Knowledge grows

The Nutrition of Potatoes

Yara's complete guide

Yara Nutrition of Potatoes
Yara's complete guide

Crop Characteristics

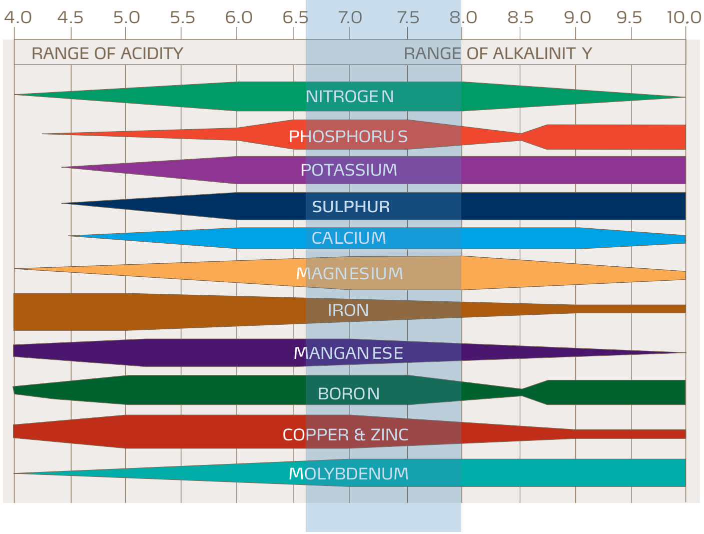
Potatoes produce a fibrous root system that is at best no more than 60cm long. As a result, potatoes are often unable to exploit nutrients and soil moisture at depth within a soil profile.

Potatoes are grown on a range of soils varying from sands to clay loams, all with different water holding capacities. An ideal potato soil is well structured, with good drainage to allow proper root aeration and tuber development with minimal root disease infestation. Potatoes prefer soils with a pH of 5.5 to 7.0 and low salinity. However, in practice potatoes are grown in soil pH's from 4.5 to 8.5 and this has a distinct impact on the availability of certain nutrients (Figure 1).

At lower pH values potatoes can suffer from aluminium and other heavy metal ion toxicity, as well as restricted P or Mo availability.

At pH values above 7.5, nutrient availability, in particular of phosphorus and the micronutrients, can be reduced, even though high total amounts of these elements may be present in the soil. Liming can ameliorate undesirable, low pH values although care must be taken to ensure that the lime is applied at least 6 months before the potatoes are to be planted. Potatoes are more prone to common scab when grown in high pH soils.

Figure 1. Soil pH has a direct influence on nutrient availability



Analysis

As well as being important within their own right, most nutrients have the role of ensuring that the most is made of any nitrogen applied. This is illustrated by Leigbig's barrel – The Law of the Minimum. Typically nitrogen is the most limiting factor, but shortages of any other nutrient will limit yield and limit the benefit of nitrogen applied.

The starting point for identifying any nutritional limitations is soil analysis. This can help to show the levels of each nutrient that are held in the soil. This isn't however the full picture as there are many other factors that can affect the amount of any nutrient that the crop is able to get hold of. Dry soil conditions in particular can dramatically reduce the availability of a nutrient to the crop, but also soil structure, rooting and the interactions between nutrients can all have a bearing.

Petiole Analysis

Interpretation of potato petiole analysis

Independent research has demonstrated the particular importance of phosphorus for tuber bulking. The longer the phosphorus level in the crop is maintained at a high level, the greater the yield potential. Yield potential is increased by around 0.5 t/ha for each extra day that the phosphorus level in the petiole is kept above 0.22%. However the level of phosphorus in the petiole peaks at tuber initiation and then declines as the season progresses. In northern European conditions the phosphorus level normally arrives at 0.22% around 100 to 110 days after planting. Any "premature deficiency" incurs a yield penalty of 0.5 tonne per hectare per day.

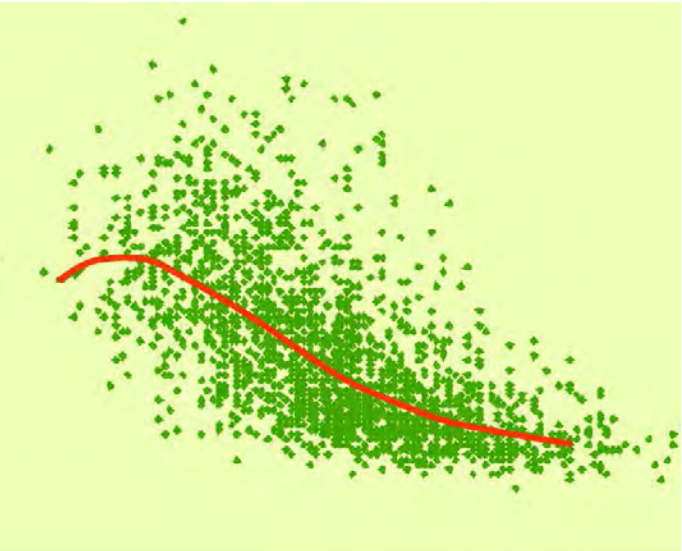
Predicting the P_2O_5 requirement

If prediction of the P_2O_5 requirement can be made early in the season then the 0.5 tonnes per hectare per day through the bulking phase can be saved - or gained. Yara has the answer in its petiole analysis databank and range of effective foliar phosphates.

Megalab potato petiole programme

Since 1993 Lancrop Laboratories have been analysing petiole samples from UK potato crops and our database currently stands at over 5,000 samples and continues to rise. Biometric analysis of results allows us to establish phosphorus values early in the season which are equivalent to the critical figure of 0.22% at 100 days after planting (shown by the red line in Figure 2).

Figure 2. Decline in petiole phosphorus level.
Target level is shown in red.



The Yara petiole Megalab system is therefore much more PROACTIVE because when a petiole sample is analysed we are asking the question "Will this crop make it to 100 days after planting before the phosphorus level drops below 0.22%?". Another benefit is that normally only one sample per season is needed, however, if extremes of weather occur, a further petiole sample 3-4 weeks later will highlight any adverse trends.

Other nutrients

Similar trends exist for the other important nutrients for the potato crop. So using Megalab means that yield potential is not limited by reduced levels of major, secondary or micro nutrients.

Sampling instructions for potato petiole analysis

Choose the youngest fully expanded leaf (usually 4th) at a stage no earlier than 10% flowering. For each complete leaf, separate the leaflets from the petiole and discard the leaflets as soon as possible after sampling. Keep samples in a cool dark place and send to the lab immediately.

