TECHNICAL NOTES FOR AQ10®

These notes are designed to support the main product manual insert on AQ10 and advise on how to obtain the best possible disease control from the product.

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USE PLANT PROTECTION PRODUCTS SAFELY.
ALWAYS READ THE LABEL AND PRODUCT INFORMATION BEFORE USE

WHAT IS AQ10?

AQ10 is a registered bio-fungicide "AQ 10" under MAPP number 15518 for the control of powdery mildew diseases. AQ10 is formulated as a water dispersible granule formulation containing 58% w/w *Ampelomyces quisqualis* strain M-10 (5 x 10^9 spores per g product).

The active component, a naturally occurring fungus parasitises the powdery mildew hyphae, conidial chains and can infect the chasmothecia (fruiting bodies) of the powdery mildews. The remaining inert material in the formulation has a low water absorption potential to keep spores dry and viable. AQ10 does not contain anything that is genetically modified. AQ10 has approval in the UK for use on protected: aubergine, courgette, cucumber, melon, pepper, strawberry, tomato, winter squash and pumpkin.

WHY USE AQ10?

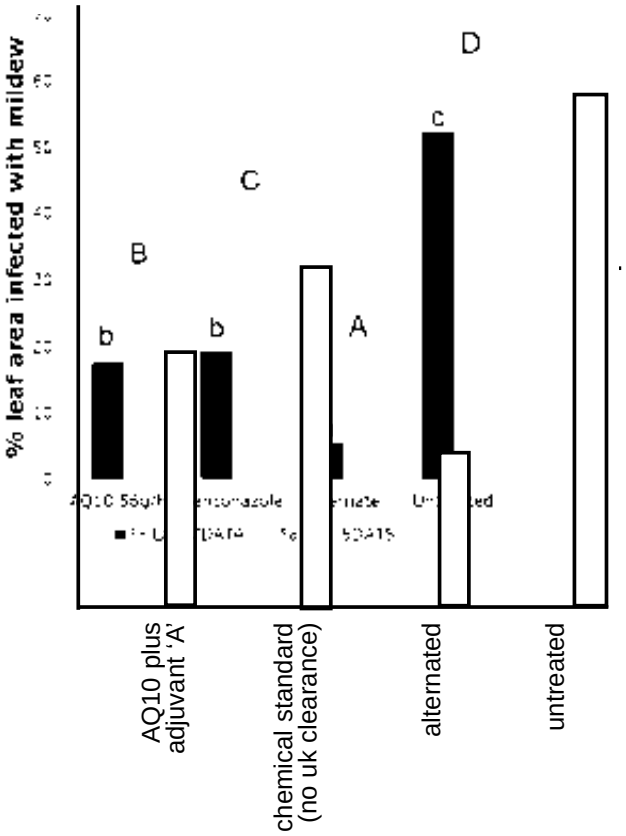
- AQ10 is a biological control of powdery mildew.
- AQ10 reduces the risk of powdery mildew resistant to chemical fungicides appearing.
- AQ10 can have a synergistic effect with compatible** chemical fungicides.
- AQ10 is active at a lower temperature (12°C) than sulphur.
- AQ10 may reduce the amount of overwintering powdery mildew inoculum.
- No phytotoxicity has been seen*.
- AQ10 leaves no chemical residues.
- AQ10 is usable in organic systems subject to certification body approval.

*AQ10 has been used on a wide range of crops under a range of conditions and no phytotoxicity has been observed.

**Trials have shown a synergistic effect when used with myclobutanil.

Figures 1 to 5 below demonstrate activity.

Figure 1: AQ10 on cucumber



AQ10 on cucumber:

Plants with natural infection of powdery mildew *Podosphaera xanthii* (*Sphaerotheca fulginia*).

5 applications were applied at 7 - 10 day intervals.

Treatments :

First bars: AQ10 at 56 g/ha with adjuvant 'A' (a product similar to Nu Film P).

Second bars: chemical standard (fungicide) (no cucumber approval in UK).

Third bars: alternated treatment - AQ10 at 56 g/ha with adjuvant 'A' (3 applications) alternated with chemical standard (no cucumber approval in UK) (2 applications).

Fourth bars: untreated.

