TwinN®

YIELD INCREASING MICROBES

POTATO TRIALS

Mapleton Agri Biotec Pty Ltd

INTRODUCTION

TwinN is a high grade, freeze dried microbial inoculum that is used in many countries on many crops to enhance productivity, profitability and sustainability. TwinN delivers these benefits via several mechanisms:

- **Fixes N_2 from the atmosphere into plant available nitrogen.**
- **Drives increased root growth to capture nutrients and water more effectively.**
- **Frees up bound phosphorous for use by the crop.**
- **Restores balance and health to soil microflora and root zone.**

Please refer to **www.mabiotec.com** for a more detailed description of Mechanisms of Action of TwinN microbes. In addition to these economic benefits, TwinN assists in increasing sustainability of production, particularly in reducing carbon footprint of produce.

TwinN is used commercially in many crops in the UK and Europe, USA, Canada, multiple countries in Africa, Turkey, India, Chile, Ecuador, Malaysia and Australia. TwinN has been tested in multiple independent replicated trials by universities, government departments and independent professional trial organisations in different countries, as well as in countless on-farm demonstrations. Please take the time to visit **www.mabiotec.com** and go to the Crop Trials tab to find a list of trial results for viewing or downloads.

TwinN is used for different purposes in different farming systems. In broad acre crops it is often used to enable cuts to nitrogen fertiliser costs while retaining high yields. In horticulture TwinN is also used to increase profits by reducing input costs. But in most horticulture crops, including potato, the high value of the crop means that yield increases are a priority.

This booklet has the summaries of five replicated trials in potato, carried out by independent organizations in the UK, India, South Africa and Tasmania, Australia. The Tasmanian trial was not statistically analysed. These results provide examples of how TwinN has been used in different potato growing systems ranging from organic to conventional.

TwinN is used very effectively in organic potato crops in conjunction with ample supplies of manure, compost and other organic sources of nutrition. The two trials in Herefordshire, UK, in subsequent years showed very large increases in both tuber yield and in the proportion of larger, more marketable tubers. The results improved with two applications of TwinN compared to a single application.

These results were mirrored in the trial in India in the treatment receiving no synthetic nitrogen fertiliser but getting 25 t/ha manure, where application of TwinN provided large increases in yields of marketable tubers. Organic farmers must combine TwinN with good organic nutritional practices and not use it as a substitute for applications of manures and composts to maximise the benefits of the TwinN technology.

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TwinN is commonly used in combination with conventionally fertilised potato crops with a reduction in post-plant nitrogen fertiliser and two applications of TwinN. The trials in Tasmania, Australia, India, and in South Africa, showed that reductions of 50% of post-plant nitrogen were possible while achieving increased tuber yields.

For the majority of potato producers that use nitrogen fertiliser to underpin production, MAB makes these recommendations for TwinN use:

1. Consult with your agronomist or local TwinN distributor for advice on how to integrate TwinN into your crop system. Make sure you do not overturn your current system just to fit TwinN into your program.

2. Apply the standard pre-plant applications and make reductions to nitrogen fertiliser later in the crop cycle.

3. Make sure your non-nitrogen crop nutrition is optimal. Do not reduce P, K or other nutrients.

4. Make your first application of TwinN when there are about 4 leaves, use at least 200 L of non-chlorinated water per hectare, band the applications directly onto the plants, use a coarse nozzle and do not tank mix TwinN with agrochemicals. Ideally this application delivers the microbes to the leaves and also into the roots.

5. Make the second application at tuber initiation/early development. This is usually a month after the first application. Consider testing a small side comparison on a strip of crop with three applications at 21 day intervals to see if an extra application provides advantages in your system.

OTHER BENEFITS

Carbon Footprint

Reduction in nitrogen fertiliser applications will substantially reduce your crop's carbon footprint. Visit **www.mabiotec.com** for more information on this topic. MAB has purchased carbon offsets against the small carbon footprint that the CO_2 audit identified for TwinN - see the Carbon Footprint tab on our website.

Soil Health

Studies by the USDA and University of Missouri have confirmed some of the anecdotal reports MAB receives that use of TwinN increases beneficial microbes and this assists reduction of disease pressure from some root pathogens. Reduced nitrogen fertiliser applications, increased soil carbon and a healthy balanced soil microflora are a recipe for healthy, productive crops.

TWINN CROP TRIAL

Potato Trial: Herefordshire, England 2007 & 2008

KEY RESULT

A single application of TwinN in combination with organic fertiliser application resulted in **15 and 20% yield increases** over organic fertiliser application without TwinN, in a 2007 independent replicated trial using two cultivars. In the same trial, **yield increases of 28 and 29%** were measured for the same two cultivars when treated with two applications of TwinN. A repeat independent trial in 2008 resulted in **yield increases of 29 and 43%** in one cultivar, **and 12 and 26%** in a second cultivar. A significant shift in tuber size distribution towards larger tubers was observed in all TwinN plots in both trials.