Sampling pattern

Draw from at least 20 different locations in the field. At each location take one leaf branch from each of 3-4 plants (minimum of 60-80 branches in total). Do not sample fields within 3-5 days after being sprayed with pesticides or foliar nutrients.

Nutrition is also important for plant health, improving resistance or tolerance to disease. Shortages in any nutrient (particularly potassium, calcium, boron, manganese, copper or zinc) could lead to an increase in disease levels, which if not controlled effectively through fungicides can also decrease the yield response from nitrogen.

Tissue Sampling

Broad spectrum tissue sampling is also a good indicator of phosphate levels, as well as all other nutrients required by the plant. It takes less time to conduct than petiole sampling however it is not as accurate therefore the end use of the data needs to be considered. When taking a tissue sample the same sampling pattern can be used as for the petiole test but the youngest fully expanded leaves should be taken as the sample, not the whole leaf branch. You will get results showing the levels required for each nutrient and whether your sample was sufficient or deficient using a colour-coded system, then enabling you to correct any deficiencies with applications.

Are your potatoes getting enough Calcium?

Nutrition is also important for plant health, improving resistance or tolerance to disease. Shortages in any nutrient (particularly potassium, calcium, boron, manganese, copper or zinc) could lead to an increase in disease levels, which if not controlled effectively through fungicides can also decrease the yield response from nitrogen.

Calcium is a vital nutrient for high quality potatoes:

- Calcium is required for maintenance of cell walls and healthy leaf and tuber development
- Calcium reaches developing tubers directly from stolon roots and absorption through the tuber skin
- Calcium is not redistributed from the leaves to the tubers
- Tuber uptake relies upon having a readily available source of calcium in the soil surrounding the developing tubers

Figure 3. Calcium uptake and movement

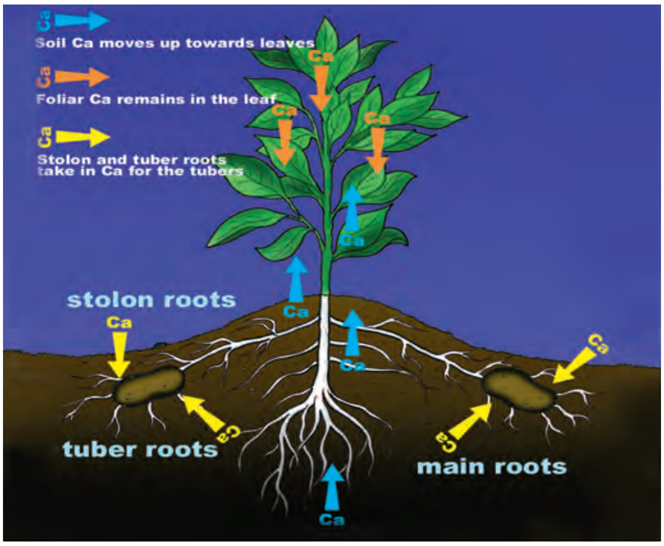


Figure 4. Internal Rust Spot

a recognised calcium deficiency disorder.

Figure 5. Improve skin finish

addition of calcium promotes strong cell walls.

Figure 6. Resist bacterial soft rot invasion

improve tuber cell wall calcium pectate content.

Figure 7a. **YaraLiva™** TROPICOTE
can help reduce Internal Rust Spot

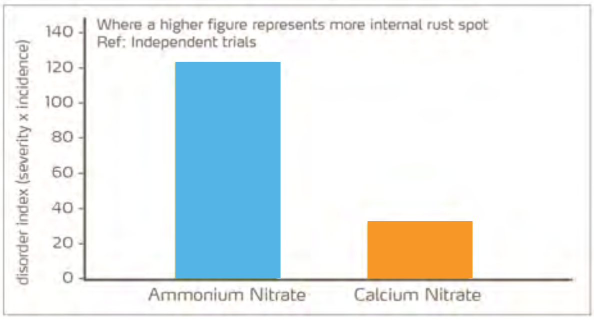


Figure 7b. **YaraLiva™** TROPICOTE
improves skin finish

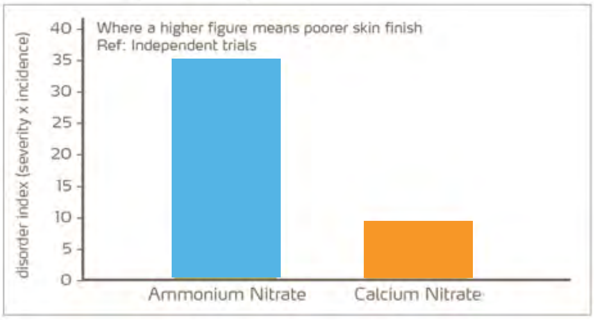
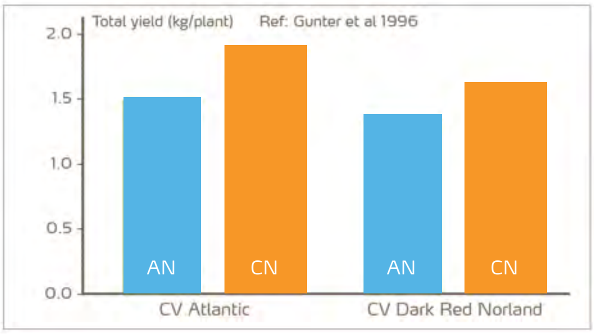


Figure 7c. **YaraLiva™** TROPICOTE
produces seed potato tubers with greater yield and vigour potential



Benefits of **YaraLiva™** TROPICOTE

- Suppression of internal rust spot
- Improved skin finish
- Suppression of soft rots in store
- Helps stress relief (heat)
- Reduced incidence of bruising
- All nitrate nitrogen
- Improved fry colour in crisping varieties
- Healthier seed crop

Recommendations

Apply 60 - 70% of the recommended nitrogen requirement in the base dressing.

Top-dress the remainder as YaraLiva Tropicote™ at tuber initiation 3 - 4 bags/ac (375 - 500 kg/ha).

Applying a minimum of 400 kg product/ha provides over 100 kg/ha of readily available calcium (CaO).