Key:

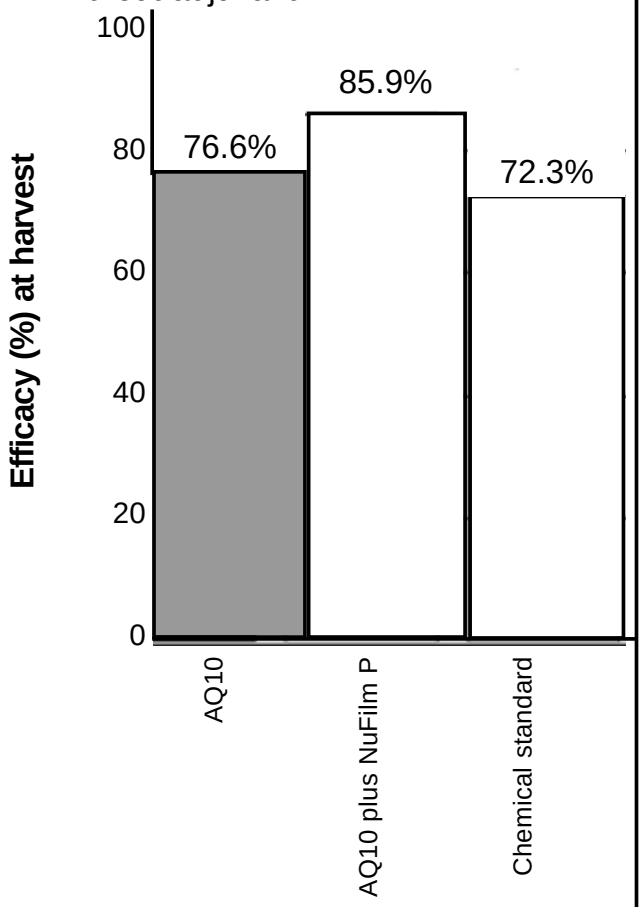
Black bars: - % leaf area infected 7 days after treatment 4.

Clear bars: - % leaf area infected 5 days after treatment 5.

AQ10 performed as well or better than the chemical standard and when used in alternation with the chemical gave high levels of control.

(Intrachem Italy).

Figure 2: AQ10 on cucumber with and without adjuvant.

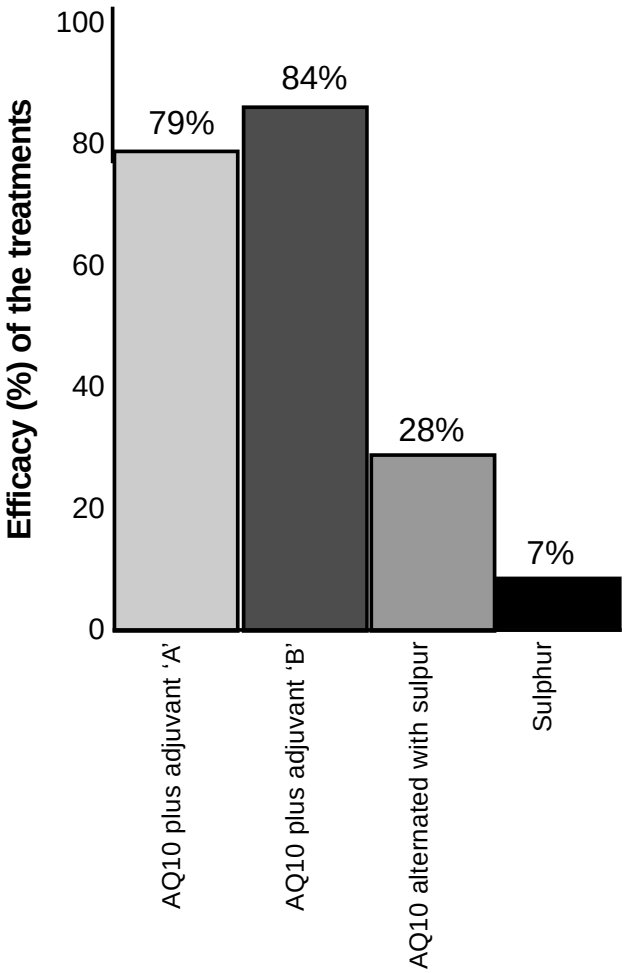


AQ10 on cucumber with and without an adjuvant:
Three applications per treatment carried out on 24th and 31st August and 8th September. Assessment on 23 September. Spray volume 600 litres per ha.

Treatments:
First bar: AQ10 at 7 g/100 litres, no adjuvant.
Second bar: AQ10 at 7 g/100 litres plus Nu Film P at 30 ml per 100 litres.
Third bar: chemical standard.