TRIAL RESULTS

Table 1: Total Yields of 2 CVs of Potato in 2007 & 2008

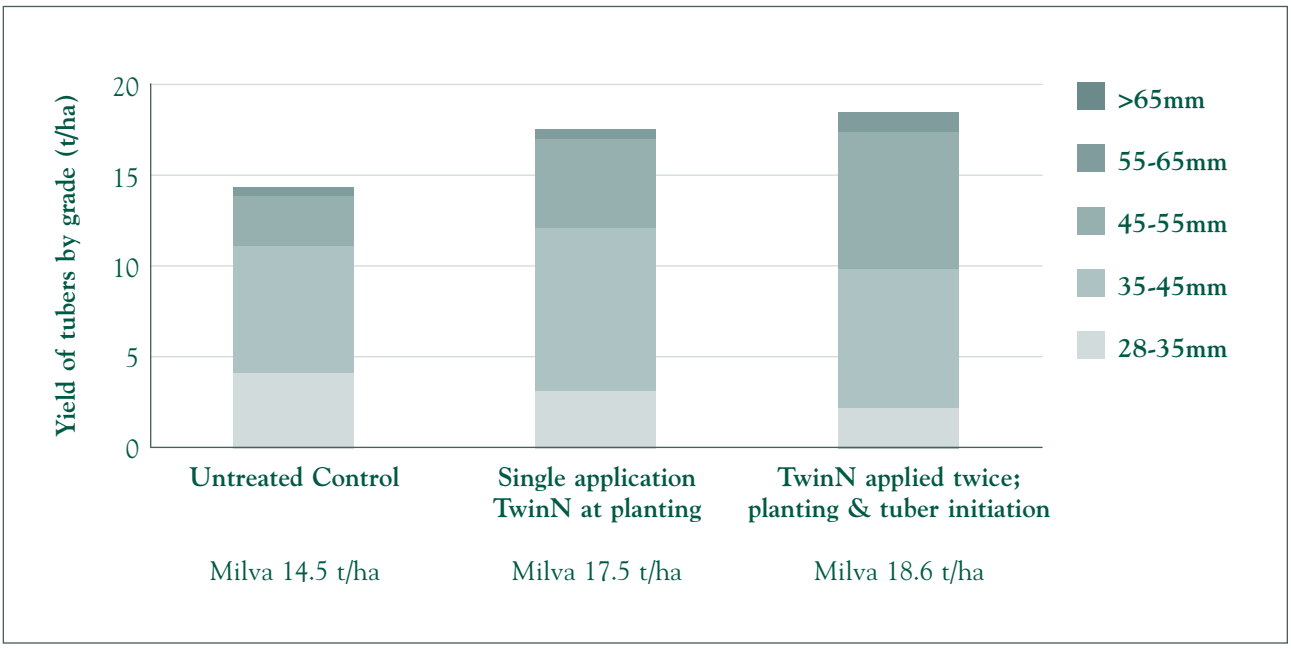
2007 RESULTS	Milva		Valor	
	Tonnes/ha	% of control	Tonnes/ha	% of control
Untreated control	14.5 a	100 a	18.6 a	100 a
Single TwinN at planting	17.5 b	120 b	21.4 b	115 b
TwinN twice soil and foliar	18.6 c	128 c	23.9 c	129 c
LSD ($p<0.05$)	0.84 t/ha	6%	0.63 t/ha	3%

Data values that share adjacent lower case letters **a, b,** or **c** are not significantly different ($p<0.05$).

2008 RESULTS	Amarosa		Valor	
	Tonnes/ha	% of control	Tonnes/ha	% of control
Untreated control	10.9 a	100 a	29.3 a	100 a
TwinN at planting, emergence	12.2 ab	112 ab	37.9 b	129 b
...at planting, emergence, tuber	13.7 bc	126 bc	41.7 bc	143 bc
LSD ($p<0.05$)	2.46 t/ha	23%	6.53 t/ha	22%

Data values that share adjacent lower case letters **a, b,** or **c** are not significantly different ($p<0.05$).

Table 2: Effect of TwinN on Tuber Size in CVs Milva & Valor in 2007



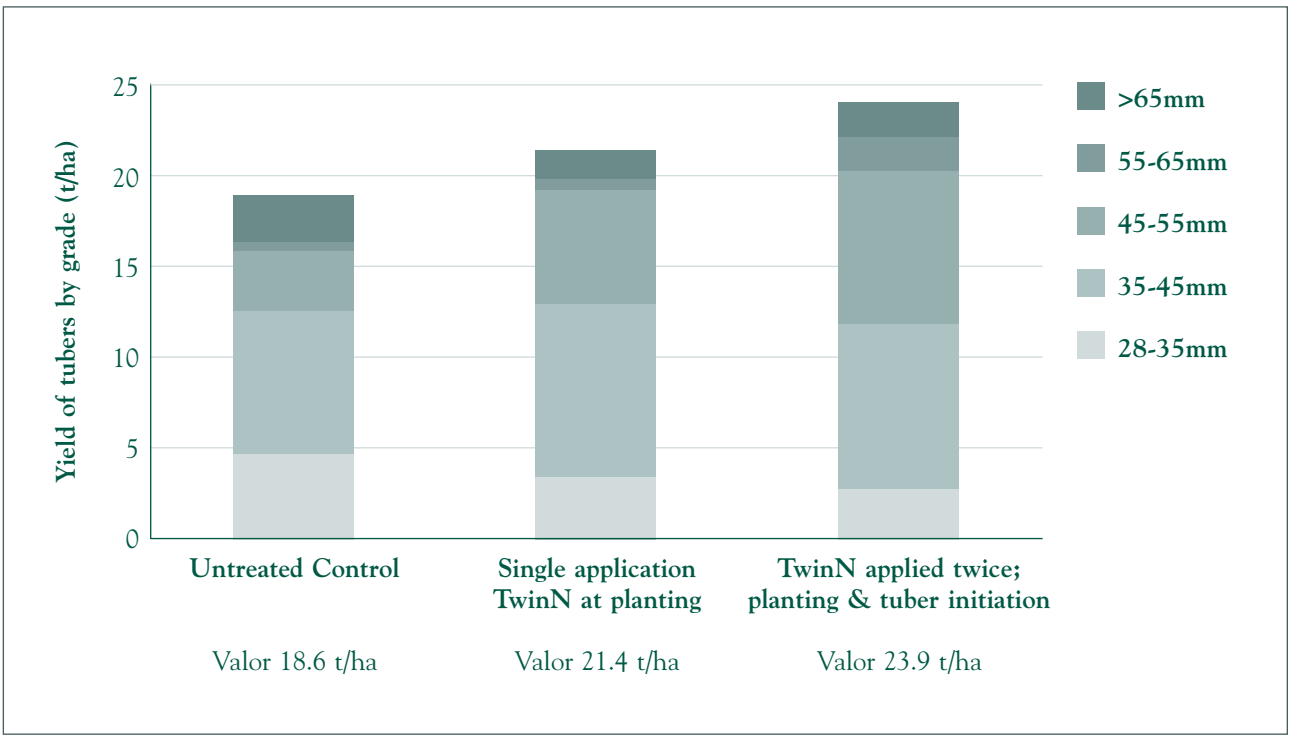


Table 3: Tuber Size Distribution in 2007 Expressed as Percentages

	2007	Yield as % of the untreated control		
Treatment	TwinN spray treatments	>45mm	28-45mm	Total
Milva 0	Untreated control	100% a	100% b	100% a
Milva 1	TwinN once at planting	176% b	105% b	120% b
Milva 2	... twice: planting, tuber initiation	281% c	86% a	128% c
	LSD (p<0.05)	59%	*12%*	6%
Valor 0	Untreated control	100% a	100% a	100% a
Valor 1	TwinN once at planting	139% b	104% a	115% b
Valor 2	TwinN twice: soil & foliar	204% c	93% a	129% c
	LSD (p<0.05)	14%	*12%*	3%

Photograph taken 26 July 2007 showing untreated control on left of centre, and TwinN applied twice on right of centre. Although it appeared in the field that the untreated plots were slightly paler in colour, analysis was not employed to confirm this.

