a week or longer.

To realize a good yield and feed value of the harvested grass, it seems logical to re-apply N as soon as possible after the harvest, preferably on the same day. The sooner N is re-applied, the sooner grass growth can resume and the higher the yield. It is however the question whether this approach is true. Literature research shows that regrowth of grass during the first days is mainly based on mobilisation of proteins stored in the stubbles and roots. Ourry et al. (1989) concluded that during the first six days of regrowth, about 70% of the N in new leaf material came from proteins in stubbles and roots. Protein reserves of stubbles and roots decreased with 55 and 60%, respectively, in the first four days of regrowth. After fourteen days of regrowth, 45% of N in new leaf material originated from proteins in stubbles and roots and the remainder was taken up from the soil. Thornton et al. (1993) concluded that after eight days of regrowth (at 20°C), 65% of the N in the new leaf material originated from stubbles and roots. This percentage was reduced to 40% after 14 days of regrowth and to 25% after 22 days of regrowth. Because in the first week after harvest regrowth is mainly based on internal N mobilization, it is probably better not to apply N directly after harvest. Whereas applied N is initially only scarcely taken up, it is prone to get lost to the environment by leaching, volatilization and denitrification.

Other processes might also reduce the need for immediate re-application of N. In an experiment by Ennik (1981), grass grown in pots was continuously supplied with N and harvested each month. When four days prior to harvest the N supply was suspended, root volume increased strongly. After two harvests with this treatment, root volume was 20 to 35 ml compared to 10 to 20 ml for the control treatment. After three harvests with this treatment, root volume was 25 to 50 ml compared to 10 to 20 ml for the control treatment. Based on these results, it can be hypothesized that a delay in N application might increase root volume (and possibly also rooting depth) of perennial ryegrass. If this is true, delaying of N application could be used by dairy farmers as a management practice to increase N use efficiency and yield, because N use efficiency usually increases with increased root biomass and rooting depth. Increased root biomass and rooting depth could also reduce the sensitivity of grassland to drought, especially on drought-sensitive sandy soils.

So far, limited research is available on the use of a delay in N application as a management practice to increase N uptake efficiency and yield of grassland. In the UK, Sheldrick et al. (1994) delayed the re-application of N fertilizer with 0, 3, 7, 10 or 14 days. Results show that a delay up to 10 days had no substantial effect on yield and N use efficiency. In this experiment, grassland was irrigated after each N application, to avoid effects of drought (availability of applied N) on the results.

For Dutch dairy farmers, it is important to know whether under Dutch weather conditions it is possible to delay N re-application after grass harvest for a week or longer, without experiencing negative effects on yield and N use efficiency. If this is possible, it would give them extra flexibility in their management. To investigate the effect of a delay in N application on yield and N use efficiency, a field experiment was carried out in 2011. This experiment was funded for one year by the Dutch Dairy Board (Productschap Zuivel, Zoetermeer).

2 Materials & methods

2.1 Experimental setup

The field experiment was carried out in 2011 on six different permanent grassland fields on drought-sensitive sandy soil, in a circle of a few kilometres around experimental farm 'Vredepeel' in Vredepeel, the Netherlands. The experiment had a randomized block design with six replications in six blocks and each block located on a different grassland field. The treatment was to delay the N application after each grass harvest with 0, 3, 6, 9 or 12 days. For the first growth period, N application for the delay treatments was applied 3, 6, 9 or 12 days later than a reference date (delay of 0 days). The N application level was 320 kg N ha^{-1} and N distribution over the growth periods was 80, 60, 60, 50, 40 and 30 kg N ha^{-1} for the first to the sixth growth period, respectively. Gross plot dimensions were 10 x 2.5 m. An overview of the experimental design is given in Appendix 1.

2.2 Field experiment

N was applied as calcium ammonium nitrate (CAN, 27% N). CAN was applied with a converted grain sowing machine. N application dates are given for each plot in Appendix 2. Contrary to the approach in Sheldrick et al. (1994), fields were not irrigated after CAN application. The reason for this is that Dutch dairy farmers will not irrigate either, because of the cost and work involved. Possible benefits of delayed N application therefore have to be realized without irrigation. A disadvantage of this choice is that it is more difficult to distinguish between effects due to delay in N application and due to drought. The grassland fields were not additionally fertilized with P or K. In an earlier field experiment in the same area, P-Al varied between 37 and 72 (av. 54 mg P_2O_5 100 g^{-1} of dry soil) and K-PAE between 61 and 134 (av. 94 mg K kg^{-1} of dry soil).