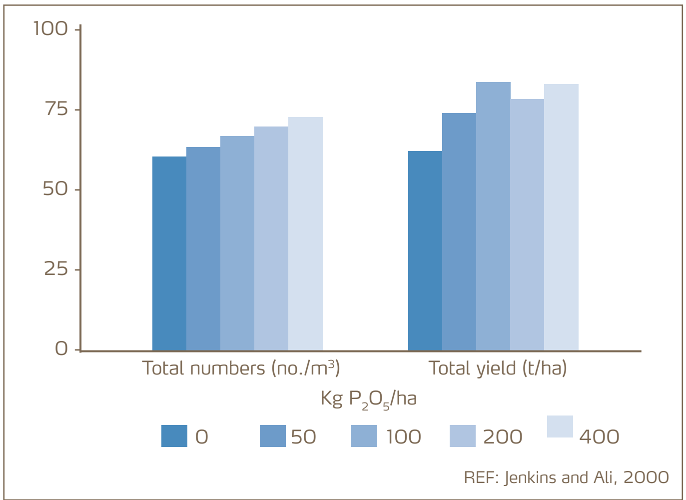
Increasing Potato Tuber Numbers

The numbers of potato tubers produced by each potato plant is influenced by agronomy and varietal potential. A large number of tubers per hectare will produce a crop of predominately small tubers, ideal for canning, salad or seed potatoes. A relatively low tuber number provides less competition per unit area and allows the crop's energies and resources to be used to produce larger potatoes for the fresh or processing markets.

Phosphate availability at tuber initiation is important to ensure maximum tuber set, especially if tuber numbers need to be increased for certain varieties, or where the market demands a large number of smaller tubers (e.g. seed production).

Figure 8. Phosphorus and yield

Wales - Desiree



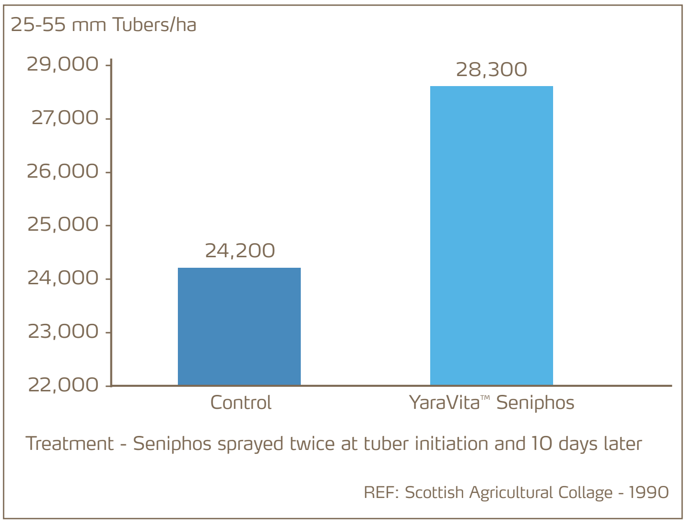
Study from Wales showing the effect of phosphorus on increasing total tuber numbers and overall yield.

Because phosphorus is relatively immobile in the soil it is important that fertilizer –P is placed close to the tuber, banding the fertilizer usually works better than broadcasting, especially on soils with the potential for very high phosphorus lock-up.

While potatoes are very responsive to fresh phosphate, the economic optimum rate is often difficult to define. Rates will depend on soil type and soil test results. Where sufficient soil phosphate is not available for growth, foliar phosphate ensures rapid availability.

Figure 9. Foliar Phosphorus - Effect on tuber number

Scotland - Estima



Study from Scotland showing the effect of foliar phosphorus on increasing total tuber numbers.

YaraVita™ MAGPHOS K

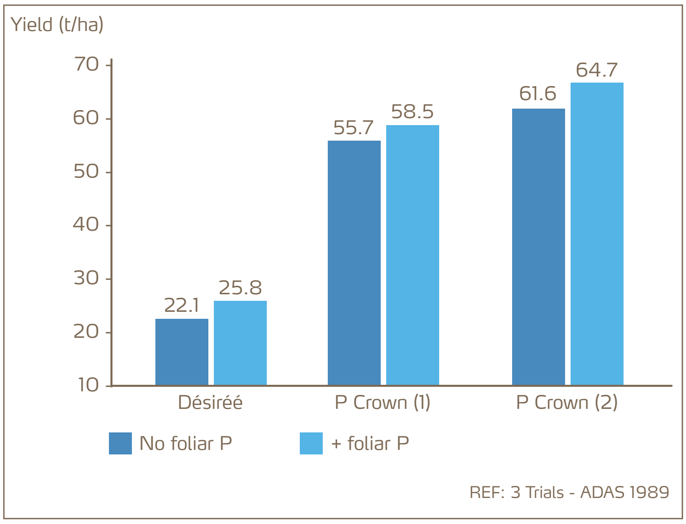
To increase tuber number, 10 l/ha at tuber initiation (when 50% of the tip swellings are twice the diameter of the rest of the stolon).

Increasing Potato Tuber Size

Tuber size and uniformity is critical for every market, whether it is fresh potatoes, seed or processing crops. Anything that the grower can do to prolong a healthy leaf canopy will increase the average tuber size.

Foliar phosphate, applied after tuber initiation, increases tuber size and so increases tuber yields. However, foliar phosphate is not a substitute for soil applied phosphate and without adequate soil phosphate early season growth is sub-optimal.

Figure 10. Foliar Phosphorus - Effect on yield
England



These trials conducted independently in England show a consistent yield increase from applications of foliar phosphate after tuber initiation resulting in an increase in tuber size and so overall yield.

YaraVita™ MAGPHOS K

To increase tuber size a minimum of 2 applications of 5 l/ha during tuber bulking (as soon as first formed tubers are 10 mm in diameter). Allow 10-14 days between applications. Water rate: 200 l/ha.

Foliar phosphorus application promotes root development. Plant on left received a typical YaraVita "phos" input (10 l/ha MagphosK) a few weeks before these pictures were taken. Note the increase in root density which will help nutrient uptake from the soil

Zinc

Zinc acts as a binding agent in enzyme reactions and protects proteins from denaturation. Therefore, it plays a role in nitrogen metabolism. Yield effects of zinc application can be expected on soils low in zinc and with a high or low soil pH.

Zinc deficiency shows in younger leaves as interveinal chlorosis and necrosis which occurs in irregular patches. Whitish spots develop within the brown necrotic tissue. Symptoms may also start on older leaves. Deficiency is made worse by organic and high pH soils. Soils rich in phosphorus or those receiving high phosphorus application can also induce zinc deficiency, as can cold wet conditions.

Zinc is used to suppress powdery scab, but only soil applications provide sufficient zinc to have an effect on powdery scab.

