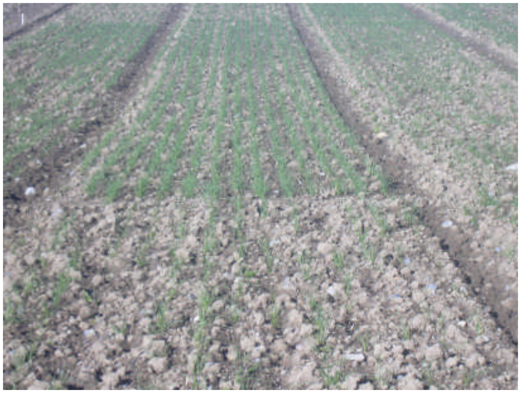
An investigation of seed treatments for the control of crow damage to newly-sown wheat



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Summary

Seed treatments for the control of crow damage to newly-sown winter and spring wheat were evaluated in field trials from 2004 to 2007. Treatments included six fungicides, three insecticides, a product marketed as a bird repellent and three possible repellents. Various rates of selected compounds were investigated. Winter wheat was sown in December and spring wheat in late-January to mid-February. Sowing depth was 2 to 4 cm while some selected treatments were also sown at 5 to 9 cm deep. Crow damage was assessed by recording plant density and grain yield. Severe damage by crows was recorded. The plant population for untreated spring wheat seed in 2004, 2005 and 2006 was reduced by 59%, 72% and 89%, respectively. The corresponding reductions caused by crows to winter wheat sown in December 2004, 2005 and 2006 was 97%, 89% and 96%. Best control of crow damage was provided by the fungicide Thiram. Increasing the rate of Thiram applied to seed improved the control of crow damage by increasing plant density in the range 42 to 70% and 36 to 57%, respectively, for spring and winter wheat when compared with untreated seed. Anchor, which contains the fungicides Thiram and Carboxin, also gave reasonably good control. The commonly used fungicide product panoctine gave poor control of crow damage. Other treatments investigated were ineffective in controlling damage. Increasing the sowing depth to more than 4.6 cm significantly reduced damage to both treated and untreated seed when compared with similar treatments sown less than this depth.

Introduction

Rooks (*Corvus frugilegus* L.), commonly known as crows, are widespread and numerous in Ireland throughout the year. Included in the diet of crows are insects, worms, snails, slugs, berries, legumes and cereals. The most serious crow damage to cereals is due to feeding on seed either before or after emergence resulting in reduced plant populations. Cereal crops sown in late-autumn or early-spring, which are mostly wheat, may be subjected to major damage by the feeding activity of crows. It would appear from the pattern of ‘excavation’ holes where damage occurs that crows are quite efficient at locating seed in newly-sown crops. In newly-emerged crops crows uproot seedlings to which the seed with some remaining endosperm is attached. Control of crow damage to cereals is difficult and products such as anthraquinone (Morkit) which was marketed as a crow-repellent only provides limited control. Prior to 2002, the insecticide lindane (Kotol) was applied for the control wireworm damage to all wheat, barley and oat seed sold in Ireland. This insecticide also provided some control of crow damage to germinating and establishing cereal crops. Investigations in the early 1990's (Kennedy and Connery, unpublished) indicated the seed fungicide guazatine (Panoctine) was more effective than lindane in preventing crow damage to cereals. The occurrence of relatively serious crow-damage to some Panoctine treated cereal crops in recent seasons has raised concerns about its continued effectiveness in providing control of crow damage. The objective of this investigation was to evaluate various seed applied treatments including fungicides and products considered to have bird repellent properties for the control of crow damage to germinating and establishing cereal seedlings.

Materials and Methods

Seed treatments

The control of crow (*Corvus frugilegus*) damage to newly-sown and establishing winter and spring wheat, by means of seed treatments, was investigated at Oak Park, Carlow, in the period 2004 to 2007. The seed treatments and rates of application, given in Table 1, included 6 fungicides, 3 insecticides, a product marketed as a bird repellent and three possible repellents. Treatments were applied to seed within one week before sowing. Application to seed was by means of a specialised applicator (Wintersteiger, Model HEGE 11). During the course of the trial products giving poor control of damage were replaced with others considered to offer greater prospects of control

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Table 1. Products applied as seed treatments.

