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CONTROL OF LOW-TEMPERATURE PARASITIC FUNGI IN WINTER CEREALS BY FUNGICIDAL TREATMENT OF STANDS

E. A. JAMALAINEN

Agricultural Research Centre, Department of Plant Pathology, Tikkurila, Finland

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In studies on the overwintering of plants, the Department of Plant Pathology has experimented with treatment of winter cereal stands with various fungicides in attempts to control low-temperature parasitic fungi. At the present time this method is used in many countries in order to prevent such fungal damage to golf courses, sport fields and grass lawns. On the other hand, similar fungicide treatment is apparently not used to any great extent on field crops, although experimental trials on such crops, principally on winter cereals, have been carried out in many countries. The first trials were performed in Austria, using pentachloronitrobenzene (PCNB), and good results were obtained in controlling snow mould (*Fusarium nivale*) on winter rye (PICHLER 1940; cf. also PICHLER 1957). In Western Germany, WAGNER (1955, 1957) achieved good results with PCNB on winter rye in areas where snow mould is detrimental. In the United States, experiments have been conducted with various fungicides to control damage caused by *Typhula* fungi and snow mould on winter wheat. The best results in these trials were obtained with the organic mercury preparation Ceresan, phenylmercury acetate, as well as with chloranil and diclone compounds (HOLTON and SPRAGUE 1949; HOLTON 1953; SPRAGUE 1953, 1955; STARKER 1954; "Chemical spray fights snow mold" 1954). Among other similar control trials of low-temperature parasitic fungi on winter cereals can be mentioned those carried out in Japan with the organic mercury preparation Ceresan and mixtures of copper and lime ("The Agricultural Experiment Stations of Japan" 1949) as well as with organic mercury compounds (TOMIYAMA 1955), those carried out in Sweden with PCNB (ÅKERBERG 1958, 1959) those in France (PONCHET and AUGE 1959) with organic mercury preparations and with other organic fungicides, and those in the Soviet Union (YAKOVLEV 1956; SHALAVIN 1960) with the organic mercury preparation Granosan.

In Finland, fungicide control trials against low-temperature parasitic fungi in overwintering plants have been carried out by the Department of Plant Pathology since the year 1945, at which time the initial trials were made on winter rye and red clover. Subsequently in the 1950's numerous trials have been performed in various parts of the country on winter rye, winter wheat, red clover, winter turnip rape, coniferous seedlings in nurseries, and to some extent on cultivated grasses. Results of the winter cereal trials conducted by the Department of Plant Pathology of the Agricultural Research Centre have been published in the following papers: JAMALAINEN (1956), JAMALAINEN and YLIMÄKI (1956), JAMALAINEN (1958 b), HÄNNINEN (1958, 1959), ANTTINEN (1962), LINNOMÄKI (1962, 1963), and ISOTALO and VOGEL (1962). In addition, the Department of Plant Pathology of the University of Helsinki has carried out trials on winter rye using PCNB at the Muddusniemi Experimental Farm near Inari in northernmost Finland (POHJAKALLIO and SALONEN 1958; POHJAKALLIO *et al.* 1962).

The present paper describes fungicide trials on the control of low-temperature parasitic fungi which have been conducted by the Department of Plant Pathology. Among the trials carried out at the Central Finland Exp. Station, only those arranged by the Department of Plant Pathology are described here. The director of this station, Dr. P. Hänninen, has organized numerous trials during several years on fungicide treatment of winter wheat stands, the results of which will be subsequently published. The detailed results of trials carried out on winter cereal varieties at the Häme Exp. Station will likewise be published in a separate paper.

Methods and fungicides used

The results of the present studies have been collected from trials carried out during a long period of time in different parts of the country and under various conditions. Thus the data on the extent of damage caused by the fungi vary according to the method of analysis. At the Department of Plant Pathology attempts have been made to perform thorough and extensive analyses of fungal damage; at the experimental stations, however, this has not always been possible. In the tables showing the results from the experimental stations, the overwintering of the stands (T) indicates the proportion of the stand which survived until the spring according to the formula $T = \frac{100 \times \text{density in the spring}}{\text{density in the autumn}}$ %.
In the analyses performed under the auspices of the Department of Plant Pathology, the greenness of the stand in the spring was determined by estimating how large a proportion of the leaves of the seedlings in the trial plots were green.

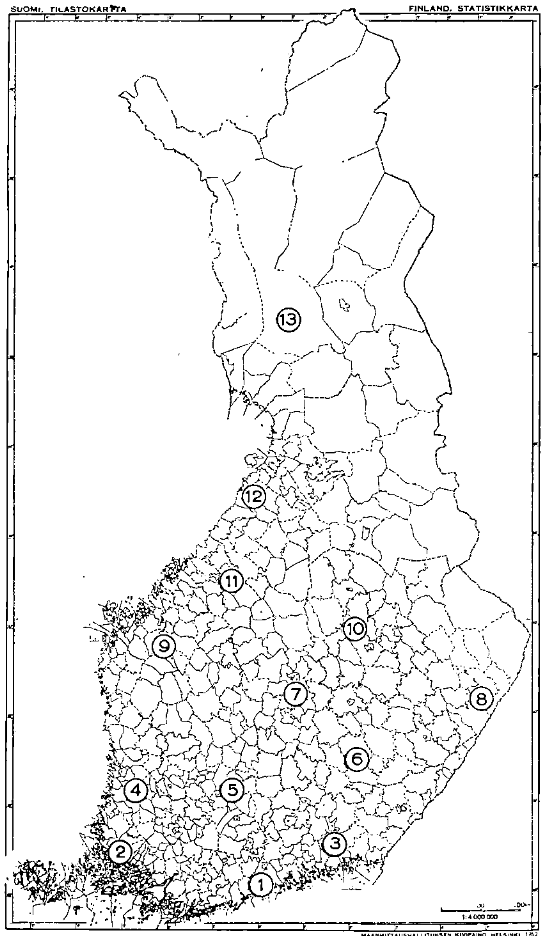

Fig. 1. *Kuva 1.*

1. Department of Plant Pathology *Kasvitautien tutkimuslaitos,* Tikkurila
2. Southwest Agr. Exp. Sta. *Lounais-Suomen koeasema,* Mietoinen
3. Carelia Agr. Exp. Sta. *Karjalan koeasema,* Anjala
4. Satakunta Agr. Exp. Sta. *Satakunnan koeasema,* Harjavalta
5. Häme Agr. Exp. Sta. *Hämeen koeasema,* Pälkäne
6. South Savo Agr. Exp. Sta. *Etelä-Savon koeasema,* Mikkeli
7. Central Finland Agr. Exp. Sta. *Keski-Suomen koeasema,* Kuusa
8. Agr. Exp. Sta. of Peat Cultiv. Soc. *Suoviljelysyhdistyksen Karjalan koeasema,* Tohmajärvi
9. South Ostrobothnia Agr. Exp. Sta. *Etelä-Pohjanmaan koeasema,* Ylistaro
10. North Savo Agr. Sta. *Pohjois-Savon koeasema,* Maaninka
11. Central Ostrobothnia Agr. Exp. Sta. *Keski-Pohjanmaan koeasema,* Toholampi
12. North Ostrobothnia Agr. Exp. Sta. *Pohjois-Pohjanmaan koeasema,* Revonlahti
13. Arctic Circle Agr. Exp. Sta. *Perä Pohjolan koeasema,* Rovaniemi

A large number of fungicides of different types are now available for the control of low-temperature parasitic fungi in turf grasses, and new compounds are continuously being developed (cf. SMITH 1959; FUSHTEY 1961; COUCH, MOORE and BEDFORD 1962). In the trials on winter cereals described in this paper many different preparations were used; they are listed in the following tabulation together with their method of use. Most of the trials were made with preparations containing pentachloronitrobenzene (PCNB) or quitozene and those containing phenyl mercury acetate (PMA).

Since 1961, preliminary tests with some antibiotic compounds were made on winter rye and winter wheat at the Department of Plant Pathology at Tikkurila as well as at the Häme and Central Finland Exp. Stations. The rates of application were calculated so as to correspond to the use of these compounds in treatment of turf grasses. All the antibiotics tested had only a slight effect in these trials on low-temperature parasitic fungi.

Fungicides used in the trials

Kokeissa käytetyt fungisidit

The organic mercury seed dressing preparations (usually Ceresan or Täyssato) were used at a rate of 2 g per kg seed.

Peittauksessa käytetty org. elohopea-aineita, useimmissa tapauksissa Ceresan- tai Täyssato-valmisteita, 2 g 1:lle siemenkilolle.

Preparation *Valmiste*	Active ingredient *Tehoaine*	Method of use *Käyttötapa*	Amount of preparation per hectare *Määrä valmistetta hehtaarille*	Manufacturer *Valmistaja*
Bayer no. 4426	phenyl mercury acetate (PMA), 0.3 % (Hg 0.18)	dust *pölytys*	12.5, 25 kg	Bayer, F.R. Germany
Bayer no. TB 4468a	arsenic compound, 14 % (As 2.5 %) *Arseeniyhdiste*	spray *ruiskutus*	2.8, 3 kg	—»—
Bayer no. 4905	methyl arsine sulphide or urbasulf, 1 % (As 0.62 %) *Arseeniyhdiste urbasulf*	dust *pölytys*	25, 50, 100 kg	—»—
Bayer no. 4934	urbasulf, 32.5 % (As 20 %) *Arseeniyhdiste urbasulf*	spray *ruiskutus*	0.75, 3 kg	—»—
Cadmium chloride	100 % *Kadmiumkloridi 100 %*	spray *ruiskutus*	0.6, 1.2 kg	
Ceresan	methyl ethyl mercury silicate, 2.39 % (Hg 1.5 %)	dust *pölytys* seed dressing *peittaus*	25 kg	Bayer, F.R. Germany
Ceresan 200 (Granosan 200)	ethyl mercury 2,3-dihydroxy propyl mercaptide, 6 %, ethyl mercury acetate, 1.3 % (Hg 4.5 %)	spray *ruiskutus*	3, 4, 4.3 kg	Du Pont, USA
Ceresan M-2X (Granosan M-2X)	ethyl mercury p-toluene sulphonanilide, 15.4 % (Hg 6.5 %)	spray *ruiskutus*	2.8 l	—»—
Dithane M-22	maneb 70 %	spray *ruiskutus*	6.7 kg	Room & Haas, USA
Femma-sprays *ruiskutejauheet*	phenyl mercury acetate (PMA) 2.5 % (Hg 1.5 %) 5.0 % (Hg 2.98 %)	spray or broadcast *ruiskutus tai sirotus*	4, 8, 8.5, 12, 12.5, 17 kg 8, 12 kg	Rikkihappo, Helsinki
Femma-dust *pölyte*	phenyl mercury acetate (PMA) 0.5 % (Hg 0.59 %)	dust or broadcast *pölytys tai sirotus*	20, 62.5 kg	—»—
Fernasan 75	thiram 75 %	spray *ruiskutus*	7 kg	Plant Protection, England

Preparation *Valmiste*	Active ingredient *Tehoaine*	Method of use *Käyttötapa*	Amount of preparation per hectare *Määrä valmistetta hehtaarille*	Manufacturer *Valmistaja*
Fundilan S	PCNB 10 %; hexachlorobenzene 8 %, copper-8-hydroxyquinoline 7 %, metasulphon-N-trichlormethanesulphenyl-4-chloranilide 10 %	spray *ruiskutus*	6 kg	Svenska AB Philips, Sweden
Maneb "Bayer"	maneb 70 %	spray *ruiskutus*	7 kg	Bayer F.R. Germany
Mercadmine	phenylmercury salicylate, 5 %+cadium ricinolate, 5 % (Hg 2.35 %)	spray *ruiskutus*	4.7 l	Woudhuysen, USA
Merculine	methyl mercury salicylate, 10 % (Hg 4.7 %)	spray *ruiskutus*	4.5, 4.7 l	—»—
Panogen	methyl mercurydicyamide 1.2 % (Hg 0.8 %)	spray *ruiskutus*	2.5 l	Casco, Sweden
Panogen 15	methyl mercurydicyandiamide 2.5 % (Hg 1.5 %)	seed dressing *peittaus*		—»—
PCNB-dusts *pölytteet* Avicol Botrilex Brassicol Fartox Sclero PCNB-20	pentachloronitrobenzene 20 %		12.5, 25, 50 kg	Hoechst, F.R. Germany
PCNB-sprays *ruiskutteet* Avicol Brassicol Sclero PCNB-50	pentachloronitrobenzene 50 %		8, 10 kg	—»—
Brassicol superb.	pentachloronitrobenzene 60 %		8.5 kg	—»—
Bofors PCNB	pentachloronitrobenzene 50 %		10 kg	Svenska AB Philips, Sweden
Pomarsol forte	thiram 80 %	dust *pölytys*	10 kg	Bayer, F.R. Germany
Trimangol	maneb 80 %	spray *ruiskutus*	6 kg	Vondelingeplaat, The Netherlands
Täyssato	methoxethylmercury chloride 2.2 % (Hg 1.5 %)	seed dressing *peittaus*		Rikkihappo, Helsinki
Verdasan	phenyl mercury acetate (PMA), 5 % (Hg 2.5 %)	spray *ruiskutus* dust or broadcast *pölytys tai sirotus*	8.5, 10 kg 4.25, 8.5, 25 kg	Plant Protection, England

Trials on winter rye

Low-temperature parasitic fungi

The main cause of poor overwintering of winter rye in Finland is snow mould, caused by *Fusarium nivale* (Fr.) Ces. (cf. JAMALAINEN 1956, 1959, 1962). Also in the trials described in the present paper snow mould was the most important causal agent of winter damage to winter rye. Other fungi which can injure rye during the winter are those of the genus *Typhula,* mainly *T. ishikariensis* Lasch *ex* Fr. (syn. *T. idahoensis* Remsb.) and less frequently *T. incarnata* Remsb. (syn. *T. itoana* Imai) (JAMALAINEN 1956, 1957). In the central and northern parts of the country *Sclerotinia borealis* Bub. & Vleug. can be especially injurious to winter rye (JAMALAINEN 1949).

It has often been observed that rye seedlings which are infected by *Fusarium nivale* immediately after the melting of the snow in the spring, subsequently recover — often quite satisfactorily — and even yield good grain harvests. This has often been mentioned in the literature, and the results shown in Tables 1 and 2 also confirm it. On the other hand, seedlings infected with *Typhula* fungi do not recover as well as those injured by snow mould.

During the period of the present studies there was one winter, 1956/57, when the snow cover was very thin and subsequently fungal damage was light. The other winters had heavy covers of snow, as is usual in Finland, and as a result there was much damage caused by low-temperature parasitic fungi at most of the trial locations.

The efficacy of the fungicides tested on low-temperature parasitic fungi

In certain trials the analyses performed in the spring showed nearly as much snow mould in the stands treated with fungicides as in those not treated. In spite of this, however, the treated stands gave considerably larger grain yields than the controls. This indicates that the injury caused by snow mould was less intensive in the stands receiving the fungicide treatment than in the untreated ones.

Most of the trials were performed with PCNB (pentachloronitribenzene) or PMA (phenyl mercury acetate) compounds.

P C N B c o m p o u n d s. In the first trial, carried out at Tikkurila in 1945/46, PCNB (applied as 20 % at a rate of 60 kg/ha) reduced damage by snow mould and so improved the grain yield of winter rye by 26 % (JAMALAINEN & YLIMÄKI 1956). In later trials PCNB was usually applied either as a 20 % dust at 25 kg/ha or as a 50 % spray at 10 kg/ha, corresponding to 100 % PCNB at 5 kg/ha. In the trial at the Department of Plant Pathology at Tikkurila in 1959/60 (Table 1, p. 23) 12.5 kg/ha of 20 % PCNB gave a good control of snow mould and resulted in nearly as large a yield increase as a rate of 25 kg/ha. On the other hand, in the trials conducted at the Karelia Exp.

Station in 1961/62 (Table 1, p. 25) and the South Savo Exp. Station in 1958/59 (Table 1, p. 29) it was established that 5 kg/ ha of 100 % PCNB was not sufficient to prevent damage by this disease. However, this rate gave satisfactory results, especially in the case of varieties susceptible to snow mould, and resulted in considerable increases in grain yield (Table 1; tabulation on p. 18).

Typhula fungi occurred only in a few of the winter rye trials. In one of the 1955/56 trials at Tikkurila PCNB gave a good control of these fungi while in the other the fungicide was ineffective. In the trial at the North Savo Exp. Station in 1956/57 PCNB provided a satisfactory control of *Typhula* fungi (JAMALAINEN 1958 b). At the Arctic Circle Exp. Station PCNB was effective against *Typhula* in 1957/58 but not in the following year 1958/59. In 1957/58 PCNB prevented damage by *Sclerotinia borealis* (Table 1, p. 36).

P M A p r e p a r a t i o n s were the following three: Bayer 4426, Femma and Verdasan. In the 1959/60 trial at Tikkurila (Table 1, p. 23) Femma (2.5 % PMA) applied as a spray at 17 kg/ha gave a better control of snow mould than the rate of 8.5 kg/ha. In the following year at the same place 4 kg/ha of the same Femma preparation as spray had only a poor effect, while 12 kg/ha resulted in a yield increase. At the Häme Exp. Station in 1960/61 (Table 1, p. 27) Femma at the rate of 4 kg/ha gave almost the same control as 12.5 kg/ha. In the same trial a threefold increase in application rate of Femma (0.5 % PMA) as dust gave a result not much better than 20 kg/ha. In the 1961/62 trial at this station both 8 kg/ha and 12 kg/ha Femma (2.5 % PMA) gave a satisfactory control of snow mould, the larger rate producing a greater increase in grain yield. In all the trials the PMA preparation Bayer 4426 was effective in controlling snow mould (Table 1). Good results were generally obtained with Verdasan against snow mould when used at the rate of 8.5 kg/ha. In the 1959/60 trial at the Häme Exp. Station (Table 1, p. 26) it was found that not even the high rate of 25 kg/ha of Veradan was sufficient to control snow mould completely. Preparations of PMA were somewhat more effective against low-temperature parasitic fungi that those containing PCNB (cf. summary of grain yields, p. 18). Under the conditions in this country 8.5 kg/ha of Verdasan, as is recommended by the manufacturer, can be considered a suitable rate. The best application rate of Femma (2.5 % PMA) as spray appears to be 10—12 kg/ha.

O t h e r o r g a n i c m e r c u r y c o m p o u n d s. The preparations Mercadmine and Merculine gave good results in controlling snow mould and *Typhula* fungi at Tikkurila in 1955/56; in 1957/58 at the same place Mercadmine was effective against snow mould (JAMALAINEN 1958 b). At the North Savo Exp. Station Merculine controlled snow mould in 1957/58 (Table 1, p. 30). At the Arctic Circle Exp. Station the seed dressing compound Ceresan used at 25 kg/ha gave a good control of snow mould and *Typhula* fungi in 1957/58 and 1958/59; in the former year *Sclerotinia borealis* was also controlled (ISOTALO and VOGEL 1962; cf. also Table 1, p. 36). Ceresan 200 gave good results in preventing damage by snow mould at the Häme Exp. Station in 1962/63 (Table 1, p. 28).

The urbasulf preparation Bayer 4934 was effective against snow mould in 1961/62 at both Tikkurila (Table 1, p. 23) and the Häme Exp. Station (Table 1, p. 27); at the Central Finland Exp. Station is was effective against snow mould and *Typhula fungi* (Table 1, p. 30).

The maneb preparation Dithane M-22 gave good control of snow mould in 1961/62 at Tikkurila (Table 1, p. 23), Häme Exp. Station (Table 1, p. 28) and Central Finland Exp. Station (Table 1, p. 30); at the latter station it was also very effective against *Typhula* fungi. On the other hand, in the 1962/63 trial at the Häme Exp. Station maneb preparations were weak in controlling snow mould (Table 1, p. 28).

Cadmium chloride (100 % at 0.6 kg/ha) had a weak effect on snow mould in 1961/62 at Tikkurila (Table 1, p. 24), at the Häme Exp. Station (Table 1, p. 28) and at the Central Finland Exp. Station (Table 1, p. 30).

Fundilan S had no effect on snow mould in 1962/63 at the Häme Exp. Station (Table 1, p. 28).

The thiram preparation Fernasan 75 was ineffective in preventing snow mould damage in the trial at Tikkurila in 1962/63 (Table 1, p. 24).

Seed dressing gave a very good control of snow mould in certain trials, in some cases giving results equal or nearly equal to those obtained by treatment of stands (for instance in the 1958/59 and 1959/60 trials at Tikkurila, Table 1, p. 28—33 and in the 1961/62 trials at the Häme Exp. Station, Table 1, p. 27). In other trials, on the contrary, seed dressing had no effect whatsoever on snow mould, whereas treatment of stands led to good results (for instance, in the 1960/61 trial at Tikkurila, Table 1, p. 23, cf. also p. 11; in the 1962/63 trial at the Häme Exp. Station, Table 1, p. 28; and in the 1961/62 trial at the Central Finland Exp. Station, Table 1, p. 30).

Local trials

In the years 1956/57, 1957/58, 1958/59 and 1959/60, a total of 60 trials on fungicide treatment of winter rye stands were carried out in various parts of the country. In these trials 20 % PCNB was used at rates of 25 and 30 kg/ha. Most of these local trials were conducted in the provinces of South Häme, South Ostrobothnia and Central Ostrobothnia. In South Häme the increase in grain yield was 10 % or greater in 8 trials out of 18, in South Ostrobothnia in 4 trials out of 19, and in Central Ostrobothnia in 2 trials out of 8. In 48 % of the trials the yield increases were over 100 kg/ha as a result of the PCNB treatment (cf. summary of the results, p. 18). The principal varieties of rye in these trials were Ensi and Toivo, which may explain the relatively modest yield increases obtained.