Table 4: Yield of Potatoes by Grade (t/ha) in CVs Valor & Amarosa, 2008

VALOR	<25mm	25-35	35-45	45-55	55-65	65-75	>75mm	Total
Untreated control	0.09 a	0.40 a	2.4 a	8.8 a	13.5 a	4.2 a	0.0 a	29.3 a
TwinN at planting, emergence	0.05 a	0.36 a	1.7 a	8.7 a	17.0 abc	9.3 bcd	0.7 a	37.9 b
... as above + at tuber initiation	0.03 a	0.35 a	2.4 a	11.2 a	19.0 bc	8.3 bc	0.5 a	41.7 bc
LSD (p<0.05)	0.086	0.446	2.13	4.36	4.01	3.43	3.03	6.53
AMAROSA	<25mm	25-35	35-45	45-55	55-65	65-75	>75mm	Total
Untreated control	0.03 a	1.5 a	4.7 ab	3.4 a	1.1 a	0.0 a	0.0 a	10.9 a
TwinN at planting, emergence	0.02 a	0.9 a	3.2 a	5.1 abc	2.0 a	0.8 a	0.0 a	12.2 ab
... as above + at tuber initiation	0.03 a	1.6 a	5.8 b	4.4 ab	1.2 a	0.3 a	0.0 a	13.7 bc
LSD (p<0.05)	0.24	0.92	1.95	1.91	1.88	1.99	0.0	2.46

TRIAL SUMMARY

Trial Performed & Analysed By: Peter Glendinning, Independent UK Agronomist in 2007 and Peter Glendinning and Agrimarc Ltd in 2008.

Trial Design: 2007: Randomised block design with 2 replicates for each cv. 2008: Randomised complete block design with 4 replicates. Separate site for each cv.

TRIAL DETAILS: 2007

Varieties: Milva, Valor
Sowing date: 24/04/07
Harvest date: 19/09/07
Trial layout: Randomised block design, 2 replicate blocks per treatment in 2 varieties. Block size: 25m x 250m
Fertiliser data: Preplant application of Bioganix at 5 t/ha, equivalent to 80 kgN/ha
Soil data: Reddish fine silty clay loam over shale, with good water retention and moderate permeability.
Site history: Wheat 2006

TwinN applications:

1. Untreated control.
2. TwinN applied once, to bare soil at planting, 26/4/07 (note that manufacturer's instructions are to apply to emerging plants rather than bare soil). Application onto moist soil.
3. TwinN applied twice, once to bare soil at planting, 26/4/07 and again at tuber initiation, 11/6/07. Application was onto dry foliage on a summer afternoon (not recommended by manufacturer).

Application was by a Berthoud 2000 commercial spray rig at 400l/ha at 45 psi and TwinN was applied at 2X commercial rate.

TRIAL DETAILS: 2008

Varieties:	Amarosa, Valor
Sowing date:	15/5/08
Harvest date:	12/11/08
Trial layout:	Strip design, 4 replicate blocks per treatment for each variety. Block size 1.9m x30m. Separate sites were used for each variety.
Fertiliser data:	Preplant application of Bioganix at 10t/ha, equivalent to 160 kgN/ha on Valor site and nil fertiliser at Amarosa site.
Soil data:	Reddish fine silty clay loam over shale, with good water retention and moderate permeability.
Site history:	Valor site - clover grass ley; Amarosa site - peas

TwinN applications:

1. Untreated control.
2. TwinN applied to bare soil at planting, 20/5/08 (note that manufacturer's instructions are to apply to emerging plants rather than bare soil) and to soil and foliage at full emergence, 22/6/08 in light drizzle, late afternoon.
3. TwinN applied to bare soil at planting, 20/5/08, full emergence, 22/6/08 in light drizzle and at tuber initiation, 17/7/08 in light drizzle, late afternoon.

Application was made using a hand operated CP3 knapsack sprayer at 3-bar pressure at 600 l/ha and TwinN was applied at 2x commercial rate.

CONCLUSIONS: 2007 Trial

1. A single application of TwinN, sprayed onto bare soil at planting, significantly increased the total yield of potatoes harvested in both the varieties tested. A yield increase of about 3 t/ha was measured in both varieties, amounting to 20% for Milva and 15% for Valor. Note that the recommended application for TwinN is at emergence rather onto bare soil.
2. A second application of TwinN, as a foliar spray at tuber initiation increased yields still further. These were an additional 1 t/ha (8%) for Milva, and 2.5 t/ha (14%) for the higher yielding Valor.
3. Two applications of TwinN increased potato yields more significantly over the untreated control, than a single application at planting. Overall yield increases were almost identical in both varieties; 28% for Milva and 29% for Valor.
4. TwinN applied to the soil at planting significantly increased the weights of both 35-45 and 45-55mm grades, by over 20% and nearly 90% respectively. These increases were clearly at the expense of the yields of the smallest tubers, which were reduced by over 25% in both varieties.
5. Two applications of TwinN more than doubled the yield of the larger tubers between 45 and 65mm. Whereas a single application of TwinN increased the yield of tubers larger than 45mm by 2.4 t/ha, a second application gave an additional 60% for Milva at 3.3 t/ha, and 47% more for Valor, at 3.8 t/ha. The smallest tubers, were reduced to about half those of the untreated control.

CONCLUSIONS: 2008 Trial

1. TwinN applied to the bare soil a few days after planting and repeated at full emergence, gave a significant yield increase of 8 t/ha (29%) for Valor. Although the increase in total yield of 1 t/ha in the low yielding Amarosa was not significant at $p<0.05$, the yield of tubers over 45mm was, with an increase of over 3 t/ha (76%).
2. An additional application of TwinN at tuber initiation increased yields further, but this was not quite significant at $p<0.05$, despite being a 14% increase in both varieties. However, compared to the untreated control, three applications of TwinN gave a significant yield increase of 7 t/ha (43%) for Valor, and over 2 t/ha (26%) of Amarosa.
3. Excepting one anomaly, all the yield increases described above were measured in the larger tubers: between 45 & 65mm for the Amarosa and 55 to 75mm in the Valor. Yield increases in larger tubers were proportionately much larger than the total yield increases.
4. The sprays applied at tuber initiation gave consistent but small yield increases although none of these was statistically significant. The majority of the treatment effects were seen from the earlier application.
5. Despite the varieties yielding very differently, the yield increases from the treatments were proportionally very similar in both varieties.