All plots on a field were harvested at the same date, irrespective of the delay treatment. However, a harvesting date could vary between fields because of differences in yield development. After the first harvest, plots were harvested every five weeks. Plots were harvested with a Haldrup grass harvesting machine (J. Haldrup a/s, Løgstør, Denmark). Harvesting dates are given for each plot in Appendix 2. Field 2 could not be harvested for the fifth and sixth time, due to feeding damage caused by *Elateridae* larvae. At harvest, grass was cut back to 6 cm and sampled. The samples were dried at 70°C, dry matter concentration was determined and the dried material was analysed for total N concentration (Dumas method).

At the 27th of September 2011, soil layers 10 to 20 cm, 20 to 30 cm, and 30 to 40 cm, were sampled in order to determine root biomass. Sampling was done on field 3, 4, 5 en 6. Field 1 was excluded because of a later harvesting date; field 2 because of the feeding damage. Three soil cores (ø of 8.5 cm) per plot were taken to determine the root biomass. The soil in the samples was thoroughly washed out with water, roots were oven-dried at 70 °C and dry matter was determined.

Rainfall data were collected from the Dutch Royal Meteorological Institute (KNMI, Station Venray). Spring and early summer (March through June) were unusually dry, whereas July and August were unusually wet (Table 4).

2.3 Statistical analysis

All data for N-uptake, yield and root biomass were statistically analysed using ANOVA in statistical package Genstat (version 11). In this report, a difference is considered significant when $P < 0.05$, unless stated otherwise.

3 Results

3.1 N uptake

N uptake of the fourth and fifth growth period was significantly affected by a delay in N application (Table 1). At the fourth harvest, N uptake was significantly higher after 12 days of delay compared to 0, 3 or 6 days of delay. At the fifth harvest, N uptake was significantly higher after 3, 6, 9 or 12 days of delay compared to 0 days of delay. However, N uptake of the fifth growth period did not increase any further when the delay was longer than 3 days. Total N uptake over the growth season was not significantly affected by a delay in N application for up to 12 days.

Table 1 N uptake (kg N ha^{-1}), per ryegrass harvest and over the growth season, after a delay in N (re-) application after harvest with 0, 3, 6, 9 or 12 days

Delay (days)	Harvest nr.						Total[4)]
	1[1)]	2	3	4	5[3)]	6[3)]	
0	55	67	56	46[a2)]	39[a]	20	224
3	49	70	51	46[a]	49[b]	24	239
6	54	66	56	48[a]	47[b]	25	238
9	57	64	55	51[ab]	48[b]	23	236
12	60	62	51	59[b]	50[b]	23	241
LSD (p < 0.05)	n.a.	10	13	8	6	4	25
P-value	n.a.	0.450	0.884	0.010	0.009	0.258	0.649

[1)] Data of one block/replication; other data missing due to missing N analysis results
[2)] Different letters within a column indicate a significant (P < 0.05) difference between treatments
[3)] Averages of five replications/, excl. the fifth and sixth harvest of field 2 due to feeding damage caused by *Elateridae* larvae
[4)] Excl. data of the first harvest for all fields and data of the fifth and sixth harvest for field 2

3.2 Yield

Only the yield of the third harvest was significantly affected by a delay in N application (Table 2). Yield of the third harvest was significantly lower with a delay of 12 days compared to a delay of six days or less. Yield of the second harvest tended to decrease as a result of delay in N application and yield of the fourth harvest tended to increase. The results were less consistent for the first, fifth and sixth harvest. The total yield of the growth season tended to be lower when the delay in N application was longer than three days.

Table 2 Yield (Mg dm ha^{-1}), per ryegrass harvest and over the growth season, after a delay in N (re-) application after harvest with 0, 3, 6, 9 or 12 days

Delay (days)	Harvest nr.						Total[3)]
	1	2	3	4	5[2)]	6[2)]	
0	2.4	2.9[a]	2.2[a1)]	1.7	1.1	0.6	11.1
3	2.2	2.9[a]	2.2[a]	1.8	1.3	0.7	11.4
6	2.2	2.7[ab]	2.1[a]	1.8	1.3	0.7	11.1
9	2.3	2.5[b]	2.0[ab]	1.8	1.2	0.6	10.7
12	2.2	2.4[b]	1.7[b]	2.0	1.2	0.6	10.5
LSD (p < 0.05)	0.2	0.4	0.3	0.3	0.1	0.1	0.8
P-value	0.143	0.08	0.018	0.112	0.071	0.345	0.180

