A novel approach in priming technology for sugar beet seed

V Heyes and S Harper

Germain's Technology Group, Hansa Road, Hardwick Industrial Estate, King's Lynn, Norfolk PE30 4LG, UK

Email: vheyes@germains.com

Introduction

Rapid emergence and field establishment are essential to minimise constraints on yield potential. For sugar beet, delays in early crop growth and development may be attributable to a number of factors such as cold, wet conditions following planting, the formation of crusts and caps following heavy rain, or rapid drying conditions combined with prolonged lack of natural precipitation. Faced with any of these challenges, the more vigorous and fastest emerged plants have a better chance of surviving the often transient yet penalising conditions that can result in heterogeneous final stands, which limit yield potential.

In the UK, Advantage® priming technology has been used on 100% of the beet crop since the mid-2000s, offering an average gain of 2–3 days' benefit in emergence to 50% and a 4% adjusted tonnage benefit over unprimed beet. Further development, based on studies and experiments both in the USA and the UK, has now resulted in a step improvement in priming technology for sugar beet seed: XBEET®.

Methods

Twenty-seven sites comprising commercial grower-scale fields and small-scale replicated experiments were put in place across the UK beet-growing area in 2008. This ensured representative spread over soil types and drilling dates. Advantage was compared with XBEET at all stages from planting to harvest. Both received the standard UK fungicide seed treatment and were also treated with the insecticide Poncho® Beta.

Results

- Speed of emergence: XBEET primed beet reached 50% emergence across all drilling dates by an average of 5 days faster than Advantage primed beet.
- Final establishment: XBEET provided over 26 of 27 sites a final population benefit over Advantage. The average benefit over 27 sites was 9.9% higher populations.
- Yield: 11 sites were taken to final yield assessment. XBEET returned a 3.0% adjusted tonne yield benefit over Advantage.

Conclusions

- Sugar beet seed priming is a consistent and reliable aid ensuring strong and early plant establishment. It is also accepted in the UK as a yield-boosting tool delivering increased tonnage over unprimed beet.
- The new technology XBEET offers a step improvement in both early establishment and yield. It has also shown the new benefit of increased final populations.

Poncho Beta: Registered to Bayer AG. XBEET, Advantage: Registered to Food Investments Ltd.

The effect of thiamethoxam on the early growth of wheat, oilseed rape and maize seedlings

N J Wooliscroft and M C Hare

Crop & Environment Research Centre, Harper Adams University College, Edgmond, Newport, Shropshire TF10 8NB, UK

Email: m.hare@harper-adams.ac.uk

Summary

The effect of thiamethoxam on the speed of emergence of wheat seedlings was tested in a glasshouse pot experiment along with three other commercially available seed treatments. Seedlings emerged most quickly following treatment with thiamethoxam and significantly faster than fuberidazole + triadimenol. A subsequent pot experiment showed a similar increase in the speed of seedling emergence over untreated wheat following treatment with thiamethoxam. This effect was also observed for maize and oilseed rape. Thiamethoxam treatment also resulted in increased shoot lengths for all three crop species. This study has produced evidence that thiamethoxam has positive effects on seedling growth of wheat, maize and oilseed rape, and it may have similar effects in a range of crops. These effects, in some situations, could prove to be of economic significance to a farmer.

Introduction

It has been well documented that certain plant protection products can affect crop growth in addition to having their desired pesticidal activity. These effects are quite varied, and can be as a result of either positive or negative effects on physiological processes. Examples are the plant growth regulatory effects of fungicidal triazoles and the 'greening effects' of strobilurins. These effects may have little consequence with respect to the agronomy of the crop, and in the field even go unnoticed by the farmer. Knowledge of such effects, however, can prove to be very useful to the overall agronomy of a crop; for example the effects of triazoles on crop canopy management in oilseed rape and the interaction between strobilurins and nitrogen in wheat.