Common name	Active ingredient	Type	litres/tonne
Panoctine	Guazatine	Fungicide	1
Anchor	Carboxin + thiram	Fungicide	3
Thiram[2]	Thiram	Fungicide	1, 2, 4, and 8
Beret-Gold	Fludioxinil	Fungicide	2
Robust	Imazalil + triticonazole	Fungicide	4
Kinto[2]	Triticonazole + Prochloraz	Fungicide	2
Evict[1]	Tefluthrin	Insecticide	2
Cruiser[1]	Thiamethoxam	Insecticide	1
Kotol[3]	Lindane	Insecticide	1
Morkit[2]	Anthraquinone	Bird-repellent	2.25[a]
Bitrex[4]	Denatonium benzoate	Repellent	2[b]
Grape extract 12.5%[1]	Methyl anthranilate	Repellent	2
Grape extract 25%[1]	Methyl anthranilate	Repellent	2
Grape extract 50%[4]	Methyl anthranilate	Repellent	2, 4 and 8
Disco Agro[5]	Methyl anthranilate + other fruit extracts	Repellent	1.5, 3 and 6
Copper oxychloride[1]	Copper oxychloride	Repellent	11.5
Untreated seed	-	-	-

[a]kg/tonne
[b]Solutions containing 0.02, 0.1, 0.25, 0.5, 1.25, 2.5, 10, 20, 40 and 80 grammes of Denatonium benzoate per litre were each applied to seed at a rate of 2 l/t of seed.
[1]Spring wheat 2004 only. [2]Not applied to spring wheat 2004. [3]Applied to winter wheat 2006 and 2007 and spring wheat 2006. [4]Spring wheat 2004 and 2005 and winter wheat 2005.
[5]Winter wheat 2006/07 only.

Experimental design

The design of each trial was a complete randomised block with five replicates per treatment. The dimension of each plot replicate was 2 x 20 m. Adjacent plots were separated by fallow strips 0.4 m wide and plot ends by strips 1 m wide. Sowing was by means of a Wintersteiger seeder (A-4910 Type PDS-14) at a rate of 179.3 kg/ha. The 1000 grain weight of seed was recorded for the purpose of estimating the potential plant population in the absence of crow damage. The germination capacity of seed was assumed to be 95%. Normal dept of sowing ranged from 2 to 4 cm while some selected treatments were also sown at 5 to 9 cm deep. Spring wheat, cv Raffles, was sown 27 January, 15 February and 9 February 2004, 2005 and 2006, respectively. Winter wheat was sown 3, 9 and 21 December in these three seasons. The varieties were Einstein, Glasgow and Cordiale in 2004, 2005 and 2006, respectively. Normal husbandry practices were applied to both winter and spring wheat crops.

Harvesting was by means of a specially modified combine harvester Duetz-Fahr 3370 (Modifications by Trials Equipment Ltd., Essex, UK).

Assessments

Plant populations were recorded at growth stage 22-23 using a quadrant 0.5 m^2. The two outermost drills on either side of the 14-drill plot were omitted from plant counts due to more excessive crow damage at the edges of plots. Quadrant counts were made at four positions approximately 4 m apart on a single diagonal of each plot. Plot yields were recorded at harvest. Grain moisture was measured in a hot-air over. Yields are expressed as t/ha at 85% dry matter.

Data analysis

The data were analysed using the general linear model procedure of the Statistical Analysis Systems Institute (SAS 9.1 2003). Pair-wise differences between treatments were evaluated using Tukey's Test.

Results

Crows were numerous on trial sites particularly in the first three weeks post sowing. Most damage was due to feeding on seed before seedling emergence. Limited damage resulted from the uprooting of seedlings by crows to feed on the 'mother seed'. Damage to spring wheat in 2004 was concentrated on the most elevated area of the trial. In the remaining trials damage was relatively even across replicates.