Varieties

Fungicide treatment of stands of winter rye gives higher yield increases in the case of varieties susceptible to snow mould than with those varieties which are known to be resistant to this disease (cf. JAMALAINEN 1958 b). LINNOMÄKI (1962, 1963) has shown that in the trials carried out at the Häme Exp. Station in 1958—63, the increases in grain yield produced by using PCNB were considerably greater for the rye variety Visa (average increase in grain yield 37 %) than for the variety Toivo (average increase of grain yield 7 %).

The following tabulation presents the percentage grain yield increases (+) or decreases (—) in the stands treated with PCNB and PMA for the winter rye varieties which have most often been included in the trials. These data are taken from the trials shown in Table 1, from the paper of LINNOMÄKI (1962), from earlier published results of JAMALAINEN and YLIMÄKI (1956), JAMALAINEN (1958 b) and from the above described local trials.

		Percentage grain yield increases (+) or decreases (—) of winter rye varieties in trials with PCNB and PMA compounds *Syysruislajikkeiden jyväsatojen prosentuaalinen lisääntyminen (+) tai vähentyminen (—) kokeissa, joissa oraat oli käsitelty PCNB- ja PMA- valmisteilla*	
		PCNB	PMA
Ensi	South Savo Exp. Sta. *Etelä-Savon koeasema*	—3, +3, +5, +8, +8, +18	+1, +2, +11, +11, +15, +16
	North Savo Exp. Sta. *Pohjois-Savon koeasema*	—1, +6	—4, +13
	Peat Cultiv. Soc. Exp. Sta. *Karjalan Suoviljelyskoeasema*	—7, —1, +5, +31	—7, +7, +16, +28
	Local trials. *Paikalliskokeet*	—3, +4, +8, +11, +16	
Greus	North Ostrobothnia Exp. Sta. *Pohjois-Pohjanmaan koeasema*	+2	
	Arctic Circle Exp. Sta. *Perä-Pohjolan koeasema*	+1, +3, +6, +10	+13, +47
Kuningas II	Dep. of Plant Pathology, Tikkurila *Kasvitautien tutkimuslaitos*	+18, +20, +42	+29, +56
	Häme Exp. Sta. *Hämeen koeasema*	+75	
Pekka	Dep. of Plant Pathology, Tikkurila *Kasvitautien tutkimuslaitos*	+11, +23, +23, +24, +62, +62, +77	+30, +39, +62
	Häme Exp. Sta. *Hämeen koeasema*	+1, +5	
Sangaste	Dep. of Plant Pathology, Tikkurila *Kasvitautien tutkimuslaitos*	+26	
	Local trials *Paikalliskokeet*	+1, +3, +23, +66	

		Percentage grain yield increases (+) or decreases (—) of winter rye varieties in trials with PCNB and PMA compounds *Syysruislajikkeiden jyväsatojen prosentuaalinen lisääntyminen (+) tai vähentyminen (—) kokeissa, joissa oraat oli käsitelty PCNB- ja PMA- valmisteilla*	
		PCNB	PMA
Toivo	Häme Exp. Sta. *Hämeen koeasema*	+1, +5, +7, +12, +12	
	North Savo Exp. Sta. *Pohjois-Savon koeasema*	+1, +1, +1	—16, +17, +17
	Arctic Circle Exp. Sta. *Perä-Pohjolan koeasema*	+35	
	Local trials *Paikalliskokeet*	—5, —5, —5, —4, ±0, +1, +1, +2, +2, +3, +4, +9, +10, +12, +12, +12, +13, +25	
Visa	Dep. of Plant Pathology, Tikkurila *Kasvitautien tutkimuslaitos*	+22	+26, +64, +121
	Häme Exp. Sta. *Hämeen koeasema*	+5, +16, +31, +35, +104	+15, +24, +74
	Karelia Exp. Sta. *Karjalan koeasema*	+9	+22
	Arctic Circle Exp. Sta. *Perä-Pohjolan koeasema*	+18	

In general the yield increases for the winter rye varieties Ensi, Toivo and the local strain Greus were smaller than for the varieties Kuningas II (Swedish Kungs II), Pekka, Sangaste and Visa. This shows that the latter are more resistant to snow mould than the former. However, if conditions are favourable for the occurrence of snow mould, these winter-hardy varieties may also be seriously damaged by fungal infection; in such cases fungicide treatment of the stands has led to considerable yield increases.

Fungicide treatment resulting in too dense a stand

In the variety trials carried out at the North Savo Exp. Station in 1958/59 and 1959/60 (Table 1, p. 31) the yields of the plots receiving fungicide treatment were actually smaller than those of the control plots, even though the fungicides had effectively controlled damage by snow mould. The explanation given by the director of the station Mr. Martti Salminen M. Sc. in his annual reports is that the stands which had been treated escaped damage by snow mould and as a result grew very densely, the consequence being that their grain yield was smaller than the control stands. During the winter 1958/59, yield decreases occurred in many of the varieties treated with PMA. In the following winter, reductions in yield were noted for the stands treated with PCNB, whereas PMA treatment gave yield increases for most of the varieties (cf. Table 1, p. 31).

In certain cases decreases in grain yield in this country have also been found after seed dressing (JAMALAINEN 1962). In the present work such a phenomenon was observed in the 1960/61 trial at Tikkurila (Table 1, p. 23). In the autumn the treated seedlings were considerably more vigorous than the controls and thus were more heavily infested with snow mould during the winter, with the result that their grain yield in the following summer was 8 % lower than that of the untreated stands.

Time of treatment

In the control of low-temperature parasitic fungi on winter cereals the best results are generally obtained when the fungicide application is made as late as possible, preferably just before the arrival of a lasting snow cover. Thus in the trial at Tikkurila in 1955/56 treatment made on November 14 led to better results than that made at the beginning of November (JAMALAINEN 1958 b). At the Häme Exp. Station in 1958/59 treatment was more effective in November than in October (Table 1, p. 26).

The significance of time of PCNB treatment was also evident in the local trials with winter rye, described on page 8. In these trials higher average yield increases were obtained from the stands treated in November than from those treated in October.

The effect of fungicide treatment in different parts of the country

Damage caused by snow mould is less severe in the western and southwestern parts of Finland than in other areas of the country. The coastal regions in West Finland, as well as the forestless areas to the interior, are characterized

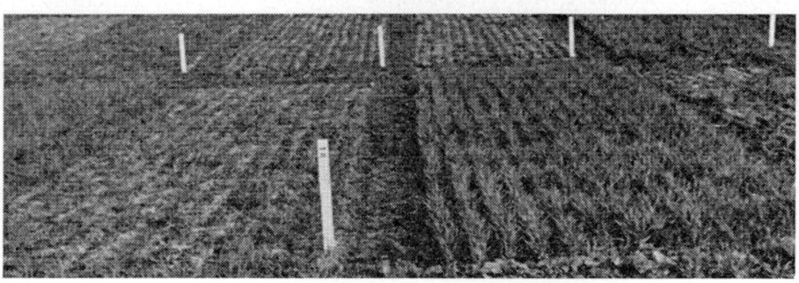

Fig. 2. Fungicide trial on Kuningas II rye at the Häme Exp. Station at Pälkäne 1962/63. Untreated control plot on the left; plot on the right treated in the autumn with Ceresan 200 at the rate of 4 l/ha. The damage was caused by snow mould. Photo 16. 5. 1963.

Kuva 2. Fungisidikoe Kuningas II-syysrukiilla Hämeen koeasemalla Pälkäneellä 1962/63. Koeruutu vasemmalla, ei käsitelty; oikealla oraat käsitelty syystalvella Ceresan 200-valmisteella käyttäen 4 litraa ha:lle. Vauriot lumihomeen aiheuttamia. Valok. 16. 5. 1963.

by a relatively slight amount of snow mould injury (cf. JAMALAINEN 1962). It is noteworthy that in only a very few of the trials performed in Central Ostrobothnia were there appreciable injuries due to snow mould (Table 1, p. 33; cf. also section "Local trials", p. 8). This is a low-lying, unforested region, where the soil in the early part of the winter is often frozen to a considerable depth.

In the province of Uusimaa in South Finland conditions for snow mould are quite variable. In some places injury caused by this disease may be very severe, as has been shown by some of the trials carried out at Tikkurila. In other places in Uusimaa snow mould causes relatively little damage (JAMALAINEN 1962).

In the interior of the country (Häme Exp. Station, South Savo Exp. Station, Peat Cultivation Exp. Station at Tormajärvi, and Arctic Circle Exp. Station) fungicide treatment of winter rye stands gave considerable yield increases in many of the trials (Table 1).

Trials on winter wheat

Low-temperature parasitic fungi

The causal agents of fungal damage in these trials were *Fusarium nivale* and *Typhula* fungi, mainly *T. ishikariensis* but sometimes also *T. incarnata.* In the trials at the Häme Experiment Station in 1958/59 severe injuries caused by *Septoria* fungi were observed in the spring on silt soils (Table 2, p. 42). In the trials at the North Ostrobothnia Exp. Station in 1958/59 the principal damaging fungus was *Sclerotinia borealis* (Table 2, p. 49).

The efficacy of the fungicides tested on low-temperature parasitic fungi

As in the case of winter rye, most of the trials with winter wheat were treated with PCNB and PMA compounds.

PCNB compounds. In certain trials damage caused by low-temperature parasitic fungi was so great that the rates of PCNB used were not always sufficient to control these fungi, especially *Typhula.* Such was the case in the trials at Tikkurila in 1955/56 (JAMALAINEN 1958 b), at the Häme Exp. Station in 1959/60 (Table 2, p. 43), and at the Central Finland Exp. Station in 1961/62 (Table 2, p. 47). According to the 1962 annual report of the Karelia Exp. Station, PCNB treatment in 1961/62 did not prevent damage by *Typhula* fungi, which in spite of the fungicide almost completely destroyed the stand. At Tikkurila good results were obtained in one trial in 1958/59 and in two trials in 1961/62 (Table 2, p. 37—39) in which damage by snow mould was almost entirely controlled by the treatment, and in one trial *Typhula* fungi were also successfully checked. Also in 1962/63, good results against snow mould and *Typhula* fungi were obtained with PCNB at Tikkurila (Table 2, p. 39). In the same year this treatment provided good control of snow mould at the

Häme Exp. Station (Table 2, p. 46) and in 1957/58 at the North Savo Exp. Station this disease was also controlled by PCNB (Table 2, p. 49). Interesting results were obtained in trials carried out at the North Ostrobothnia Exp. Station in 1958/59, in which PCNB successfully controlled *Sclerotinia borealis*, whereas PMA was completely ineffective (Table 2, p. 49).

As in the case of winter rye, the rate of 5 kg/ha of 100 % PCNB can also be considered suitable for the treatment of winter wheat stands.

The P M A c o m p o u n d s used were the same as those in the trials on winter rye: Bayer 4426, Femma and Verdasan. Like the PCNB preparations, the PMA fungicides were far from completely effective in controlling damage by low-temperature parasitic fungi. For instance, the preparation Femma (0.5 and 2.5 % PMA) gave a moderate control of snow mould at the Häme Exp. Station in 1960/61 (Table 2, p. 44). On the other hand, this same preparation was effective against both snow mould and *Typhula* fungi at Tikkurila in 1962/63 (Table 2, p. 39). At the Central Finland Exp. Station in 1961/62 Femma at the rate of 12 kg/ha provided a good control of snow mould but did not prevent damage by *Typhula* fungi (Table 2, p. 47). Good results were obtained with the product Bayer 4426 against *Typhula* fungi at Tikkurila in 1957/58 (JAMALAINEN 1958 b) and against both snow mould and *Typhula* at the same place in 1958/59 (Table 2, p. 37). Verdasan effectively controlled snow mould at Tikkurila in 1957/58 (JAMALAINEN 1958 b) and at the South Savo Exp. Station in 1959/60 (Table 2, p. 47). At the Central Finland Exp. Station PMA has given, on the average, better results than PCNB (HÄNNINEN 1959). According to the results of the trials described in this paper, of which a summary is presented on p. 18, the efficacy of PMA compounds was somewhat better than that of PCNB compounds. The rates of the PMA preparations used in these trials, Verdasan 8.5 kg/ha and Femma (2.5 % PMA) 10—12 kg/ha, can be considered to be appropriate under the conditions in this country.

O t h e r o r g a n i c m e r c u r y p r e p a r a t i o n s. Ceresan 200 gave a good control of snow mould and *Typhula* fungi in the Tikkurila trials in 1961/62 and 1962/63 (Table 2, p. 38—39), in the trials at the Häme Exp. Station in 1960/61, 1961/62 and 1962/63 (Table 2, p. 45—46) and in the 1961/62 trial at the Central Finland Exp. Station (Table 2, p. 47). Ceresan M-2X was effective against both snow mould and *Typhula* fungi at Tikkurila in 1958/59 (Table 2, p. 37). . The product Merculine effectively controlled snow mould at the North Savo Exp. Station in 1957/58 (Table 2, p. 49).

A r s e n i c p r e p a r a t i o n s were effective against *Typhula* fungi at Tikkurila in 1958/59 and resulted in an increase in grain yield (Table 2, p. 38). Bayer 4934 gave a good control of snow mould and *Typhula* fungi at Tikkurila in 1961/62 (Table 2, p. 38) and a moderate control of snow mould at the Häme Exp. Station in the same year (Table 2, p. 45). At the latter station in 1960/61 arsenic preparations were ineffective against snow mould (Table 2, p. 44).

The maneb preparation Dithane M-22 effectively controlled snow mould and *Typhula* at Tikkurila in 1961/62 (Table 2, p. 38). In this same year it was also quite effective against snow mould at the Häme Exp. Station (Table 2, p. 45) and very effective against both snow mould and *Typhula* at the Central Finland Exp. Station (Table 2, p. 48). On the other hand, the efficacy of maneb preparation was weak in 1962/63 at Tikkurila (Table 2, p. 39) at the Häme Exp. Station (Table 2, p. 46).

Cadmium chloride at the rate of 0.6 kg/ha (100 %) was only weakly effective or completely ineffective against low-temperature parasitic fungi in the trials carried out in 1961/62 at Tikurila (Table 2, p. 38), Häme Exp. Station (Table 2, p. 45) and Central Finland Exp. Station (Table 2, p. 48). When the rate was doubled to 1.2 kg/ha, this fungicide gave excellect control at Tikkurila (Table 2, p. 39) but only weak control ot the other locations.

The preparation Fundilan S was weakly effective against snow mould in the trials performed in 1962/63 at Tikkurila (Table 2, p. 39) and at the Häme Exp. Station (Table 2, p. 46).

Time of treatment

The best time for fungicide treatment of winter wheat stands in the region where this cereal is cultivated is during the month of November, as is shown by the trials at Tikkurila in 1957/58 (JAMALAINEN 1958 b) and at the Häme Exp. Station in 1958/59 (Table 2, p. 42).

Fungicide treatment resulting in too dense a stand

In the winter wheat trials at the Häme Exp. Station in 1960/61 when both snow mould and *Typhula* fungi were abundant, and also in 1961/62 when there was much snow mould, PCNB treatment did not result in increased seed yields in all cases. Instead, the yields of the treated stands in some of the trials were somewhat lower than those of the untreated controls (Table 2, p. 43—44). This situation was explained by LINNOMÄKI (1963) as follows: In the spring of both 1961 and 1962 considerable fungal damage was found in the untreated plots, but the growing conditions in the early summer were so favorable that most of the plants recovered from the damage. Since the growing season of both years was especially rainy, the undiseased PCNB-treated plots grew too vigorously, and particularly on silt soil the weak-strawed varieties, such as Varma and Antti, lodged so badly already in the early part of their growth that a loss in yield was unavoidable. Ertus, on the other hand, is a stronger-strawed variety, and thus the loss due to lodging did not outweigh the beneficial effect caused by the fungicide treatment.

Soil type

Winter wheat is cultivated in Finland mainly on clay soils in the southern and southwestern parts of the country. Even there this crop, if grown on sandy, silt or peat soils, does not thrive during winters with a heavy snow cover because of damage caused by low-temperature parasitic fungi. In other parts of the country the cultivation of winter wheat is risky owing to fungal damage during the winter (cf. JAMALAINEN 1956; LINNOMÄKI 1963), and in the north of the country also to the shortness of the growing season.

At Tikkurila most of the trials were carried out on coarse finesand soils; on clay soils winter fungal damage is less frequent.

During several years the Häme Exp. Station arranged trials on two different soil types: coarse finesand and silt soil. These trials have been described by the director of the station, Mr. P. JALKANEN M. Sc., in the annual reports of the station in 1959 and 1960 (cf. also LINNOMÄKI 1963). During winter 1958/59, the fungal damage in the untreated stands on sandy soil was estimated to be 15—20 % (Table 2, p. 42). About 2/3rds of the injury was caused by snow mould and the rest by *Typhula* fungi. The yield increases of certain varieties as a result of PCNB treatment were 10—20 %. During the same winter the silt soil, where other trials were located, thawed as early as February, and the yields of the untreated plots in these trials were extremely low. The fungal damage had been so severe that 2/3rds of the yield was lost. Snow mould was the principal cause of the damage, and *Typhula* fungi were in the second place. *Septoria* fungi also caused considerable injury, and they were not controlled by the fungicides used. Treatment of the stands with PCNB improved the grain yields of winter wheat, in some cases as much as doubling them, but because of fungal damage the yields of even the treated stands were very low. At the Häme Exp. Station in 1959/60 (Table 2, p. 43) the damage caused by *Typhula* fungi in the trial on silt soil was very great, ranging from 30 to 70 % depending upon the variety. PCNB treatment resulted in yield increases of 15—30 % for most of the varieties but prevented only about 40—50 % of the fungal injuries. The corresponding trials on coarse finesand soil in 1959/60 suffered less fungal damage than those on silt soil.

In 1962/63 at this same station (Table 2, p. 46) Ertus wheat growing on sandy soil was heavily damaged by snow mould; Ceresan 200 and PCNB were effective in controlling the fungus. In the trial on silt soil Antti wheat showed less fungal damage than on sandy soil. In this trial effective control of low-temperature parasitic fungi was obtained with the above-mentioned preparations and also with PMA (Table 2, p. 46).

Varieties

In the trials carried out at the Department of Plant Pathology at Tikkurila and at the experiment stations it was found that the winter wheat variety Ertus was susceptible to injury by low-temperature parasitic fungi (JAMALAINEN 1958 b). At the Häme Exp. Station PCNB treatment considerably improved the grain yield of the varieties Antti, Vakka and Varma growing on silt soil (LINNOMÄKI 1962, 1963).

The following tabulation presents the percentage grain yield increases (+) or decreases (—) in the stands treated with PCNB and PMA for the winter wheat varieties which have most often been included in the trials. These data are taken from the results shown in Table 2 as well as from those in the papers of JAMALAINEN and YLIMÄKI (1956), JAMALAINEN (1958 b) and LINNOMÄKI (1962).

		Percentage grain yield increases (+) or decreases (—) of winter wheat varieties in the trials with PCNB and PMA compounds *Syysruislajikkeiden jyväsatojen prosentuaalinen lisääntyminen (+) tai vähentyminen (—) kokeissa, joissa oraat oli käsitelty PCNB- ja PMA-valmisteilla*	
		PCNB	PMA
Ertus	Dep. of Plant Pathology, Tikkurila *Kasvitautien tutkimuslaitos*	+13, +21, +21, +35, +37, +68, +86	+6, +21, +37, +73, +89
	Häme Exp. Sta. *Hämeen koeasema*	+70	
	North Ostrobothnia Exp. Sta. *Pohjois-Pohjanmaan koeasema*	+34	±0
Vakka	Häme Exp. Sta. *Hämeen koeasema*	+8, +14, +15, +18, +20	+16, +20, +20
	Central Finland Exp. Sta. *Keski-Suomen koeasema*	—3, +2	±0, +16
Varma	Dep. of Plant Pathology, Tikkurila *Kasvitautien tutkimuslaitos*	+3	+10
	Southwest Finland Exp. Sta. *Lounais-Suomen koeasema*	+4	+10
	Häme Exp. Sta. *Hämeen koeasema*	—6, —3, —1, —2, ±0, ±0, +3, +4, +4, +9, +46, +84, +88, +101	+8, +17
	South Savo Exp. Sta. *Etelä-Savon koeasema*	+6, +16	+3, +27
	North Ostrobothnia Exp. Sta. *Pohjois-Pohjanmaan koeasema*	+54	+1

The greatest yield increases resulting from fungicide treatment of winter wheat stands were obtained with the variety Ertus. The yield increases with Vakka and Varma were smaller, but even in the case of these varieties fungicide treatment in many of the trials produced considerable increases in grain yield when conditions had been favourable for low-temperature parasitic fungi.

The effect of fungicide treatment of winter wheat in different parts of the country

At the Southwest Finland Exp. Station and the Satakunta Exp. Station practically no fungal damage occurred, and therefore fungicide treatment did not produce increases in grain yield. As was mentioned earlier, heavy fungal damage occurred during many years in the trials at Tikkurila carried out on finesand soil. Injuries were also considerable in certain years at the Häme, South Savo, Central Finland and North Savo exp. stations. At the North Ostrobothnia Exp. Station trial results were obtained only in the year 1958/59, but they were noteworthy, since, as was mentioned earlier, PCNB was effective in controlling *Sclerotinia borealis* while PMA had no effect upon this fungus (Table 2, p. 49).