The most obvious example of physiological effects from a seed treatment may well be the growth retardant effect of triadimenol in wheat. This was initially thought of as a negative effect, and rightly so; however, if used strategically to in effect delay emergence, positive effects through disease avoidance can be achieved. There is evidence that other seed treatments have more obvious positive effects, such as those documented for carboxin.

It is therefore sensible to propose that the non-pesticidal effects that plant protection products may have on crops are analysed and evaluated in order to optimise both agronomy and inputs.

Materials and methods

Two pot experiments were conducted in the glasshouse to investigate the effect of thiamethoxam seed treatment on the growth of seedlings. In the first experiment, conducted on wheat, the effect of thiamethoxam was assessed in relation to three commonly used seed treatments and an untreated control. In the second experiment, the effect of thiamethoxam was assessed on three different crop species. In both experiments, seeds were sown in John Innes No. 2 compost in half seed trays.

In the first experiment (experiment 1), winter wheat seeds cv. Claire were treated using a Mini-rotostat with carboxin + thiram, fludioxonil, fuberidazole + triadimenol or thiamethoxam at manufactures' recommended dose rates, or were untreated to provide a control. Seeds were then sown in compost and grown under glasshouse conditions in a fully randomised design with 10 replicates of each treatment. Seedling emergence counts were performed and the time to 50% emergence calculated. Data from each of the five assessment times were then subjected to ANOVA and emergence curves were fitted using Genstat 8.1.

A second pot experiment (experiment 2) was conducted to investigate further the effect of thiamethoxam on wheat (cv. Claire) and to test for a similar effect on forage maize (cv. Gazelle) and oilseed rape (cv. Bravour). Following treatment with thiamethoxam (wheat @ 1 l^{-1}, oilseed rape @ 6.8 l^{-1} and maize @ 1.4 ml per 1000 seeds), seeds were sown in compost and grown under glasshouse conditions in a randomised block design with six replicates of each treatment. Untreated seeds were used as a control. Seedling emergence was assessed frequently and the data were analysed as for experiment 1. Shoot length was also recorded once emergence was complete. Data were analysed using factorial ANOVA.

Results

In experiment 1 there was a significant effect ($P < 0.005$) of treatment on the number of emerged seedlings in all but the final assessment. Only two treatments significantly affected the speed of seedling emergence compared with the untreated control; fuberidazole + triadimenol increased the time to 50% emergence by 3.4 h, whilst thiamethoxam reduced the time to 50% emergence by 3.2 h (Figure 1).

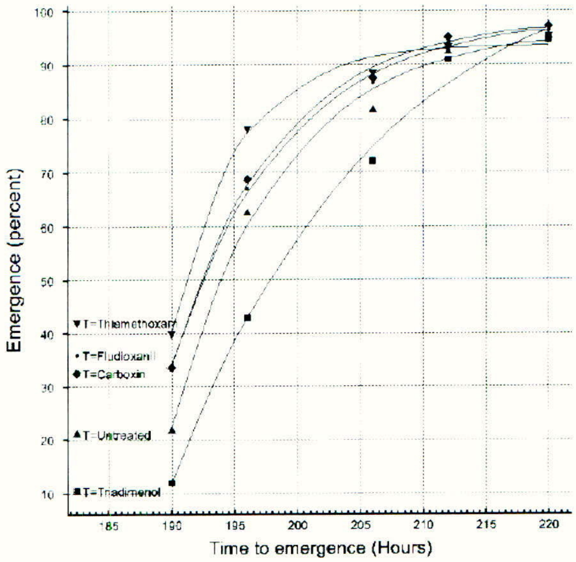

Figure 1 Effect of seed treatment with thiamethoxam, triadimenol, carboxin, fludioxanil and untreated on the emergence of wheat seedlings cv. Claire