2004

Spring wheat grown from untreated seed had 153 plants/m^2 from a potential 374 plants/m^2 (Table 2). Twelve of the 17 seed treatments had more plants per square meter when compared with that for the untreated seed (range 1.6% to 41%). However, no treatment had significantly more plants than that for untreated seed. The treatment giving best control of crow damage was Anchor applied at 6 l/t. The latter treatment had 215.8 plants/m^2 . Panoctine only improved plant numbers by 18% relative to untreated seed. Increasing the rate of Panoctine applied to seed to twice the recommended rate resulted in a lower plant density relative to that for a single treatment. Control of crow damage by Grape extract (methyl anthranilate) ranged from 18.2% to 27.5% but did not significantly improve plant population when compared with that for untreated seed. Denatonium benzoate only provided a modest improvement in plant numbers relative to untreated seed. The fungicides Robust and Evict and the insecticide Cruiser had plant populations below those for untreated seed.

Table 2 The effect of seed treatments on plant density and grain yield of spring wheat 2004.

Treatment	Rate (l/tonne)	Plants/m^2	Yield (t/ha)
Anchor x 2	6	215.8 a	8.32 ab
Anchor	3	204.2 a	8.85 ab
Beret-Gold	2	200.6 a	8.77 ab
Grape-extract 25%	2	195.0 a	7.53 ab
Grape-extract 12.5%	2	190.4 a	8.90 a
Grape-extract 50%	2	180.8 a	7.72 ab
Panoctine	2	180.6 a	8.37 ab
Denatonium benzoate 0.02[a]	2	176.0 a	7.70 ab
Denatonium benzoate 1.25[a]	2	173.6 a	8.55 ab
Denatonium benzoate 0.5[a]	2	167.2 a	7.51 ab
Copper oxychloride	11.5	165.4 a	8.86 ab
Panoctine x 2	4	155.4 a	8.01 ab
Robust	4	147.2 a	7.64 ab
Denatonium benzoate 0.1[a]	2	145.6 a	7.96 ab
Cruiser	1	138.0 a	7.63 ab
Evict	2	126.0 a	7.25 ab
Denatonium benzoate 0.25[a]	2	121.2 a	6.34 b
UNTREATED	-	153.0 a	6.99 ab

[a]Grams *a.i.*/l. Values followed by the same letter are not significantly different.

Best grain yield, 8.9 t/ha, was recorded for the treatment Grape-extract 12.5% concentration. The latter treatment differed significantly from only one other treatment, Denatonium benzoate 0.25 g *a.i.*/litre. Plots grown from untreated seed yielded 6.99 t/ha. While grain yields differed substantially between some treatments differences were not significant due to the non-random damage by crows.

2005

Feeding on winter wheat seed by crows was extensive and damage severe. In the days post sowing crow damage was evident by lines of holes corresponding to where seeds were located and excavated. Plant populations, recorded 5 April, and are given in Table 3. Thiram, applied at 8 l/t, had the highest plant population but had only 26.6 plants per square metre. The lowest density was 5 plants/m^2. Because the damage was so severe, the trial was ploughed up in late spring.

Crow damage to spring wheat was severe (Table 3). Plots sown with untreated seed had only 115.6 plants/m^2 from a potential 418 plants/m^2. While all seed treatments had more plants than that for untreated seed only in the case of 6 treatments were the differences significant. These were Thiram at 0.5, 1, 2 and 4 times the recommended rate as well as Anchor and Panoctine x 1.5 the normal rate. Best control of crow damage was provided by Thiram, applied at 4 l/t of seed, having a plant population of 273.2 plants/m^2 . Panoctine treated seed had 60% more plants than the untreated seed but the difference was not significant. Morkit, a known bird repellent, improved plant establishment relative to controls by a non-significant amount. Morkit had significantly fewer plants than Thiram applied at either 2, 4 or 8 l/t. Plant populations for plots sown with seed treated with Beret-Gold, Robust and Kinto were not significantly greater than those for untreated seed. Denatonium benzoate proved to be ineffective in controlling crow damage to seed and seedlings even when used at high rates. Grape-extract was similarly ineffective. Sowing untreated seed at 8 cm deep resulted in significantly reduced crow damage compared with that for untreated seed sown at 4 cm deep. The respective plant densities differed significantly being 218.4 plants/m^2 and 115.6 plants/m^2 .