[1)] Different letters within a column indicate a significant (P < 0.05) difference between treatments
[2)] Averages of five replications, excl. the fifth and sixth harvest of field 2 due to feeding damage caused by *Elateridae* larvae
[3)] Excl. data of the fifth and sixth harvest of field 2

3.3 Root biomass

A delay in N application had no significant effects on total root biomass in soil layer 10 to 40 cm (Table 3). Only in soil layer 20 to 30 cm, root biomass was significantly higher after a delay of 12 days compared to a shorter delay.

Table 3 Ryegrass root biomass (g dry matter per sample) on the 27th of September 2011, in soil layers 10 to 20 cm, 20 to 30 cm and 30 to 40 cm, after delay in N (re-)application after harvest with 0, 3, 6, 9 or 12 days

Delay (days)	Soil layer			
	10 to 20 cm	20 to 30 cm	30 to 40 cm	10 to 40 cm
0	0.50	0.28[a1)]	0.23	0.90
3	0.59	0.29[a]	0.17	1.06
6	0.48	0.32[a]	0.16	0.96
9	0.68	0.28[a]	0.21	1.18
12	0.54	0.42[b]	0.25	1.20
LSD ($p < 0.05$)	0.30	0.09	0.11	0.43
P-value	0.610	0.029	0.411	0.496

[1)] Different letters within a column indicate a significant ($P < 0.05$) difference between treatments

4 Discussion

The most likely explanation for the observed effects, especially for N uptake of the fourth and fifth harvest, are the rainfall pattern and the rainfall amounts after N application. With heavy rainfall after N application, a considerable amount of N can leach to the subsoil, resulting in lower N uptake and potentially also lower yield. When the amount of rainfall is accumulated for all growth periods and treatments, it shows that the amount of rainfall was relatively high during the fourth growth period (Table 4).

Table 4 Accumulated rainfall (mm) between the moment of N application and ryegrass harvest, for each growth period and delay treatment

Delay (days)	Harvest nr.					
	1	2	3	4	5	6
0	40	10	83	146	112	73
3	40	10	78	141	83	73
6	40	10	66	141	72	72
9	40	10	52	121	65	72
12	37	8	52	102	51	72

Source: Dutch Royal Meteorological Institute (KNMI, Station Venray)

Focussing on the first 12 days of the fourth growth period, it is observed that there was a relatively high amount of rainfall on day six, eight and ten (Table 5). This coincides rather well with the increase in N uptake of the fourth harvest after a delay in N application with nine or 12 days (Table 1). When the rainfall pattern during the first 12 days of the fifth growth period are linked with the N uptake, it becomes evident why any delay in N application resulted in a significantly higher N uptake: on the second day, there was a heavy rainfall incidence with 29 mm of precipitation. It is likely that, because of this large amount of rainfall, a considerable part of N applied on day 0 has leached to the subsoil, resulting in the significantly higher N uptake of treatments with later N application. The results indicate that 10 kg out of 40 kg N applied, or 25%, was lost to the subsoil. Another interesting observation is that during the second growth period a delay in N application resulted in lower yield, whereas there was no rainfall during the first nine days (Table 5). This suggests that, despite the absence of rainfall, the applied N could dissolve and being taken up by the grass roots.

Table 5 Daily rainfall (mm) during the first 12 days after ryegrass harvest and application of N delay treatments, for each growth period (averaged dates per treatment)

Harvest nr.	Days after harvest													Total
	0	1	2	3	4	5	6	7	8	9	10	11	12	
1	0	0	0	0	0	0	0	0	0	0	0	3	0	3
2	0	0	0	0	0	0	0	0	0	0	2	0	0	2
3	0	5	0	2	10	0	0	5	9	0	0	0	0	31
4	5	0	0	0	0	0	8	1	11	0	17	2	0	44
5	0	29	0	3	0	8	7	0	0	10	3	2	0	61
6	0	0	0	0	0	0	0	0	0	0	0	0	1	1

Source: Dutch Royal Meteorological Institute (KNMI, Station Venray)

In this research, a relationship between a delay in N application and the amount of root biomass could not be established. It is possible (though not likely) that differences did exist earlier during the growth season, but had disappeared at the moment of sampling. For follow-up research, it is recommendable to sample root biomass several times during the growth season. Root biomass is a rather general indicator as it includes both older and younger roots. Possibly, differences could have been observed when, for example, root length or root volume had been measured, or when a distinction had been made between young root growth and roots remaining from the previous growing season(s). For this purpose, other techniques, like for example the ingrowth-core method, could be used.

