EVALUATION OF LONG TERM FIELD TRIALS OF DIFFERENT PLANT PROTECTION MEASURES IN THE CULTIVATION OF LUPINS IN NORTHERN GERMANY/MECKLENBURG – WESTERN POMERANIA

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ABSTRACT

In the last ten years some of the problems related to anthracnose and effective control of weeds were investigated in the stocks of cultivated lupin (*L. albus, L. angustifolius and L. luteus*) in Mecklenburg – Western Pomerania. In more than 25 series of field trials (quadruplicated (fungicide) or duplicated (herbicide) in a randomised block design) new results for monitoring and control of disease and weed problems were obtained. Based on these results new recommendations were given to the lupin growers.

KEYWORDS

Lupinus albus, *L. angustifolius*, *L. luteus*, *Colletotrichum lupini* var. *setosum*, weeds, fungicides, herbicides, measure of plant protection

INTRODUCTION

The treatment of lupin seed, effective control of weeds, the control of fungal pathogens and the control of plant–sucking insects or insectivorous pests are elementary measures of plant protection in the cultivation of lupins. The purposes of these measures are: (1) a high rate of germination and the wanted density per area of lupin plants; (2) a good development of lupins without pressure of competition and for prevention of late appearance of weeds; (3) the application of plant protection products by taking into consideration the real rate of infestation with *Colletotrichum lupini, Fusarium* spp., *Sclerotinia* spp. and other pests.

Before the appearance of anthracnose in the year 1996 the only chemical crop management input necessary for lupin production besides the nutrition with P and K was the application of herbicides (Heidel, 2005). Typical symptoms of anthracnose (*Colletotrichum lupini* var. *setosum*) include the appearance of wilting and death of young leaves, twisted shoots in the bud stage and beginning of the blossom. The final symptoms are the death of shoots, blossoms, pods and plant.

There are various reasons for the field trials conducted by the state board of plant protection: (1) the German law for plant protection from 1998; (2) a lack of authorisations for plant protection products in lupins; (3) gaps (intended use, products without good effect in lupins) in control of pests and weeds; (4) the unexpected infestation with anthracnose or other pests in the stocks of lupins; and (5) the permanent necessity to check current recommendations in the use of pesticides.

MATERIALS AND METHODS

The results presented here for disease management come from more than 14 series of field trials and 134 fungicide treatments (Figs 1 and 2). Many suitable fungicides and active ingredients of the strobilurine group (e.g. Azoxystrobin, Kresoxim–methyl or Fluoxastrobin*)* or of the azoles group (e.g. Boscalid, Cyprodinil, Difenoconazol, Epoxiconazol, Flusilazol, Metconazol, Prothioconazol or Tebuconazol) were included in these trials. During the trials the fungicide application occurred at three growth stages: T1 (BBCH 25–35), T2 (BBCH 61–65) and T3 (BBCH 71–75) either as individual timings or in combination.

The results presented here for weed control come more than 9 series of field trials and 72 herbicide treatments. More than 27 herbicide products were tested pure or in combination with other products (Table 1).

Minimal requirements for fungicide field trials were a completely randomised experimental design, four replicates, a minimal plot size of 1.5 x 8.0 m, a separation of lupin plots through oat buffers and the collection of the same survey data (Heidel, 2005). Minimal requirements for herbicide field trials were a completely randomised experimental design, two replicates and a minimal plot size of 1.5 x 8.0 m.

RESULTS AND DISCUSSION

DEVELOPMENT OF INFECTIONS

From 2004 until 2007 the different influences on development of infection of *Colletotrichum lupini* var. *setosum* were investigated in cooperation with the BBA (Biologische Bundesanstalt). Klocke (2007) discussed in the final report the influence of temperature and foliar