The grain yields for the various treatments (Table 3) related with plant density (correlation co-efficient r = 0.925). Thiram, applied at 8 l/t, had the greatest grain yield at 9.85 t/ha. The grain yields for the four rates of Thiram and Anchor were significantly greater than the 8.09 t/ha recorded for the untreated seed. The remaining treatments did not differ significantly from that for the untreated seed. Plots grown from Denatonium benzoate (80 g/l) treated seed yielded less than the untreated seed plots. Grain yield for untreated seed sown at 8 cm deep was greater by a non-significant 0.84 t/ha than that sown at 4 cm deep

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Table 3 The effect of seed treatments on plant density and grain yield of winter and spring wheat, 2004 - 2005.

Treatment	Rate (l/t)	Winter wheat 2004 - 2005 Plants/m^2	Spring wheat 2005 Plants/m^2	Spring wheat 2005 Yield (t/ha)
Thiram x 2	4	18.2 ab	273.2 a	9.71 ab
Thiram	2	13.8 ab	268.2 a	9.72 ab
Thiram x 4	8	26.6 a	266.4 a	9.85 a
Anchor	3	8.2 b	236.0 ab	9.73 ab
Thiram x 0.5	1	13.8 ab	227.8 abc	9.71 ab
Panoctine x 1.5	3	7.8 b	217.8 abcd	8.99 abc
Panoctine	2	15.4 ab	185.4 bcde	8.94 abc
Beret-Gold	2	7.4 b	172.6 bcde	8.68 abc
Morkit	2.25*	8.8 b	172.4 bcde	9.25 abc
Robust	4	11.6 ab	170.8 bcde	8.60 bc
Kinto	2	12.4 ab	168.0 bcde	8.77 abc
Denatonium benzoate 10[a]	2	8.0 b	156.0 cde	8.76 abc
Grape-extract 50% x 4	8	12.8 ab	153.2 de	8.44 c
Denatonium benzoate 40[a]	2	6.2 b	150.2 de	8.51 bc
Grape-extract 50% x 2	4	5.0 b	150.2 de	8.76 abc
Denatonium benzoate 2.5[a]	2	11.4 ab	146.6 de	8.31 c
Denatonium benzoate 20[a]	2	6.0 b	142.0 e	8.15 c
Denatonium benzoate 80[a]	2	5.4 b	134.4 e	8.01 c
Grape-extract 50%	2	14.2 ab	134.2 e	8.38 c
UNTREATED Deep sowing	-	-	218.4 abcd	8.93 abc
UNTREATED	-	13.0 ab	115.6 e	8.09 c

[a]Grams *a.i.*/l. *kg. Values followed by the same letter are not significantly different.

2006

Crow damage to winter wheat was severe. The plant density for untreated seed was 42.2 plants/m^2 from a potential of 359 plants/m^2. Thiram, applied at either 1, 2, 4 or 8 l/t, was the only product to have a significantly greater plant density relative to untreated seed (Table 4). Thiram applied at 8 l/t had the greatest plant density, 245 plants/m^2. This was significantly greater than applying the product at either one or two litres per tonne. Wheat plots grown from Anchor and Panoctine treated seed had 112.6 and 75.4 plants/m^2 , respectively. These values did not differ significantly from that for untreated seed. The remaining treatments; Morkit, Panoctine x 1.5, Beret-Gold, Kinto and Kotol gave poor control of crow damage with plant density reduced by more than 79%. Comparing the control of crow damage to seed treated with Anchor, Thiram (2 l/t), Panoctine, Kotol, Kinto, Beret-Gold and untreated seed sown at 8 cm deep with that for these treatments sown at 4 cm deep showed a significant increase in plant density for the deeper planted seed of each treatment. These increases ranged from 2- to 5.3 fold. Of the treatments sown at 8 cm deep only Anchor and Thiram had significantly more plants when compared with untreated seed.