Conclusions

- A delay in N application up to 12 days after harvest had no negative effect on total N uptake (~ protein yield) of the growth season
- A delay in N application up to six days had no negative effect on total DM-yield of the growth season
- A relationship between root biomass and delay in N application could not be established; the observed positive effects of delay in N application on N uptake of the fourth and fifth growth period appear to be the result of avoidance of leaching (caused by rainfall after the application moment)
- Management practices to reduce this leaching risk can increase N use efficiency and yield of grassland

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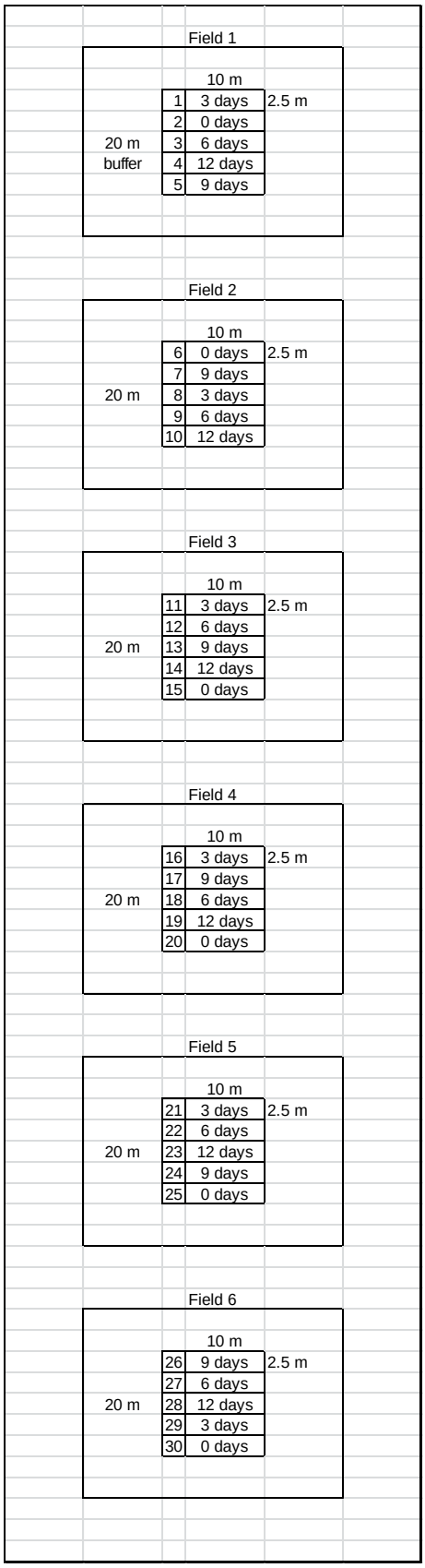
Appendices