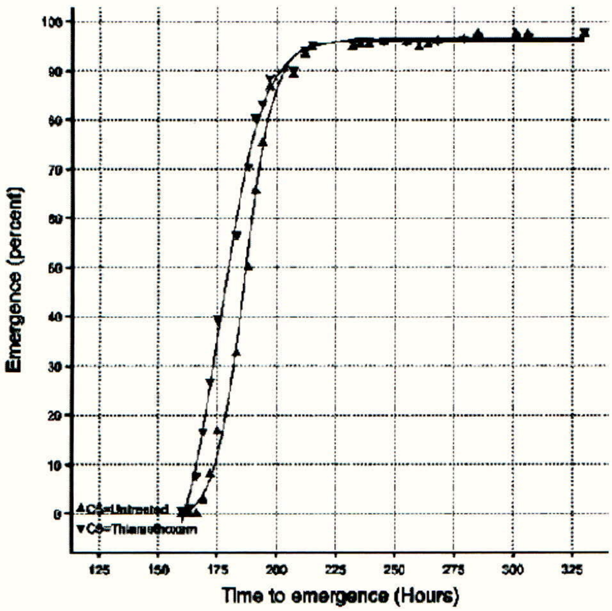

Figure 2 Relationship between seed treatment with thiamethoxam and the emergence of wheat seedlings cv. Claire

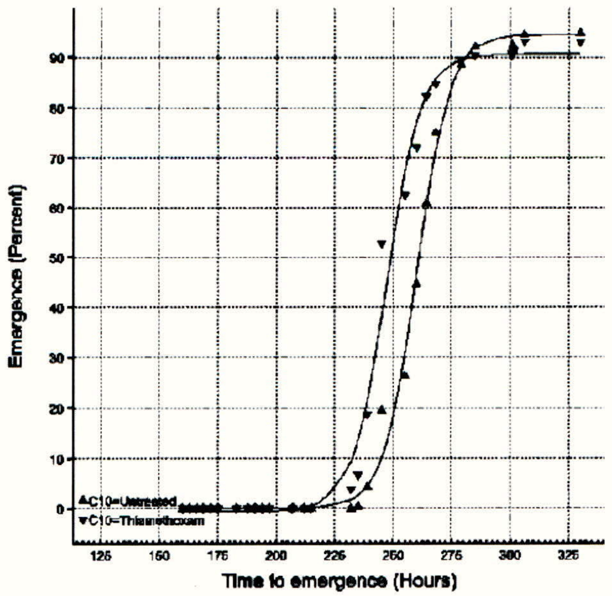

Figure 3 Relationship between seed treatment with thiamethoxam and the emergence of forage maize seedlings cv. Gazelle

In experiment 2, thiamethoxam again reduced the time to emergence for wheat (Figure 2), and also for maize (Figure 3) and oilseed rape (Figure 4), with respect to the untreated controls. No significant effect of seed treatment on the final number of emerged seedlings for each of the three crops was observed.

Shoot length in experiment 2 was significantly greater for the thiamethoxam treatment for all three crop species (Figure 5). Factorial analysis, however, revealed a significant interaction

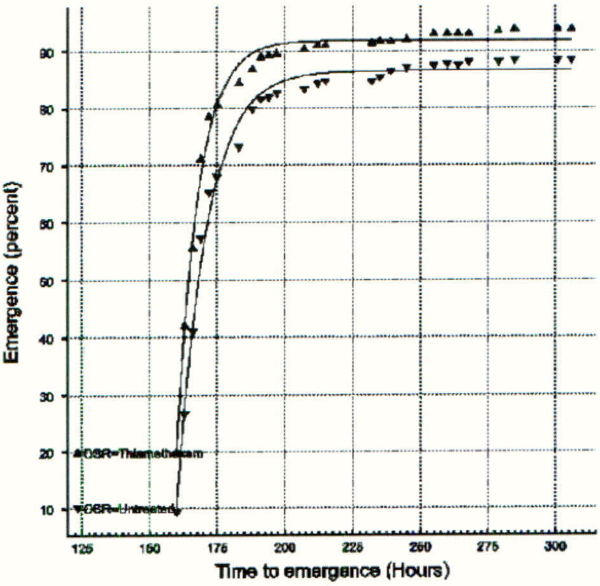

Figure 4 Relationship between seed treatment with thiamethoxam and the emergence of oilseed rape seedlings cv. Bravour