The significance of fungicide treatment of winter cereals stands in Finland

One of the most important means of preventing damage to winter cereals by low-temperature parasitic fungi is the cultivation of varieties resistant to such fungi. As the trial results have shown, however, even Finnish varieties which are known to be resistant to low-temperature parasitic fungi may suffer damage if conditions are favourable for these microorganisms.

Depending upon the weather conditions during the overwintering period, fungicidal treatment of cereal stands sometimes leads to complete control, whereas at other times the effect is quite weak. *Typhula* fungi (mainly *T. ishikariensis* in the trials) may in certain cases be particularly difficult to control. The optimum time for treatment in the autumn is often difficult to determine, since it must be delayed as late as possible before the arrival of the snow. Another drawback is the relatively high price of fungicides in Finland; in this country PCNB preparations are considerably more expensive than in some other countries. If conditions are such that winter fungal damage is non-existent or very light, the cost of performing the treatment brings no economic profit to the farmer. Thus in each individual case a decision must be made as to whether or not it would be profitable to treat the stands with fungicide in the autumn.

In the tabulation on p. 18 the trials with PCNB and PMA — with which most of the trials were performed — on winter rye and wheat are placed in different groups according to their increases in grain yield. The results in the variety trials are taken from the most commonly cultivated variety (usually Toivo rye and Varma wheat).

As is seen in the tabulation, in most of the trials at the Department of Plant Pathology and experiment stations the yield increases due to stand treatment were 10—24 %. In about one-third of the trials the increases were greater than 25 %. Among the local trials most of them showed yield increases of 1—9 % and in nearly one-third the increases were in the range 10—24 %. When grouped according to weight of grain increase, most of the trials showed increases due to fungicide treatment amounting to 100—499 kg/ha. At the Department of Plant Pathology and at the exp. stations about one-third of the rye trials and nearly half the wheat trials gave yield increases exceeding 500 kg/ha. Among the local trials this increase group comprised only 8 % of the trials. The

Yield increase group, % / *Sadonlisäys-prosenttiryhmät*	Trials at the Department of Plant Pathology and experiment stations 1945-1963 / *Kasvitautien tutkimuslaitoksen ja koeasemien kokeet v. 1954-1963*								Local trials 1954-1960 / *Paikalliskokeet vv. 1954-1960*	
	Winter rye / *Syysruis*				Winter wheat / *Syysvehnä*				Winter rye / *Syysruis*	
	PCNB / *PCNB*		PMA / *PMA*		PCNB / *PCNB*		PMA / *PMA*		PCNB / *PCNB*	
	no. / *kpl.*	%	no. / *kpl.*	%	no. / *kpl.*	%	no. / *kpl.*	%	no. / *kpl.*	%
50 <	7	13	4	11	9	21	3	13	2	3
25—49 %	5	9	9	26	5	12	3	13	3	5
10—24 %	19	35	13	37	11	26	9	39	16	27
1—9 %	16	30	6	17	9	21	7	30	25	42
≦0	7	13	3	9	8	19	1	4	14	23
	54		35		42		23		60	
Yield increase group, kg/ha / *Sadonlisäysryhmät kg/ha*										
1000 <	8	15	3	8	9	21	5	22	—	—
500—999 kg/ha	9	17	10	29	10	24	7	30	5	8
100—499 kg/ha	23	43	14	40	13	31	5	22	24	40
1—99 kg/ha	7	13	6	17	4	10	6	26	17	28
≦0	7	13	2	6	6	14	—	—	14	23
	54		35		42		23		60	

relatively poorer results of the local trials were a consequence of the fact that most of these were performed with rye varieties resistant to snow mould, whereas in the other trials there were many more susceptible varieties. No great differences in yield increases between the PCNB and PMA treatments were observed. The most distinct differences in this regard concerned winter rye, which gave slightly greater yield increases when treated with PMA than with PCNB.

In the case of w i n t e r r y e, fungicide treatment of stands is generally not profitable if resistant Finnish varieties — such as Toivo and Ensi — and local strains are cultivated. Only in certain areas, expecially in the interior of the country where fungal damage is common year after year, can the use of fungicides on such varieties be recommended. If more susceptible Finnish varieties are cultivated, such as Pekka and Visa, which are higher-yielding and stronger-strawed than the above-mentioned varieties, fungicide treatment will lead to increased grain yields in snowy regions and in restricted areas where the snow cover is heavy (cf. LINNOMÄKI 1963). The use of fungicides so reduces the risk of damage that it is even possible to cultivate foreign varieties of winter rye which are high-yielding and short-stalked but susceptible to snow mould. Such varieties are mainly Swedish, such as Kungs II (Finnish name Kuningas II), Doddelstål and Värne (cf. Fig. 2). Combine-harvesting of these varieties is much easier than the long-stalked Finnish varieties.

In the case of w i n t e r w h e a t, fungicide treatment of stands had no effect on clay soils in Southwest and South Finland because of the very sparse occurrence of low-temperature parasitic fungi. On the other hand, on sandy, silt and humus soils in the present area of cultivation of winter wheat, fungicides can be recommended to prevent fungal damage to this crop. In the central parts of the country, stand treatment can ensure greater certainty in growing winter wheat than previously. This method is thus a reliable means of improving the overwintering of winter wheat, since even the most winter-hardy varieties in present use do not thrive in the interior of the country because of poor winter survival. In this manner the cultivation of winter wheat could be extended further to the north.

Summary

T r i a l s o n w i n t e r r y e. The main cause of poor winter survival of rye in the trials was snow mould (*Fusarium nivale*). Less often, damage was produced by *Typhula* fungi, mainly *T. ishikariensis*. *Sclerotinia borealis* was injurious in the trials at the Arctic Circle Exp. Station.

Most of the trials were performed with PCNB (pentachloronitrobenzene) and PMA (phenyl mercury acetate) compounds.

The PCNB fungicides were most often applied as 20 % dusts at 25 kg/ha or as 50 % sprays at 10 kg/ha, both of which corresponded to 5 kg/ha of 100 % PCNB. In most of the trials this rate gave good or satisfactory results, although in some cases it was not sufficient to prevent damage by snow mould. The rate of 5 kg of 100 % PCNB per hectare can be considered as most suitable under the conditions in Finland.

The PMA preparations tested were Bayer 4426, Femma and Verdasan. The PMA compounds were somewhat more effective against snow mould than those containing PCNB, although they, too, were not always sufficient to prevent injuries caused by this disease. Verdasan was used at the rate of 8.5 kg/ha, and in most of the trials. Femma (2.5 % PMA) was applied at 8—12 kg/ha, its optimum rate being 10—12 kg/ha.

The efficacy of PCNB and PMA preparations against *Typhula* fungi was variable and generally weaker than against snow mould.

Other organic mercury compounds (Ceresan 200, Ceresan M-2X, Mercadmine and Merculine) as well as arsenic compounds gave a good or satisfactory control of snow mould and *Typhula* fungi.

Fungicide treatment of winter rye varieties more susceptible to snow mould (Pekka, Visa and Kungs II) results in larger yield increases than in the case of resistant varieties (Ensi, Toivo and local strains). If conditions are favourable for the occurrence of snow mould, even the most highly resistant rye varieties may suffer damage from this disease.

In the trials in 1958/59 and 1959/60 at the North Savo Exp. Station the rye stands which had been treated with fungicide in the autumn yielded a smaller grain harvest than the untreated stands, even though the fungicide had prevented injury by snow mould. This was due to the fact that the treated stands, which had escaped fungal injury, grew very profusely and subsequently lodged. A similar effect was noted in the winter wheat trials at the Häme Exp. Station in 1960/61 and 1961/62.

The optimum time for treating winter rye stands in most of Finland is the month of November. The best time in South Finland is the latter half of November, in the central parts of the country the first half, and in North Finland the latter part of October.

The most severe fungal damage in the trials at the exp. stations occurred during many winters in Central, East and North Finland; in these regions fungicide treatment of stands often resulted in considerable yield increases. In southern Finland, also, there are areas where snow mould injury is severe. In the southwestern and western regions of Finland damage by snow mould is less serious than in the remainder of the country.

Trials on winter wheat. The causes of winter fungal damage to wheat were *Typhula* fungi, mainly *T. ishikariensis* and to a lesser degree *T. incarnata*, as well as snow mould (*Fusarium nivale*). In the trials at the Häme Experiment Station in 1958/59 there was extensive injury by *Septoria* fungi on silt soils. At the North Ostrobothnia Exp. Station *Sclerotinia borealis* was the main cause of damage to wheat during the winter 1958/59.

Most of the trials on winter wheat were performed with PCNB and PMA compounds.

The rates of PCNB used in the trials were not always sufficient to control snow mould and *Typhula* fungi. At the North Ostrobothnia Exp. Station in 1958/59 PCNB effectively prevented damage by *Sclerotinia borealis*, while PMA was ineffective against it. The rate of 5 kg of 100 % PCNB per hectare can be considered the best amount for stands of winter wheat.

Both PMA and PCNB preparations were similar in their effectiveness against low-temperature parasitic fungi. Verdasan was used at a rate of 8.5 kg/ha and Femma (2.5 % PMA) in most of the trials at 8—12 kg/ha, the optimum rate of the latter being 10—12 kg/ha.

Among the organic mercury preparations Ceresan 200 gave good control of both snow mould and *Typhula* fungi. The urbasulf preparation Bayer 4934 (arsenic compound) was effective against *Typhula* fungi, but against snow mould its effect was variable.

The optimum time for stand treatment of winter wheat is the month of November.

In the variety trials on silt soil carried out at the Häme Exp. Station, *Typhula* fungi and snow mould caused severe damage in the winters of 1958/59, 1959/60 and 1960/61. In 1958/59 *Septoria* fungi were also destructive, but they were not controlled by the fungicides used. In the trials on coarse finesand soil, on the other hand, injuries by low-temperature parasitic fungi were smaller during these years than on silt soil.

When conditions are favourable for low-temperature parasitic fungi, even moderately winter-hardy wheat varieties in this country suffer considerable fungal damage.

At the Southwest Finland Exp. Station and the Satakunta Exp. Station no injury by low-temperature parasitic fungi occurred. In the trials on sandy soil at Tikkurila, such fungi caused severe damage in many years. They were also destructive in certain years at the experiment stations located in Häme, South Savo, Central Finland and North Savo.

The significance of fungicide treatment of winter cereal stands in Finland. In the trials on winter rye (results in the table on page 18) PCNB was used in 114 trials and PMA in 35 trials; in the case of winter wheat the corresponding figures were PCNB 42 and PMA 23 trials. Most of the trials carried out at the Department of Plant Pathology and at the exp. stations showed grain yield increases due to the fungicide treatment amounting to 10—24 %. Among the local trials, most gave increases of 1—9 % and in nearly one-third the increases amounted to 10—24 %. In most of the local trials, varieties resistant to snow mould were used, while in the other trials there were many more susceptible varieties.

Fungicide treatment of stands of Finnish winter rye varieties which are highly resistant to snow mould can be considered only in the interior regions of the country, in areas where damage caused by this disease occurs repeatedly. In cultivation of Finnish varieties which are higher-yielding but relatively susceptible to this disease, the treatment of stands with fungicides will lead to yield increases all over the country in areas with a heavy snow cover. The use of fungicides so reduces the risk of damage that it is even possible to cultivate foreign varieties of winter rye (mainly Swedish) which are high-yielding and short-stalked but which are susceptible to low-temperature parasitic fungi.

Fungiside treatment of stands of winter wheat has no effect on clay soils in Southwest and South Finland because of the very sparse occurrence of low-temperature parasitic fungi. On sandy, silt and humus soils in the present area of cultivation of winter wheat the damage caused by these fungi is often considerable and the use of fungicides can lead to good results. In the central parts of the country where damage by low-temperature fungi usually occurs, stand treatment can ensure greater certainty in growing winter wheat than previously and thus the cultivation of winter wheat could be extended further to the north.

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Table 1. Fungicide trials on stands of winter rye.

Taulukko 1. Syysrukiin oraiden fungisidikäsittelykokeet.

Results of the earlier winter rye trials have been published previously: at the Department of Plant Pathology, Tikkurila, one trial in 1945/46 and two trials in 1954/55 (JAMALAINEN & YLIMÄKI 1956); three trials in 1955/56 and two trials in 1957/58; at the Fiskar estate two trials in 1955/56; at the North Savo Exp. Station one trial in 1956/57 (JAMALAINEN 1958); at the Häme Exp. Station variety trials in 1957—1961 (LINNOMÄKI 1962); trials at the Arctic Circle Exp. Station 1956—1960 (ISOTALO & VOGEL 1962). Some of the trial results from the two latter stations are also included in this table.

Unless otherwise mentioned, the size of the trial plots was 15—20 m^2 and the number of replicates 4; O = seed untreated, D = seed treated with organic mercury preparation at the rate of 2 g per kg of seed; description of fungicides, p. 4—5; the letters F, T and Sb indicate the part of the stand damaged respectively by snow mould (*Fusarium nivale*), *Typhula* fungi, and *Sclerotinia borealis;* T. ish. = *T. ishikariensis*, T. inc. = *T. incarnata;* * = sporadic occurrence, ** = approx. 1 %, *** = 2—3 %. S.D. = significant difference kg/ha; overwintering and greenness, see p. 2; Kuningas II (Swedish variety Kungs II).

Aikaisemmin suoritettujen syysruiskokeiden tuloksista on julkaistu: Kasvitautien tutkimuslaitoksella Tikkurilassa 1945/46 yksi koe, 1954/55 kaksi koetta (JAMALAINEN & YLIMÄKI *1956), 1955/56 kolme koetta ja 1957/58 kaksi koetta; Fiskarsin kartanossa Fiskarsissa 1955/56 kaksi koetta; Pohjois-Savon koeasemalla 1956/57 yksi koe* (JAMALAINEN *1958); Hämeen koeaseman lajikekokeet vv. 1957—1961* (LINNOMÄKI *1962); kokeet Perä-Pohjolan koeasemalla vv. 1956—1960* (ISOTALO & VOGEL *1962). Kahdella viimeksi mainitulla koeasemalla suoritettujen kokeiden tuloksia on esitetty myös tässä taulukossa.*

*Koeruudut 15—20 m^2, ellei toisin mainita; kerranteita 4, ellei toisin mainita; O = siemen peittaamaton; D = siemen peitattu org. elohopeavalmisteella käyttäen 2 g 1:lle siemenkilolle; selostus kokeissa käytetyistä valmisteista s. 4—5; F = lumihomeen (Fusarium nivale), T = Typhula-sienten, Sb = Sclerotinia borealis in vaurioittama osa kasvustosta; T. ish. = T. ishikariensis, T. inc. = T. incarnata; * = sporaadisesti, ** = n. 1 %, *** = 2—3 %, S.D. = "merkittävä ero" kg/ha; talvehtiminen ja vihreys ks. s. 2.*

Year *Vuosi*	Soil type *Maalaji*	Variety *Lajike*	Dressing of seed *Siemenen peittaus*	Treatment of stand — *Oraiden käsittely*			Greenness *Vihreys*	Fungal diseases in spring *Sienivauriot keväällä*		Grain yield *Jyväsato*	
				time *aika*	preparation *valmiste*	kg/ha	%	F %	T %	dt/ha	rel. *sl.*
1	2	3	4	5	6	7	8	9	10	11	12

Department of Plant Pathology —
Kasvitautien tutkimuslaitos, Tikkurila

1958/59	Coarser finesand	Pekka	O	—	—	—	75	31	0.8	24.7	100
	Karkea hieta		O	18. 11.	Bayer 4426	25	100	0	0	32.1	130
			O	—»—	PCNB 20 %	25	100	0	0	30.5	123
			D	—	Täyssato	—	100	*	*	30.5	123
										S.D. 201 kg/ha	

1	2	3	4	5	6	7	8	9	10	11	12
1959/60	Coarser finesand *Karkea hieta*	Pekka	O	—	—	—	35	95		21.3	100
			O	25. 11.	Femma 2.5 %	8.5	84	70		34.6	162
			O	—»—	—»—	17.0	96	9		42.3	199
			O	—»—	PCNB 20 %	12.5	76	19		33.1	155
			O	—»—	—»—	25.0	93	6		34.4	162
			D	—	Täyssato	—	84	41		41.9	197
										S.D. 967 kg/ha	
1960/61	Coarser finesand *Karkea hieta*	Kuningas II	O	—	—	—	65	35		20.2	100
			O	5. 12.	Femma 2.5 %	4	90	2		21.4	106
			O	—»—	—»—	12	90	2		26.1	129
			O	—»—	PCNB 50 % broadcast *sirot.*	10	90	2		23.9	118
			O	—»—	PCNB 50 % spray *ruisk.*	10	90	2		23.8	118
			D	—	Täyssato	—	45	54		18.5	92
1961/62	Coarser finesand *Karkea hieta*	Kuningas II	O	—	—	—	39	60	0	31.4	100
			O	21. 11.	Cadmium chloride	0.6	58	40	*	42.9	137
			O	—»—	PCNB 50 %	10	83	10	*	44.5	142
			D	—	Panogen 15, 0.75 ccm/1 kg	—	61	39	0.5	36.8	117
			D	—	Panogen 15, 1.0 ccm/1 kg	—	71	29	0	41.2	131
			D	—	Täyssato	—	65	35	*	33.2	106
										S.D. 870 kg/ha	
1961/62	Coarser finesand, plots 2 m² *Karkea hieta, koeruudut 2 m²*	Kuningas II	O	—	—	—	49	51	**		
			O	21. 11.	Bayer 4934	3	86	14	0		
			O	—»—	Cadmium chloride	0.6	59	42	*		
			O	—»—	Dithane M-22	7	89	4	**		
			O	—»—	PCNB 50 %	10	96	4	**		

Year *Vuosi*	Soil type *Maalaji*	Variety *Lajike*	Dressing of seed *Siemenen peittaus*	Treatment of stand — *Oraiden käsittely*: time *aika*	preparation *valmiste*	kg/ha	Fungal damage *Sienivauriot* 8. 5. -61: F %	T. ish. %	T. inc. %	Av. no. of plants with heads per plot rel. *Tähkällisiä korsia keskim. ruudulla sl.*
1961/62	Coarser finesand, plots 2 m^2 *Karkea hieta, koeruudut 2 m^2*	Kuningas II	O	—	—	—	51	**	0	100 (= 383 plants)
			O	27. 11.	Bayer 4934	3	14	0	0	150
			O	—»—	Cadmium chloride	0.6	42	*	*	133
			O	—»—	Dithane M-22	7	4	**	*	137
			O	—»—	PCNB 50 %	10	4	**	**	173
			D	—	Täyssato	—	38	**	0	131

Year *Vuosi*	Soil type *Maalaji*	Variety *Lajike*	Dressing of seed	time	preparation	kg/ha	Analysis of stand *Oraiden analyysi* 22. 4. -63: Greenness *Vihreys* %	F %	13. 5. -63: Greenness *Vihreys* %	F %	Grain yield *Jyväsato*: dt/ha	rel. *sl.*
1962/63	Coarser finesand, plots 2 m^2 *Karkea hieta, koeruudut 2 m^2*	Kuningas II	O	—	—	—	55	45	74	26	17.5	100
			O	19. 11.	Fernasan 75	7	50	50	78	23	17.3	99
			O	—»—	PCNB 50 %, Avicol	10	96	4	97	4	21.3	120
			O	—»—	PCNB 60 %, Brassicol sup.	8.3	95	5	95	5	21.5	123
			O	—»—	PCNB 50 %, Bofors	10	88	12	89	10	21.0	120

School Farm at Västankvarn — *Västankvarnin koulutila*, Inkoo

Year	Soil type	Variety	Dressing of seed	time	preparation	kg/ha	Greenness *Vihreys* %	Fungal damage in spring *Sienivauriot keväällä*: F %	T %
1961/62	Medium humous clay *Multava savi*	Visa	O	—	—	—	65	28	***
			O	27. 11.	Femma 2.5 %	12	80	4	*
			O	—»—	PCNB 50 %	10	82	7	*

T = *T. incarnata* and *T. ishikariensis*

Year *Vuosi*	Soil type *Maalaji*	Variety *Lajike*	Dressing of seed *Siemenen peittaus*	Treatment of stand – *Oraiden käsittely* time *aika*	preparation *valmiste*	kg/ha	Overwintering *Talvehtiminen* %	Fungal diseases in spring *Sienivauriot keväällä* F %	T %	Grain yield *Jyväsato* dt/ha	rel. *sl.*
Southwest Finland Agr. Exp. Sta. — *Lounais-Suomen koeasema*, Mietoinen											
1958/59	Humus-rich silt soil *Runsasmultainen hiesumaa*	Saaren ruis (local strain)	D	—	—	—	70	No damage *Ei vaurioita*		18.7	100
			D	21. 11.	PCNB 20 %	25	70			19.0	102
			D	—»—	Verdasan	8.5	70			18.9	101
1959/60	Muddy, finer finesand *Liejuinen hieno hieta*	Saaren ruis	D	—	—	—	100	No damage *Ei vaurioita*		25.2	100
			D	3. 12.	PCNB 50 %	10	100			24.6	98
			D	—»—	Verdasan	8.5	100			25.7	102
Karelia Agr. Exp. Sta. — *Karjalan koeasema*, Anjala											
1961/62	Silt soil *Hiesu*	Visa	D	—	—	—	55	56		14.3	100
			D	13. 11.	PCNB 50 %	10	61	38		15.6	109
			D	—»—	Verdasan	8.5	67	40		17.5	122
										S.D. 428 kg/ha	
Häme Agr. Exp. Sta. — *Hämeen koeasema*, Pälkäne											
1956/57	Coarser finesand *Karkea hieta*	Pekka	D	—	—	—	95	No noticeable damage *Ei sanottavampia vaurioita*		28.0	100
			D	10. 10.	PCNB 20 %	25	93			28.3	101
			D	30. 11.	—»—	25	95			26.3	94
			D	22. 12.	—»—	25	95			29.3	105
										S.D. 317 kg/ha	
1957/58	Coarser finesand, variety trial, 2 replicates *Karkea hieta, lajikekoe, 2 kerrannetta*	Toivo	D	—	—	—	84			35.5	100
			D	16. 11.	PCNB 20 %	25	96			37.9	107
		Visa	D	—	—	—	55			28.3	100
			D	16. 11.	PCNB 20 %	25	90			37.0	131