AQ10 performed better than the chemical standard. The performance of AQ10 was improved with NuFilm P but the difference was not statistically significant.
(Intrachem Italy)

Figure 3: AQ10 on strawberry.

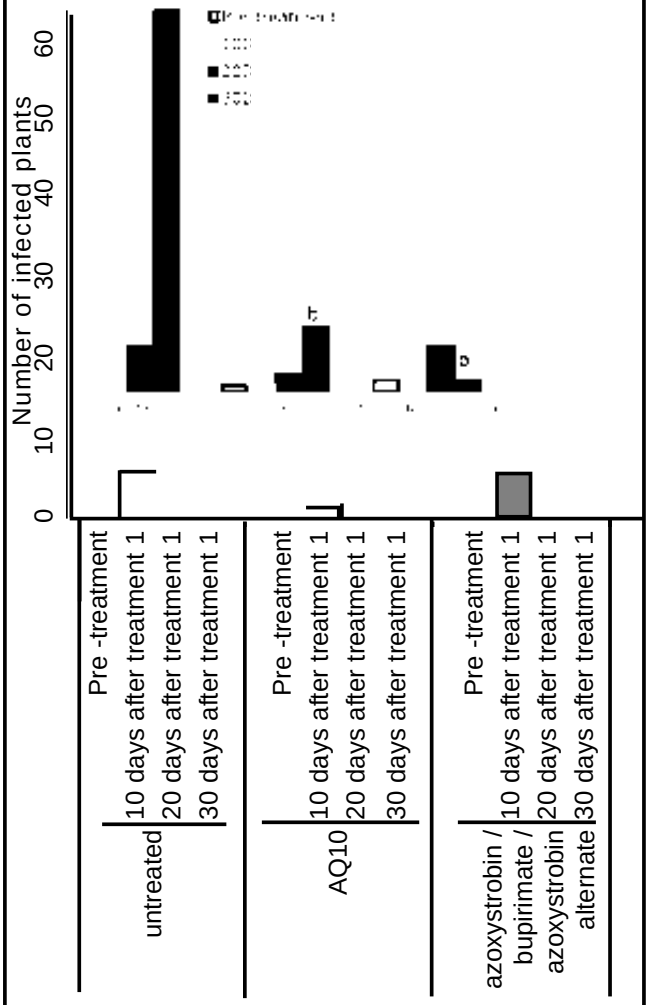


AQ10 on strawberry comparing efficacy with sulphur and alternated with sulphur fungicide:
The crop was field grown in Italy (note that the UK label is for protected strawberry only). The applications were made at weekly intervals.

Treatments:
First bar: AQ10 plus adjuvant 'A' (product similar to Nu Film P),
Second bar: AQ10 plus adjuvant 'B' (a mineral oil).
Third bar: AQ10 alternated with a sulphur fungicide.
Fourth bar: sulphur fungicide.

AQ10 outperformed the sulphur treatment and applied alone outperformed an alternating sulphur AQ10 programme.
(Intrachem Italy)

Figure 4: AQ10 on *Lonicera.*



AQ10 on *Lonicera.*
Powdery mildew, *Microsphaera penicillata* (*Erysiphe alni*) , natural infection.
3 applications at 10 day intervals.
Number of powdery mildew infected *Lonicera* plants (maximum/treatment=144)
Treatments:
First bars: untreated.
Second bars: AQ10 at 5g/100l plus the adjuvant Activator 90 at 50ml/100l.
Third bars: azoxystrobin followed by bupirimate followed by azoxystrobin.
The bars are for pre-treatment assessment, 10 days after first treatment, 20 days after first treatment and 30 days after first treatment.

AQ10 maintained control over time, performed well under high disease pressure and caused no crop damage unlike the chemical fungicide programme.
Note that AQ10 my be used on ornamentals using the extension of authorisation EAMU. see page 5.
(Belchim UK).

WHAT DISEASES DOES AQ10 CONTROL?

Development work has shown activity on a wide range of powdery mildew diseases.