There was good relationship between plant density and grain yield (correlation co-efficient r = 0.923). Best yield was obtained for Thiram applied at 8 l/t which yielded 9.22 t/ha (Table 4). The untreated seed yielded 5.3 t/ha. Thiram applied at 1, 2, 4 and 8 l/t and Anchor were the only treatments to have significantly greater grain yields relative to untreated seed. The remaining six treatments improved yields by non-significant amounts in the range 0.07 to 1.79 t/ha. The grain yields for Anchor, Thiram, Panoctine, Kotol, Kinto and Beret-Gold sown at 8 cm deep were not significantly greater than the yields for untreated seed sown at this depth. The mean yield for these treatments and for untreated seed sown at 8 cm deep was greater by 2.1 t/ha (range 0.77 to 3.44 t/ha) than when sown at 4 cm deep. Anchor provided the best yield of the deeper sown treatments but this was only 0.53 t/ha greater than the deep sown untreated seed.

Crow damage to spring wheat was again severe. The untreated plots had only 42.8 plants/m^2 (Table 4). Thiram and Anchor were the only products to have significantly greater plant densities when compared with that for untreated seed. Treating seed with Panoctine (1 and 1.5 rate), Morkit, Beret-Gold, Kinto and Kotol only gave modest and non-significant increases in plant populations relative to untreated seed. Increasing the rate of Thiram from 1 l/t of seed to 2, 4 and 8 l/t increased plant density by 41.8%, 120.3% and 131.2%, respectively. The plant densities for Thiram at both 4 and 8 l/t were significantly greater than for this product applied at either one or two litres per tonne of seed. Comparing plant density for Anchor, Thiram, Panoctine, Kotol, Kinto, Beret-Gold and untreated seed sown at 2.8 and 4.7 cm deep showed greater plant numbers for the deeper sowing. The increases ranged from 1.2 to 2.4 fold. Of the treatments sown at 4.7 cm deep Anchor, Thiram, Panoctine and Kotol had significantly more plants when compared with untreated seed.

Table 4. The effect of seed treatments and sowing depth on plant density and grain yield of winter and spring wheat, 2005 - 2006.

		Winter wheat 2005 - 2006		Spring wheat 2006	
Treatment	Rate (l/t)	Plants/m^2	Yield (t/ha)	Plants/m^2	Yield (t/ha)
		Sown 4 cm deep		*Sown 2.8 cm deep*	
Thiram	8	245.0 a	9.22 a	314.4 a	7.97 ab
Thiram	4	193.6 ab	8.73 ab	299.6 a	8.08 a
Thiram	2	129.0 bc	8.09 abc	192.8 b	6.99 abc
Thiram	1	126.0 bc	7.81 abc	136.0 bc	6.33 cd
Anchor	3	112.6 bcd	8.05 abc	126.4 bc	6.49 bcd
Panoctine	2	75.4 cd	7.09 abcd	72.6 cd	5.58 cde
Morkit	2.25*	72.4 cd	7.05 bcd	83.2 cd	5.40 de
Panoctine x 1.5	3	51.4 cd	6.19 cd	99.2 cd	5.93 cde
Beret-Gold	2	47.8 cd	5.38 d	76.6 cd	5.58 cde
Kinto	2	41.8 d	6.23 cd	84.6 cd	5.32 de
Kotol	1	37.6 d	5.37 d	67.6 cd	5.50 cde
UNTREATED	-	42.2 d	5.30 d	42.8 d	4.79 e
		Sown 8 cm deep		*Sown 4.7 cm deep*	
Anchor	3	274.4 a	8.98 a	210.0 ab	6.93 a
Thiram	2	265.0 a	8.86 a	236.2 a	7.07 a
Panoctine	2	214.6 ab	8.12 a	176.6 abc	6.69 a
Kotol	1	200.4 ab	8.32 a	161.8 abc	6.05 a
Kinto	2	189.8 ab	8.75 a	146.0 bcd	6.32 a
Beret-Gold	2	172.4 b	8.82 a	132.8 cd	6.56 a
UNTREATED	-	140.8 b	8.45 a	85.4 d	6.01 a

Values followed by the same letter are not significantly different. *kg.