Damage: snow mould *Vauriot: lumihome*

Year *Vuosi*	Soil type *Maalaji*	Variety *Lajike*	Dressing of seed *Siemenen peittaus*	Treatment of stand — *Oraiden käsittely*			Over-wintering *Talvehtiminen* %	Fungal diseases in spring *Sienivauriot keväällä*		Grain yield *Jyväsato*	
				time *aika*	preparation *valmiste*	kg/ha		F %	T %	dt/ha	rel. *sl.*
1	2	3	4	5	6	7	8	9	10	11	12
1958/59	Silt soil *Hiesu*	Jokioinen 028	D	—	—	—	40			41.1	100
			D	19. 11.	PCNB 20 %	25	70			48.3	118
	Damage: snow mould *Vauriot: lumihome*									S.D. 692 kg/ha	
1958/59	Silt soil *Hiesu*	Jokioinen 028	D	—	—	—	49			26.1	100
			D	19. 11.	PCNB 20 %	25	77			45.1	173
	Damage: snow mould *Vauriot: lumihome*									S.D. 255 kg/ha	
1958/59	Coarser finesand *Karkea hieta*	Toivo	D	—	—	—	89			45.7	100
			D	19. 11.	PCNB 20 %	25	94			48.1	105
	Damage: snow mould *Vauriot: lumihome*									S.D. 651 kg/ha	
1958/59	Coarser finesand *Karkea hieta*	Visa	D	—	—	—	74			36.5	100
			D	16. 10.	PCNB 20 %	25	80			39.6	108
			D	7. 11.	—»—	25	88			41.3	113
			D	15. 11.	—»—	25	93			42.5	116
			D	15. 11.	Verdasan, broadcast *sirot.*	25	97			45.8	125
	Damage: snow mould *Vauriot: lumihome*									S.D. 418 kg/ha	
1959/60	Coarser finesand *Karkea hieta*	Visa	D	—	—	—	7	95		17.0	100
			D	17. 11.	PCNB 20 %	25	85	5		34.6	204
			D	—»—	Verdasan, broadcast *sirot.*	4.25	33	80		25.9	152
			D	—»—	—»—	8.5	52	45		29.6	174
			D	—»—	—»—	25	80	15		34.7	204
										S.D. 210 kg/ha	

1	2	3	4	5	6	7	8	9	10	11	12
1959/60	Silt soil	Jokioinen 028	D	—	—	—	49	50	*	19.0	100
	Hiesu		D	16. 11.	PCNB 20 %	25	59	40	1	23.1	122
										S.D. 320	kg/ha
1959/60	Coarser finesand,	Toivo	D	—	—	—	79	20	*	31.8	100
	variety trial		D	16. 11.	PCNB 20 %	25	97	3	*	35.6	112
	Karkea hieta,									S.D. 435	kg/ha
	lajikekoe										
1960/61	Coarser finesand	Visa	D	—	—	—	45	55		19.6	100
	Karkea hieta		D	1. 11.	Femma 0.5 %	20	54	46		23.5	120
			D	—»—	—»—	62.5	66	34		24.4	124
			D	—»—	Femma 2.5 %	4	56	44		24.2	123
			D	—»—	Femma 2.5 % + sticker + *kiinnitysaine*	4	58	43		24.3	124
			D	—»—	Femma 2.5 %	12.5	64	36		24.3	124
			D	—»—	PCNB 50 %	10	72	28		26.5	135
										S.D. 191	kg/ha
1960/61	Coarser finesand,	Toivo	D	—	—	—	7.9			30.3	100
	variety trial		D	5. 12.	PCNB 20 %	25	8.6			33.8	112
	Karkea hieta, lajikekoe									S.D. 341	kg/ha
	Damage: snow mould										
	Vauriot: lumihome										
1961/62	Coarser finesand	Visa	O	—	—	—	63	29	***	26.1	100
	Karkea hieta		O	17. 11.	Bayer 4426	25	90	8	**	32.4	124
			O	—»—	Femma 2.5 %	8	91	6	*	27.2	104
			O	—»—	—»—	12	81	*	**	30.1	115
			O	—»—	PCNB 50 %	10	93	*	*	27.5	105
			D	—	Täyssato	—	78	29	**	29.6	113
	T = mainly *T. ishikariensis*									S.D. 400	kg/ha
	T = pääasiallisesti T. ishikariensis										
1961/62	Coarser finesand,	Toivo	D	—	—	—	80	No damage		36.7	100
	variety trial		D	17. 11.	PCNB 20 %	25	91	*Ei vaurioita*		37.1	101
	Karkea hieta, lajikekoe									S.D. 308	kg/ha

Year *Vuosi*	Soil type *Maalaji*	Variety *Lajike*	Dressing of seed *Siemenen peittaus*	Treatment of stand — *Oraiden käsittely*: time *aika*	preparation *valmiste*	kg/ha	Greenness *Vihreys* %	Fungal damage *Sienivauriot* 25. 5. -62: F %	T. ish. %	T. inc. %	Av. no. of plants with heads per plot *Tähkällisiä korsia keskim. ruudulla*
1961/62	Coarser finesand,	Kuningas II	O	—	—	—	46	54	***	0	100 (= 266 plants)
	plots 2 m²		O	17. 11.	Bayer 4934	3	84	16	*	0	198
	Karkea hieta,		O	—»—	Cadmium chloride	0.6	74	26	***	0	189
	koeruudut 2 m²		O	—»—	Dithane M-22	7	90	10	**	0	228
			O	—»—	PCNB 50 %	10	78	23	***	*	182
			D	—	Täyssato	—	64	36	***	0	136

Year	Soil type	Variety	Dressing	time	preparation	kg/ha	Analysis of stand *Oraiden analyysi* 2. 5. -63 Greenness *Vihreys* %	F %	16. 5. -63 Greenness *Vihreys* %	Grain yield *Jyväsato* dt/ha	rel. *sl.*
1962/63	Silt soil with	Kuningas II	O	—	—	—	23	78	29	31.0	100
	finesand,		O	12. 11.	Ceresan 200	3 l	60	40	79	51.7	167
	plots 8 m²		O	—»—	—»—	4 l	66	34	88	58.1	187
	Hietapitoinen hiesu,		O	—»—	Maneb "Bayer"	7	41	60	69	46.7	151
	koeruudut 8 m²		O	—»—	PCNB 50 %, Avicol	10	78	22	63	55.6	179
			O	—»—	PCNB 60 %, Brassicol sup.	8.3	84	16	90	49.5	160
1962/63	Coarser finesand	Kuningas II	O	—	—	—	5	96	4	12.6	100
	Karkea hieta		O	12. 11.	Ceresan 200	4 l	83	18	90	58.1	461
			O	—»—	Dithane M-22	7	23	78	28	34.0	270
			O	—»—	Fundilan S	4	7	93	8	15.9	123
			O	—»—	PCNB 50 %	10	86	14	90	54.8	435
			D	—	Ceresan	—	5	96	4	15.2	121
										S.D. 467 kg/ha	

Year *Vuosi*	Soil type *Maalaji*	Variety *Lajike*	Dress-ing of seed *Siemenen peittaus*	Treatment of stand — *Oraiden käsittely* time *aika*	preparation *valmiste*	kg/ha	Over-winter-ing *Talvehti-minen* %	Fungal diseases in spring *Sienivauriot keväällä* F %	T %	Grain yield *Jyväsato* dt/ha	rel. *sl.*
South Savo Agr. Exp. Sta. — *Etelä-Savon koeasema,* Mikkeli											
1957/58	Coarser finesand	Ensi	D	—	—	—	90			21.7	100
	Karkea hieta		D	4. 11	PCNB 20 %	25	95			21.7	97
			D	4. 11. and 12. 11.	—»—	50	93			24.0	111
			D	4. 11.	Verdasan	8.5	100			24.1	111
	Damage: snow mould	*Vauriot: lumihome*									
1958/59	Finer finesand	Ensi	D	—	—	—	54	90		36.6	100
	Hieno hieta		D	28. 10.	PCNB 20 %	25	73	79		37.7	103
			D	—»—	Bayer 4426	25	60	86		37.3	102
Damage: 50 % snow mould, 50 % *Typhula* fungi *Vauriot: 50 % lumihome, 50 % Typhula-sienet*											
1958/59	Finer finesand	Ensi	D	—	—	—	58	80		26.8	100
	Hieno hieta		D	16. 11.	PCNB 50 %	10	92	40		31.7	118
			D	—»—	Verdasan	10	95	55		30.7	115
1960/61	Finer finesand	Ensi	D	—	—	—	69			22.2	100
	Hieno hieta		D	29. 10.	PCNB 50 %	10	82			23.3	105
			D	—»—	Femma 2.5 %	12	81			22.4	101
	Damage: snow mould	*Vauriot: lumihome*								S.D. 408 kg/ha	
		Ensi	D	—	—	—	74			24.1	100
			D	10. 11.	PCNB 50 %	10	90			26.1	108
			D	—»—	Femma 2.5 %	12	94			28.0	116
	Damage: snow mould	*Vauriot: lumihome*								S.D. 602 kg/ha	
1961/62	Finesand moraine	Ensi	D	—	—	—	71				
	Hietamoreeni		D	13. 11.	PCNB 50 %	10	87			22.3	100
			D	—»—	Verdasan	8.5	92			24.1	108
	Damage: snow mould	*Vauriot: lumihome*								24.8	111

Year *Vuosi*	Soil type *Maalaji*	Variety *Lajike*	Dressing of seed *Siemenen peittaus*	Treatment of stand — *Oraiden käsittely*			Over-wintering *Talvehtiminen*	Fungal diseases in spring *Sienivauriot keväällä*		Grain yield *Jyväsato*	
				time *aika*	preparation *valmiste*	kg/ha	%	F %	T %	dt/ha	rel. *sl.*
1	2	3	4	5	6	7	8	9	10	11	12
South Ostrobothnia Agr. Exp. Sta. — *Etelä-Pohjanmaan koeasema,* Ylistaro											
1958/59	Mud clay *Liejusavi*	Korhosen ruis (local strain)	D	—	—	—		20			
			D	15. 11.	Bayer 4426	8.5		0			
			D	—»—	PCNB 20 %	25		0			
1960/61	Mud clay *Liejusavi*	Korhosen ruis	D					No damage *Ei vaurioita*			
1961/62	Mud clay *Liejusavi*	Onni	D	—	—	—		54			
			D	23. 11.	PCNB 50 %	10		25			
			D	—»—	Verdasan	8.5		27			
Central Finland Agr. Exp. Sta. — *Keski-Suomen koeasema,* Kuusa											
1961/62	Coarser finesand, plots 2 m² *Karkea hieta, koeruudut 2 m²*	Kuningas II	O	—	—	—	65	31	18		
			O	9. 11.	Bayer 4934	3	86	12	7		
			O	—»—	Cadmium chloride	0.6	66	23	21		
			O	—»—	Dithane M-22	7	94	4	0.5		
			O	—»—	PCNB 50 %	10	88	8	10		
			D	—»—	Täyssato	—	72	20	25		
	T = *T. ishikariensis*										
North Savo Agr. Exp. Sta. — *Pohjois-Savon koeasema,* Maaninka											
1957/58	Mould *Multamaa*	Halola (local strain)	D	—	—	—				24.0	100
			D	1. 11.	Merculine	4.5 l.				29.0	120
			D	—»—	PCNB 50 %	10				29.6	122
			D	—»—	Verdasan	8.5				28.8	119
										S.D. 265 kg/ha	

Damage: snow mould *Vauriot: lumihome*

1	2	3	4	5	6	7	8	9	10	11	12
1958/59	Coarser finesand *Karkea hieta*	Ensi	D	—	—	—	94	70		34.7	100
			D	13. 11.	PCNB 20 %	25	95	40		36.8	106
			D	—»—	Verdasan	8.5	100	15		33.4	96
		Halola	D	—	—	—	73	80		40.8	100
			D	13. 11.	PCNB 20 %	25	81	15		37.1	91
			D	—»—	Verdasan	8.5	86	7		35.2	86
		Toivo	O	—	—	—	85	99		36.3	100
			O	13. 11.	PCNB 20 %	25	89	89		36.8	101
			O	—»—	Verdasan	8.5	95	47		30.6	84
			D	—	—	—	86	99		34.8	100
			D	13. 11.	PCNB 20 %	25	93	77		30.8	89
			D	—»—	Verdasan	8.5	98	40		31.1	89
		Vatia	D	—	—	—	91	90		32.1	100
		(local strain)	D	13. 11.	PCNB 20 %	25	99	25		36.9	115
			D	—»—	Verdasan	8.5	100	7		28.9	90
		Vjatka	O	—	—	—	94	99		38.4	100
			O	13. 11.	PCNB 20 %	25	95	57		39.4	103
			O	—»—	Verdasan	8.5	100	10		39.2	102
			D	—	—	—	95	97		28.0	100
			D	13. 11.	PCNB 20 %	25	95	60		35.6	127
			D	—»—	Verdasan	8.5	100	34		35.2	126
	In spite of severe snow mould damage, the stand recovered in the spring cf. p. 10. *Huolimatta runsaasta lumihomesaastunnasta oraat keväällä elpyivät, ks. s. 10.*										
1959/60	Coarser finesand *Karkea hieta*	Ensi	D	—	—	—	85			32.8	100
			D	3. 11.	PCNB 20 %	25	96			32.5	99
			D	—»—	Verdasan	8.5	98			37.1	113
		Halola	D	—	—	—	88			37.6	100
			D	3. 11.	PCNB 20 %	25	98			35.0	93
			D	—»—	Verdasan	8.5	99			44.0	117
		Toivo	O	—	—	—	76			34.2	100
			O	3. 11.	PCNB 20 %	25	95			34.5	101
			O	—»—	Verdasan	8.5	96			39.9	117
			D	—	—	—	89			34.8	100
			D	3. 11.	PCNB 20 %	25	98			34.4	99
			D	—»—	Verdasan	8.5	98			40.8	117

Year *Vuosi*	Soil type *Maalaji*	Variety *Lajike*	Dressing of seed *Siemenen peittaus*	Treatment of stand — *Oraiden käsittely* time *aika*	preparation *valmiste*	kg/ha	Over-wintering *Talvehtiminen* %	Fungal diseases in spring *Sienivauriot keväällä* F %	T %	Grain yield *Jyväsato* dt/ha	rel. *sl.*
1	2	3	4	5	6	7	8	9	10	11	12
1959/60	Coarser finesand	Vatia	D	—	—	—	94			32.3	100
	Karkea hieta		D	3. 11.	PCNB 20 %	25	99			27.5	85
			D	—»—	Verdasan	8.5	99			36.0	111
		Vjatka	O	—	—	—	78			32.7	100
			O	3. 11.	PCNB 20 %	25	95			32.2	98
			O	—»—	Verdasan	8.5	96			38.3	117
			D	—	—	—	89			35.3	100
			D	3. 11.	PCNB 20 %	25	98			31.0	88
			D	—»—	Verdasan	8.5	98			40.3	114

The low yields of the PCNB-treated stands was due to the fact that the plants were almost completely free of snow mould and subsequently grew too profusely, cf. p. 10.

Satojen alhaisuus PCNB koejäsenissä johtui siitä, että kasvusto kehittyi liian tiheäksi oraiden ollessa miltei kokonaan vapaita lumihomeesta, ks. s. 10.

Year *Vuosi*	Soil type *Maalaji*	Variety *Lajike*	Dressing of seed	time	preparation	kg/ha	Over-wintering %	F %	T %	dt/ha	rel.
1959/60	Coarser finesand	Halola	D	—	—	—		No damage		34.6	100
	Karkea hieta,		D	3. 11.	PCNB 50 %	10		*Ei vaurioita*		31.8	92
			D	—»—	Verdasan	8.5				35.2	102
										S.D. 491 kg/ha	
1959/60	Coarser finesand,	Toivo	O	—	—	—	76			34.2	100
	variety trial		O	3. 11.	PCNB 20 %	25	95			34.5	101
	Karkea hieta		O	—»—	Verdasan	8.5	96			39.9	117
	lajikekoe		D	—	—	—	89			34.8	100
			D	3. 11.	PCNB 20 %	25	98			34.4	99
			D	—»—	Verdasan	8.5	98			40.8	117
	Damage: snow mould *Vauriot: lumihome*									S.D. 252 kg/ha	
1960/61	Finer finesand	Halola x	D	—	—	—	60			16.8	100
	Hieno hieta	Pekka	D	3. 11.	PCNB 50 %	10	79			20.4	121
			D	—»—	Verdasan	8.5	83			20.6	123

Damage: snow mould *Vauriot: lumihome*

1	2	3	4	5	6	7	8	9	10	11	12
1961/62	Coarser finesand *Karkea hieta*	Halola x Kuningas II	D D D	— 10. 11. —»—	— PCNB 50 % Verdasan	— 10 8.5	88 93 94	30 2 2		15.7 14.8 16.1	100 94 103
Central Ostrobothnia Agr. Exp. Sta. — *Keski-Pohjanmaan koeasema*, Kannus											
1956/57	K ä l v i ä	Ensi and Onni Pekka, Toivo and Visa							No damage *Ei vaurioita* No noticeable damage *Ei sanottavia vaurioita*		
1957/58	K ä l v i ä								No noticeable damage *Ei sanottavia vaurioita*		
1959/60	K a n n u s, Farming school Medium humous finesand *Maamieskoulu* *Multava hieta*	Toivo	D D D	— 23. 10. —»—	— PCNB 20 % Verdasan	— 25 8.5	75 78 81		No noticeable damage *Ei sanottavia vaurioita*		
1959/60	T o h o l a m p i, Bog peat *Rahkasuoturve*	Pekka	D D D	— 2. 10. —»—	— PCNB 20 % Verdasan	— 25 8.5	65 69 68		No noticeable damage *Ei sanottavia vaurioita*		
1959/60	T o h o l a m p i, Isopuron tila Finesand *Hietamaa*	Pekka	D D D	— 1. 12. —»—	— PCNB 20 % Verdasan	— 25 8.5	65 64 63		No noticeable damage *Ei sanottavia vaurioita*		
1959/60	T o h o l a m p i, A. Salon tila Bog peat *Rahkasuoturve*	Pekka	D D D	— 2. 10. —»—	— PCNB 10 % Verdasan	— 25 8.5	65 69 68		No noticeable damage *Ei sanottavia vaurioita*		

Year *Vuosi*	Soil type *Maalaji*	Variety *Lajike*	Dressing of seed *Siemenen peittaus*	Treatment of stand – *Oraiden käsittely*: time *aika*	preparation *valmiste*	kg/ha	Overwintering *Talvehtiminen* %	Fungal diseases in spring *Sienivauriot keväällä*: F %	T %	Grain yield *Jyväsato*: dt/ha	rel. *sl.*
1	2	3	4	5	6	7	8	9	10	11	12
1960/61	Kannus,	Toivo	D	—	—	—	50	2			
	Farming school		D	14. 10.	PCNB 50 %	25	49	3			
	Finer finesand		D	—»—	Verdasan	8.5	49	2			
	Maamieskoulu										
	Hieno hieta										
1960/61	Toholampi,	Canadian	D	—	—	—	78	35			
	Salon tila	variety	D	13. 10.	PCNB 50 %	25	90	7			
	Silty finesand	*Kanadalainen*	D	—»—	Verdasan	8.5	92	2			
	Hiesuinen hieno	*lajike*									
	hieta										
1960/61	Toholampi,	Sangaste	D	—	—	—	87	No damage			
	Toristojan tila		D	13. 10.	PCNB 50 %	10	87	*Ei vaurioita*			
	Finer finesand		D	—»—	Verdasan	8.5	87				
	Hieno hieta										
1961/62	Toholampi,	Toivo	D	—	—	—	73	23			
	Oikemuksen tila		D	31. 10.	PCNB 50 %	10	85	14			
	Finer finesand		D	—»—	Verdasan	8.5	95	0			
	containing abundant										
	organic matter										
	Runsasmultainen										
	hieno hieta										
1961/62	Kannus,	Toivo	D	—	—	—	75	22			
	Ollikkalan tila		D	1. 11.	PCNB 50 %	10	81	18			
	Medium humous		D	—»—	Verdasan	8.5	86	15			
	finer finesand										
	Multava, hieno										
	hieta										