Figure 11. Effect on yield - Effect of Zinc on total yield (t/ha) of potatoes, 2014

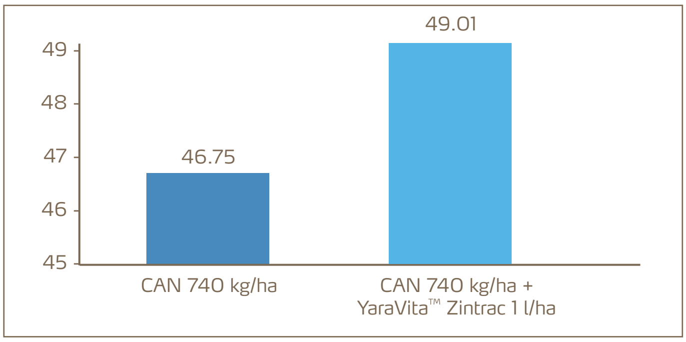
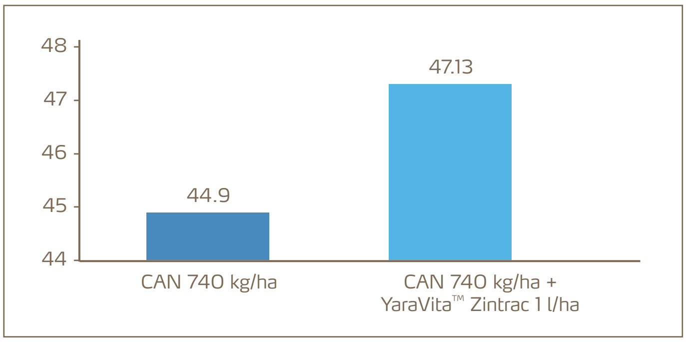


Figure 12. Effect on marketable yield - Effect of Zinc on marketable yield (t/ha) of potatoes, 2014



Application Accuracy

YaraMila™ Compounds

The Yara brand sets the standard in fertilizer quality. The aim is to provide consistency from bag to bag and from year to year. The majority of Yara's NPK grade range of products are true uniform compounds where all the nutrients are contained in each granule or prill which assures accurate spreading of nutrients. For easy identification, these grades are clearly branded YaraMila™ followed by the brand name and analysis.

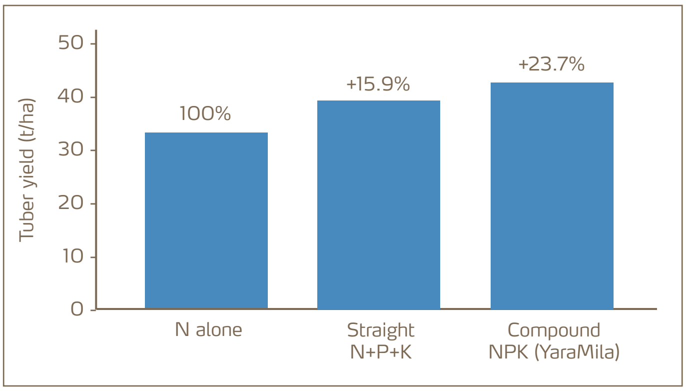
All Yara products are formulated to the declaration and the analysis is guaranteed, giving confidence that "What is on the bag is in the bag". On occasions Yara may blend some products. Yara's high quality blends are produced with size and moisture matched components to give good spreading characteristics.

All YaraMila™ grades are produced in Yara factories which have installed Yara's developed N_2O catalytic abatement technology - reducing our emissions by 90% - with further reductions targeted. They have a guaranteed carbon footprint < 4 kg CO_2-eqv / kg N. This in conjunction with our in-field advice means using Yara's nitrate based fertilizers can reduce the fertilizer carbon footprint by ~ 50% (taking account of the life cycle approach (LCA) to their use).

Uniform application and distribution of nutrients is one of the key benefits of using a true uniform compound fertiliser, as found in the YaraMila range, providing better access for the plant roots to all nutrients. Every prill or granule contains all the stated nutrients, ensuring a balanced supply.

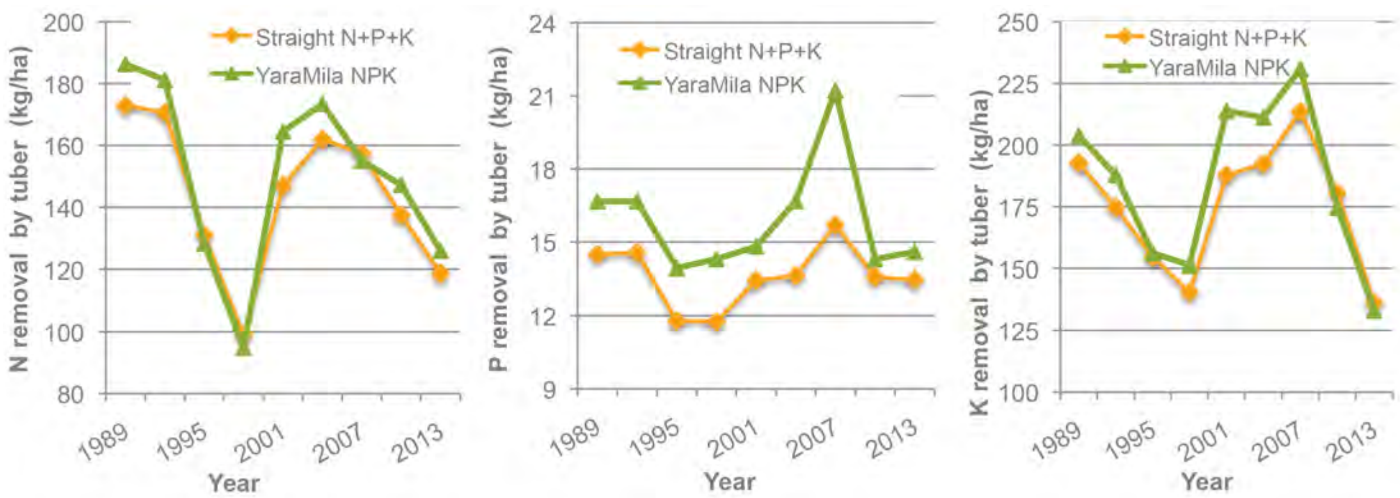
Since 1989, the Yara Research Centre at Hanninghof has been running a long term trial with a cereal-potato crop rotation. Results from nine potato harvests show the highest yield response with a YaraMila grade in all years. With N, P and K applied as straights, yield increased on average by 15.9%, and with YaraMila the yield increase was 23.7% (Fig. 13).