Grain yields correlated well with plant density (r = 0.977). Two products, Thiram and Anchor, had significantly greater yields relative to that for untreated seed. Thiram applied at 4 l/t had the best yield, 8.08 t/ha, which exceeded that for untreated seed by 3.29 t/ha. Thiram applied at 4 and 8 l/t of seed had significantly greater grain yield than that for Anchor, Panoctine (1 and 1.5 rate), Morkit, Beret-Gold, Kinto and Kotol. The latter six treatments out yielded that for untreated seed by non-significant amounts varying from 0.53 to 1.14 t/ha. The grain yields for Anchor, Thiram, Panoctine, Kotol, Kinto and Beret-Gold sown at 4.7 cm deep were not significantly greater than that for untreated seed sown at this depth. The mean yields for these treatments and untreated seed sown at 4.7 cm deep was greater by 0.77 t/ha (range 0.08 to 1.22 t/ha) than when sown at 2.8 cm deep. Thiram had the greater yield of the deeper sown treatments, 7.07 t/ha, which exceeded that for untreated seed sown at 4.7 cm by 1.06 t/ha.

Discussion

The damage to winter and spring wheat due to crows feeding on seed and uprooting seedlings in trials was more severe than anticipated. The plant populations for untreated seed in three spring wheat trials were estimated to have been reduced by 62%, 72% and 89%. The damage to winter wheat was 97%, 89% and 96%. With the exception of spring wheat in 2004, crow damage was random across the trials. In 2004 damage was greater on the most elevated section of the trial possibly due to more easily accessible seed resulting from shallower planting. The observation of trials during daylight (09.00 h to 17.00 h) did not reveal the presence of large flocks of birds. Most damage was considered to have occurred at dusk when flocks were congregating prior to their nightly return to nearby rookeries. Normally crow damage is associated with crops sown when food is scarce, for example, late-sown winter crops and early-sown spring crops. Damage is generally confined to individual crops and is seldom widespread across farms. It would appear that crow damage to wheat crops is a uniquely Irish problem since there is an absence of information in the literature on the occurrence and control of damage by crows in newly sown and emerging wheat crops. While house-crows (*Corvus splendens*) have been reported to damage seedling wheat in India (Dhindsa and Saini, 1994) bird damage to other seedling crops mostly concern rice (Bruggers, *et al.*, 1981; Avery, *et al.*, 1998; 2000; Cummings, *et al.*, 2002). Most of the literature on bird damage to crops relates to ripening grain and fruit and involves various bird species other than crows (Stickley and Guarino, 1972; Kassa and Jackson, 1979; Duncan and Boswell, 1981; Mason and Clark, 1995; Blackwell, Helon and Dolbeer, 2001; Rizvi, Pervez and Ahmed, 2002).

In this study, Panoctine, which is the most widely used seed fungicide, gave poor control of crow damage. The plant density arising from Panoctine treated seed was greater than that for untreated seed in all eight comparisons but only in one comparison was the difference significant. Increasing the rate of panoctine applied to seed by a factor of two, in the hope of increasing crow repellency, caused phytotoxicity. The latter was confirmed in separate glasshouse studies. In three comparisons in the early 1990's (Kennedy and Connery, unpublished) Panoctine treated seed had significantly greater plant densities than had untreated seed. The reduced effectiveness of Panoctine in the current investigation is attributed to a more severe attack by crows as indicated by the level of damage to untreated seed. Winter wheat trials in the early 1990's were sown early- to mid-November while in the current trials wheat was sown in December when few if any other crops were sown in the vicinity and food was likely to be less plentiful than earlier in the season.

Anchor, which is the second most widely used fungicide seed treatment, had greater plant density than Panoctine in seven of the eight comparisons undertaken. Overall, Anchor had almost 27% more plants than Panoctine (range 6 to 74%). The crow repellent properties of Anchor are attributed to the Thiram element of the product. The bird repellency of Thiram was recorded by Parodi and Raezynski (1971) when finding that applying sprays of Thiram to the ears of wheat at the milky-ripe stage of growth, in Chile, helped control bird damage and reduce yield loss. The use of Thiram as a seed treatment in India was found to give considerable protection to sprouting wheat from damage by house-crows (*Corvus splendens*) (Dhindsa and Saini, 1994). In France, the repulsive effect of Thiram applied to maize seed left in piles in the vicinity of rookeries was recorded by Gorreau and Jackson, (2001). Based on the repulsive properties of Thiram as measured by these workers in the laboratory Thiram was registered as a bird repellent for maize and wheat in France in 1999. In investigations reported here, Thiram applied at 2 l/t of seed improved plant density in the range 6 to 350% when compared with untreated seed and was significant for four of the seven comparisons made.