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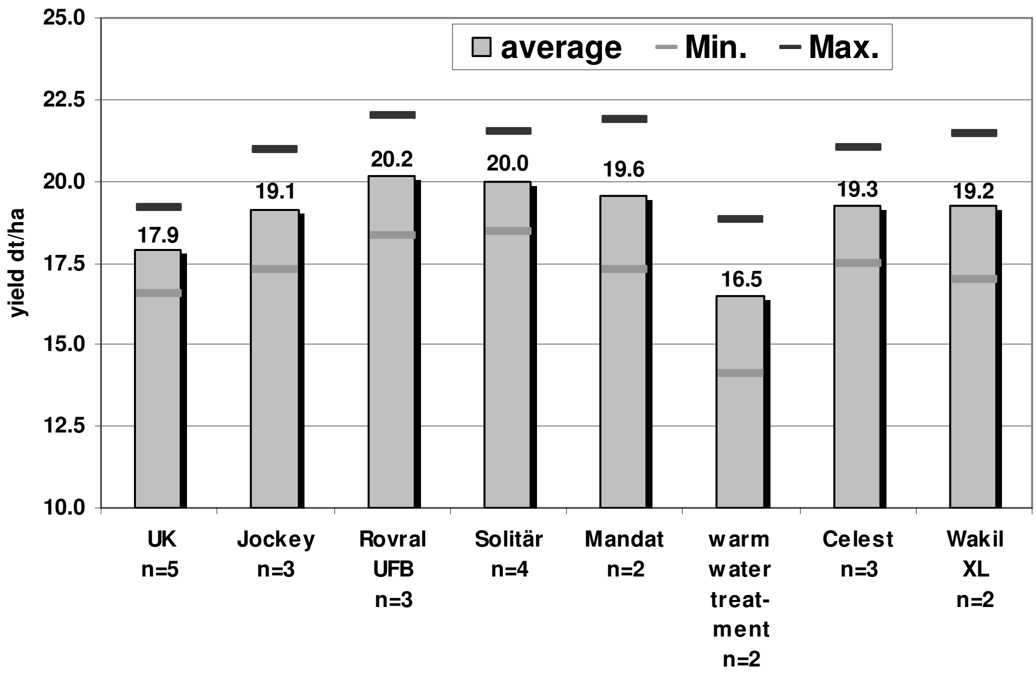

Fig. 1. Influence of fungicide seed treatment in lupin on yield (1999–2006).