Figure 13. Average yield of potatoes (n = 9 years)



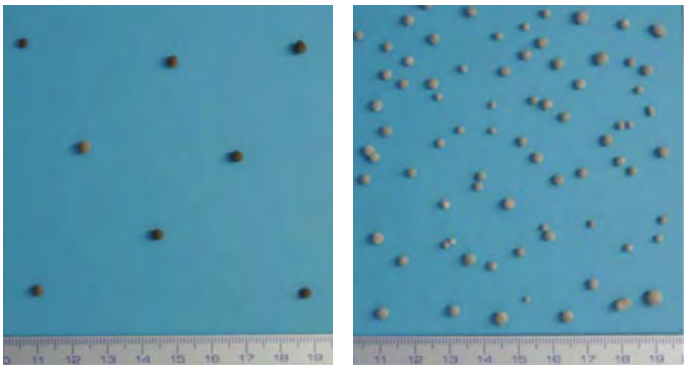
These results showed an increase in the nutrient uptake from the YaraMila grade compared to the application of straights, particularly for phosphate, which is potentially where a large proportion of the yield response came from.

Figure 14. Nutrient removal of potato is higher with YaraMila compared to straight N, P and K (Yara field trial)



When applying the same amount of phosphate with a YaraMila grade and TSP, the required application rates of TSP are lower and there are fewer granules (landing sites) in every square metre (Fig. 14). As crops can only take up phosphate from soil solution close (within 1-2mm) to the roots this makes it more difficult for them to get hold of phosphate from TSP, as they have to grow a longer distance. This is particularly important in potato crops where the rooting is shallow and the demand for phosphate high.

Figure 15. When applying an equal amount of P, YaraMila provides a better P distribution than TSP.



TSP 100 kg/ha P_2O_5 = 22.2 G/M²

YaraMila 20-7-10 100 kg/ha P_2O_5 = 142.8 G/M²

The combination of water- and citrate-soluble P-forms in YaraMila grades provides a longer lasting supply of available P (Fig. 16). This is especially important for potato as it shows a strong response to P application and benefits from a constant supply of available P (Fig 17).

Figure 15. Di-calcium phosphate (DCP), the citrate soluble P fraction of YaraMila, dissolves at a constant rate providing a sustained supply of plant available P. DCP is not absorbed by Fe- and Al-hydroxides and thus protected from fixation.

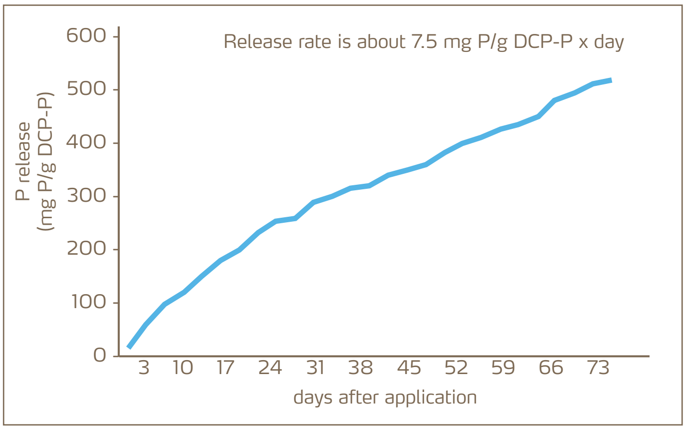
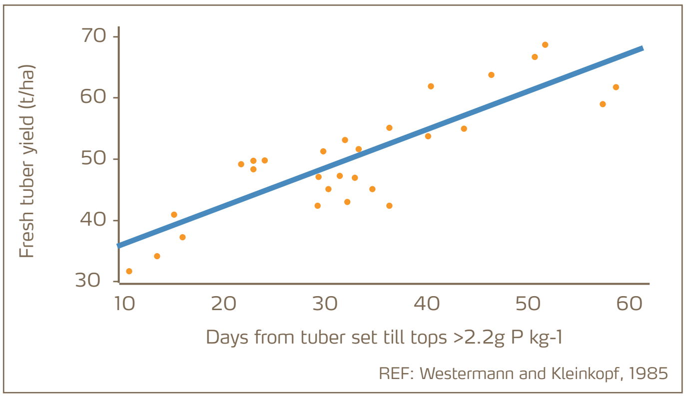


Figure 17. Keeping the leaf P content high during bulking has a positive impact on yield. Tuber yield is increased by 0.5 t/ha for each day leaf tissue P content is maintained above 0.22%.

USA - Russet Burbank (Westermann and Kleinkopf, 1985)



Placement

Fertilizer placement techniques have over the last few decades, become widely accepted as best practice by the UK's leading growers. A controlled supply of nutrient produces both increases in marketable yield and a more even sample size.

Improved Agronomy

The use of ammonium phosphates increases the amount of phosphate available to the plant by local acidification. This results in a higher early growth response. It is also known that this early response to applied phosphate increases with the amount of water soluble phosphate available to the plant. The precision placement of fertilizer below the potato crop provides all of the phosphate, in the water soluble form, in a continuous band and is therefore provided in the form and in a position that allows maximum usage by the crop.

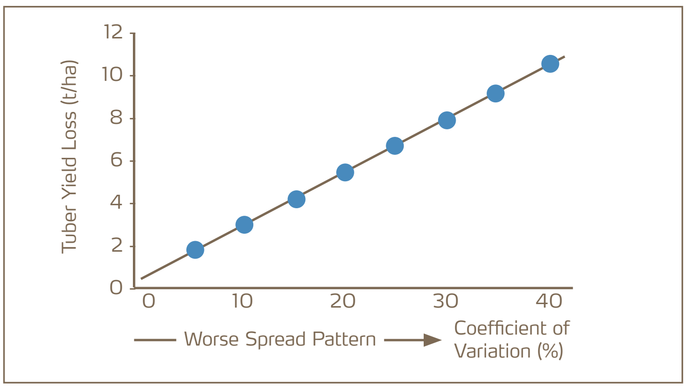
Where fertilizer is broadcast on the soil surface before planting, the mixing of the soil that occurs between fertilizer application and planting results in it being evenly distributed throughout the ridge. Some of the phosphate will inevitably be above the potato seed where it cannot be utilised. This mixing of fertilizer and soil leads to rapid "lock up" of water soluble phosphates. In contrast the placing of fertilizer at least 5cm below and to the side of the seed leads to a high concentration of phosphate and a slower "lock up".

Unbeatable Accuracy

Reduced CV

Fertilizer can be very accurately applied using placement and achieve a coefficient of variation (CV%) of 5%. The CV of broadcast applications is typically 10-15% when carried out properly. Therefore placement of fertilizer provides greater accuracy to achieve the target nutrient rates advised by your potato agronomist.