TWINN CROP TRIAL

Dryland Potato, South Africa, Oct 2008 - May 2009

KEY RESULTS

An independent replicated trial in potato showed:

- Use of 2 applications of TwinN combined with 50% synthetic N fertiliser gave an 4% (0.9 t/ha) increase in yield and a 9% (A$605/ha) increase in profitability compared to the conventional 100% N fertiliser program.
- Use of TwinN enabled accumulation of high yields using 25% or 50% of the normal rates of N fertiliser.
- TwinN treatments gave significantly larger tuber size compared to the 100% N fertiliser program.

TREATMENTS

Treatment	Preplant (kg/ha)	1st TwinN Week 3	Topdress 1 Week 4	2nd TwinN Week 5	Total chemical N/ha
1. Full chemical fertiliser program	300 MAP 200 KCl	0	320 kg/ha LAN 50 kg/ha KCl	0	123 kg
2. 25% chemical N	300 MAP 200 KCl	0	50 kg/ha KCl	0	33 kg
3. 50% chemical N	300 MAP 200 KCl	0	96 kg/ha LAN 50 kg/ha KCl	0	60 kg
4. 25% chemical N + 2 TwinN *(1 soil, 1 foliar)*	300 MAP 200 KCl	Soil applied	50 kg/ha KCl	Foliar applied	33 kg
5. 50% chemical N + 2 TwinN *(1 soil, 1 foliar)*	300 MAP 200 KCl	Soil applied	96 kg/ha LAN 50 kg/ha KCl	Foliar applied	60 kg
6. 25% chemical N + 2 TwinN *(both foliar)*	300 MAP 200 KCl	Foliar applied	50 kg/ha KCl	Foliar applied	33 kg
7. 50% chemical N + 2 TwinN *(both foliar)*	300 MAP 200 KCl	Foliar applied	96 kg/ha LAN 50 kg/ha KCl	Foliar applied	60 kg
8. As per Treatment 7 + organic N[a]	300 MAP 200 KCl Organic N	Foliar applied	96 kg/ha LAN 50 kg/ha KCl	Foliar applied	60 kg

a: 15 T/ha Gromor compost; LAN is limestone ammonium nitrate; MAP is mono ammonium phosphate.

TRIAL SUMMARY

Trial Performed & Analysed By: Neu-agri Consulting, Republic of South Africa, as an independent trial

Trial Design: Randomised block design with eight treatments and four replicates of each treatment.

TRIAL RESULTS: Yield and Profit Increase Comparisons

Treatment	Yield (T/ha)	% Yield Increase[y]	% Large Tubers[t]	Fertiliser Costs ($AU/ha)	Profit[p] $AU/ha	Change in Profit[i] (%)
1. Full chemical fertiliser program	23.7 b	29	41 a	1722	6858	0
2. 25% chemical N	18.4 a	0	46 a	1328	5316	-22
3. 50% chemical N	22.2 b	21	47 a	1446	6577	-4
4. 25% chemical N + 2 TwinN *(1 soil, 1 foliar)*	22.7 b	23	47 a	1328	6859	0
5. 50% chemical N + 2 TwinN *(1 soil, 1 foliar)*	24.1 b	31	51 b	1446	7260	6
6. 25% chemical N + 2 TwinN *(both foliar)*	23.2 b	26	50 b	1328	7049	3
7. 50% chemical N + 2 TwinN *(both foliar)*	24.6 b	34	54 b	1446	7463	9
8. As per Treatment 7 + organic N[a]	23.6 b	29	51 b	3108	5433	-21

LSD (p= 0.05) for yield = 3.07 T/ha and yields with the same letter (a, b) beside them are not statistically different. For example, T1 is different from T2 because they don't share an a or b.

y: % increase in yield is compared to T2.
t: % of tubers larger than 60 mm diameter.
p: Profit per ha is calculated by multiplication of the yield by the potato price and subtraction of all fertiliser and TwinN prices that were current in RSA at the time of the trial. Currency conversions are 1AU$ = R6.5, US$0.77, EUR 0.56. Profit calculation does not include premium for % larger tubers.
i: Change in profit is compared to 100% chemical fertiliser treatment.

SUMMARY OF RESULTS

- Two TwinN applications plus 50% chemical N fertiliser gave the highest **yield** in the trial with a 34% (6.3 t/ha) yield increase over the 25% N/ zero TwinN control and a 4% (0.9 t/ha) increase over the 100% N treatment.
- Two TwinN applications plus 50% N gave a 9% (A$605/ha) increase in **profitability** compared to the 100% N. This was due to a combination of a 4% (0.9 t/ha) yield increase and an 16% (A$276) decrease in total fertiliser costs.
- Two TwinN applications plus 50% N gave a 13% increase in the proportion of large prime grade tubers, compared to the 100% N.
- Yield was strongly affected by N application rate, with the 25% N yielding 29% less than the 100% N treatment.
- The 25% N plus 2 TwinN application treatments and the 50% N plus 2 TwinN treatments were all statistically equal with the 100% chemical N treatment yields, demonstrating that it is possible to achieve normal high yields with greatly reduced rates of N fertiliser application using TwinN.
- The substitution of the first foliar application of TwinN with a soil drench application in combination with 25 or 50% N did not statistically alter yields, although the yields were consistently slightly lower than those from two foliar applications.
- Addition of organic fertiliser in T8 reduced yields and profitability. This is thought to be due to use of non-composted organic material and is strongly at odds with other trials of TwinN combined with organic fertilisers.

TRIAL DETAILS

Crop Data

Crop: Potato Variety: Mondial Row width: 90cm
Plot size: 4 rows by 4m, middle 2 harvested.
Sowing date: 3/11/2008
TwinN application dates: 26/11/2008, 10/12/2008
Harvest date: 16/2/09

Tubers were graded into small (<60mm) and large (>60mm).

Soil Data

Soils were red in colour with approximately 52% clay and 3.0% organic carbon content. Soils were free draining with very little moisture retention in the top 50mm. NH_4N levels in soil were approximately 3.5ppm and NO_3N levels 15.4ppm. 500 kg/ha dolomitic lime was applied prior to discing of the land.

TwinN Applications

The first foliar application was at 8am at 23 days post-planting when the plants were at the 4-5 leaf stage. Weather conditions were 15°C, misty with overcast conditions for the remainder of the day. The second application was made at tuber initiation under similar conditions, but the foliar moisture dried off after 1.5 hours and the daily temperature rose to 29°C followed by 15mm rain late in the day. Foliar applications were made using a backpack at 400L/ha using a coarse nozzle setting and banding over the top of the crop. Soil applications were made at a rate of 1000L/ha onto moist soil and banded onto the base of plants.