1	2	3	4	5	6	7	8	9	10	11	12
Agr. Exp. Sta. of Peat Cultiv. Soc. — *Suoviljelysyhdistyksen Karjalan koeasema,* Tohmajärvi											
1958/59	Finesand	Ensi	D	—	—	—	70			27.9	100
	Hietamaa		D	5. 11.	PCNB 20 %	25	100			36.5	131
			D	—»—	Verdasan, dust. *pölyt.*	25	100			35.8	128
	Damage: snow mould									S.D. 595 kg/ha	
	Vauriot: lumihome										
1959/60	Finesand	Ensi	D	—	—	—	85	3		27.7	100
	Hietamaa		D	26. 11.	PCNB 50 %	10	95	*		27.5	99
			D	—»—	Verdasan	8.5	88	2		25.8	93
										S.D. 440 kg/ha	
1960/61	Fine finesand	Ensi	D	—	—	—	56			18.5	100
	Hieno hiekka		D	24. 10.	PCNB 50 %	10	64			19.5	105
			D	—»—	Verdasan	8.5	69			21.5	116
	Damage: snow mould									S.D. 294 kg/ha	
	Vauriot: lumihome										
1961/62	Forest bog peat	Ensi	D	—	—	—	80			15.9	100
	Metsäsaraturve		D	13. 11.	PCNB 20 %	25	80			14.8	93
			D	—»—	Verdasan	85	80			17.0	107
	Damage: snow mould										
	Vauriot: lumihome										
North Ostrobothnia Agr. Exp. Sta. — *Pohjois-Pohjanmaan koeasema,* Revonlahti											
1956/57	Finer finesand	Greus	D	—	—	—	90	10		21.3	100
	Hieno hieta	(local strain)	D	2. 11.	PCNB 20 %	25	96	0		21.8	102
			D	27. 10. and 2. 11	—»—	2×25	98	0		21.8	102

Year *Vuosi*	Soil type *Maalaji*	Variety *Lajike*	Dressing of seed *Siemenen peittaus*	Treatment of stand — *Oraiden käsittely* time *aika*	preparation *valmiste*	kg/ha	Overwintering *Talvehtiminen* %	Fungal diases in spring *Sienivauriot keväällä* F %	T %	Sb %	Grain yield *Jyväsato* dt/ha	rel. *sl.*
Arctic Circle Agr. Exp. Sta. — *Perä-Pohjolan koeasema*, Rovaniemi												
1956/57	Moraine finesand *Hietamoreeni*	Greus	D	—	—	—	35	47	17	0	15.0	100
			D	22. 10.	PCNB 20 %	25	87	0	7	0	15.2	101
			D	5. 10. and 22. 10.	—»—	2×25	87	5	7	0	15.3	102
1957/58	Moraine finesand *Hietamoreeni*	Toivo	D	—	—	—	38	31	16	15	17.6	100
			D	9. 11.	PCNB 20 %	25	73	17	6	10	23.7	135
		Visa	D	—	—	—	48	27	13	12	17.2	100
			D	9. 11.	PCNB 20 %	25	68	11	1	6	20.2	118
											S.D. 465 kg/ha	
1957/58	Moraine finesand *Hietamoreeni*	Greus	O	—	—	—	68	25	2	7	17.3	100
			O	9. 11.	Ceresan, dust *pölyt.*	25	95	2	3	1	18.5	107
			O	—»—	PCNB 20 %	25	95	4	1	0	17.9	103
				The stand cut 24. 10. 57 *Oras niitetty 24. 10. 57*		—	99	0	0	0	17.2	100
1958/59	Moraine finesand *Hietamoreeni*	Greus	O	—	—	—	60	30	10	0	15.8	100
			O	25. 10.	Bayer 4426, dust *pölyt.*	25	80	10	10	0	23.2	147
			O	—»—	Ceresan, dust *pölyt.*	25	80	10	10	0	20.0	127
			O	—»—	PCNB 20 %	25	70	15	15	0	16.7	106
				The stand cut 22. 8. 58 *Oras niitetty 22. 8. 58*		—	65	0	0	0	17.1	108
1959/60	Moraine finesand *Hietamoreeni*	Greus	O	—	—	—	78	25	*	*	30.0	100
			O	24. 10.	PCNB 20 %	25	93	0	*	0	33.4	110
			O	—»—	Verdasan, dust *pölyt.*	25	90	0	*	*	33.9	113

Table 2. Fungicide trials on stands of winter wheat

Taulukko 2. Syysvehnän oraiden fungisidikäsittelykokeet

Results of the earlier winter wheat trials have previously been published; at the Department of Plant Pathology, Tikkurila, one trial in 1954/55 (JAMALAINEN & YLIMÄKI 1956), two trials in 1955/56 and one trial in 1957/58 (JAMALAINEN 1958); trials at the Häme Experiment Station in 1956—1961 (LINNOMÄKI 1962), the results of which are also included in this table.

Unless otherwise mentioned, the size of the trial plots was 15—20 m^2 and the number of replicates 4; O = seed untreated, D = seed treated with organic mercury preparation at the rate of 2 g per kg of seed; description of fungicides, p. 4—5; the letters F, T and Sb indicate the part of the stand damaged respectively by snow mould (*Fusarium nivale*), *Typhula* fungi, and *Sclerotinia borealis*; T. ish. = *T. ishikariensis*, T inc. = *T. incarnata*; * = sporadic occurrence, ** = approx. 1 %, *** = 2 — 3 %; S.D. = significant difference kg/ha; overwintering and greennes, see p. 2.

Aikaisemmin suoritettujen syysvehnäkokeiden tuloksista on julkaistu: Kasvitautien tutkimuslaitoksella Tikkurilassa 1954/55 yksi koe (JAMALAINEN *& YLIMÄKI 1956), 1955/56 kaksi koetta ja 1957/58 yksi koe* (JAMALAINEN *1958); kokeet Hämeen koeasemalla vv. 1956—1961* (LINNOMÄKI *1962), joiden tuloksia on esitetty myös tässä taulukossa.*

*Koeruudut 15—20 m^2, ellei toisin mainita; kerranteita 4, ellei toisin mainita; O = siemen peittaamaton, D = siemen peitattu org. elohopeavalmisteella käyttäen 2 g 1:lle siemenkilolle; selostus kokeissa käytetyistä valmisteista, ks. valmisteaineluettelo s. 4—5; F = lumihomeen (Fusarium nivale), T = Typhula-sienten, Sb = Sclerotinia borealis*in *vaurioittama osa kasvustosta; T. ish. = ishikariensis, T. inc. = T. incarnata; * = sporaadisesti, ** = n. 1 %, *** = 2—3 %; S.D. = merkittävä ero kg/ha; talvehtiminen ja vihreys ks. s. 2.*

Year *Vuosi*	Soil type *Maalaji*	Variety *Lajike*	Dressing of seed *Siemenen peittaus*	Treatment of stand — *Oraiden käsittely*: time *aika*	preparation *valmiste*	kg/ha	Greenness *Vihreys* %	Fungal diseases in spring *Sienivauriot keväällä* F %	T %	Grain yield *Jyväsato* dt/ha	rel. *sl.*
Department of Plant Pathology — *Kasvitautien tutkimuslaitos*, Tikkurila											
1958/59	Coarser finesand *Karkea hieta*	Ertus	O	—	—	—	8	27	48.4	23.4	100
			O	18. 11.	Bayer 4426	25	98	0	*	40.4	173
			O	—»—	PCNB 20 %	25	98	0	*	39.2	168
			O	—»—	Bayer 4426+PCNB 20 %	12.5+12.5	96	0	*	39.8	170
			O	—»—	Ceresan M-2X	2.8 l	92	0	*	44.5	190
			O	—»—	Pomarsol forte	10	58	18	23.9	38.0	162
			D	—»—	Täyssato	—	18	11.6	57.6	26.9	115
										S.D. 292 kg/ha	

T = *T. ishikariensis*

Fungal diseases determined by counting the seedlings on 4 m^2 in each plot

Sienivauriot määritetty laskemalla oraat jokaisesta ruudusta 4 m^2 alalta

In the plots treated with Ceresan M-2X, the leaves, expecially the oldest ones, turned yellow in the summer

Ceresan M-2X-koejäsenessä lehdet, varsinkin vanhimmat, kesällä kellertyneitä

Year *Vuosi*	Soil type *Maalaji*	Variety *Lajike*	Dressing of seed *Siemenen peittaus*	Treatment of stand — *Oraiden käsittely* time *aika*	preparation *valmiste*	kg/ha	Greenness *Vihreys* %	Fungal diseases in spring *Sienivauriot keväällä* F %	T %	Grain yield *Jyväsato* dt/ha	rel. *sl.*
1958/59	Coarser finesand,	Ertus	O	—	—	—	20	7	71	18.5	100
	replications 3		O	17. 11.	Bayer 4905	25	86	5	37	25.9	140
	Karkea hieta,		O	—»—	—»—	100	99	3	19	28.8	156
	kerranteita 3		O	—»—	Bayer 4934	0.75	40	8	52	19.0	103
			O	—»—	—»—	3	97	7	31	27.0	146
			O	—»—	Bayer TB 4468 a	2.8	93	3	19	34.1	184
			O	—»—	Ceresan 200	4.3 l	99	9	10	37.6	203
			O	—»—	Panogen	2.5 l	78	3	33	24.9	135
	T = main *Typhula ishikariensis*			Fungal disease determined by counting the seedlings on 1.3 m² in each plot							
	T = pääasiallisesti T. ishikariensis			*Sienivauriot määritetty laskemalla oraat jokaisesta ruudusta 1.3 m² alalta*							
1959/60	Coarser finesand *Karkea hieta*	Ertus	O					No damage *Ei vaurioita*			
1960/61	Coarser finesand	Ertus	O	—	—	—	85	13	*	26.4	100
	Karkea hieta		O	14. 11.	Femma 2.5 %, broadcast *sirot.*	12	95	*	*	28.1	106
			O	—»—	Ceresan 200	4.3 l	100	0	*	31.2	118
			O	—»—	PCNB 50 %	10	90	2	*	29.8	113
	T = *T. ishikariensis* and *T. incarnata*			The tips of the leaves in the Ceresan 200 treatment turned yellow in the summer							
				Ceresan 200-koejäsenessä kesällä lehtien kärjissä kellertymistä							
1961/62	Coarser finesand	Ertus	O	—	—	—	56	13	34	20.1	100
	Karkea hieta		O	21. 11.	Bayer 4426	25	72	4	8	27.5	137
			O	—»—	Ceresan 200	4.3 l	81	1	0.5	28.8	143
			O	—»—	Mercadmine	4.7 l	71	7	21	25.4	126
			O	—»—	PCNB 50 %	10	72	1	11	27.1	135
	T = *T. ishikariensis* and *T. incarnata*									S.D. 425 kg/ha	
1961/62	Coarser finesand,	Ertus	O	—	—	—	62	16	27		
	plots 2 m²		O	21. 11.	Bayer 4934	3	88	8	5		
	Karkea hieta,		O	—»—	Dithane M-22	7	94	3	2		
	ruudut 2 m²		O	—»—	Cadmium chloride	0.6	79	14	22		
			O	—»—	—»—	1.2	98	2	0		
			O	—»—	PCNB 50 %	10	96	4	17		
	T = *T. ishikariensis* and *T. incarnata*										

Year *Vuosi*	Soil type *Maalaji*	Variety *Lajike*	Dressing of seed *Siemenen peittaus*	Treatment of stand — *Oraiden käsittely*: time *aika*	preparation *valmiste*	kg/ha	Fungal damage *Sienivauriot* 10. 5. -62: F	T	Av. no. of plants with heads per plot rel. *Tähkällisiä korsia keskim. ruudulla* sl.
1961/62	Coarser finesand, plots 2 m²	Ertus	O	—	—	—	16	27	100 (= 376 plants)
	Karkea hieta, koeruudut 2 m²		O	27. 11.	Bayer 4934	3	8	5	145
			O	—»—	Cadmium chloride	0.6	14	22	122
			O	—»—	—»—	1.2	2	0	178
			O	—»—	Dithane M-22	7	3	1	149
			O	—»—	PCNB 50 %	10	4	2	149

T = *T. ishikariensis* and *T. incarnata*

Year *Vuosi*	Soil type *Maalaji*	Variety *Lajike*	Dressing of seed	time	preparation	kg/ha	Analysis of stand *Oraiden analyysi* 22. 4. -63: Greenness *Vihreys* %	F %	T. ish. %	T. inc. %	13. 5. -63: Greenness *Vihreys* %	F %	T. sp. %	Grain yield *Jyväsato* dt/ha	rel. *sl.*
1962/63	Coarser finesand, plots 2 m²	Ertus	O	—	—	—	62	22	8	8	81	21	7	17.7	100
	Karkea hieta, koeruudut 2 m²		O	27. 11.	Ceresan 200	3 l	95	3	2	0	99	2	0	18.3	104
			O	—»—	—»—	4 l	97	2	1	0.5	99	2	0	20.3	115
			O	—»—	Fernasan 75	7	82	10	5	3	97	3	1	23.0	130
			O	—»—	Fernasan 75 +	7									
					Femma 2.5 %	4	89	7	3	1	97	3	1	22.7	128
			O	—»—	Fundilan S	6	82	11	6	2	93	5	3	20.7	117
			O	—»—	Maneb "Bayer"	7	76	14	5.5	5.5	92	4	4	21.7	123
			O	—»—	Maneb, Dithane M-22	7	80	11	5	4	95	4	1	22.3	123
			O	—»—	Maneb, Trimangol	6	78	11	5	6	94	3	3	21.7	123
			O	—»—	PCNB 50 %, Avicol	10	94	-2	2	2	99	1	*	20.3	115
			O	—»—	PCNB 60 %, Brassicol sup.	8.5	94	4	2	2	97	3	*	20.7	117
			O	—»—	PCNB 50 %, Bofors	10	88	7	3	3	96	4	0.5	21.3	121

Year *Vuosi*	Soil type *Maalaji*	Variety *Lajike*	Dressing of seed *Siemenen peittaus*	Treatment of stand — *Oraiden käsittely*: time *aika*	preparation *valmiste*	kg/ha	Over-wintering *Talvehtiminen* %	Fungal diseases in spring *Sienivauriot keväällä*: F %	T %	Grain yield *Jyväsato*: dt/ha	rel. *sl.*
1	2	3	4	5	6	7	8	9	10	11	12
School Farm at Västankvarn — *Västankvarnin koulutila*, Inkoo											
1961/62		Ertus	O					No damage *Ei vaurioita*			
Southwest Finland Agr. Exp. Sta. — *Lounais-Suomen koeasema*, Mietoinen											
1956/57	Nousiainen	Ertus	D					No damage *Ei vaurioita*			
	Paimio	—»—	D								
	Parainen	—»—	D					—»—			
	Piikkiö	—»—	D					—»—			
	Turku	—»—	D					—»—			
1957/58	Nousiainen	Ertus	D					—»—			
	Parainen	—»—	D					—»—			
1958/59	Mietoinen	Ertus	D	—	—	—	70	No damage		19.5	100
	Medium humous		D	21. 11.	PCNB 20 %	25	70	*Ei vaurioita*		17.5	90
	silt soil		D	—»—	Verdasan, dust *pölyt.*	25	70			19.7	101
	Multava hiesusavi										
1960/61	Mietoinen	Varma	D	—	—	—	73			26.3	100
	Medium humous		D	19. 11.	PCNB 50 %	10	80			27.4	104
	silt soil		D	—»—	Verdasan	8.5	80			28.9	110
	Multava hietasavi										

Damage: snow mould
Vauriot: lumihome

1	2	3	4	5	6	7	8	9	10	11	12
Satakunta Agr. Exp. Sta. — *Satakunnan koeasema,* Harjavalta											
1958/59	No damage by low-temperature parasitic fungi in a trial with Varma wheat				*Kokeessa Varma-vehnällä ei talvituhosienivaurioita*						
1959/60	—»—	—»—			—»—			—»—			
1960/61	—»—	—»—			—»—			—»—			
Häme Agr. Exp. Sta. — *Hämeen koeasema,* Pälkäne											
1956/57	Silt soil *Hiesu*	Varma	D D	— 30. 10.	— PCNB 20 %	— 25	95 95			40.3 40.3	100 100
1956/57	Coarser finesand *Karkea hieta*	Varma	D D D D	— 10. 10. 30. 10. 22. 12.	— PCNB 20 % —»— —»—	— 25 25 25	95 95 95 90			32.8 38.1 32.9 32.5 S.D. 317 kg/ha	100 116 100 99
	Damage: snow mould *Vauriot: lumihome*										
1957/58	Light finesand, variety trial *Kevyt hieta, lajikekoe*	Varma	D D	— 16. 11.	— PCNB 20 %	— 25	88 89			40.0 41.4 S.D. 363 kg/ha	100 104
	Damage: snow mould and *T. ishikariensis* *Vauriot: lumihome ja T. ishikariensis*										
1957/58	Coarser finesand *Karkea hieta*	Varma	D D	— 16. 11.	— PCNB 20 %	— 25	88 90	No damage *Ei vaurioita*		35.4 35.0	100 99
1957/58	Silt soil *Hiesu*	Vakka	D D	— 16. 11.	— PCNB 20 %	— 25	91 91			36.6 39.7	100 108

Year *Vuosi*	Soil type *Maalaji*	Variety *Lajike*	Dressing of seed *Siemenen peittaus*	Treatment of stand – *Oraiden käsittely*: time *aika*	preparation *valmiste*	kg/ha	Over-wintering *Talvehtiminen* %	Fungal diseases in spring *Sienivauriot keväällä* F %	T %	Grain yield *Jyväsato* dt/ha	rel. *sl.*
1	2	3	4	5	6	7	8	9	10	11	12
1958/59	Coarser finesand, variety trial *Karkea hieta, lajikekoe*	Varma	D	—	—	—	71			31.5	100
			D	19. 11.	PCNB 20 %	25	88			32.5	103
										S.D. 651 kg/ha	
Damage: snow mould and *T. ishikariensis* (cf. p. 15) *Vauriot: lumihome ja T. ishikariensis (ks. s. 15)*											
1958/59	Coarser finesand *Karkea hieta*	Vakka	D	—	—	—	62			40.7	100
			D	16. 10.	PCNB 20 %	25	74			44.2	109
			D	7. 11.	—»—	25	83			46.0	113
			D	15. 11.	—»—	25	87			46.9	115
			D	15. 11.	Verdasan, dust. *pölyt.*	25	97			48.8	120
										S.D. 328 kg/ha	
Damage: snow mould and *T. ishikariensis* (cf. p. 15) *Vauriot: lumihome ja T. ishikariensis (ks. s. 15)*											
1958/59	Silt soil, variety trial *Hiesu, lajikekoe*	Varma	D	—	—	—	21			13.3	100
			D	19. 11.	PCNB 20 %	25	47			26.7	201
										S.D. 178 kg/ha	
Damage: 2/3 snow mould, 1/3 *Typhula* sp. and *Septoria* sp. *Vauriot: 2/3 lumihome, 1/3 Typhula sp ja Septoria sp*											
1958/59	Silt soil, variety trial *Hiesu, lajikekoe*	Varma	D	—	—	—	11			9.4	100
			D	19. 11.	PCNB 20 %	25	34			17.3	184
										S.D. 255 kg/ha	
Damage as in previous trial *Vauriot kuten edellisessä kokeessa*											
1958/59	Silt soil, variety trial *Hiesu, lajikekoe*	Varma	D	—	—	—	17			13.3	100
			D	19. 11.	PCNB 20 %	25	49			25.0	188
Damage as in previous trial *Vauriot kuten edellisessä kokeessa*											

1	2	3	4	5	6	7	8	9	10	11	12
1959/60	Coarser finesand, variety trial *Karkea hieta, lajikekoe*	Varma	D	—	—	—	89	2	9	31.4	100
			D	16. 11.	PCNB 20 %	25	90	*	10	32.8	104
										S.D. 435 kg/ha	
1959/60	Medium fine sand *Karkea hieta*	Vakka	D	—	—	—	90			36.6	100
			D	17. 11.	PCNB 20 %	25	95			43.1	118
			D	—»—	Verdasan, broadcast *sirot.*	4.25	94			39.1	107
			D	—»—	—»— —»—	8.5	94			42.2	115
			D	—»—	—»— —»—	25.0	95			43.4	119
	Damage: snow mould and *Typhula* fungi *Vauriot: lumihome ja Typhula-sienet*										
1959/60	Silt soil, variety trial *Hiesu, lajikekoe*	Varma	D	—	—	—	71	*	29	26.5	100
			D	16. 11.	PCNB 20 %	25	78	*	22	29.0	109
										S.D. 320 kg/ha	
1960/61	Silt *Hiesu*	Vakka	D	—	—	—	60			32.5	100
			D	23. 9.	Ground limestone *Kalkkikivijauhe*	2500	59			35.3	109
			D	7. 12.	PCNB 20 %	25	90			36.9	114
			D	—»—	PCNB 20 % + Ground limestone *Kalkkikivijauhe*	25 2500	84			41.5	128
	Damage: snow mould *Vauriot: lumihome*									S.D. 603 kg/ha	
1960/61	Silt soil, variety trial *Hiesu, lajikekoe*	Varma	D	—	—	—	74			39.2	100
			D	5. 12.	PCNB 20 %	25	90			38.3	98
										S.D. 466 kg/ha	

Damage: snow mould 70 % and *Typhula* fungi 30 % as a result of the treatment the stand grew too profusely and lodged already at the time of heading
Vauriot: lumihome 70 %, Typhula-sienet 30 %; kasvusto kehittynyt käsittelyn vuoksi liian tiheäksi ja lakoutui jo tähkimisen aikana