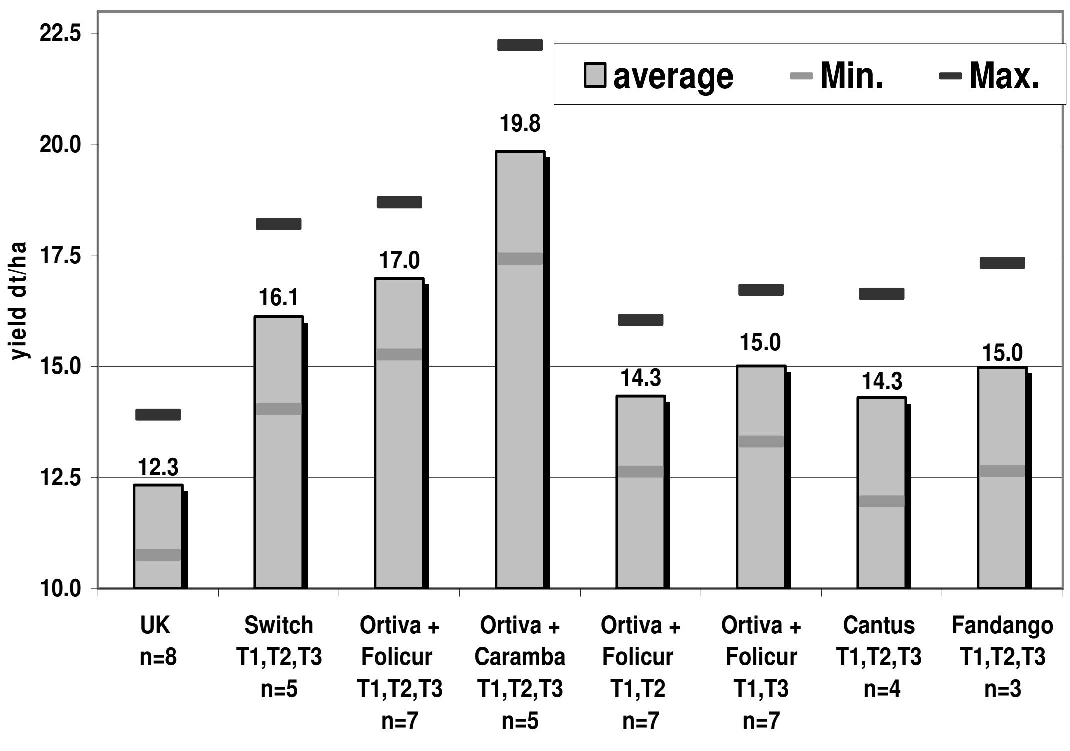

Fig. 2. Influence of fungicide application at different times in lupin (1999–2006).

Table 1. Herbicides used in the trial series in Mecklenburg – Western Pomerania (2001–2007).

Nr.	Trade name	Active substances	kg, L/ha	Timing
1	Artist	*Metribuzin + Flufenacet*	1,5	VA
2	Bolero	*Imazamox*	1,25	NA*
3	Boxer °	*Prosulfocarb*	5,0	NA
4	Boxer + Stomp SC	*(Prosulfocarb) + (Pendimethalin)*	2,0 + 2,0	VA
5	Butisan Top	*Metazachlor + Quinmerac*	2,0	VA
6	Cadou	*Flufenacet*	0,5	VA
7	Cadou + Stomp SC	*Flufenacet + Pendimethalin*	0,3 + 2,5	VA
8	Callisto	*Mesotrione*	1,0	VA
9	Centium 36 CS	*Clomazone*	0,25	VA
10	Centium 36 CS + Fenikan	*(Clomazone) + (Diflufenican + Isoproturon)*	0,25 + 0,5	VA
11	Centium 36 CS + Stomp SC	*(Clomazone) + (Pendimethalin)*	0,25 + 2,5	VA
12	Click + Stomp SC	*Terbuthylazin + Pendimethalin*	1,5 + 3,0	VA
13	Fenikan	*Diflufenican + Isoproturon*	1,0	VA/NA
14	Fenikan + Stomp SC	*(Diflufenican + Isoproturon) + (Pendimethalin)*	0,8 + 0,2	VA
15	Fenikan + Tacco	*(Diflufenican + Isoproturon) + (Metosulam)*	1,0 + 0,2	VA + NA
16	Fusilade Max °	*Fluazifop-P*	4,0	NA
17	Gallant Super	*Haloxyfop-R*	0,75–1,25	NA
18	Gardo Gold °	*Terbuthylazin + S–Metolachlor*	4,0	VA
19	Gardo Gold + Fenikan	*(Terbuthylazin + S–Metolachlor) + (Diflufenican + Isoproturon)*	2,0 + 0,8	VA
20	Gardo Gold + Stomp SC	*(Terbuthylazin + Pendimethalin) + Pendimethalin*	2,0 + 2,0	VA
21	Goltix Super	*Ethofumesat + Metamitron*	2,0	NA
22	Harmony	*Thifensulfuron*	0,005	NA*
23	Herbaflex	*Beflubutamid + Isoproturon*	1,5–2,0	VA
24	Herold	*Flufenacet + Diflufenican*	0,3	VA
25	Malibu	*Flufenacet + Pendimethalin*	2,0	VA
26	Pico + Cadou	*(Picolinafen) + (Flufenacet)*	0,125 + 0,25	VA
27	Pico + Stomp SC	*(Picolinafen) + (Pendimethalin)*	0,125 + 2,5	VA
28	Powertwin	*Ethofumesat + Phenmedipham*	1,0	NA
29	Spectrum	*Dimethenamid-P*	1,5	VA
30	Spectrum + Stomp SC	*(Dimethenamid-P) + (Pendimethalin)*	1,25 + 2,25	VA
31	Stomp SC °	*Pendimethalin*	4,0	VA
32	Stomp SC + Bolero	*(Pendimethalin) + (Imazamox)*	2,6 + 1,875	VA + NA*
33	Sumimax	*Flumioxazin*	0,04–0,06	VA
34	Successor TR	*Terbuthylazin + Pethoxamid*	3,0–4,0	VA/NA*
35	Successor TR + Fenikan	*(Terbuthylazin + Pethoxamid) + (Diflufenican + Isoproturon)*	2,0 + 0,8	VA
36	Successor TR + Stomp SC	*(Terbuthylazin + Pethoxamid) + Pendimethalin*	2,0 + 2,0	VA
37	Tacco	*Metosulam*	0,2	VA*/NA*
38	Targa Super	*Quizalofop-P*	1,25–2,0	NA