Crop Protection Treatments

Karate (Cyhalothrin) applied at planting for cutworm. Greencure (natural pyrethrum) at 22/12/08 for beetles.

CONCLUSIONS

- **Use of 2 TwinN applications combined with 50% chemical N gave the highest yields in the trial and the highest profitability (increase of 9%) compared to the standard 100% N treatment. This is the recommended program for most producers as it maximises both profit and yield per unit of land, while improving environmental outcomes by reducing use of nitrogen fertilisers.**
- **Use of 2 foliar applications of TwinN combined with 25% chemical N gave similar yield and slightly increased profitability compared to 100% chemical N. This program may be suitable for producers who need to farm with lower fertiliser inputs.**

Fig. 1: Trial site at first TwinN application stage.

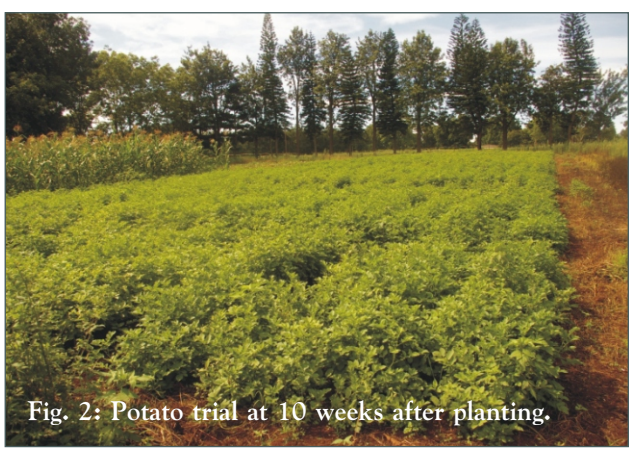


Fig. 2: Potato trial at 10 weeks after planting.

DEMONSTRATION

On Farm Demonstration on a Commercial Potato Farm: Tasmania, Australia, 2009-10

SUMMARY OF DEMONSTRATION

The demonstration was set up as an applied grower trial to assess the capacity of TwinN to produce high yields with reduced urea applications. The demonstration was performed independently, as a replicated trial with no statistical analysis, by SERVE-AG Pty Ltd, Tasmania. The product was supplied by Green Pastures, Tasmania[a]. The trial compared the grower standard nutrient program with the grower standard program, minus 125 kg urea, plus TwinN. A seaweed extract was also included in the comparison as an addition to the standard urea program.

KEY RESULTS

- The TwinN/reduced urea treatment (125 kg urea/ha) produced the highest total yields with a 3.33 T/ha (7.4%) increase over the standard nutrient program (250 kg urea/ha).
- A similar increase was measured in marketable yield with the TwinN/reduced urea treatment producing an increase of 3.12 T/ha (7.4%).
- Petiole sap N levels were maintained at higher levels in the TwinN/reduced urea treatment than the standard nutrient program throughout the trial.
- Farmer's profitability was improved substantially.

DEMONSTRATION RESULTS

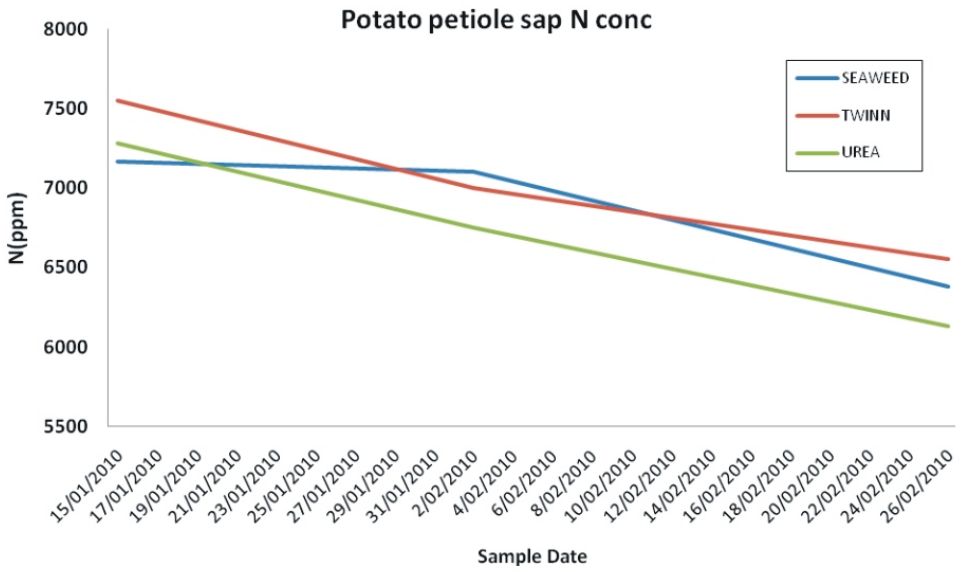
Table 1: Total and Marketable Yield for the three treatments

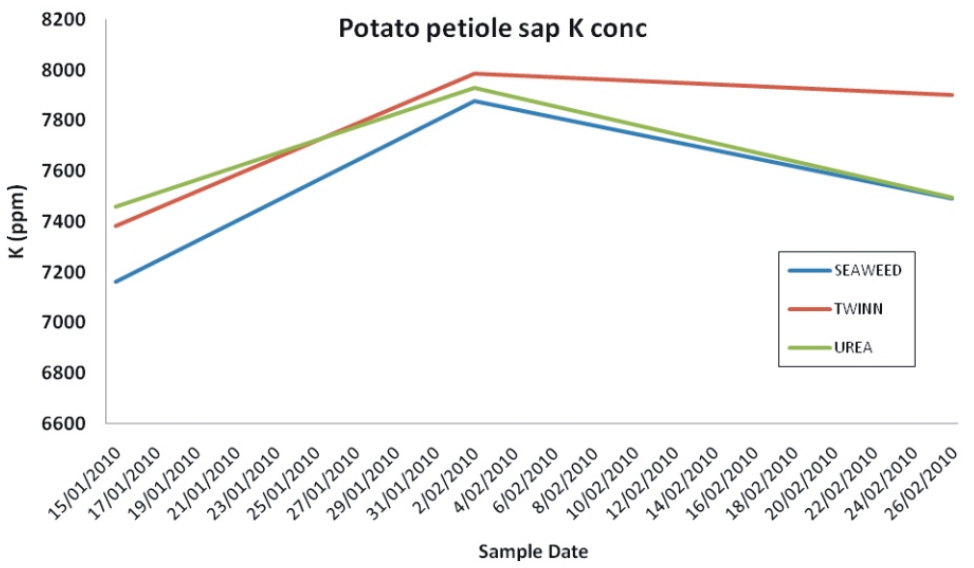
Treatment	Urea	Urea/Seaweed	TwinN/Reduced Urea	% increase over Urea
Total Yield T/ha	44.75	44.71	48.08	7.4%
Marketable Yield T/ha	42.21	42.29	45.33	7.4%