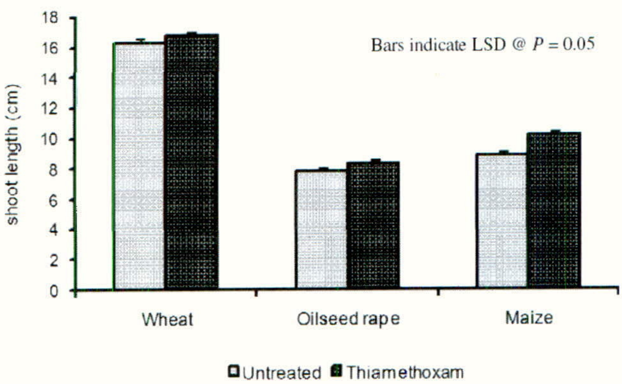

Figure 5 Effect of thiamethoxam seed treatment on the shoot length (cm) of wheat, oilseed rape and maize seedlings (P < 0.001, SEM = 0.1, df = 25, CV = 0.7 %)

between thiamethoxam seed treatment and crop for shoot length. Thiamethoxam increased the shoot length of wheat by 0.45 cm or 2.69%, oilseed rape by 0.47 cm or 5.67%, and maize by 1.3 cm or 12.8%. This is similar to experiment 1, where thiamethoxam increased the shoot length of wheat by 0.64 cm or 3.6%.

Conclusions

This study has produced evidence that thiamethoxam has positive effects on early seedling growth of wheat, maize and oilseed rape. It may have similar effects in a range of crops. These effects, in some situations, could prove to be of economic significance to a farmer. The speed of seedling emergence has been linked with the severity of some seedling diseases, such as fusarium seedling blight of wheat; the greater the rate of seedlings emergence the less severe the disease.

Increasing the speed of seedling emergence may also have agronomic significance. If the data for maize from this experiment are used to calculate the accumulated growing degree days (GDD) – a measure for the thermal time requirement for 50% emergence – according to the method of Gesch and Archer (2005), values of 33.3 and 37.1 for thiamethoxam-treated and untreated seeds are produced. The GDD value for untreated seeds is similar to that calculated by Gesch and Archer for late April-drilled maize in the USA (39.5). A crude calculation based on these data suggests that thiamethoxam treatment may reduce the time to 50% emergence in the field by up to 3 days.

Acknowledgements

Thanks to Dr Christoph Grimm, Syngenta for his support of this work and Professor Andy Cobb, Harper Adams University College for his constructive comments on this paper.

References

Gesch RW; Archer DW (2005) Influence of sowing date on emergence characteristics of maize seed coated with a temperature-activated polymer. *Agronomy Journal*, **97**, 1543–1550.

Response of green beans to *Rhizobium* inoculation of the seed bed

A J Biddle and S Thompson

Processors and Growers Research Organisation, Great North Road, Thornhaugh, Peterborough, PE8 6HJ, UK

Email: anthony@pgro.org

Summary

In a trial carried out in Norfolk, UK, two varieties of green beans (*Phaseolus vulgaris*), cvs Scuba and Laguna, were planted in a commercial crop of beans with two rates of a granular *Rhizobium* inoculant together with 50 kg/ha of nitrogen fertiliser. The treatments were compared with an uninoculated standard application of 100 kg/ha N fertiliser. The higher rate of fertiliser inhibited nodulation from a background natural *Rhizobium*. The addition of the inoculum produced a significantly high level of nodulation in both varieties. There was a non-significant yield increase of pods, but this compared well with the standard fertiliser application.