HISTORY AND DEVELOPMENT

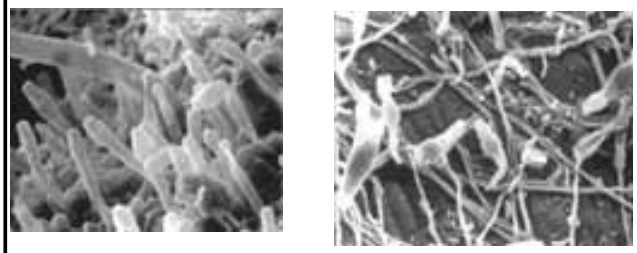
In 1861 the first drawing of a powdery mildew infected with *A. quisqualis* was made. In 1930 *A. quisqualis* was identified as an antagonist of powdery mildew. In 1986 Prof Sztejnberg's laboratory in Israel isolated what became strain M-10 from the wild plant *Caltha edulis*. AQ10 has been commercially produced as a biofungicide since 1994. Registrations are held in Germany, Italy, Slovenia, South Africa, Switzerland, Greece and Egypt. AQ10 was first approved in the UK in October 2011, the approval being based on a mutual recognition of a German label following earlier inclusion on the European Annex I.
The fungus readily grows in liquid fermentation and produces large numbers of spores.

HOW DOES AQ10 WORK?

Ampelomyces has a "mycoparasitic" mode of action. This means it is a parasite of powdery mildew. It penetrates and invades the fungal cells.

Ampelomyces invades the host mycelium (powdery mildew hyphae), conidiophores (part of powdery mildew that produces spores) and conidiospores (powdery mildew spores), it destroys the powdery mildew's cytoplasm (contents of the powdery mildew's hyphae) killing the disease.

Figure 5: untreated powdery mildew (left) and with treatment of AQ10 (right)..



(Ecogen / Intrachem).

It is able to infect chasmothecia /cleistothecium.

WHEN SHOULD AQ10 BE APPLIED?

Apply when conditions are conducive to powdery mildew infection and development but before mildew mycelium becomes established in the crop .

Powdery mildew Life cycle

Infection:

Spores (both ascospores) and conidiospores (also termed conidia, the common asexual spore type produced in long chains) germinate, penetrate the leaf, form a haustorium (a feeding structure in a plant cell which remains alive), then leaf surface mycelium is produced.

Multiplication:

Long chains of conidia (spores are produced from the leaf surface mycelium leading to mass spore production and widespread infection under suitable conditions).

Infection:

Unlike other diseases there is no need for the presence of free water on the leaf surface for infection. High humidity is required by most species and this can be provided by change from cold night to day conditions or where there is poor air circulation.

Symptoms:

Early symptoms of infection are dwarfing and stunting and possibly reddening of tissues caused by withdrawal of plant foods by the fungus. This may take the form of leaf curling or cupping and distortion. Mycelium can then be observed on the leaf surface, usually but not always on the upper leaf surface. Infection can be on the plant stems. Typically the fungus is white and can start as a white spot. Characteristic powdery symptoms will be caused by production of long chains on conidia.

Survival overwinter:

The fungus can survive overwinter as mycelium (fungal strands) on infected plants. Sexual reproduction of the fungus results in the formation of ascospores (a type of spore) contained in a chasmothecium (also termed a perithecia or cleistothecia), a long term survival structure for the fungus which can survive on dead or alive plant tissue (crop debris and on leaf).

Various computer models are being produced to predict infection based on humidity and temperature.

AQ10 should be applied preventatively, or at low infection levels of less than 3% infected leaf area. AQ10 has been found to parasitise the overwintering chasmothecium (mainly at immature stage). In southern Europe trials have demonstrated a reduction in the number of viable chasmothecium from autumn treatments.

ON WHAT CROPS AND IN WHAT SITUATIONS CAN AQ10 BE USED?

In the UK AQ10 is approved for use in protected crops of: aubergine, courgette, cucumber, melon, pepper, strawberry, tomato, winter squash and pumpkin.

Ampelomyces quisqualis has been excluded from the long term arrangements for extension of use since 1 June 2009 so for use on ornamentals an extension of authorisation is for minor uses (EAMU) is required, see below.

EXTENSION OF AUTHORISATION (SOLA):

CRD have granted an extension of authorisation EAMU, previously known as a specific off label approval or SOLA.

1324 of 2012:

Protected crops of "forest nursery", ornamental plant production, chilli, marrow, watermelon, named herbs, blueberry, gooseberry, other small fruit and berries, redcurrant and whitecurrant. Protected crops (propagating material) of: apple, crab apple, pear, quince, table grapes, wine grapes.