Yield

The results in Table 1 show that the reduced urea/TwinN treatment gave an increase of 3.12 T/ha in marketable yield. The results in Figure 1 show the petiole sap test results for N, P, and K over part of the season, and these nutrient levels underpin the increased yield results for the TwinN treatment. Nitrogen is essential for good haulm development and the use of TwinN and reduced urea application was able to supply sufficient nitrogen to the crop to maximize yield.

Potatoes require large quantities of K, therefore adequate amounts of the nutrient need to be supplied. K is important in increasing tuber size. The petiole sap measurements shown in Figure 1 show that the TwinN treated plants had elevated K levels during the latter half of the crop cycle when K is most important. P levels were considered by the trial agronomists to be sub-optimal across the entire trial.





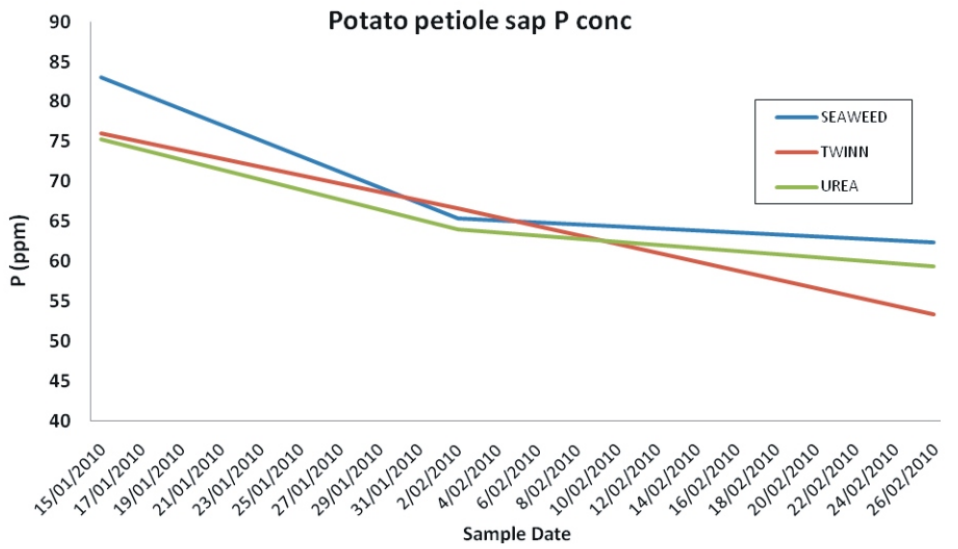


Figure 1: Petiole sap N, P, K concentrations in each treatment through the crop cycle

Profitability

In this demonstration the reduced urea/TwinN treatment gave the highest return to the farmer, due mainly to increased returns. Reduced urea costs were offset by the application of three TwinN applications. Many potato growers use two applications of TwinN but in this demonstration three applications were very successful in maximising yield and therefore, profit to the farmer.

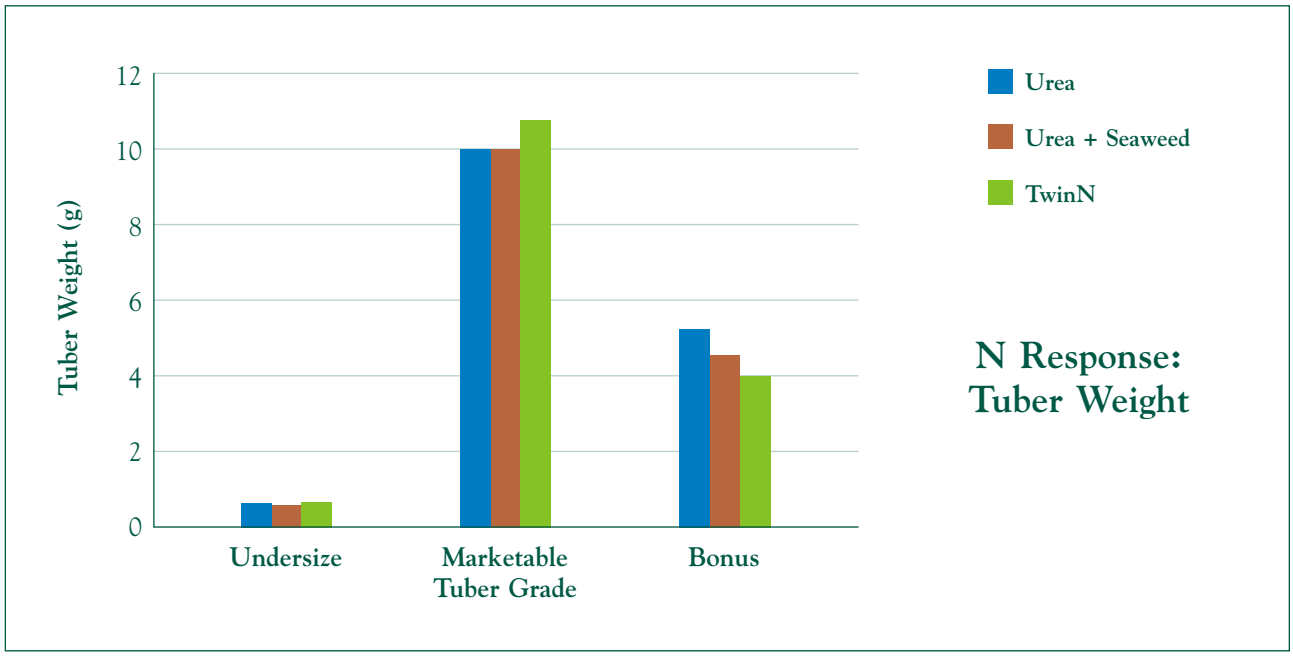


Figure 2: Distribution of tuber weights in different tuber grades for the three treatments

DEMONSTRATION DETAILS

Potato Cultivar	Russet Burbank
Previous Crop	Perennial pasture (2005-2008)
Areas Evaluated	3 replicated plots 25 m x 200 m
Planting Date	10 November 2009
Soil Type	Ferrosol
TwinN Applications	Applications were made early in the day in moist conditions and onto moist soils. A boom spray was used at 160 L/ha.