As anticipated, the corresponding grain yields were improved being significant for three of the five comparisons for which yields were recorded. Comparisons between Panoctine and Thiram, at 2 l/t, showed greater plant densities for Thiram with two of the seven comparisons differing significantly. Thiram out-yield Panoctine in all comparisons by amounts from 5.7 to 25.3% but which did not significantly differ. Increasing the rate of Thiram improved the control of crow damage. Thiram applied at 2, 4 and 8 litres per tonne of seed had 20%, 82% and 87% greater plant density, respectively, when compared with that for Thiram at 1 l/t. The corresponding increase in grain yields were 4%, 11% and 13%, respectively. It would seem reasonable, therefore, to expect enhanced control of crow damage to wheat could be achieved by increasing the Thiram element of the product Anchor which is a registered pesticide in Ireland.

Morkit which was marketed as a bird repellent was investigated in four trials. While this product did provide some protection against damage by crows neither plant density nor grain yield of plots grown from Morkit treated seed were significantly greater when compared with similar measurements for untreated seed. In laboratory/aviary trials Anthraquinone has been found to deter sand-cranes from feeding on treated maize kernels (Blackwell, Helon and Dolbeer, 2001) and red-winged-blackbirds and brown-headed cowbirds from feeding on treated rice seed (Avery *et al*,. 1998; Cummings *et al*,. 2002). However, while some control of bird damage to seedling rice and grassland by Anthraquinone in field studies have been reported (Avery *et al*,. 1998; Cummings *et al*,. 2002; Dolbeer *et al*,.1998) control of crow damage in field trials, as recorded in the present study, has been modest.

Kotol, which prior to its removal from use in 2001 was considered to control crow damage to cereals. However, investigations in the early 1990's (Kennedy and Connery, unpublished) showed that while Kotol treated seed always produced more plants than untreated seed the differences were not always significant. The treatment of winter wheat seed in 2004 and 2005 and spring wheat in 2006 with Kotol obtained in 1994 showed the product produced only marginally and non-significantly more plants than untreated seed. The reduced effectiveness of Kotol in controlling crow damage in these trials relative to earlier investigations was due in part to a more severe attack by crows in recent trials but may also be attributable to diminished effectiveness due to the age of the product.

Grape extract (methyl anthranilate, the active ingredient in concord grapes) did give modest though non-significant increases in plant density relative to that for untreated seed. Nevertheless, even using this product at 50% concentration and increasing the rate of application four-fold failed to control crow damage by improving plant density. The Disco Agro product from Inotec (fruit extracts) was investigated on winter wheat sown December 2006 also failed to control crow damage. Methyl anthranilate is registered as an avian feeding repellent (Avery, 2002) and is marketed in the U.S. mainly for use on fruit crops. In laboratory and aviary trials reduced feeding by various bird species has been recorded for methyl anthranilate treated baits and seeds when compared with untreated controls (Russell, Clark and Miller, 1993; Clark, Bryant and Mezine, 2000; Blackwell, Helon and Dolbeer, 2001). When used on ripening crops of rice and sunflowers, however, methyl anthranilate was ineffective in controlling damage by blackbirds (Werner, *et al.,* 2005).

At the commencement of these trials it was surmised that crows might be averse to feeding on seed treated with Denatonium benzoate (Bitrex) since the product is extremely bitter. However, treating seed wheat with Denatonium benzoate failed to deter crows from feeding on seed. This product was also ineffective in controlling pest damage to conifer seedlings in field trials in the U.S. (Witmer, Pipas and Bucher, 1998). Increasing the depth of sowing reduced plant damage by crows. Sowing wheat at 5 cm deep should make seed unavailable to crows and the ‘mother-seed’ remaining attached to seedlings emerging from this depth would be exhausted as a food source for crows and would therefore not be uprooted. However, sowing cereals at greater than this depth in heavier clay soils may result in problems with seedlings struggling or failing to emerge.