VA = pre–emergent; NA = post–emergent * = toxic against lupin.

wetness for spread of this disease in relation to species and variety resistance. The velocity of infection extension can depend on the degree of seed infection. Narrow–leafed lupin is less susceptible to this pathogen than the other two species of lupin tested (*L. albus, L. luteus).*

SEED TREATMENTS

Since 1998, annual field trials tested the following seed protectants: Solitär (Fludioxonil, Cyprodinil and Tebuconazol), Mandat (Iprodion and Triticonazol), Rovral UFB (Iprodion and Carbendazim), Prelude UW (Carboxin and Prochloraz), Jockey (Fluquinconazol and Prochloraz) and alternative treatments with humid heat or electron treatment. Their results indicate that losses of lupin plants and grain yield were reduced by seed treatment (Fig. 1 and Lindner *et al.* 2000).

FUNGICIDE APPLICATIONS

Use of either fungicides of the strobilurine group or azoles group alone does not provide satisfactory disease control. Therefore combinations of azoles and strobilurines were tested also. The combined application of Azoxystrobin and Metconazol or Tebuconazol respectively showed the best control of anthracnose. The maximum number of applications, three, at the recommended rate always gave the best control and highest yields, but wasn't economical. The next best results were applications at T1 and T3. 'Switch' was the best product among the fungicides of the azoles group when used alone (Fig. 2). In the past it was apparent that the level of seed infection is reduced when the producer applied fungicide. Even with fungicide application, the lower infection levels seen in narrow–leafed lupin production were not as profitable as in yellow lupin. Based on the work of Klocke (2007), our Plant Protection Board fortunately can implement new disease forecast models and tools which will make fungicide applications better timed and more economically feasible.

HERBICIDE APPLICATIONS

Young lupin crops are poorly competitive against weeds and grasses. Therefore weed control is necessary by mechanical means or herbicides. An herbicide for use in the post–emergent stage of lupin would be advantageous. Unfortunately there are not so many possibilities for this. Therefore growers must apply herbicides in pre–emergent stage with the risk of an insufficient effect. There are restrictions on the use of many herbicide groups in Germany due to environmental reasons. The best results were obtained with 'Gardo Gold' pre–emergent in combination with other herbicides against a broad spectrum of weeds and with 'Fusilade Max' post–emergent against grasses (Table 1).

OTHER MEASURES OF PLANT PROTECTION

Often young lupin stocks are protected against beetles (*Sitona lineatus; S. griseus*) or a pernicious butterfly (*Cnephasia wahlbomiana*) by use of insecticides of pyrethroid group. Sometimes growers use insecticide for control of lupin aphid (*Macrosiphum albifrons*).

In years with high amounts of rain the use of plant protection products (*Deiquate*, *Glyphosate*) for desiccation are necessary to achieve a rich harvest. The use of plant protection products might also be economical with late appearance of weeds in the growing crops, non–uniform lupin maturity or an obstruction during harvest.

CONCLUSIONS

- Fungicide seed treatments reduce loss of plants and yield attributable to anthracnose.
- Fungicides must have curative and prophylactic characteristics to be suitable for management of anthracnose. With new disease forecast models and tools the recommendations for the use of fungicides will become economically feasible.
- Growers can't renounce the use of seed treatments and herbicides for successful cultivation of lupin.
- The occasional use of fungicides, insecticides and defoliants/desiccants will increase the costs in lupin production. The profit from growing lupins depends a lot on the use of these pant protection products.

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