[a]MAB would like to express our appreciation to the growers who contributed to performing this trial.

Table 2: Nutrient applications and timings for the three treatments

Application Date	Product	Control/Urea: kg/ha	Urea/Kelp: kg or L/ha	TwinN/Reduced Urea: kg/ha
Pre Plant fertilizer				
04/11/09	5-9-18-4 + kg/ha	1050	1050	1050
At Planting				
11/11/09	9-10-23-4	1000	1000	1000
Top Dress				
01/12/09	Kelp Extract	-	15	-
12/12/09	Calcium Nitrate	100	100	100
24/12/09	TwinN	-	-	+
30/12/09	Urea	90	90	45
09/01/10	DAP, KSO_2	Standard	Standard	Standard
15/01/10	TwinN	-	-	+
20/01/10	Urea	90	90	45
28/01/10	Kelp Extract	-	15	-
30/01/10	Calcium Nitrate	50	50	50
09/02/10	TwinN	-	-	+
17/02/10	Urea	70	70	35
25/02/10	Kelp Extract	-	15	-
05/03/10	Kelp Extract	-	15	-

Control/Urea and Urea/Kelp treatments received 250 kg Urea and TwinN/Reduced Urea received 125 kg Urea.

TWINN CROP TRIAL

Potato: Karnataka, India, April 2010

INTRODUCTION

The trial was performed as an independent assessment of the capacity of TwinN to enable high yields in potato, in India, with reduced nitrogen fertiliser (N) application rates. One and two applications of TwinN were combined with 50%, 25% and 0% of the standard rate of nitrogen and compared with the standard 100% University recommended fertiliser program.

KEY RESULTS

- Two applications of TwinN combined with 50% of the standard nitrogen fertiliser application produced an 88% (+14.9 t/ha) increase in yield of marketable potatoes compared to the standard 100% fertiliser applications.
- A single application of TwinN and 50% nitrogen, or one or two applications of TwinN with 25% nitrogen, all yielded substantially higher than the standard 100% nitrogen fertiliser program.
- TwinN increased yields significantly in treatments that received only 25t/ha manure and no inorganic fertiliser.

TREATMENTS

1. 100% N 125 kg/ha (Standard Program)	5. 25% N 31kg/ha + Two TwinN
2. 50% N 62.5 kg/ha + One TwinN	6. No nitrogen & no TwinN
3. 50% N 62.5 kg/ha + Two TwinN	7. No nitrogen + One TwinN
4. 25% N 31 kg/ha + One TwinN	8. No nitrogen + Two TwinN

All treatments received 25 t/ha Farm Yard Manure and standard rates of P and K.

RESULTS

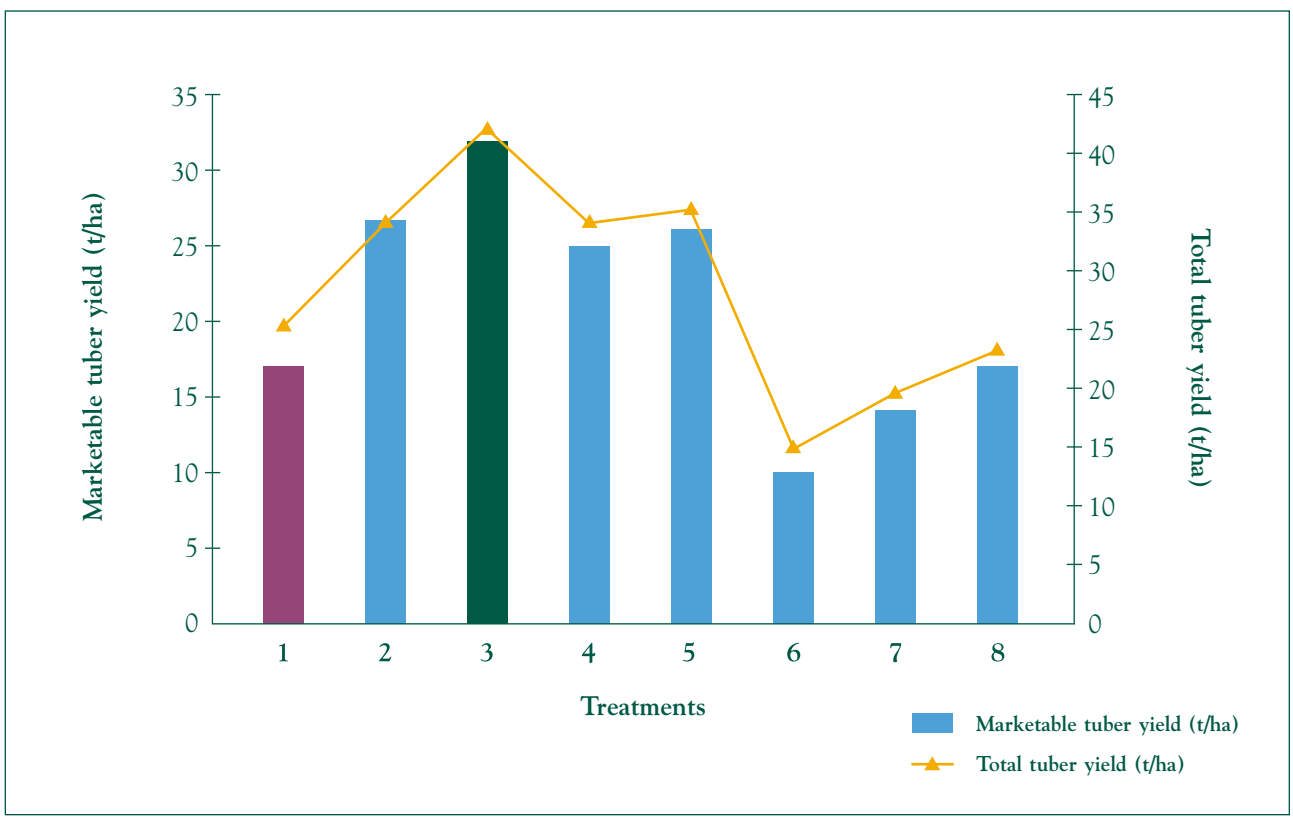
A reduction of N to 50% of the standard rate combined with a single application of TwinN resulted in an increase of 9.6 t/ha (+57%) in marketable tubers compared to the 100% N treatment. 50% N plus two applications of TwinN produced a significantly larger increase of 14.9 t/ha (+88%) compared to the 100%N treatment. Use of this treatment delivered savings in N fertiliser costs and a large increase in returns due to large increases in marketable tubers.