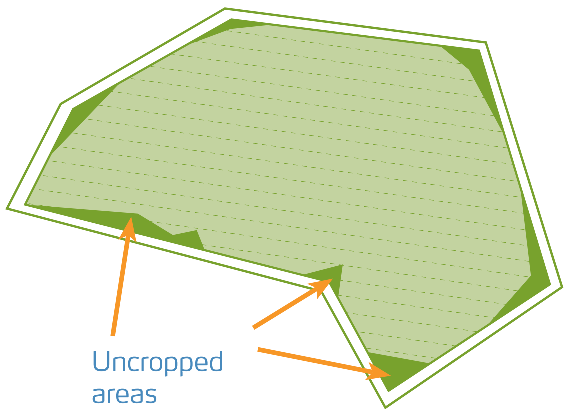
Figure 18. Effect of poor nutrient application

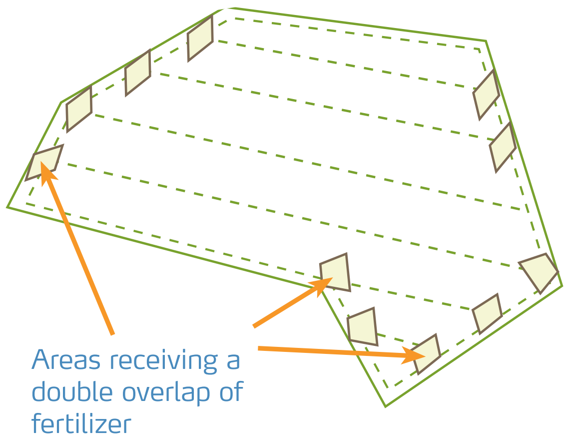


Fertilizer is only applied to cropped areas with no overlaps

3-7% of a potato field is NOT planted to allow for harvesting, irrigation and spraying headlands. Fertilizer placement at planting only places fertilizer where the crop requires it.

This saves fertilizer and reduces the risk of leaching of nutrients into ground water supplies. Areas being cropped will reduce leaching risk as active plant growth will keep both nitrate and water levels in the soil at low levels during the growing season. On irrigated land there could be increased risk of leaching on uncropped areas.

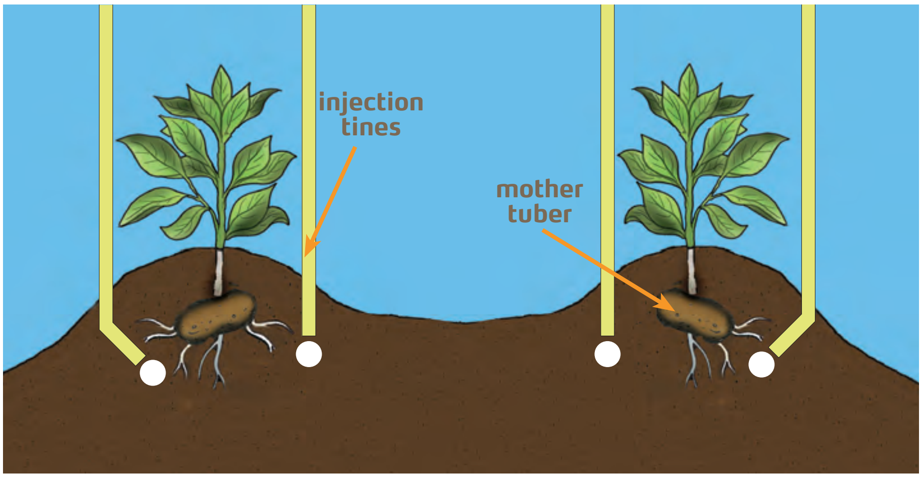




Increased Efficiency

Increased concentrations of fertilizer in narrow bands reduces lock-up of phosphate with free cations in soil (eg Ca^{2+}, Al^{3+} etc) keeping the phosphate available for plant uptake.

Because the fertilizer is accurately placed below the soil surface into the moist root zone at a controlled distance from the seeds the nutrients are immediately available to the crop even in dry periods, without the risk of scorching.



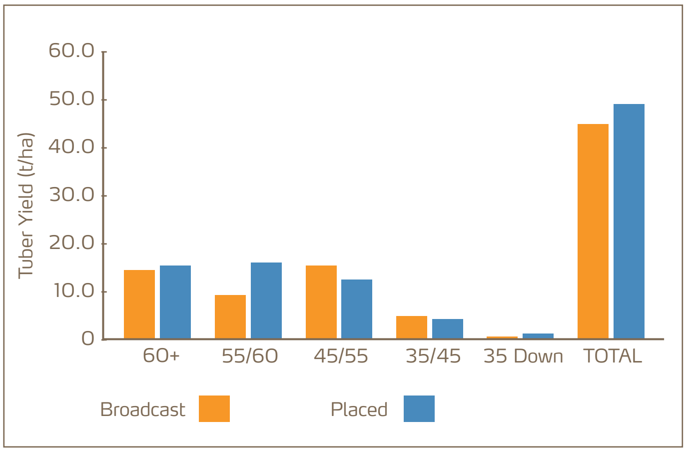
Trials Results

Trials carried out on behalf of Yara since the early 1990's have helped to highlight the potential yield benefits available. The average yield increase from fertilizer placement compared to broadcast fertilizer applications was 10.8%, with increases of up to 22% being recorded.

Table 1. Trial summary (1991-2009)

Site	Year	Variety	Ware Yield (t/ha) Placed	Ware Yield (t/ha) Broadcast	% Increase
Telford	1991	Dell	59	52	13.5%
Ramsey	1992	Piper	76	63	20.6%
Northwich	1994	Piper	43	45	-4.4%
Keelby	1995	Broddick	56	47	19.1%
Flint	1995	Estima	47	52	-9.6%
Whittlesey	1995	Sante	46	44	4.5%
Telford	1995	Estima	44	36	22.2%
Whittlesey	1996	Sante	59	56	5.4%
Ormby	1996	Edward	52	53	-1.9%
Telford	1996	Dell	40	33	21.2%
JSR	2002	Nadine	104	86	21.2%
Wragby	2003	Marfona	47	44	6.7%
Wragby	2005	Melody	56	48	16.0%
East Yorkshire	2007	Dell	65	55	17.3%
East Yorkshire	2009	Carlita	49	45	9.4%
Average					**10.8%**

Figure 19. Yield – Broadcast vs Placed (2009)



Application Systems

Various machinery manufacturers can supply and fit conversion kits enabling planters to simultaneously place fertilizer while planting. Placement kits are available to fit a wide range of planter and tractor combinations. Modern electronic rate controllers and GPS technology allows highly accurate application, with very little wastage to be achieved. The increased marketable yields give a very good return on capital employed from the equipment required.