It is concluded that: *(i)* wheat crops sown in the period December to February are likely to be attacked by crows, particularly isolated crops in the vicinity of rookeries. *(ii)* Where crops are under severe and prolonged attack by crows there is currently no seed treatment available that will give effective control. *(iii)* Thiram is the most effective of the seed treatments investigated for the control of crow damage to newly-sown and emerging cereal crops. *(vi)* Of the two seed treatments commercially available Anchor is more effective than Panoctine at reducing crow damage to newly sown wheat. *(v)* Better control of crow damage to wheat crops could be obtained by increasing the Thiram element of Anchor and sowing seed at 5 cm deep in months other than December and January.

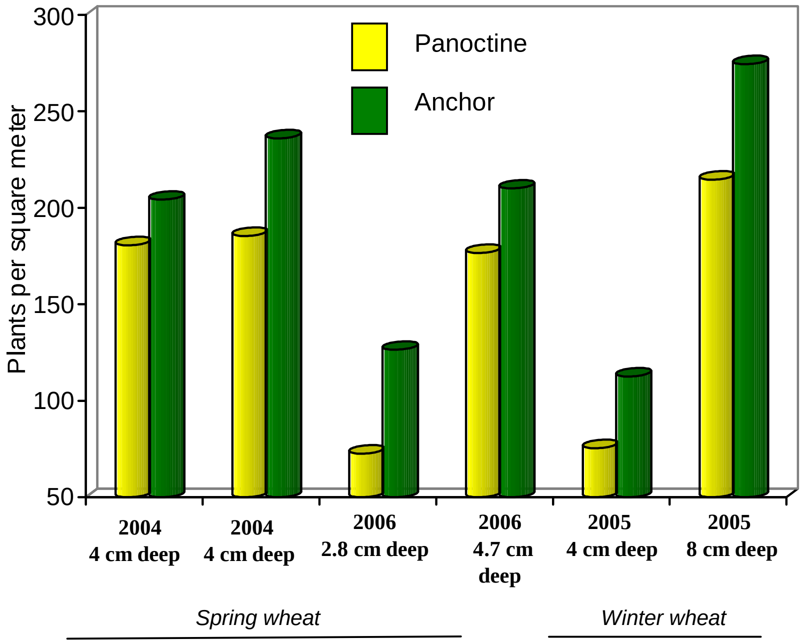

Figure 1. The plant density per m^2 for Panoctine and Anchor treated spring and winter wheat seed, Oak Park, 2004 - 2006

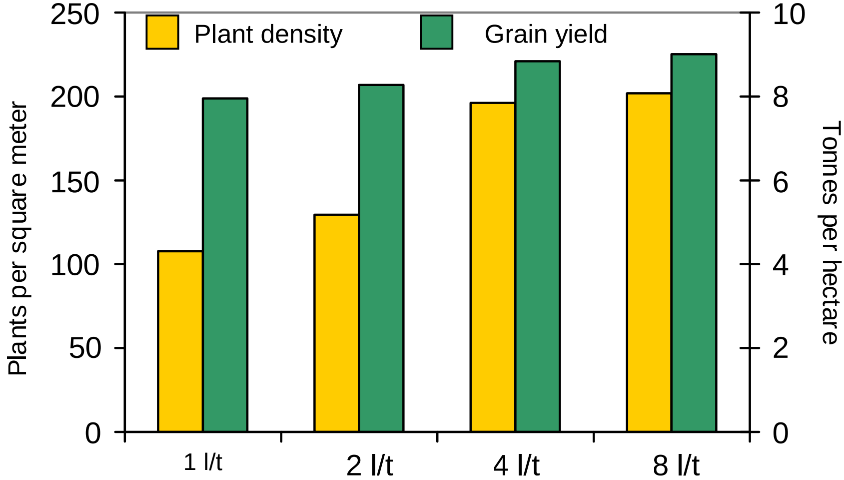

Figure 2. The plant density and grain yield for wheat treated with four rates of Thiram, Oak Park, 2004 to 2007.

Reference:

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