A further reduction to 25% of the standard rate of N combined with one or two applications of TwinN also delivered significantly higher total and marketable tuber yields compared to the standard 100% N program. Two applications of TwinN with no added inorganic N (0%N) gave the same yield as the standard 100% N treatment, but it should be noted that all treatments received 25 t/ha farmyard manure. The farmyard manure treatment is similar to an organic production system since the major supplies of N are from manure and TwinN.

Table 1: Effect of TwinN on tuber yield of potato

TREATMENT	Marketable tubers /plant		Total tubers /plant		Marketable tubers t/ha	Total tubers t/ha
	Number	Weight g	Number	Weight g		
1. 100% N 125 kg/ha (Standard Program)	1.53	107.00	4.07	162.13	16.84	25.49
2. 50% N 62.5 kg/ha + 1 TwinN	2.07	170.93	5.00	220.60	26.43	34.09
3. 50% N 62.5 kg/ha + 2 TwinN	2.40	187.07	5.20	245.07	31.74	41.60
4. 25% N 31 kg/ha + 1 TwinN	1.87	149.80	4.47	202.73	24.99	33.85
5. 25% N 31 kg/ha + 2 TwinN	1.87	155.47	4.13	211.42	25.99	35.36
6. 0% N & no TwinN	1.20	60.60	3.40	91.33	9.96	15.01
7. 0% N + 1 TwinN	1.47	83.93	3.13	116.79	14.11	19.63
8. 0% N + 2 TwinN	1.67	107.87	3.80	147.87	16.87	23.07
CD (p=0.05)*	0.37	15.53	0.44	15.52	3.40	4.07

*CD (p=0.05) Treatment means that differ by more than this value are statistically different.



Tables 2 and 3 (following page) show that the TwinN plus 50% N and the standard 100% N treatments produced taller, larger plants than the treatments receiving less N fertiliser. It is of interest to note that, despite producing less vegetative matter than the 100% N treatment, the TwinN plus 25% N treated plants produced higher tuber yields. Similarly, the TwinN plus 50% N treatments had approximately equal haulm heights and weights as the 100% N treatment but produced much higher tuber yields. In this trial TwinN had a stronger effect on tuber yield than vegetative growth.

Table 2: Effect of TwinN on growth parameters of potato

TREATMENT	Plant emergence (%)	Plant ht (cm)	No. stems/plant	No. leaves/plant
1. 100% N 125 kg/ha (Standard)	83.95	48.93	59.06	1.50
2. 50% N 62.5 kg/ha + 1 TwinN	82.22	48.40	57.72	1.43
3. 50% N 62.5 kg/ha + 2 TwinN	90.87	47.40	58.58	1.57
4. 25% N 31 kg/ha + 1 TwinN	89.13	44.07	55.06	1.40
5. 25% N 31 kg/ha + 2 TwinN	89.38	41.60	57.58	1.67
6. No nitrogen & no TwinN	87.63	31.10	34.01	1.40
7. No nitrogen + 1 TwinN	89.63	32.60	35.13	1.37
8. No nitrogen + 2 TwinN	83.23	36.47	42.79	1.40
CD (p=0.05)	NS	7.68	4.96	0.20

Table 3: Effect of TwinN on haulm and root weights of potato

TREATMENT	Fresh haulm wgt (g/plant)	Dry wgt of haulm (g/plant)	Root fresh wgt (g/plant)	Root dry wgt (g/plant)	Tuber dry matter (%)
1. 100% N 125 kg/ha (Standard)	77.93	41.78	6.79	4.07	17.30
2. 50% N 62.5 kg/ha + 1 TwinN	72.26	39.37	6.04	3.97	17.25
3. 50% N 62.5 kg/ha + 2 TwinN	73.63	41.41	6.87	4.09	17.35
4. 25% N 31 kg/ha + 1 TwinN	69.08	34.44	6.12	3.70	17.07
5. 25% N 31 kg/ha + 2 TwinN	71.87	37.44	6.66	4.02	17.17
6. No nitrogen & no TwinN	42.49	19.00	4.26	2.83	14.10
7. No nitrogen + 1 TwinN	48.33	22.42	4.60	3.24	16.50
8. No nitrogen + 2 TwinN	52.75	28.99	5.86	3.48	17.02
CD (p=0.05)	6.27	3.22	1.01	0.40	1.13

TRIAL SUMMARY

Trial Performed & Analysed By: Agricultural Research Station, University of Agricultural Science (B), Madenur Post, Hassan - 573 220, Karnataka, India.

Trial Design: Randomised Complete Block Design, 8 treatments, 3 replicates. Plots were 5.4 m x 3 m with 4.2 m x 2.8 m harvested. Plant spacing was 60 cm x 20 cm.

TRIAL DETAILS

Crop: Potato
Planting date: 15/1/2010
TwinN application dates: 17/2/2010 and 5/3/2010 (for treatments receiving two applications)
Harvest date: 15/4/2010
Irrigated: Yes

Fertiliser data: Standard fertiliser program (T1) is N 125 kg/ha, P 100 kg/ha, K 125 kg/ha plus 25 t/ha farm yard manure. P, K and farm yard manure rates were maintained constant across all treatments, with N varied according to each treatment. N was applied in two splits, the first at planting and the second at earthing up stage.

Soil data: Initial soil fertility status of experimental plot

pH	EC (ds/m)	OC (%)	N_2O (kg/ha)	P_2O_5 (kg/ha)	K_2O (kg/ha)
6.74	0.16	0.37	270 (low)	297.77	365.30

TwinN applications: TwinN was mixed and applied according to the standard instructions. A backpack was used to apply the tank mix to the plots.

CONCLUSIONS

- Use of two applications of TwinN enabled reductions to 50% of normal nitrogen fertiliser and produced large increases in yields of marketable tubers (+14.9 t/ha, +88%). This result would provide a great improvement in profits to farmers.
- Two applications of TwinN gave a significantly better result than one application at 50% N.
- TwinN gave a significant increase in yield of marketable tubers in the absence of inorganic N fertiliser and the presence of 25 t/ha farm yard manure.