The N-Sensor is being used to map potato canopy growth and development through the colour and biomass measurements as well as for 'scouting' to identify early problem areas in the field. This ability to track senescence enables it to be used for variable crop dessication resulting in a more effective kill.

Fertilizer Placement Summary:

- Placement trials have shown on average a 10.8% yield increase
- Unbeatable accuracy
- Increased efficiency
- Polyphosphate based fertilizers

Feasibility Study

Trials carried out on behalf of Yara since the early 1990s have helped to highlight the potential yield benefits available. The average yield increase from fertilizer placement compared to broadcast fertilizer applications was 10.8%, with increases of up to 22% being recorded.

Benefits of Potato Placement

Potato Fertilizer placement can offer many benefits, including less waste of fertilizer and increased crop yields. Trials carried out on behalf of Yara since the early 90s shows an average yield increase from placing fertilizer of 10.1% compared to broadcast applications. On top of this 3-7% of a field is not planted and 3.5-5% of a field receives a double overlap when broadcasting fertilizer, therefore Placement techniques can help cut down on wasted fertilizer.

Potato Area Grown	ha	50	**Nitrogen Cost**		£ / m3	268
Average Crop Yield	tonnes / ha	45	**Base Application of Nitrogen**		kg / ha	100
Crop Value	£ / tonne	150	**Width of Bed**		metres	1.8
Yield Increase from Placement	%	10.1	**Width of Planting**		metres	1.6
		COST OF WASTED FERTILIZER				**TOTAL BENEFIT**
Area fertilized but unplanted	%	5	ha	2.50	£	**£181.08**
Area of Fertilizer Overlap	%	4	ha	2.00	£	**£144.86**
Area of Bed not Utilized	%	11.1%	ha	5.56	£	**£402.40**
		YIELD INCREASE				
Increase in Yield	tonnes / ha	4.55	tonnes	227.25		**£34,087.50**
TOTAL BENEFIT FROM PLACEMENT						**£34,816**

Knowledge grows

Potato Crop Nutrition
Early Potatoes
Solid Fertilizer Programme

	Pre-Planting	Planting	Vegetative Growth	Tuber Initiation	Early Tuber Bulking	Maturity
YaraMila™		COMPLEX ** 1000 kg/ha MAINCROP ** 850 kg/ha ACTYVA S ** 750 kg/ha				
YaraLiva™				TROPICOTE 300 - 400 kg/ha		
YaraVita™			MAGFLO 300 2 – 4 l/ha MANTRAC PRO 1 l/ha	MAGPHOS K - for tuber numbers 10 l/ha	MAGPHOS K - for tuber size 2 x 5 l/ha	
Analytical Tools	Broad Spec Soil Analysis - to identify limiting nutrients		Petiole and Tissue Analysis - to identify limiting nutrients	N-Sensor - to variably apply nitrogen and increase N use efficiency (if applying a top dressing)		N-Sensor - for desiccation

Read label before application of any YaraVita product ** Choose just one of these fertilizer products, as appropriate

Soil applied products Foliar applied products Analytical tools

Knowledge grows

Potato Crop Nutrition
Maincrop Potatoes
Solid Fertilizer Programme

	Pre-Planting	Planting	Vegetative Growth	Tuber Initiation	Early Tuber Bulking	Maturity
YaraMila™		COMPLEX ** 1000-1250 kg/ha MAINCROP ** 850 – 1100 kg/ha ACTYVA S ** 750 – 1000 kg/ha				
YaraLiva™				TROPICOTE 375-500 kg/ha		
YaraVita™			MAGFLO 300 2 – 4 l/ha MANTRAC PRO 1 l/ha	MAGPHOS K - for tuber numbers 10 l/ha	MAGPHOS K - for tuber size 2 x 5 l/ha	CROPLIFT PRO 2.5 - 5 kg/ha *
Analytical Tools	Broad Spec Soil Analysis - to identify limiting nutrients		Petiole and Tissue Analysis - to identify limiting nutrients	N-Sensor - to variably apply nitrogen and increase N use efficiency (if applying a top dressing)		N-Sensor - for desiccation N-Tester - to monitor N status of canopy

Read label before application of any YaraVita product

* Rate depends on N-Tester
** Choose just one of these fertilizer products, as appropriate

Soil applied products Foliar applied products Analytical tools

Knowledge grows

Potato Crop Nutrition
Seed Potatoes
Solid Fertilizer Programme

	Pre-Planting	Planting	Vegetative Growth	Tuber Initiation	Early Tuber Bulking	Maturity
YaraMila™		COMPLEX ** 700 - 875 kg/ha MAINCROP ** 600 - 750 kg/ha ACTYVA S ** 525 - 650 kg/ha				
YaraLiva™				TROPICOTE 200 - 300 kg/ha		
YaraVita™			MAGFLO 300 2 – 4 l/ha MANTRAC PRO 1 l/ha	MAGPHOS K - for tuber numbers 10 l/ha		
Analytical Tools	Broad Spec Soil Analysis - to identify limiting nutrients		Petiole and Tissue Analysis - to identify limiting nutrients	N-Sensor - to variably apply nitrogen and increase N use efficiency (if applying a top dressing)		N-Sensor - for desiccation

Yara UK Ltd, Harvest House, Europarc, Grimsby, North East Lincolnshire, DN37 9TZ.
Email:agronomy.uk@yara.com
Recommendations are based on Yara's field experience and field trial results

Disclaimer: The information contained herein is to the best of Yara's knowledge and belief, accurate.Recommendations may need to be amended to ensure they comply with NVZ Nmax calculations where relevant.

YaraVita™ grades

Emergence

YaraVita™ BORTRAC 150
One application of 1 to 2 l/ha applied one week after 100% emergence.
A second application may be made 10 to 14 days later. Water rate: 200 l/ha.

YaraVita™ MAGFLO 300
2-4 l/ha 1 week after 100% emergence. For moderate to severe deficiency, repeat applications at 10-14 day intervals. Water rate: 200 l/ha.

YaraVita™ MANTRAC PRO
1 l/ha 1 week after 100% emergence. For moderate to severe deficiency, repeat applications may be necessary at 10-14 day intervals. Water rate: 200 l/ha.

YaraVita™ THIOTRAC 300
5 l/ha one week after 100% emergence. Repeat applications may be necessary at 10 to 14 day intervals. Water rate: 200 l/ha.

YaraVita™ ZINTRAC 700
1 l/ha one week after 100% emergence. For moderate to severe deficiency, repeat applications may be necessary at 10 to 14 day intervals.