"This extension of authorised use provides for the use of AQ10 in respect of crops and situations, other than those included on the product label. No efficacy or phytotoxicity data have been assessed and as such the 'extension of use' is at all times done at the user's

choosing, and the commercial risk is entirely theirs".

Before use of any pesticide under an extension of authorisation users must have a copy of the document which is available at www.pesticides.gov.uk. These documents are frequently revised and therefore it is important to check that the documentation is current and correct before any use.

HOW BEST TO APPLY AQ10?

Ideally apply weekly starting from the very first sign of mildew or when it is expected.

What is the application rate?:

The rates depend on the plant height, see table 1 below and are from 35 to 70 g per ha. Spray the crop using conventional sprayers with sufficient water to ensure uniform coverage including the underside of the leaf.

Table 1: rates of use.

Protected crop	**Plant height / growing system**	**AQ10 application rate**
Aubergine, Cucumber, Pepper & Tomato.	Up to 50cm	35g/ha
	50 to 125cm	53g/ha
	above 125cm	70g/ha
Courgette, Melon, Pumpkin & Winter squash.	Crops not grown vertically	70g/ha
	Up to 50cm	35g/ha
	50 to 125cm	53g/ha
	Above 125cm	70g/ha
Strawberry.	All growing systems.	70g/ha

What is the recommended water volume for dilution?:

Use sufficient water to ensure uniform coverage of the crop, without causing run-off .

Why is an adjuvant recommended and which one to use?

Adjuvants are not necessary but in repeated trials there is a tendancy for efficacy to be improved by a small but statistically insignificant percentage, see figure 2. Adjuvants are most valuable under conditions of low humidity and high temperature. Experience in Italy and other markets shows that the use of adjuvants is not required for good efficacy.

The label recommends use of AQ10 with the adjuvant Nufilm P. As the label text comes from mutual recognition of a German label the recommended adjuvant may not be the most appropriate for the UK where adjuvants have different authorisation from Germany.

Options include:

Nu Film P: (A0635) (96% pinene ologomers) recommended on label. This adjuvant is subject to a 30 day harvest interval on the labelled edible crops and therefore its use is not normally practicable on these crops.

Activator 90: (A0547) (alkoxylated alcohols and tall oil fatty acids). This performs a wetting function and worked well in one of the trials. For edible crops this may mean that AQ10 may have to be used at half the recommended rate. For more information see the Activator 90 approval. Efficacy at half rate is untested.

Codacide Oil: (A0639 (95% rapeseed triglycerides) Extender sticker and wetting agent based on natural vegetable oil. Allowable with permission from organic certification bodies.

Silwet: AQ10 is compatible with Silwet.

For edible crops this may mean that AQ10 may have to be used at half the recommended rate. For more information see the Silwet approval. Efficacy at half rate is untested.

The efficacy and safety of these adjuvant combinations may not have been fully tested so growers are advised to trial their use on a small area before widespread use.

Practical Points:

Apply when humidity is increasing. Do not apply in direct sunlight. Apply at a temperature of 12°C to 30°C. Typically apply early morning or late evening.

Apply at high water volume at high pressure with a fine spray. Thorough coverage

of leaf surface is required. In trials A. *quisqualis* spores have survived pressures up to 10 bar.

APPLICATION WITH ULV EQUIPMENT.

ULV application can work well provided the coverage is sufficient to place the product in the areas of infection. It is recommended that the minimum nozzle size is no smaller than 0.5mm, that the application is made late evening when the relative humidity is highest (optimum over 80%). The spore size of AQ10 is 2 by 10 micron.

WHAT IS THE EFFECTIVE TEMPERATURE RANGE?

From 12°C to 30°C. See above "practical points".

IS THERE A LIMIT ON THE ACIDITY OR ALKALINITY OF THE SPRAY SOLUTION ?

No problems have been reported with normal pH water within the range 6 to 7. Avoid water at over pH8.

IS THERE ANY BENEFIT FROM PRE-MIXING TO ACTIVATE SPORES BEFORE USE?

It is recommended to add AQ10 to water (over 15°C and less than 30°C) and stir. Leave to soak for 30 minutes to an hour. Finally agitate to release and mix the spores into solution. The viability of the spores may decline if left in water suspension for more than 12 hours. The use of pre-soaking can improve efficacy, certainly greater than the use of an adjuvant.

WILL AQ10 WORK AT ALL HUMIDITY LEVELS

A. *quisqualis* spores need humidity for germination and therefore application in the evening is preferred.

WHAT TREATMENT INTERVAL IS RECOMMENDED?