Year *Vuosi*	Soil type *Maalaji*	Variety *Lajike*	Dressing of seed *Siemenen peittaus*	Treatment of stand – *Oraiden käsittely* time *aika*	preparation *valmiste*	kg/ha	Over-wintering *Talvehtiminen* %	Fungal diseases in spring *Sienivauriot keväällä* F %	T %	Grain yield *Jyväsato* dt ha	rel. *sl.*
1	2	3	4	5	6	7	8	9	10	11	12
1960/61	Coarser finesand, variety trial *Karkea hieta, lajikekoe*	Varma	D	—	—	—	65			27.1	100
			D	5. 12.	PCNB 20 %	25	78			25.4	94
										S.D. 341 kg/ha	
	Damage as in previous trial *Vauriot kuten edellisessä kokeessa*										
1960/61	Coarser finesand, plots 9 m² *Karkea hieta, ruudut 9 m²*	Vakka	D	—	—	—	62	35	5	26.9	100
			D	1. 11.	Bayer 4905	50	70	30	9	28.4	106
			D	—»—	Bayer 4905	100	65	28	2	30.3	113
			D	—»—	Bayer 4934	3	65	30	3	30.3	113
			D	—»—	Bayer TB 4468 a	3	60	34	3	28.1	104
			D	—»—	Ceresan 200	4.3 l	82	15	2	31.6	117
			D	—»—	Femma 0.5 %	20	74	28	2	30.6	114
			D	—»—	—»—	62.5	81	20	2	28.4	106
			D	—»—	Femma 2.5 %	4	71	30	2	27.5	102
			D	—»—	Femma 2.5 % + stikker *kiinnitysaine*	4	74	26	3	29.4	109
			D	—»—	Femma 2.5 %	12.5	74	26	2	31.6	117
			D	—»—	PCNB 50 %	10	68	28	5	32.2	120
			D	—»—	Verdasan	8.5	84	16	2	32.2	120
										S.D. 510 kg/ha	
1961/62	Coarser finesand, variety test *Karkea hieta, lajikoe*	Varma	D	—	—	—	49			28.2	100
			D	17. 11.	PCNB 20 %	25	76			27.4	97
										S.D. 308 kg/ha	
	Damage: snow mould and *Typhula* fungi; as a result of the treatment the stand grev too profusely and lodged *Vauriot: lumihome ja Typhula-sienet; kasvusto kehittynyt käsittelyn vuoksi liian tiheäksi ja lakoontui*										
1961/62	Silt soil *Hiesu*	Varma	D	—	—	—	38			22.4	100
			D	17. 11.	PCNB 20 %	25	63			32.6	146
										S.D. 771 kg/ha	
	Damage as in previous trial *Vauriot kuten edellisessä kokeessa*										

1	2	3	4	5	6	7	8	9	10	11	12
1961/62	Silt soil	Varma	O	—	—	—	38	24		21.4	100
	Hiesu		O	17. 11.	Bayer 4934	3	78	10		26.7	125
			O	—»—	Cadmium chloride	0.6	56	19		26.5	124
			O	—»—	—»—	1.0	68	15		26.4	123
			O	—»—	Ceresan 200	4.3 l	84	*		27.1	127
			O	—»—	Femma 2.5 %	12	80	9		25.0	117
			O	—»—	Mercadmine	4.7 l	70	13		26.8	125
										S.D. 209 kg/ha	
1961/62	Silt soil,	Ertus	O	—	—	—	45	38	**		
	plots 2 m²		O	17. 11.	Bayer 4934	3	79	20	*		
	Hiesu,		O	—»—	Cadmium chloride	0.6	55	36	*		
	ruudut 2 m²		O	—»—	—»—	1.2	64	33	**		
			O	—»—	Dithane M-22	7	75	23	**		
			O	—»—	PCNB 50 %	10	68	29	**		
	T = T. *ishikariensis*										
1961/62	Coarser finesand	Varma	O	—	—	—	60			27.9	100
	Karkea hieta		O	17. 11.	Bayer 4426	25	70			30.1	108
			O	—»—	Bayer 4934	3	78			30.6	110
			O	—»—	Femma 2.5 %	8	70			28.3	101
			O	—»—	—»—	12	71			29.0	104
			O	—»—	PCNB 50 %	10	76			28.8	103
			D	—	Täyssato	—	59			28.5	102

Damage: 1/3rd snow mould, 2/3rd disease like *Typhula* mould with very few sclerotia; the most vigorous plants lodged
Vauriot: 1/3 lumihome, 2/3 Typhula-homeen kaltaista tautia, pahkoja hyvin vähän; parhaiten talvehtinut kasvusto lakoontui

Year *Vuosi*	Soil type *Maalaji*	Variety *Lajike*	Dress-ing of seed *Siemenen peittaus*	Treatment of stand — *Oraiden käsittely*: time *aika*	preparation *valmiste*	kg/ha	Fungal damage *Sienivauriot*: F %	T. ish. %	T. inc. %	Av. no. of plants with heads per plot rel. *Tähkällisiä korsia keskim. ruudulla sl.*
1961/62	Silt soil,	Ertus	O	—	—	—	38	**	0	100 (= 179 plants)
	plots 2 m²		O	17. 11.	Bayer 4934	3	20	*	**	251
	Hiesu,		O	—»—	Cadmium chloride	0.6	36	*	**	140
	koeruudut 2 m²		O	—»—	—»—	1.2	33	**	*	146
			O	—»—	Dithane M-22	6	23	**	*	225
			O	—»—	PCNB 50 %	10	29	**	0	175

Year *Vuosi*	Soil type *Maalaji*	Variety *Lajike*	Dress-ing of seed *Siemenen peittaus*	time *aika*	preparation *valmiste*	kg/ha	Analysis of stands *Oraiden analyysit* 2. 5. -63 Green-ness *Vihreys* %	2. 5. -63 Fungal damages *Sieni-vauriot* %	6. 5. -63 Green-ness *Vihreys* %	Grain yield *Jyväsadot* dt/ha	rel. *sl.*
1962/63	Coarser finesand,	Ertus	O	—	—	—	30	70	38	16.7	100
	plots 8 m²		O	12. 11.	Ceresan 200	3 l	63	38	86	27.1	162
	Karkea hieta,		O	—»—	—»—	4 l	66	34	88	30.2	181
	koeruudut 8 m²		O	—»—	Maneb "Bayer"	7	36	64	43	25.1	150
			O	—»—	PCNB 50 %, Avicol	10	63	38	82	28.4	170
			O	—»—	PCNB 60 %, Brassicol sup	8.5	71	29	82	31.9	191
	Damage: mainly by snow mould *Vauriot: pääasiallisesti lumihome*										
1962/63	Silt soil,	Antti	O	—	—	—	69	31	85	57.1	100
	plots 15 m²		O	12. 11.	Ceresan 200	4 l	94	6	97	59.3	104
	Hiesu,		O	—»—	Dithane M-22	7	86	14	96	59.9	105
	koeruudut 15 m²		O	—»—	Femma 5 %	8	94	6	94	62.2	109
			O	—»—	Femma 2.5 %	12	94	7	95	63.7	112
			O	—»—	Fundilan S	6	73	28	83	58.0	102
			O	—»—	PCNB 50 %	10	95	5	84	61.8	108
			D	—	Ceresan	—	73	27	82	57.8	101
										S.D. 245 kg/ha	

Damage: 85—90 % snow mould, 10—15 % *Typhula* fungi
Vauriot: 85—90 % lumihome, 10—15 % Typhula-sienet

Year *Vuosi*	Soil type *Maalaji*	Variety *Lajike*	Dressing of seed *Siemenen peittaus*	Treatment of stand — *Oraiden käsittely* time *aika*	preparation *valmiste*	kg/ha	Over-wintering *Talvehtiminen* %	Fungal diseases in spring *Sienivauriot keväällä* F %	T %	Grain yield *Jyväsato* dt/ha	rel. *sl.*
1	2	3	4	5	6	7	8	9	10	11	12
South Savo Agr. Exp. Sta. — *Etelä-Savon koeasema*, Mikkeli											
1959/60	Coarser finesand *Karkea hinta*	Varma	D	—	—	—	62			22.3	100
			D	16. 11.	PCNB 50 %	10	100			25.8	116
			D	—»—	Verdasan	10	99			28.4	127
	Damage: snow mould *Vauriot: lumihome*										
1960/61	Finer finesand *Hieno hieta*	Antti	D	—	—	—	75			23.6	100
			D	29. 10.	PCNB 50 %	10	90			23.8	101
			D	—»—	Femma 2.5 %	12	93			25.7	109
	Damage: mainly by snow mould *Vauriot: pääasiallisesti lumihomeen aiheuttamat*										
1961/62	Coarser finesand *Karkea hinta*	Varma	D	—	—	—	87			20.5	100
			D	13. 11.	PCNB 50 %	10	98			21.8	106
			D	—»—	Verdasan	8.5	99			21.1	103
	Damage: snow mould *Vauriot: lumihome*										
Central Finland Agr. Exp. Sta. — *Keski-Suomen koeasema*, Kuusa											
1961/62	Finer finesand poor in humus *Vähämultainen hieno hieta*	Vakka	O	—	—	—	75	12		29.3	100
			O	9. 11.	Bayer 4934	3	79	2		29.3	100
			O	—»—	PCNB 50 %	10	77	1		28.5	97
1961/62	Silt soil containing 3 % organic matter *Vähämultainen hiesu*	Vakka	O	—	—	—	53	23	23	16.0	100
			O	9. 11.	Bayer 4426	25	59	10	25	16.9	106
			O	—»—	Bayer 4934	3	69	5	9	17.3	108
			O	—»—	Ceresan 200	4.1 l	68	0.5	3	17.8	111
			O	—»—	Femma 2.5 %	12	67	3	18	18.6	116
			O	—»—	PCNB 50 %	10	59	13	25	16.3	102
										S.D. 130 kg/ha	

1	2	3	4	5	6	7	8	9	10	11	12
1961/62	Coarser finesand, plots 2 m² *Karkea hieta, koeruudut 2 m²*	Ertus	O	—	—	—	28	38	***		
			O	9. 11.	Bayer 4934	3	55	16	*		
			O	—»—	Cadmium chloride	0.6	50	25	**		
			O	—»—	—»—	1.2	56	16	***		
			O	—»—	Dithane M-22	7	60	9	*		
			O	—»—	PCNB 50 %	10	62	20	**		
	T = *Typhula ishikariensis*						Fungal damage *Sienivauriot* 17. 5. -62 F %	T.ish. %	T.inc. %	Av. no. of plants with heads per plot rel. *Tähkällisiä korsia keskim. ruudulla sl.*	
1961/62	Coarser finesand, plots 2 m² *Karkea hieta, koeruudut 2 m²*	Ertus	O	—	—	—	38	***	0	100 (= 189 plants)	
			O	—	Bayer 4934	3	16	0	0	224	
			O	—	Cadmium chloride	0.6	25	**	0	188	
			O	—	—»—	1.2	16	***	0	211	
			O	—	Dithane M-22	7	9	*	0	247	
			O	—	PCNB 50 %	10	20	**	0	192	
							Analysis of stand *Oraiden analyysi* 15 5. -63 Greenness *Vihreys* %		Fungal damages *Sienivauriot* %	Grain Yield *Jyvätsato* dt/ha	rel. *sl.*
1962/63	Silt soil, plots 8 m² *Hiesu, koeruudut 8 m²*	Ertus	O	—	—	—	85.5		13.3	18.0	100
			O	1. 11.	Ceresan 200	3 l	96.0		2.8	25.3	141
			O	—»—	—»—	4 l	96.5		3.3	25.2	140
			O	—»—	Maneb, "Bayer"	7	92.5		6.8	20.8	116
			O	—»—	PCNB 50 %, Avicol	10	96.5		3.3	26.9	149

Fungal damages: 95—98 % snow mould, 2—5 % *Typhula* fungi
Sienivauriot: 95—98 % lumihome, 2—5 % Typhula-sienet

Year *Vuosi*	Soil type *Maalaji*	Variety *Lajike*	Dressing of seed *Siemenen peittaus*	Treatment of stand — *Oraiden käsittely* time *aika*	preparation *valmiste*	kg/ha	Over-wintering *Talvehtiminen* %	Fungal diseases in spring *Sienivauriot keväällä* F %	T %	Grain yield *Jyväsato* dt/ha	rel. *sl.*
1962/63	Silt soil with finesand	Vakka	O	—	—	—	87	5	1	17.2	100
	Hietapitoinen hiesu		O	10. 11.	Ceresan 200	4 l	94	0	0	18.1	105
			O	—»—	Dithane Z-78	7	85	1	1	16.3	95
			O	—»—	Dithane M-22	7	85	*	0	19.1	111
			O	—»—	Femma 2.5 %	12	93	0	*	18.3	106
			O	—»—	Fundilan S	4	89	3	2	16.3	95
			O	—»—	PCNB 50 %	10	90	0	4	16.9	98
			O	—»—	Verdasan	8	89	0	0	17.7	103
North Savo Agr. Exp. Sta. — *Pohjois-Savon koeasema*, Maaninka											
1957/58	Coarser finesand	Tammisto	D	—	—	—	40	60		25.9	100
	Karkea hieta	24/48	D	1. 11.	Merculine	4.7 l	73	27		41.9	162
			D	—»—	PCNB 50 %	8	63	37		36.8	142
										S.D. 173 kg/ha	
1958/59	Coarser finesand	Tammisto	D	—	—	—	93			32.2	100
	Karkea hieta	24/48	D	3. 11.	PCNB 50 %	10	98			35.2	109
			D	—»—	Verdasan	8.5	98			37.4	116
	Damage: snow mould	*Vauriot: lumihome*									
North Ostrobothnia Agr. Exp. Sta. — *Pohjois-Pohjanmaan koeasema*, Ruukki											
1956/57	Finer finesand containing clay	Ertus	D					No damage *Ei vaurioita*			
	Savinen hieno hieta	Varma	D					—»—			
1957/58	Finer finesand containing clay	Antti	D					No damage *Ei vaurioita*			
	Savinen hieno hieta	Virtus	D					—»—			
1958/59	Finer finesand	Ertus	D	—	—	—	55			22.2	100
	containing clay		D	28. 10.	Bayer 4426, dust *pölyt.*	25	60			22.3	100
	Savinen hieno hieta		D	—»—	PCNB 20 %	25	78			29.7	134
		Varma	D	—	—	—	50			28.8	100
			D	28. 10.	Bayer 4426, dust *pölyt.*	25	51			29.2	101
			D	—»—	PCNB 20 %	25	82			44.3	154
										S.D. 360 kg/ha	

Damage: mainly by *Sclerotinia borealis*, some snow mould
Vauriot: pääasiallisesti Sclerotinia borealis, jonkin verran lumihometta

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SELOSTUS

Syysviljojen talvituhosienien torjunta oraiden fungisidikäsittelyillä

E. A. JAMALAINEN

Maatalouden tutkimuskeskus, Kasvitautien tutkimuslaitos, Tikkurila

Syysruiskokeet

Talvehtimisen huonouteen oli kokeissa tärkeimpänä syynä lumihome (*Fusarium nivale*). Pahkulahometta aiheuttavia *Typhula*-sieniä, pääasiallisesti *T. ishikariensis*ta, esiintyi kokeissa vain harvoin suurien vahinkojen aiheuttajina. Pohjolan pahkahometta (*Sclerotinia borealis*) tavattiin vaurioiden aiheuttajana Perä-Pohjolan koeaseman kokeissa.

Kokeissa käytetyt valmisteet on selostettu asetelmassa s. 4—5 ja koetulokset esitetty taulukossa 1. Useimmat kokeet suoritettiin PCNB- (pentakloornitrobetseeni-) ja PMA- (fenylmerkuriasetaatti-) valmisteilla.

PCNB-valmisteita käytettiin tavallisimmin joko 20-%:sina pölytteinä 25 kg/ha tai 50-%:sina ruiskutteina 10 kg/ha eli 100-%:sena PCNB:na 5 kg/ha. Useimmissa kokeissa tämä määrä PCNB:tä antoi hyvän tai tyydyttävän tuloksen. Joissakin kokeissa ei aine ollut riittävä ehkäisemään lumihomeen vaurioita. Ottaen huomioon toiselta puolen melkoiset PCNB:n käytöstä johtuvat ainekustannukset ja toiselta puolen lumihomeen runsaan esiintymisen on 5 kg/ha 100-%:sta PCNB:tä pidettävä Suomen oloissa tarkoituksenmukaisimpana määränä.

PMAS-valmisteista olivat kokeiltavina Bayer 4426, Femma ja Verdasan. PMAS-valmisteet olivat jonkin verran tehokkaampia lumihomeeseen kuin PCNB. Kuten PCNB, eivät elohopeavalmisteetkaan olleet aina riittävän tehokkaita torjumaan lumihomeen vaurioita. Suomen oloissa voidaan 10—12 kg:aa/ha Femma- (2.5 % PMA) valmistetta ja 8.5 kg:aa/ha Verdasanvalmistetta pitää sopivana määränä.

PCNB- ja PMAS-valmisteiden teho *Typhula*-sieniin oli vaihteleva ja yleensä heikompi kuin lumihomeeseen.

Muut org. elohopeavalmisteet (Ceresan 200, Ceresan M-2X, Mercadmine ja Merculine) ja arseenipitoiset valmisteet tehosivat hyvin tai melko hyvin lumihomeeseen ja *Typhula*-sieniin.

Lumihomeelle alttiit syysruislajikkeet (Pekka, Visa ja Kuningas II) saadaan oraiden fungisidikäsittelyllä tuottamaan runsaampia sadonlisäyksiä kuin taudille kestäväksi tunnetut lajikkeet (Ensi, Toivo ja kotimaiset kannat). Jos olosuhteet ovat kuitenkin suotuisat lumihomeen esiintymiselle, myös tautia hyvin tai melko hyvin kestäviksi tunnetut syysruislajikkeet saattavat kärsiä pahasti lumihomeen vaurioista (ks. asetelma s. 9—10).

Pohjois-Savon koeaseman kokeissa 1958/59 ja 1959/60 (taulukko 1, s. 31—32) olivat syysrukiin oraiden syystalvikäsittelyn saaneissa koejäsenissä jyväsadot pienempiä kuin kontrollikoejäsenissä, vaikka fungisidit olivat torjuneet lumihomeen vaurioita, mikä johtui siitä, että kasvusto kehittyi fungisidikäsittelyn saaneissa koejäsenissä, säilyessään lumihomeelta, liian tiheäksi ja lakoutui.

Paras syysrukiin käsittelyaika on suurimmassa osassa maata marraskuu, eteläosissa sen loppupuoli ja keskiosissa alkupuoli, sekä pohjoisimmissa osissa Suomea lokakuun loppupuoli.

Suurimmat sienivauriot esiintyivät koeasemien kokeissa useimpina talvina Keski-, Itä- ja Pohjois-Suomessa, jossa myös oraiden fungisidikäsittelyillä saatiin usein huomattavia sadonlisäyksiä. Myös Etelä-Suomessa on seutuja, joissa lumihome tekee suuria vahinkoja, kuten Tikkurilassa, ja jossa fungisidikäsittelyt johtivat huomattaviin sadonlisäyksiin. Suomen lounais- ja länsiosissa ovat lumihomeen vahingot vähäisemmät kuin maan muissa osissa. Lounais-Suomen ja Keski-Pohjanmaan koeaseman kokeissa vahingot jäivät vähäisiksi.

Syysvehnäkokeet

Tuhosienivaurioiden aiheuttajina olivat *Typhula*-sienet, pääasiallisesti *T. ishikariensis*, vähemmässä määrin *T. incarnata*, sekä lumihome (*Fusarium nivale*). Hämeen koeaseman kokeissa 1958/59 oli hiesumaalla runsaasti *Septoria*-sienten vaurioita. Pohjois-Pohjanmaan koeaseman kokeissa 1958/59 esiintyi talvehtimisvaurioiden pääasiallisena aiheuttajana *Sclerotinia borealis.*

Koetulokset on esitetty taulukossa 2. Useimmat syysvehnäkokeet oli tehty PCNB- ja PMA-valmisteilla.

Käytetyt PCNB-määrät eivät olleet aina riittävät torjumaan lumihomeen ja *Typhula*-sienten vahinkoja. Pohjanmaan koeaseman kokeissa 1958/59 PCNB pystyi tehokkaasti torjumaan *Sclerotinia borealis*en vaurioita, silloin kun PMA-valmiste oli sieneen tehoton. 5 kg:aa 100-%:sta PCNB:tä hehtaarille voidaan pitää syysvehnällä kuten syysrukiillakin käyttökelpoisimpana määränä.

PMA-valmisteet olivat teholtaan talvituhosieniin samankaltaisia kuin PCNB-valmisteet. 10—12 kg/ha Femma (2.5 %:n PMA)-valmistetta ja 8.5 kg/ha Verdasan-valmistetta voidaan katsoa tarkoituksenmukaisimmiksi maamme oloissa.

Org. elohopeavalmisteista Ceresan 200 tehosi hyvin sekä lumihometta että *Typhula*-sieniä vastaan. Urbasulfvalmiste Bayer 4934 tehosi melko hyvin *Typhula*-sieniin; lumihomeeseen tämän valmisteen vaikutus oli vaihteleva.

Paras syysvehnän käsittelyaika on marraskuu.

Hämeen koeaseman hiesumaan lajikekokeissa 1958/59, 1959/60 ja 1960/61 aiheuttivat *Typhula*-sienet ja lumihome, 1958/59 myös *Septoria*-sienet suuria vaurioita (taulukko 2, s. 42—44). Viimeksi mainittuihin sieniin eivät fungisidikäsittelyt olleet tehonneet. Vastaavasti karkean hietamaan kokeissa olivat talvituhosienten vauriot näinä vuosina pienemmät kuin hiesumaalla.

Kun edellytykset ovat suotuisat talvituhosienien esiintymiselle, myös maassamme parhaiten talvehtivat syysvehnälajikkeet kärsivät sienivaurioista (ks. asetelma s. 16).