Appendix 1. Experimental design



Appendix 2. N application and harvest dates

Harvest nr.	Plot nr.	Field nr.	Delay (days)	N application date	Harvest date
1	1	1	3	5-3-2011	5-5-2011
1	2	1	0	2-3-2011	5-5-2011
1	3	1	6	8-3-2011	5-5-2011
1	4	1	12	14-3-2011	5-5-2011
1	5	1	9	11-3-2011	5-5-2011
1	6	2	0	2-3-2011	29-4-2011
1	7	2	9	11-3-2011	29-4-2011
1	8	2	3	5-3-2011	29-4-2011
1	9	2	6	8-3-2011	29-4-2011
1	10	2	12	14-3-2011	29-4-2011
1	11	3	3	5-3-2011	29-4-2011
1	12	3	6	8-3-2011	29-4-2011
1	13	3	9	11-3-2011	29-4-2011
1	14	3	12	14-3-2011	29-4-2011
1	15	3	0	2-3-2011	29-4-2011
1	16	4	3	5-3-2011	29-4-2011
1	17	4	9	11-3-2011	29-4-2011
1	18	4	6	8-3-2011	29-4-2011
1	19	4	12	14-3-2011	29-4-2011
1	20	4	0	2-3-2011	29-4-2011
1	21	5	3	5-3-2011	29-4-2011
1	22	5	6	8-3-2011	29-4-2011
1	23	5	12	14-3-2011	29-4-2011
1	24	5	9	11-3-2011	29-4-2011
1	25	5	0	2-3-2011	29-4-2011
1	26	6	9	11-3-2011	29-4-2011
1	27	6	6	8-3-2011	29-4-2011
1	28	6	12	14-3-2011	29-4-2011
1	29	6	3	5-3-2011	29-4-2011
1	30	6	0	2-3-2011	29-4-2011
2	1	1	3	8-5-2011	14-6-2011
2	2	1	0	5-5-2011	14-6-2011
2	3	1	6	11-5-2011	14-6-2011
2	4	1	12	17-5-2011	14-6-2011
2	5	1	9	14-5-2011	14-6-2011
2	6	2	0	29-4-2011	1-6-2011
2	7	2	9	8-5-2011	1-6-2011
2	8	2	3	2-5-2011	1-6-2011
2	9	2	6	5-5-2011	1-6-2011
2	10	2	12	11-5-2011	1-6-2011
2	11	3	3	2-5-2011	1-6-2011
2	12	3	6	5-5-2011	1-6-2011
2	13	3	9	8-5-2011	1-6-2011
2	14	3	12	11-5-2011	1-6-2011
2	15	3	0	29-4-2011	1-6-2011
2	16	4	3	2-5-2011	1-6-2011
2	17	4	9	8-5-2011	1-6-2011
2	18	4	6	5-5-2011	1-6-2011
2	19	4	12	11-5-2011	1-6-2011
2	20	4	0	29-4-2011	1-6-2011
2	21	5	3	2-5-2011	1-6-2011
2	22	5	6	5-5-2011	1-6-2011
2	23	5	12	11-5-2011	1-6-2011
2	24	5	9	8-5-2011	1-6-2011
2	25	5	0	29-4-2011	1-6-2011
2	26	6	9	8-5-2011	1-6-2011
2	27	6	6	5-5-2011	1-6-2011
2	28	6	12	11-5-2011	1-6-2011
2	29	6	3	2-5-2011	1-6-2011
2	30	6	0	29-4-2011	1-6-2011
3	1	1	3	17-6-2011	20-7-2011
3	2	1	0	14-6-2011	20-7-2011
3	3	1	6	20-6-2011	20-7-2011
3	4	1	12	26-6-2011	20-7-2011
3	5	1	9	23-6-2011	20-7-2011
3	6	2	0	1-6-2011	4-7-2011
3	7	2	9	10-6-2011	4-7-2011
3	8	2	3	4-6-2011	4-7-2011