Introduction

Around 2000 ha of green beans (*Phaseolus vulgaris*) are grown in the UK for the fresh market or for freezing. Production is highly mechanised, and seed is imported from either Europe or the USA and is usually treated in the exporting country with a mixture of an insecticide and a fungicide. This gives protection against bean seed fly larvae (*Delia platura*) and damping-off diseases caused by *Pythium* or *Rhizoctonia* spp. Crops are planted from mid-May until early July to provide a harvest from August to September. Seed is drilled by precision planters, usually in 2-m-wide beds, pre-cultivated and with a fertiliser application of around 120–180 kg N per hectare (Defra, 2000). In some cases the dose is split between pre-drilling and post-emergence on the lighter, free-draining soil types, particularly where irrigation is used or there has been excessive rainfall. Harvest is usually by machine.

Although they are legumes, because green beans are not native to the UK there is no effective population of *Rhizobium phaseoli* present in soils to allow natural nodulation and nitrogen fixation to occur, hence the requirement for nitrogen fertiliser. The potential benefits of using an inoculum to promote nitrogen fixation in *Phaseolus* have been demonstrated (Taylor *et al.*, 1983), and there have been attempts to provide an effective inoculant of *Rhizobium* for green beans in the UK using formulations based on a milled peat which is mixed with the seed at drilling time. In commercial production, it was difficult to add the inoculant to the seed drill during the planting operation and some variability of performance may have been due to poor mixing, poor seed adhesion and toxicity from the pesticide seed treatment. In the most effective cases, however, nitrogen could be reduced by around 50 kg/ha with the inoculant. Despite this, the practice of seed inoculation has not been carried out in the UK for many years.

The recent increase in the cost of nitrogen has highlighted areas where savings could be made, and the recent development of a clay granular formulation of *Rhizobium* inoculant (Nodulator®) for *P. vulgaris* has meant a re-evaluation of inoculation in green beans for UK production.

As a pilot study, seedbed applications of the product were compared with unfertilised and reduced nitrogen-fertilised beans in trials carried out in 2008. The results are discussed in this paper.

Materials and methods

Two commonly grown varieties of green beans, Laguna and Scuba, treated with a mixture of chlopyrifos and thiram, were obtained for the trials. A site in a commercial crop of green beans was chosen in Norfolk, UK. The soil type was a silt loam. Nitrogen fertiliser (as ammonium nitrate) was applied as broadcast treatments to plots measuring 5 × 2 m on cultivated soil and the inoculant was applied with the seed using an Oyjord plot drill. A standard pre-emergence herbicide was applied and the crop then received all other pesticides as the season progressed, except for any additional fertilisers. Each treatment was replicated four times in a randomised design for each variety:

Rep.	Inoculant (kg/ha)	Ammonium nitrate (kg/ha)
1	none	none
2	none	100
3	5	50
4	10	50

On 29 August 2008 the crop had reached the harvest stage for freezing, as assessed by seed length measurement (Gane *et al.*, 1975). Plants were dug at 10 locations within each plot and the roots were examined for the presence and frequency of nodulation. The numbers of nodules present on each root system were estimated using the following score:

0 = no nodulation

1 = 1–5 nodules present

2 = 6–10 nodules present.

In addition, nodules were dissected and activity was noted where the colour of the tissue within the nodules was pink, denoting the presence of leghaemoglobin and active N fixation. On 29 August, 20 previously undisturbed plants from each plot were harvested and the weight of pods recorded. Data were analysed by ANOVA.

Results

There was a significant difference in nodulation between treatments for both varieties. A naturally occurring population of *Rhizobium* had produced some nodules on unfertilised plants, but this was suppressed by the 100 kg/ha N. There was a clear increase in nodulation that could be attributed to the inoculant in the presence of 50 kg/ha N, and this was further increased by the 10 kg/ha rate of inoculant. Although yield differences as measured by the weight of pods were recorded, the differences were not statistically significant. There was a trend for the higher rate of inoculant plus the 50 kg/ha N to produce a pod weight that was almost equal to the uninoculated 100 kg/ha N treatment. Laguna produced a higher weight of pods than Scuba.