Lounais-Suomen ja Satakunnan koeasemilla ei esiintynyt sanottavasti talvituhosienivaurioita. Tikkurilassa karkealla hietamaalla suoritetuissa kokeissa talvituhosienet aiheuttivat monina vuosina suuria vaurioita. Samoin ne olivat runsaat tiettyinä vuosina Hämeen, Etelä-Savon, Keski-Suomen ja Pohjois-Savon koeasemilla tehdyissä kokeissa.

Hämeen koeaseman syysvehnäkokeessa 1960/61 ja 1961/62 ei oraiden PCNB-käsittely ollut lisännyt satoja huolimatta talvituhosienien runsaasta esiintymisestä käsittelemättömillä koeruuduilla. Päinvastoin sadot olivat käsittelyn saaneissa koejäsenissä eräissä tapauksissa jonkin verran pienemmät kuin käsittelemättömissä (taulukko 2, s. 43—44). Linnomäki (1963) selostaa syynä tähän olleen sen, että kumpainenkin kasvukausi oli erittäin sateinen, jolloin PCNB-käsittelyn saaneet kasvustot kehittyivät liian tiheiksi ja varsinkin heikkokortiset lajikkeet kuten Varma ja Antti lakoutuivat niin pahasti, että siitä oli seurauksena sadon väheneminen. Sen sijaan käsittelemättömät olivat juuri sopivasti harventuneita pysyäkseen kohtalaisesti pystyssä ja satotuloskin oli hyvä. Ertus on siinä määrin lujakortinen lajike, etteivät lakoutumisen aiheuttamat satotappiot pystyneet ehkäisemään käsittelyn edullista vaikutusta.

Fungisidien käyttömahdollisuudet syysviljojen talvituhosienien torjumiseksi

Tärkeimpiä keinoja talvituhosienien vaurioiden torjumiseksi on niitä parhaiten kestävien syysviljalajikkeiden viljeleminen. Kokeet kuitenkin osoittavat, että myös suomalaiset, talvituhosieniä vastaan kestäviksi tunnetut lajikkeet, voivat kärsiä huomattavia vaurioita, jos olosuhteet ovat suotuisat sienien esiintymiselle.

Riippuen talvehtimisajan sääolosuhteista oraiden fungisidikäsittelyillä toisissa tapauksissa saadaan talvituhosienien vauriot kokonaan torjutuksi, ja toisissa tapauksissa niiden teho jää heikoksi. Varsinkin *Typhula*-sienet (kokeissa pääasiallisesti *T. ishikariensis*) saattavat olla eräissä tapauksissa vaikeasti torjuttavia. Parhaan käsittelyajan määrittäminen on monesti vaikeaa, koska se on siirrettävä tapahtuvaksi mahdollisimman myöhään ennen lumen tuloa. Fungisidien käytön haittapuolena on niiden verraten korkea hinta; PCNB-valmisteet ovat Suomessa huomattavasti kalliimpia kuin eräissä muissa maissa. Jos olosuhteet ovat sellaiset, ettei talvituhosienivaurioita laisinkaan esiinny tai niiden vauriot ovat vähäiset, menevät käsittelyyn uhratut varat hukkaan.

Syysruiskokeissa, joista on satotulokset yhteenvetoasetelmassa s. 18, oli PCNB osaiden käsittelyaineena 114 kokeessa ja PMA 35 kokeessa, vastaavasti syysvehnällä oli PCNB käsittelyaineena 42 kokeessa ja PMA 23 kokeessa. — Asetelmasta s. 18 voidaan todeta, että Kasvitautien tutkimuslaitoksella ja koeasemilla suoritetuista kokeista oli runsain määrä sellaisia, joissa oraiden käsittely aiheutti sadonlisäystä 20—24 prosenttia. Noin kolmannessa osassa kokeita olivat sadonlisäykset yli 25 %. Paikalliskokeissa muodostavat suurimman ryhmän kokeet, joissa sadonlisäys oli 1—9 %, ja lähes kolmannessa osassa kokeita oli sadonlisäys 10—24 prosenttia. — Sadonlisäysten kilomäärän perusteella jaoteltuna joutuu suurin osa kokeista ryhmään, jossa jyväsatojen lisäykset olivat oraiden käsittelyn johdosta 100—499 kiloa hehtaarilta. Kasvitautien tutkimuslaitoksen ja koeasemien kokeista oli niitä, joissa käsittelyllä saatiin sadonlisäystä yli 500 jyväkiloa hehtaarilta, syysrukiilla noin kolmas osa ja syysvehnällä lähes puolet. Paikalliskokeista vain 8 prosentissa sadonlisäys ylitti 500 jyväkiloa hehtaarilta. — Paikalliskokeista saatu heikompi tulos johtuu siitä, että suurin osa niistä oli suoritettu lumihometta kestävillä syysruislajikkeilla, kun taas muissa kokeissa oli runsaasti talvituhosienille alttiita lajikkeita. — Suuria eroja PCNB- ja PMA-käsittelyillä saatujen sadonlisäysten välillä ei ollut todettavissa. Selvin ero on tässä suhteessa syysrukiilla, jolla PMA-käsittelyt antoivat jonkin verran paremman tuloksen kuin PCNB.

Syysrukiin oraiden fungisidikäsittelyihin ei kannata turvautua, jos viljellään talvituhosieniä vastaan hyvin kestäväksi tunnettuja suomalaisia lajikkeita (Ensi ja Toivo) ja maatiaiskantoja. Vain sellaisissa kasvupaikoissa, varsinkin maamme sisäosissa, joissa lumihomeen tuhot jatkuvasti toistuvat, voi fungisidien käyttö näilläkin lajikkeilla tulla kysymykseen. Jos halutaan viljellä kotimaisia, lumihomeelle verraten alttiita, mutta edellä mainittuja sadoltaan parempia ja lujakortisempia lajikkeita kuten Pekka- ja Visa-rukiita, voidaan näillä lajikkeilla päästä kaikkialla maassamme oraiden fungisidikäsittelyillä hyviin tuloksiin lumisilla seuduilla ja lumisissa kasvupaikoissa. Fungisideja käyttämällä voitaisiin ryhtyä entistä varmemmin tuloksin viljelemään hyväsatoisia, lyhytkortisia, mutta lumihomeelle alttiita ulkomaisia, lähinnä ruotsalaisia lajikkeita, kuten Kuningas II, Doddelstål ja Värne. Näitä on helpompi korjata leikkuupuimurilla, kun suomalaisten pitkäkortisten rukiiden korjuussa on tässä suhteessa vaikeuksia.

Syysvehnän oraiden käsittelyllä ei ole merkitystä Lounais- ja Etelä-Suomessa viljeltäessä sitä savimailla, koska niillä talvituhosienet eivät yleensä aiheuta sanottavia vaurioita. Sen sijaan voidaan fungisideilla varmistaa vehnän viljelyä hiekka- ja hietamailla, hiesumailla sekä multamailla myös sen nykyisellä viljelyalueella. Keskiosissa maatamme voidaan fungisideja käyttämällä viljellä syysvehnää varmemmin tuloksin kuin aikaisemmin. Menetelmä on näin ollen varteen otettava keino syysvehnän talvehtimisen parantamiseksi, koska nykyisin käytettävissä olevat parhaiten talvehtivat lajikkeetkaan eivät menesty edellä mainituissa olosuhteissa huonon talvehtimisen vuoksi. Tällöin voitaisiin syysvehnän viljely ulottaa maassamme nykyistä pohjoisemmaksi.

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WIRKUNG VON NIEDERSCHLAG UND TEMPERATUR AUF DEN MINERALSTOFFGEHALT DES TIMOTHEEHEUS

HILKKA HEINONEN
Zentrale für Landwirtschaftliche Forschung, Abteilung für Agrikulturchemie und -physik
Tikkurila, Finnland

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In der Zentrale für Landwirtschaftliche Forschung, im Institut für Agrikulturchemie und -physik, hat man u.a. den Einfluss verschiedener Düngung auf Ertrag und seinen Mineralstoffgehalt von Grünlandflächen der Kleegrasswirtschaft untersucht. Dabei ist ein von Düngung und Bodenart unabhängiges Schwanken nicht nur in der Grösse des Ertrages, sondern auch in seinen Mineralstoffgehalten festgestellt worden, so dass auf Grund der zur Verfügung stehenden Analysenergebnisse die durch verschiedene Witterungsverhältnisse bedingte Differenzen in den Gehalten darzulegen versucht werden sollen.

Untersuchungsmaterial

Das Material ist von Grünlandfeldversuchen, die mit verschieden hohen Stickstoff-, Phosphor- und Kalimengen gedüngt wurden, in den Jahren 1928—60 gesammelt worden. Die Versuche selbst und die ermittelten Ergebnisse sind schon früher vom Blickpunkt der Düngung zur Darstellung gelangt (SALONEN und TAINIO 1957, 1961; SALONEN *et al.* 1962).

Als Gegenstand der Arbeit sind unter den betreffenden Versuchen diejenigen Glieder, die eine möglichst gleichartige Stickstoff-Phosphor-Kalidüngung erhalten haben, ausgewählt worden, damit die durch die Düngermengen bewirkten Veränderungen das Hervortreten der Witterungseinflüsse während der Vegetationsperiode möglichst wenig stören konnten.

Da sich die Witterungsverhältnisse der jeweiligen Vegetationsperiode und des ihr vorausgegangenen Winters in der Artzusammensetzung des Grünlandes stark auswirken und dies, besonders der Anteil des Klees am Grünland, seinerseits beträchtliche Unterschiede im Mineralstoffgehalt des Aufwuchses zur Folge hat, wurden nur Heuproben untersucht, die entweder hauptsächlich oder ausschliesslich Timothee, aber überhaupt keinen Klee enthielten.

Die zwischen den einzelnen Grasarten bestehenden Unterschiede im Mineralgehalt selbst sind recht gering, wesentlich geringer als die durch den Klee-Anteil oder den Erntezeitpunkt bedingten Differenzen (u.a. Keränen 1941, Svanberg und Ekman 1946, Knoch 1961, Svanberg 1962). Die Proben enthielten durchschnittlich 80.5 % Timothee. An sonstigen Pflanzen kamen meistens Rasenschmiele und Straussgras, seltener Rispengras und Schwingel vor. Die Ernte war im allgemeinen in der ersten Hälfte der Blütezeit des Timothees vorgenommen worden.

An derartigen Proben wurden 395 St. untersucht, wobei von allen Stickstoff, Phosphorsäure und Kali sowie bei 328 von ihnen des weiteren Kalk und Magnesia bestimmt wurden. Die bei den Analysen angewandten Methoden sind früher veröffentlich worden (Salonen *et al.* 1962).

Die Proben hat man in verschiedenen Gegenden Finnlands und die ihnen entsprechenden Wetterbeobachtungswerte bei der Meteorologischen Zentralanstalt der dem Versuchsort nächstgelegenen Wetterwarte entnommen. Diese haben mit wenigen Ausnahmen in derselben oder einer benachbarten Gemeinde zur Verfügung gestanden, so dass die durch die regionale Verteilung des Niederschlages bewirkten Abweichungen von seiner wirklichen Menge auf ein möglichst Geringes eingeschränkt werden konnten.

In Tabelle 1 sind die Menge der Proben aus den verschiedenen Gemeinden und die entsprechenden Wetterwarten angegeben.

Tabelle 1. Die Anzahl der Proben bei der verschiedenen Gemeinden und die entsprechenden Wetterwarten.

Lage der Felder	Breitengrad	Proben	Wetterwarte
Kuolemajärvi	60	4	Uusikirkko, Halila
Uusikirkko	60	2	
Loimaa	61	1	Jokioinen
Kokemäki	61	6	Kokemäki, Peipohja
Nakkila	61	4	
Pihtipudas	63	119	Lestijärvi [1]
Kälviä	64	3	Reisjärvi
Lohtaja	64	1	
Himanka	64	1	
Suomussalmi	65	9	Suomussalmi
Kuusamo	66	34	Kuusamo
Karunki	66	14	Rovaniemi
Alatornio	66	14	Ylitornio
Ylitornio	66	21	
Salla (Kuolajärvi)	67	38	Salla
Sodankylä	67—68	124	Sodankylä, Tähtelä

1) Die fehlenden Mitteltemperaturwerte des Monats für 1943-47, 1953-59 sind auf Grund der betreffenden Werte der nächstgelegenen Wetterwarten berechnet worden.

Tabelle 2. Mittelwerte und Standardabweichungen des Untersuchungsmaterials

Variable	Mittelwert	Standardabweichung
Witterungsfaktor		
Niederschlagsmenge Mai—Juni mm	91.3	32.21
Temperaturmittel Juni ° C	12.6	1.97
Düngung kg/ha		
N	35.0	7.28
P_2O_5	67.0	15.86
K_2O	99.9	33.18
Heuertrag dz/ha	57.26	16.606
Mineralstoffgehalt der Gräser in ‰ der Trockensubstanz		
N	12.75	3.537
P_2O_5	5.36	1.212
K_2O	20.59	5.071
CaO	4.76	1.578
MgO	2.39	0.936

Von den Witterungsfaktoren sind Niederschlag und Lufttemperatur berücksichtigt worden, die besonders stark auf die Nährstoffaufnahme der Pflanzen einwirken. Das tägliche Temperaturmittel im Juni (° C) und der Niederschlag von Mai—Juni (mm) haben die Witterungsschwankungen charakterisiert.

Von den Proben sind 89.1 % auf Torfböden, 2.8 % auf Mullböden, 1.8 % auf Ton- und Schluffböden und 6.3 % auf gröberen Mineralböden gewachsen. Es ist davon abgesehen worden, den Einfluss der Bodenart in den Schwankungen der Analysenzahlen herauszustellen, ebensowenig war es infolge der unvollständigen Angaben möglich, den Anteil der Fruchtbarkeit des Bodens zu ermitteln.

Da jedoch nach den früheren Untersuchungen am Gleichen Material die Düngung einen grossen Einfluss auf die Mineralstoffmenge ausübt, ist jedoch die geringe Schwankung in den Verbrauchsmengen an Düngemittel bei den Berechnungen berücksichtigt worden.

In der angeführten Tabelle 2 sind die Mittelwerte und die Standardabweichungen der zu erforschenden Faktoren dargestellt.

Untersuchungsmethode

Das Material ist mittels Regressionsanalyse bearbeitet worden, wobei es darauf angekommen ist, die Schwankungen in den Mineralstoffgehalten (‰ der Trockensubstanz) durch eine Gleichung ersten Grades unter Anwendung des Temperaturmittels vom Juni (° C), der Niederschlagsmenge von Mai—Juni (mm) und der Düngermengen (10 kg/ha N, P_2O_5 und K_2O) als unabhängige Variablen zu ermitteln. Auch der Einfluss der Düngung ist also linear berücksichtigt worden, was wegen der geringen Variationsbreite als berechtigt angesehen werden kann. Da schon bei früheren Untersuchungen der Einfluss der Düngung auf die Höhe des Ertrages festgestellt worden war, und der Mehrertrag von dem betreffenden Ertragsniveau abhängig ist (SALONEN *et al.* 1962), wurde als weiterer Faktor, der die Schwankungen erklärt, die Grösse des Ertrages (dz/ha) in die Gleichung aufgenommen. Die Regressionsanalysen wurden progressiv errechnet, indem in die Gleichung, die die Schwankungen widerspiegelt, in der Signifikanzreihenfolge als erklärende Variable gewählt wurde. Die Berechnungen wurden mit einer elektronischen Rechenmaschine IBM 1620 ausgeführt (EFROYMSON 1960).

Bei der Betrachtung der durch die Regressionsanalysen gewonnenen Ergebnisse muss allerdings berücksichtigt werden, dass die den Einfluss der Düngung widerspiegelnden Koeffizienten lediglich zur Ausschaltung der in der Düngung hervortretenden Variation aus dem Material dienen. Sie eignen sich für die Erklärung des Einflusses der Düngung nicht so gut wie die Ergebnisse, die aus einem Material mit grösserer Variationsbreite erhalten worden sind.

Ergebnisse

Die durch die Regressionsanalysen gewonnenen Resultate sind in den Tabellen 3—6 wiedergegeben. Aus diesen sind die für die betreffenden Faktoren bezüglichen partiellen Regressionskoeffizienten sowie die Signifikanz bezeichnenden Sternchen [1]) und die Konstante der erhaltenen Regressionsgleichung ersichtlich. Die partiellen Regressionskoeffizienten spiegeln den durchschnittlichen Einfluss des betreffenden Faktors auf die Gehalte an Mineralstoffen wider, während die übrigen zu der Gleichung gehörenden Unabhängigen durchschnittlich bleiben. Die Zuverlässigkeit der Ergebnisse ist durch den F-Test geprüft worden.

Im folgenden werden die als signifikant erkannten Gleichungen, die möglichst viele erklärende Variablen enthalten haben, einer näheren Betrachtung unterzogen.

Aus Tabelle 3 geht hervor, dass die Differenzen im Stickstoffgehalt des Heus unter den erforschten Faktoren am meisten durch die Höhe der Stickstoff- und Phosphorgaben beeinflusst wird, aber auch die Höhe des Ertrages und die Niederschlagsverteilung zu Beginn der Vegetationsperiode einen sehr hochsignifikanten Einfluss ausgeübt haben. Gemäss Gleihung 4 hat ein Zunehmen der Stickstoffmenge den N-Gehalt des Ertrages um 1.20 ‰-Einheit je 10 kg N erhöht. Eine überdurchschnittliche Phosphorsäuredüngung dagegen hat den N-Gehalt herabgesetzt, wobei die im Material den N-Gehalt herabsetzende Wirkung der Phosphorsäuremenge 0.47 ‰-Einheit je 10 kg P_2O_5 betragen hat. Das vorherrschende Ertragsniveau, in dem sich die all-

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1) Folgende Zeichen werden in den Tabellen benutzt, um die Signifikanz der F- und t-Werte auszudrücken:

*** sehr hochsignifikant; $P \leqq 0.1\,\%$
** hochsignifikant; $0.1\,\% < P \leqq 1\,\%$
* signifikant; $1\,\% < P \leqq 5\,\%$
·· $5\,\% < P \leqq 10\,\%$
· $10\,\% < P \leqq 20\,\%$

Tabelle 3. Die Ästimaten der Parameter der Funktionen, die den durchschnittlichen Einfluss von Witterung, Düngung und Ertragsniveau auf den Stickstoffgehalt der Gräser (N ‰ der Trockensubstanz) widerspiegeln.

Gleichung	Partielle Regressionskoeffizienten						Konstante	F-Werte
	Stickstoffdüngung 10 kg/ha N	Phosphordüngung 10 kg/ha P_2O_5	Ertragsniveau dz/ha	Niederschlagsmenge mm V+VI	Kalidüngung 10 kg/ha K_2O	Temperatur °C VI		
1	1.2603***						8.34	28.33***
2	1.1516***	—0.4993***					12.07	22.03***
3	1.2241***	—0.4975***	0.0349***				9.80	12.18***
4	1.1983***	—0.4692***	0.0357***	0.0176***			8.04	11.98***
5	1.1746***	—0.4872***	0.0375***	0.0178***	—0.0597		8.73	1.40
6	1.1659***	—0.4865***	0.0380***	0.0164**	—0.0596	—0.0411	9.36	0.17

Tabelle 4. Die Ästimaten der Parameter der Funktionen, die den durchschnittlichen Einfluss von Witterung, Düngung und Ertragsniveau auf den Phosphorgehalt der Gräser (P_2O_5 ‰ der Trockensubstanz) widerspiegeln.

Gleichung	Partielle Regressionskoeffizienten						Konstante	F-Werte
	Stickstoffdüngung 10 kg/ha N	Temperatur °C VI	Niederschlagsmenge mm V+VI	Kalidüngung 10 kg/ha K_2O	Ertragsniveau dz/ha	Phosphordüngung 10 kg/ha P_2O_5		
1	0.4871***						3.65	36.72***
2	0.4478***	—0.1276**					5.40	19.06***
3	0.4508***	—0.0959**	0.0036••				4.66	2.88*
4	0.4433***	—0.0949**	0.0037••	—0.0195			4.86	1.27
5	0.4462***	—0.0976**	0.0036••	—0.0209	0.0020		4.79	0.32
6	0.4427***	—0.0973**	0.0036••	—0.0220	0.0020	—0.0150	4.91	0.17

Tabelle 5. Die Ästimaten der Parameter der Funktionen, die den durchschnittlichen Einfluss von Witterung, Düngung und Ertragsniveau auf den Kaligehalt der Gräser (K_2O ‰ der Trockensubstanz) widerspiegeln.

Gleichung	Partielle Regressionskoeffizienten						Konstante	F-Wert
	Kalidüngung 10 kg/ha K_2O	Phosphordüngung 10 kg/ha P_2O_5	Niederschlagsmenge mm V+VI	Stickstoffdüngung 10 kg/ha N	Ertragsniveau dz/ha	Temperatur °C VI		
1	0.6337***						14.26	81.56***
2	0.5894***	—0.6755***					19.23	21.88***
3	0.5855***	—0.6413***	0.0211**				17.12	9.07***
4	0.6019***	—0.6037***	0.0205**	0.7401*			14.16	5.70***
5	0.6094***	—0.6021***	0.0203**	0.7233*	—0.0098		14.71	0.52
6	0.6093***	—0.6023***	0.0206*	0.7249	—0.0099	0.0080	14.59	0.00

Tabelle 6. Die Ästimaten der Parameter der Funktionen, die den durchschnittlichen Einfluss von Witterung, Düngung und Ertragsniveau auf den Kalkgehalt der Gräser (CaO ‰ der Trockensubstanz) widerspiegeln.