Tuber Inititation

YaraVita™ CROPLIFT PRO
2.5 to 5 kg/ha. Repeat at 10 to 14 day intervals as necessary.
Water rate: 200 l/ha.

YaraVita™ MAGPHOS K
To increase tuber number, 10 l/ha at tuber initiation (when 50% of the tip swellings are twice the diameter of the rest of the stolon). Water rate: 200 l/ha

Tuber Bulking

YaraVita™ CROPLIFT PRO
2.5 to 5 kg/ha. Repeat at 10 to 14 day intervals as necessary.
Water rate: 200 l/ha.

YaraVita™ FOLIAR POTASH
One application of 10 l/ha or two applications of 5 l/ha during tuber bulking (as soon as first-formed tubers are 10mm in diameter). Allow 10 to 14 days between applications. Water rate: 200 l/ha.

YaraVita™ MAGFLO 300
2-4 l/ha following petiole analysis during tuber bulking. Water rate: 200 l/ha.

YaraVita™ MAGPHOS K
To increase tuber size a minimum of 2 applications of 5 l/ha or 1 to 2 applications of 10 l/ha during tuber bulking (as soon as first formed tubers are 10 mm in diameter). Allow 10-14 days between applications. Water rate: 200 l/ha/ha

YaraVita™ THIOTRAC 300
5 l/ha following petiole analysis during tuber bulking. Water rate: 200 l/ha.

The Benefits of Calcium Nitrate

YARA

Yara Liva Tropicote Price Comparison

Potato

Expected Marketable Crop Yield		tonnes / ha	50	
Crop Value	Grade 1	£ / tonne	170	
	General Market	£ / tonne	90	
Nitrogen Price	AN	£ / tonne	220	
	YaraLiva Tropicote	£ / tonne	300	
Nitrogen Top-dressing Rate		kg N / ha	80	
			YaraLiva Tropicote	**AN**
Marketable Yield	Grade 1	tonnes / ha	50.7	33.5
	General Market	tonnes / ha	4.6	16.6
Value of Marketable Yield		£ / ha	£9,038	£7,176
Margin over Fertilizer Cost		£ / ha	£8,882.71	£7,124.99
Benefit of YaraLiva Tropicote			**£1,758**	£ / ha

YIELD INCREASES 10.7%

Trials on potatoes have shown increases in yield from Calcium Nitrate over Ammonium Nitrate of up to 10.7%

QUALITY INCREASES 24.7%

Trials on potatoes have shown a 24.7 % increase in quality from Calcium Nitrate over Ammonium Nitrate through:

- 37% improvement in skin finish
- 82% reduction in Common & Powdery Scab incidence
- 100% reduction in Black Scurf
- 85% reduction in Silver Scurf

Based on trial data from Levington Agriculture (1997) and Simmons & Kelling (1987) showing the differences in yield between Calcium Nitrate and Ammonium Nitrate as different nitrogen sources and their impact on quality.

Yara N-Sensor™

The Yara N-Sensor has a potato specific variable rate nitrogen application module for use when top-dressing the crop with nitrogen. There are also other uses for the N Sensor, for example as an agronomy scouting tool.

Although the Yara N-Sensor operates as a stand alone system, in that GPS is not essential, this is usually supplied as part of the package to enable customers to create biomass and nitrogen application maps for each field scanned. These maps can be useful as a general agronomy tool highlighting areas of low biomass which enable the users to go back and gather more information as to the cause of the problems.

Potato Haulm Desiccation Module

An additional module for the Yara N-Sensor has been developed and was released in 2007 by Plant Research International, Wageningen in the Netherlands for site specific dosing of potato desiccants. By measuring the reflectance of a potato canopy it is possible to pick up differences in colour significantly in advance of the naked eye, therefore applying higher dose rates to the 'greener' canopies to improve the uniformity of action and help reduce overall herbicide use.

Yara N-Sensor™ - Potato Haulm Killing Herbicide Module

Recent developments in precision agriculture make variable rate application systems of pesticides on farms possible.

Plant Research International has developed decision rules for site specific dosing of haulm killing herbicides in potatoes (Minimal Lethal Herbicide Dose for Potato Haulm Killing = MLHD PHK).

With the integration of the PHK module in the N-Sensor software in 2007 a practical solution for site-specific optimization of potato haulm killing is now available.

Main steps in MLHD PHK

The Yara N-Sensor measures light reflectance of the potato canopy while driving through the crop.
Areas with 'greener' canopies, that give higher reflectance parameters, require a higher herbicide dose for potato haulm killing (Fig. 20)

The farmer selects the appropriate decision rule for his field by setting a few calibration parameters: chosen herbicide, risk level, single or split application.

The MLHD PHK module translates the reflectance data into a site-specific dose (Fig 21).

Figure 20. Example of a minimum effective dose curve

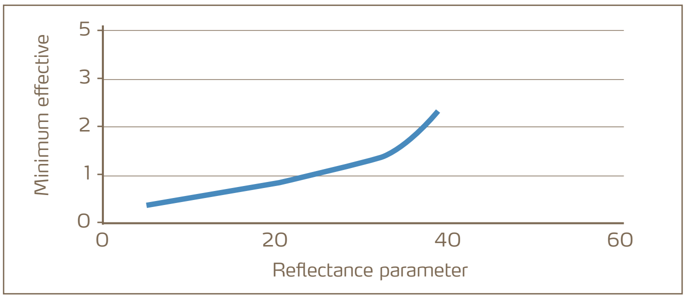
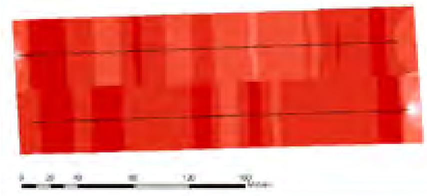


Figure 21. Example of a dose map of a relatively green potato crop. Two spray tracks and agent doses ranging from 1.5 – 3 l/ha in this crop.



Benefits of MLHD PHK with N-Sensor™

- Site-specific optimization of potato haulm killing herbicides is now possible.
- Reduction in use and costs of crop desiccants (42 % reduction in 2006 with an injection sprayer).
- Reduced application rates on sparse canopies may improve potato quality and reduce environmental impact.
- N-Sensor and PHK are compatible with most sprayers.
- Special dosing rules for high-risk situations are available.
- Websites: www.mlhd.nl or www.sensoroffice.com.

Yara UK Limited
Harvest House
Europarc
Grimsby
NE Lincolnshire
DN40 2NS

Customer Services - Tel: 01472 889301

Yara UK Limited
September 2017

@Yara_UK Yara UK 01472 889250 agronomy.uk@yara.com www.yara.co.uk