Table 1 Nodulation scores for each variety

	Treatment	Scuba	Laguna
1	Uninoculated + nil N	0.76	0.40
2	Uninoculated + 100 kg N	0.26	0.09
3	5 kg inoculant + 50 kg N	1.06	0.93
4	10 kg/ha inoculant + 50 kg N	1.10	1.18

LSD treatment 0.28 ($P \leq 0.001$)

LSD variety 0.65 (ns)

LSD treatment × variety 0.61 (ns)

Table 2 Weight of pods

	Treatment	Scuba (kg)	wt as % untreated	Laguna (kg)	wt as % untreated
1	Uninoculated + nil N	1.17	100	1.51	100
2	Uninoculated + 100 kg N	1.35	115	1.67	111
3	5 kg inoculant + 50 kg N	1.25	107	1.41	93
4	10 kg/ha inoculant + 50 kg N	1.31	112	1.61	107

LSD treatment 0.21 (ns)

LSD variety 0.17 ($P \leq 0.01$)

LSD treatment × variety 0.28 (ns)

Discussion

The inoculant produced active nodules on Laguna and Scuba green beans. There was a background population of natural *Rhizobium*, but this appeared to be generally inactive and suppressed by the 100 kg/ha standard treatment of nitrogen. The higher rate of inoculant plus 50 kg/ha N improved the nodulation score and the harvested pods yielded similarly to the standard treatments. With current nitrogen costs at around £1 per kg, savings on fertiliser would be around £50/ha. The use of inoculants in organic bean production would also be valuable.

Granule application would be a straightforward option for most UK growers where an applicator could be mounted on the drill to deliver the granules in front of the coulters. Although this product was applied as a seed-bed treatment, there would be an opportunity to develop a formulated product for direct seed application.

References

Defra (2000) *Fertiliser Recommendations for Agricultural and Horticultural Crops (RB209)*, 7th edn. Department for Environment, Food and Rural Affairs, London, 114.

Gane AJ; King JM; Gent GP (1975) *PGRO Pea and Bean Growing Handbook Vol. 2: Beans*. Processors and Growers Research Organisation, Peterborough, UK, 2–6.

Taylor JD; Day JM; Dudley CL (1983) The effect of Rhizobium inoculation and nitrogen fertilizer on nitrogen fixation and seed yield of dry beans (*Phaseolus vulgaris*). *Annals of Applied Biology*, **103**, 419–429.

Plant growth regulatory effects of azole fungicides used as seed treatment

D Portz and A Suty-Heinze

Bayer Crop Science, Alfred-Nobel-Strasse 50 D-40789 Monheim, Germany

Email: Daniela.portz@bayercropscience.com

Summary

For more than 20 years, azole fungicides have been used globally as seed treatments in cereals. In addition to their excellent fungicidal activity against basidiomycetes (*Tilletia* sp., *Ustilago* spp.) and ascomycetes (*Fusarium* spp., *Microdochium* sp., *Stagonospora* sp.), they show plant growth regulatory effects, which can strongly influence crop establishment. Tebuconazole, triadimenol and prothioconazole are used as examples to illustrate these plant growth effects of azoles. In particular, morphological differences and physiological effects have been assessed.

Normally an azole treatment leads to a significant shortening of the mesocotyl, the most sensitive part of the plant. Hence plant resistance against changes in soil structure and layers caused by frost is enhanced. The plants appear smaller and more compact than untreated control plants, but also more robust.

Additionally, physiological effects were monitored. Higher chlorophyll content in leaves of azole-treated plants indicates a potential 'greening effect' caused by some compounds of this chemical class.