Harvest nr.	Plot nr.	Field nr.	Delay (days)	N application date	Harvest date
3	9	2	6	7-6-2011	4-7-2011
3	10	2	12	13-6-2011	4-7-2011
3	11	3	3	4-6-2011	4-7-2011
3	12	3	6	7-6-2011	4-7-2011
3	13	3	9	10-6-2011	4-7-2011
3	14	3	12	13-6-2011	4-7-2011
3	15	3	0	1-6-2011	4-7-2011
3	16	4	3	4-6-2011	4-7-2011
3	17	4	9	10-6-2011	4-7-2011
3	18	4	6	7-6-2011	4-7-2011
3	19	4	12	13-6-2011	4-7-2011
3	20	4	0	1-6-2011	4-7-2011
3	21	5	3	4-6-2011	4-7-2011
3	22	5	6	7-6-2011	4-7-2011
3	23	5	12	13-6-2011	4-7-2011
3	24	5	9	10-6-2011	4-7-2011
3	25	5	0	1-6-2011	4-7-2011
3	26	6	9	10-6-2011	4-7-2011
3	27	6	6	7-6-2011	4-7-2011
3	28	6	12	13-6-2011	4-7-2011
3	29	6	3	4-6-2011	4-7-2011
3	30	6	0	1-6-2011	4-7-2011
4	1	1	3	23-7-2011	22-8-2011
4	2	1	0	20-7-2011	22-8-2011
4	3	1	6	26-7-2011	22-8-2011
4	4	1	12	1-8-2011	22-8-2011
4	5	1	9	29-7-2011	22-8-2011
4	6	2	0	4-7-2011	16-8-2011
4	7	2	9	13-7-2011	16-8-2011
4	8	2	3	7-7-2011	16-8-2011
4	9	2	6	10-7-2011	16-8-2011
4	10	2	12	16-7-2011	16-8-2011
4	11	3	3	7-7-2011	16-8-2011
4	12	3	6	10-7-2011	16-8-2011
4	13	3	9	13-7-2011	16-8-2011
4	14	3	12	16-7-2011	16-8-2011
4	15	3	0	4-7-2011	16-8-2011
4	16	4	3	7-7-2011	16-8-2011
4	17	4	9	13-7-2011	16-8-2011
4	18	4	6	10-7-2011	16-8-2011
4	19	4	12	16-7-2011	16-8-2011
4	20	4	0	4-7-2011	16-8-2011
4	21	5	3	7-7-2011	16-8-2011
4	22	5	6	10-7-2011	16-8-2011
4	23	5	12	16-7-2011	16-8-2011
4	24	5	9	13-7-2011	16-8-2011
4	25	5	0	4-7-2011	16-8-2011
4	26	6	9	13-7-2011	15-8-2011
4	27	6	6	10-7-2011	15-8-2011
4	28	6	12	16-7-2011	15-8-2011
4	29	6	3	7-7-2011	15-8-2011
4	30	6	0	4-7-2011	15-8-2011
5	1	1	3	25-8-2011	30-9-2011
5	2	1	0	22-8-2011	30-9-2011
5	3	1	6	28-8-2011	30-9-2011
5	4	1	12	3-9-2011	30-9-2011
5	5	1	9	31-8-2011	30-9-2011
5	6	2	0		
5	7	2	9		
5	8	2	3		
5	9	2	6		
5	10	2	12		
5	11	3	3	19-8-2011	23-9-2011
5	12	3	6	22-8-2011	23-9-2011
5	13	3	9	25-8-2011	23-9-2011
5	14	3	12	28-8-2011	23-9-2011
5	15	3	0	16-8-2011	23-9-2011
5	16	4	3	19-8-2011	23-9-2011
5	17	4	9	25-8-2011	23-9-2011
5	18	4	6	22-8-2011	23-9-2011
5	19	4	12	28-8-2011	23-9-2011

Harvest nr.	Plot nr.	Field nr.	Delay (days)	N application date	Harvest date
5	20	4	0	16-8-2011	23-9-2011
5	21	5	3	19-8-2011	23-9-2011
5	22	5	6	22-8-2011	23-9-2011
5	23	5	12	28-8-2011	23-9-2011
5	24	5	9	25-8-2011	23-9-2011
5	25	5	0	16-8-2011	23-9-2011
5	26	6	9	25-8-2011	14-9-2011
5	27	6	6	22-8-2011	14-9-2011
5	28	6	12	28-8-2011	14-9-2011
5	29	6	3	18-8-2011	14-9-2011
5	30	6	0	15-8-2011	14-9-2011
6	1	1	3	3-10-2011	8-11-2011
6	2	1	0	30-9-2011	8-11-2011
6	3	1	6	6-10-2011	8-11-2011
6	4	1	12	12-10-2011	8-11-2011
6	5	1	9	9-10-2011	8-11-2011
6	6	2	0		
6	7	2	9		
6	8	2	3		
6	9	2	6		
6	10	2	12		
6	11	3	3	26-9-2011	27-10-2011
6	12	3	6	29-9-2011	27-10-2011
6	13	3	9	2-10-2011	27-10-2011
6	14	3	12	5-10-2011	27-10-2011
6	15	3	0	23-9-2011	27-10-2011
6	16	4	3	26-9-2011	27-10-2011
6	17	4	9	2-10-2011	27-10-2011
6	18	4	6	29-9-2011	27-10-2011
6	19	4	12	5-10-2011	27-10-2011
6	20	4	0	23-9-2011	27-10-2011
6	21	5	3	26-9-2011	27-10-2011
6	22	5	6	29-9-2011	27-10-2011
6	23	5	12	5-10-2011	27-10-2011
6	24	5	9	2-10-2011	27-10-2011
6	25	5	0	23-9-2011	27-10-2011
6	26	6	9	23-9-2011	24-10-2011
6	27	6	6	20-9-2011	24-10-2011
6	28	6	12	26-9-2011	24-10-2011
6	29	6	3	17-9-2011	24-10-2011
6	30	6	0	14-9-2011	24-10-2011

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