Apply every 7 to 10 days with at least two successive treatments.

A maximum of 12 treatments may be applied to the crop.

TANK MIXING OR POSITION IN CROP MANAGEMENT PROGRAMME

Data and experience has been generated outside the UK so not all of the products listed here are suitable for foliar application to the approved crops or for use on the approved crop and situation in the UK.

Table 2: tank mixing.

Fungicides:

AQ10 has been successfully tank mixed with fungicides listed here without loss of spore viability:

Bacillus subtillis,	copper oxychloride,
cymoxanil,	#dimethomorph,
fenamidone,	fluazinam,
fosetyl aluminium,	iprodione,
mepanipyram,	metalaxyl,
myclobutanil,	
penconazole,	propiconazole,
pyrimethanil,	quinoxyfen,
tebuconazole,	thiophanate-methyl,
zoxamide.	

Mix AQ10 with the fungicide only at tank mix concentration, never with the concentrate. Only one formulation may have been tested and work was based on overseas formulations.

dimethomorph partial compatibility - a certain level of reduction in spore germination could occur; tank mix the fungicide with AQ10 and apply the spray solution within 30 minutes of tank mixing.

Do not tank mix and allow at least 5 days between an AQ10 treatment and any of the following fungicides:

azoxystrobin,	boscalid + pyroxystrobin,
captan,	chlorothalonil,
cyprodinil plus fludioxonil	dithianon,
dodine,	famoxadone,
fenhexamid,	kresoxim methyl,
mancozeb,	maneb,
meptyldinocap,	SB Plant Invigorator,
sulphur,	thiram,
trifloxystrobin.	

Do not tank mix

potassium bicarbonate.

continued

Table 2 tank mixing, continued.
Insecticides: AQ10 is tank mixable with: *Bacillus thuringiensis* (eg DiPel DF), *Beauveria bassiana* (Naturalis L), pyrethrins.
Do not tank mix Savona. SB Plant Invigorator (leave at least 5 days after AQ10 application before use).
Fertilisers: SB Plant Invigorator - see above. Avoid foliar feeding with high pH fertilisers.

COMPATIBILITY WITH OTHER COMPONENTS OF A CROP PRODUCTION PROGRAMME OR WITH OTHER BENEFICIAL FUNGI OR ORGANISMS?

AQ10 is very specific to powdery mildew fungi. It will have no effect on beneficial insects and mites and no effect on aquatic organisms, birds or bees.

See also "Tank mixing or position in crop management programme" (above) for compatibility data with other biofungicides and bioinsecticides.

ARE THERE ANY VISIBLE SPRAY DEPOSITS?

These have not been observed.

IS AQ10 USABLE IN ORGANIC SYSTEMS?

AQ10 is used in organic systems. Consult with the verification body concerned.

WHAT IS THE SHELF LIFE AND WHAT ARE THE RECOMMENDED STORAGE CONDITIONS ?

AQ10 is supplied in moisture proof foil containers which have a 2 year shelf life when stored at the optimum 4°C to 8°C or 1 year at room temperature.

Opened sachets should be used within 7 days at room temperature and up to 25 days when stored at between 4°C and 8°C

WHAT IS THE HARVEST INTERVAL?

There is no harvest interval. AQ10 does not produce chemical residues.

ARE THERE ANY FOOD SAFETY ISSUES WITH REGARD TO USE IN OR NEAR FOOD CROPS?

There are no chemical residues. There is no spore germination at 37°C (body temperature) and the strain is non-pathogenic to humans. There is no harvest interval on approved crops.

ARE THERE ANY ISSUES OF PLANT PHYTOTOXICITY ?

AQ10 has been used on a wide range of crops under a range of conditions and no phytotoxicity has been observed.

HOW IS AQ10 PACKAGED?

AQ10 is packed in foil sachets containing 10g or 30 g. 10g treats 1400 m^2 at the 70 g/ha rate, 30g treats 4200 m^2 at the 70 g /ha rate.

Approval Holder Marketing company:
Belchim Crop Protection Limited
1b Fenice Court, Phoenix Park
Eaton Socon, St. Neots - PE19 8EP
Tel.: 01480 403333 – Fax: 01480 403444
24-hour emergency number for AQ10:
0032 14 58 45 45

Safety data sheet available on request.

Pack Sizes: 10g (outer 45), 30g (outer 30).

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