Gleichung	Partielle Regressionskoeffizienten						Konstante	F-Wert
	Kalidüngung 10 kg/ha K_2O	Temperatur °C VI	Niederschlagsmenge mm V+VI	Stickstoffdüngung 10 kg/ha N	Ertragsniveau dz/ha	Phosphordüngung 10 kg/ha P_2O_5		
1	—0.1102***						5.83	20.74***
2	—0.1097***	—0.1002*					7.08	5.73**
3	—0.1074***	—0.1432**	—0.0049••				8.06	2.53*
4	—0.1069***	—0.1361**	—0.0048•	0.1290•			7.49	1.34
5	—0.1081***	—0.1384**	—0.0048•	0.1314	0.0019		7.42	0.13
6	—0.1081***	—0.1384**	—0.0048•	0.1313	0.0019	—0.0003	7.42	0.00

gemeine Gunst oder Ungunst der Wachstumsverhältnisse spiegelt, hat ebenfalls einen Einfluss auf den N-Gehalt der Gräser ausgeübt. Steigt der Hektarertrag auf 1 dz an, so hat der N-Gehalt durchschnittlich um 0.04 ‰ zugenommen.

Die Wirkung der Witterungsfaktoren auf den N-Gehalt ist geringer geblieben. Eine überdurchscnittliche Niederschlagsmenge während der Monate Mai und Juni hat den N-Gehalt im Mittel um 0.18 ‰ je 10 mm gesteigert. Die Temperaturschwankungen im Juni haben dagegen den N-Gehalt der Gräser nicht beeinflusst.

Auch auf den P h o s p h o r s ä u r e g e h a l t der Pflanzen (Tab. 4, Gl. 3) hat die Stickstoffdüngung eine sehr hochsignifikante Wirkung ausgeübt. Bei zunehmender Stickstoffdüngermenge ist der P_2O_5-Gehalt der Pflanzen durchschnittlich um 0.45 ‰ angestiegen. Auch die Temperaturschwankungen sind von hochsignifikantem Einfluss gewesen. So hat im Juni, wenn die Temperatur überdurchschnittlich hoch war, der P_2O_5-Gehalt um 0.10 ‰ je 1° C Anstieg der Mitteltemperatur abgenommen. Der den P_2O_5-Gehalt steigernde Einfluss des Anstiegs der Niederschlagsmenge (0.04 ‰ je 10 mm) in der beginnenden Vegetationsperiode hat über 90 % Wahrscheinlichkeit aufgewiesen.

An den Schwankungen im K a l i g e h a l t (Tab. 5, Gl. 4) haben die Verbrauchsmengen an Düngemittel einen beträchtlichen Anteil. Eine Zunahme der Kalidüngung um 10 kg/ha K_2O hat den K_2O-Gehalt der Gräser durchschnittlich um 0.60 ‰ gehoben. Die Wirkung der Phosphordünger ist ebenso gross gewesen, aber negativ, d.h. eine überdurchschnittliche Anwendung hat den K_2O-Gehalt der Gräser herabgesetzt. Sowohl Phosphor- als auch Kalidüngung erwiesen sich in ihren Wirkungen statistisch als sehr hochsignifikant. An nächster Stelle in der Signifikanzreihenfolge stand die Niederschlagsmenge von Mai—Juni. Eine überdurchschnittliche Niederschlagsmenge während dieser Zeit vermehrte den Kaligehalt der Gräser um 0.21 ‰ je 10 mm und der dies beweisende partielle Regressionskoeffizient hatte 99 % Wahrscheinlichkeit. Als hoch signifikant erwies sich auch die den K_2O-Gehalt steigernde Wirkung zusätzlicher Stickstoffdüngung, 0.74 ‰ je 10 kg N.

Den K a l k g e h a l t der Gräser (Tab. 6, Gl. 3) scheinen unter den erforschten Faktoren am meisten der Wechsel der Kalidüngermenge, die Niederschlags- und die Wärmeverhältnisse zu beeinflussen. Die Zunahme der Kalidüngung um 10 kg/ha K_2O hat den CaO-Gehalt durchschnittlich um 0.11 ‰ herabgesetzt. Dabei ist der betreffende partielle Regressionskoeffizient sehr hochsignifikant gewesen. Ein überdurchshnittlich warmer Juni hat den CaO-gehalt hochsignifikant vermindert (0.14 ‰ je 1° C). Der schwach negative Einfluss des Anstiegs in der Niederschlagsmenge von Mai—Juni (0.05 ‰ je 10 mm) kann wohl als Tendenz angesehen werden, da der Koeffizient nur die Wahrscheinlichkeitsgrenze von 80 % überschreitet.

Auf den M a g n e s i a g e h a l t (Tab. 7, Gl. 3) übt die Witterung der Vegetationsperiode, wie sich in diesem Material erwiesen hat, keinen Einfluss aus, denn unter den erforschten Faktoren hat sich hauptsächlich die Kali-

Tabelle 7. Die Ästimaten der Parameter der Funktionen, die den durchschnittlichen Einfluss von Witterung, Düngung und Ertragsniveau auf den Magnesiagehalt der Gräser (MgO ‰ der Trockensubstanz) widerspiegeln.

Gleichung	Partielle Regressionskoeffizienten						Konstante	F-Werte
	Kalidüngung 10 kg/ha K_2O	Ertragsniveau dz/ha	Stickstoffdüngung 10 kg/ha N	Phosphordüngung 10 kg/ha P_2O_5	Temperatur °C VI	Niederschlagsmenge mm V+VI		
1	—0.0782***						3.15	30.53***
2	—0.0846***	0.0099***					2.65	10.91**
3	—0.0844***	0.0102***	0.1039•				2.26	2.60*
4	—0.0858***	0.0103***	0.0955•	—0.0266			2.48	0.64
5	—0.0858***	0.0105***	0.0923•	—0.0256	—0.0122		2.63	0.25
6	—0.0855***	0.0106***	0.0905•	—0.0266	—0.0203	—0.0009	2.82	0.25

Tabelle 8. Partielle Regressionskoeffizienten für den Einfluss von Witterung, Düngung und Ertragsniveau auf die Mineralstoffgehalte sowie die ihnen entsprechenden β-Koeffizienten.

	Gleichung	Partielle Regressionskoeffizienten					Ertrags-niveau dz/ha
		Niederschlags-menge mm V+VI	Temperatur °C VI	Düngung 10 kg/ha			
				N	P_2O_5	K_2O	
N	4	0.0176***		1.1983***	—0.4692***		0.0357***
P_2O_5	3	0.0036••	—0.0959**	0.4508***			
K_2O	4	0.0205**		0.7401*	—0.6037***	0.6019***	
CaO	3	—0.0049••	—0.1432**			—0.1074***	
MgO	3			0.1039•		—0.0844***	0.0102***
		Die entsprechenden β-Koeffizienten					
N	4	0.161		0.247	—0.210		0.168
P_2O_5	3	0.095	—0.156	0.271			
K_2O	4	0.130		0.106	—0.189	0.394	
CaO	3	—0.101	—0.183			—0.239	
MgO	3			0.084		—0.316	0.179

düngung die Schwankungen im MgO-Gehalt der Gräser ausgewirkt. Er hat sich durchschnittlich um 0.08 ‰ vermindert, wenn die Düngermenge um 10 kg/ha K_2O gestiegen ist. Als sehr hochsignifikant hat sich auch das Verhältnis zwischen der Ertragshöhe und dem MgO-Gehalt erwiesen. Bei grösserem Hektarertrag ist auch der MgO-Gehalt der Pflanzen höher gewesen (0.01 ‰ je dz). Der den MgO-Gehalt steigernde Einfluss der Stickstoffdüngung hat 90 % Wahrscheinlichkeit aufgewiesen.

Diskussion

Tabelle 8 enthält die Koeffizienten und die entsprechenden sog. β-Koeffizienten von den als signifikant erkannten Gleichungen. Da die Grösse der Koeffizienten nach der Einheit, in der jede Variable ausgedrückt ist, wechselt, lässt sich die Bedeutung der Veränderungen der Faktoren besser mittels der β-Koeffizienten vergleichen, wobei der Einfluss jeder Variablen in den Einheiten ihrer eigenen Standardabweichung gemessen wird (Ezekiel und Fox 1961).

Durch die untersuchten Variablen haben von den Variationen der Mineralstoffgehalte nur 10—25 % erklärt werden können. Zusammenfassend sei festgestellt, dass, obgleich versucht worden ist, das Schwanken der Düngung auf ein möglichst Geringes zu beschränken, dadurch grössere Unterschiede in den Nährstoffgehalten der Gräser auftraten als durch den Einfluss der Witterung bedingt worden sind.

Die Erhöhung der Stickstoffdüngung steigerte die Gehalte an N, P_2O_5 und K_2O sowie in gewissen Masse auch an MgO, wirkte aber nicht auf den CaO-Gehalt ein. Auch in einigen anderen Untersuchungen über Gräser (u.a. Prince 1954, Russel *et al.* 1954) wurde dieser Einfluss von Stickstoff und ausserdem seine den CaO-Gehalt herabsetzende Wirkung festgestellt. Grunes und Krantz (1958) erklärten, der Anstieg im P_2O_5- und im K_2O-Gehalt sei auf die das Wachstum des Wurzelwerks steigernde Wirkung des Stickstoffes zurückzuführen. Dagegen ist die Magnesiumaufnahme der Pflanzen wesentlich von der Stickstoffart abhängig. Man erkannte, dass Ammoniumsticktoff die Magnesiumaufnahme erschwert, Nitratstickstoff sie dagegen erleichtert (v. Itallie 1937, Mulder 1956). Bei dem vorliegenden Untersuchungsmaterial war als Stickstoffdünger hauptsächlich Kalksalpeter, weniger Oulu-Salpeter (= Kalkammonsalpeter, fabriziert in Finnland) verwendet worden (Salonen *et al.* 1962, S. 146). Die Wirkung zusätzlicher Phosphorsäuredüngung äusserte sich in einer Verminderung der N- und der K_2O-Gehalte. Der die Stickstoffaufnahme herabsetzende Einfluss des Phosphors ist u.a. bei Gefässversuchen mit Getreide festgestellt worden (Michael 1939, Schmalfuss 1951). Das negative Korrelieren der CaO- und der MgO-Gehalte von Gräsern mit der Menge der Kalidüngung trat auch bei diesem Material sehr hochsignifikant hervor, desgleichen die den K_2O-Gehalt erhöhende Wirkung der Kalidüngung. Sie übte aber auf die N- und P_2O_5-Gehalte keinen signifikanten Einfluss aus (vgl. Washko 1949, Prince 1954, Salonen und Tainio 1961).

Aus den β-Koeffizienten geht hervor, dass die Stickstoffdüngung auf die Schwankungen des N- und P_2O_5-Gehaltes mehr als auf die des K_2O-Gehaltes und noch weniger auf den CaO-Gehalt eingewirkt hat. Die Bedeutung der Phosphorsäuredüngung war bei den Variationen des N-Gehaltes grösser als bei denen des K_2O-Gehaltes und die Bedeutung der Kalidüngung war für den K_2O- und den MgO-Gehalt stärker als für den CaO-Gehalt.

In Anbetracht der durch die Düngung verursachten Veränderungen im Mineralstoffgehalt trat auch die Bedeutung der Witterung zu Beginn der Vegetationszeit hervor. Der positive Einfluss des Anstiegs der Niederschlagsmenge von Mai—Juni auf den N- und den K_2O-Gehalt war statistisch gesichert und schien sich auch auf den P_2O_5-Gehalt positiv einzuwirken (Daniel und Harper 1935, Homb 1953). Nach den β-Koeffizienten war jedoch die Phosphoraufnahme der Gräser von den Schwankungen der Niederschlagsmenge weniger abhängig als die von Kali und Stickstoff, was mit den Ergebnissen von Untersuchungen über die Wirkung der Bodenfeuchtigkeit bei anderen Pflanzen übereinstimmte (u.a. Richards und Wadleigh 1952). Die Bedeutung des Niederschlages für die Schwankungen im CaO-Gehalt der Gräser war ebenso gross wie beim P_2O_5-Gehalt, aber eine überdurchschnittliche Niederschlagsmenge verminderte den CaO-Gehalt. Dieser den Kalkgehalt der Gräser herabsetzende Einfluss des Niederschlages ist auch bei einigen anderen Versuchen mit Mischbeständen von Gräsern und Leguminosen festgestellt worden (Woodman *et al.* 1931, Daniel und Harper 1935). Doch ist bei diesen Untersuchungen nicht der Anteil der Leguminosen im Bestand berücksichtigt worden, wobei auf das Ergebnis auch die durch die Niederschlagsmenge bedingten Veränderungen in der Menge der reichlich Kalzium enthaltenden Leguminosen hat einwirken können. Da der positive Einfluss des Niederschlages auf den Kaligehalt der Gräser hochsignifikant gewesen war, lässt sich wohl die durch den Einfluss des Niederschlages hervortretende Abnahme im CaO-Gehalt auf den Antagonismus zwischen Kali und Kalzium zurückführen.

Die Beziehungen zwischen der Temperatur und der chemischen Zusammensetzung der Gräser sind viel weniger als der Einfluss der Feuchtigkeit auf diese untersucht worden. Bei diesem Material ergab sich für eine überdurchschnittlich hohe Temperatur des Juni eine negative Wirkung auf den P_2O_5- und den CaO-Gehalt.

Die Grösse des Ertrages übte einen sehr hochsignifikanten, von den übrigen erforschten Faktoren unabhängigen Einfluss auf den N- und den MgO-Gehalt aus. Bei grösserem Ertrag waren auch der N- und der MgO-Gehalt der Gräser höher.

Zusammenfassung

Das Untersuchungsmaterial (395 Proben) ist von Grünlandfeldversuchen der Kleegraswirtschaft, die mit verschieden hohen Stickstoff-, Phosphor- und Kalimengen gedüngt wurden, in den Jahren 1928—60 gesammelt worden. Um ein Einfluss unterschiedlicher Witterungsverhältnisse während der Vegetationsperioden herauszustellen, wurden als Forschungsmaterial Versuchsglieder ausgewählt, die eine möglichst gleichartige Düngung erhalten hatten. Zur Ausschaltung der durch eine verschidene Pflanzenartzusammensetzung bedingten Variation wurden ausschliesslich Proben von Gräsern, hauptsächlich Timothee, nach den Gehalten an N, P_2O_5, K_2O, CaO und MgO untersucht. Die Schwankungen in den Mineralgehalten wurden mittels Regressionsanalyse ermittelt, indem als auf Veränderungen hinwirkende Faktoren ausser den zu Beginn der Vegetationsperiode herrschenden Niederschlags- und Temperaturverhältnissen, auch die in den Düngermengen hervortretenden Schwankungen und das Ertragsniveau Berücksichtigung fanden.

Der Anstieg der Niederschlagsmenge von Mai—Juni wirkte sich statistisch gesichert auf den N- und den K_2O-Gehalt der Gräser. Der P_2O_5-Gehalt war weniger abhängig von der Niederschlagsverteilung, aber eine schwache positive partielle Korrelation erschien im Material zwischen der Niederschlagsmenge von Mai—Juni und dem P_2O_5-Gehalt. Der CaO-Gehalt liess eine schwache Verminderung bei steigender Niederschlagsmenge erkennen. Ein übernormal warmer Juni führte zu einer Abnahme im P_2O_5- und im CaO-Gehalt.

Die Differenzen in der Höhe der Düngergaben wirkten sich auf die in den Mineralstoffgehalten des Materials erscheinenden Differenzen mehr aus als die verschiedenen Witterungsverhältnisse der Vegatationsperioden. Die Stickstoffdüngung steigerte den N-, den P_2O_5- und den K_2O-Gehalt, und auch der den Anstieg im MgO-Gehalt erweisende Koeffizient kann als richtungsgebend angesehen werden. Ein Zunehmen der Phosphorsäuredüngung senkte den N- und den K_2O-Gehalt. Kalidüngung erhöhte sehr hochsignifikant den K_2O-Gehalt der Gräser. Das negative Korrelieren des CaO- und des MgO-Gehaltes mit den Mengen der Kalidüngung war ebenfalls statistisch gesichert.

Die allgemeine Verbesserung der Wachstumsverhältnisse, die sich im Ansteigen des Ertrages widerspiegelten, vermehrte den N- und den MgO-Gehalt der Gräser.

In Anbetracht der ziemlich geringen Schwankung der Düngermengen erklärten die obengenannten Faktoren nur 10—25 % der in den Mineralstoffgehalten hervortretenden Differenzen, so dass die übrigen Bedingungen, u.a. Bodenart und -fruchtbarkeit, recht stark auf die Mengen der Mineralstoffe eingewirkt haben.

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SELOSTUS

Sademäärän ja lämpötilan vaikutus timoteiheinän kasvinravinnepitoisuuksiin

HILKKA HEINONEN

Maatalouden tutkimuskeskus, Maanviljelyskemian ja -fysiikan laitos, Tikkurila

Kirjoituksessa tarkastellaan heinäkasvien, pääasiassa timotein, kasvinravinnepitoisuuksissa ilmeneviä eroja. Tutkimusaineisto (395 näytettä) koostuu v. 1928—60 suoritettujen eri typpi-, fosfori- ja kalimäärien kenttäkokeiden tuloksista, joista on valittu mahdollisimman samanlaisen ja tasapuolisen NPK-lannoituksen saaneet koejäsenet. Kasvinäytteistä on analysoitu N, P_2O_5, K_2O, CaO ja MgO. Tarkoituksena on ollut tutkia sääolojen aiheuttamia eroja eri aineiden pitoisuuksissa, jolloin syysuhteiden paremmin esille saamiseksi muutoksia aiheuttavina tekijöinä on otettu huomioon lisäksi lannoitemäärissä ilmenevät vaihtelut ja satotaso.

Sääolojen vaikutusta kuvaavista osittaisregressiokertoimista (taul. 8) ilmenee, että touko—kesäkuun normaalia runsaampi sademäärä on kohottanut heinien N-pitoisuutta ja K_2O-pitoisuutta. Heinien fosforinsaanti on ollut sateesta vähemmän riippuvaa. CaO-pitoisuutta sademäärän lisääntyminen on alentanut. Kesäkuun normaalia korkeammalla keskilämpötilalla on ollut aineistossa pieni negatiivinen vaikutus P_2O_5- ja CaO-pitoisuuksiin.

Regressioanalyysien antamien tulosten mukaan lannoitteiden käyttömäärien vaihtelu (keskiarvo 35.0 N, 67.0 P_2O_5, 99.9 K_2O kg/ha, standardipoikkeama 7.28 N, 15.83 P_2O_5 ja 33.18 K_2O) on vaikuttanut heinien kasvinravinnepitoisuuksiin enemmän kuin kasvukauden alkupuolen lämpötila ja sademäärä. Typpilannoitus on lisännyt N- ja P_2O_5-pitoisuuksia. Melko merkitsevästi typpilannoitus on nostanut myös K_2O-pitoisuutta. MgO-pitoisuuden nousua osoittavaa kerrointa voidaan pitää suuntaa ilmaisevana. Fosforilannoituksen nousu on alentanut N- ja K_2O-pitoisuuksia. Kalilannoituksen vaikutus ilmeni heinien K_2O-, CaO- ja MgO-pitoisuuksissa. Lannoitemäärän nousu on lisännyt K_2O-pitoisuutta ja alentanut CaO- ja Mg-O-pitoisuuksia.

Satotason nousun vaikutus on ilmennyt vain N- ja MgO-pitoisuuksissa niitä nostavana. Mainituista tekijöistä riippuvaksi ei kuitenkaan voitu selittää kovin suurta osaa heinien kasvinravinnepitoisuuksien vaihteluista, joten näihin vaikuttavat voimakkaasti myös muut seikat, kuten maan viljavuus ja maalaji.

ANNALES AGRICULTURAE FENNIAE, VOL. 3: 68—79 (1964)

Seria AGRICULTURA N. 11 — Sarja KASVINVILJELY n:o 11

SEED PRODUCTION OF RED CLOVER IN FINLAND

OTTO VALLE

Agricultural Research Centre, Department of Plant Husbandry, Tikkurila, Finland

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Red clover is the most important legume crop grown in Finland. Attempts are constantly being made to improve and extend the cultivation of this crop throughout the country. Since red clover does not thrive on acidic or wet soils, adequate liming and drainage are essential measures for guaranteeing the successful growth of this plant. On mineral soils red clover grows especially well, and if adequately fertilized with potassium and phosphorus, it will give large yields high in protein.

The two main factors limiting the cultivation of red clover in Finland have been the scarcity of seed and its high price. The climate in this country, with its heavy rainfall in late summer and autumn, is unfavourable for the successful production of late-maturing seed of red clover. Clover seed yields are also dependent upon the numbers of pollinating insects, principally bumblebees, and upon the weather prevailing during the flowering period.

The production of red clover seed in Finland has proved so uncertain that generally it is not profitable to establish actual seed fields, but instead most of the seed of this crop is obtained from those parts of ordinary clover-timothy leys where the red clover is most dominant. In general the farmer does not decide which parts of the field will be left uncut for seed until the beginning of hay-making (in late June or early July).

Seed field acreage, yields and quality of red clover seed

Since the year 1936, the Finnish Agricultural Census has included estimates of the acreage of red clover fields left for seed and the seed yields. These estimates, especially in earlier years, proved to be very unreliable, since the data on seed field area were collected even before hay-making and the seed yield figures were estimated early in the autumn before the threshing results were known. Another difficulty in obtaining reliable information on clover seed yields was the fact that clover seed is generally harvested from clover-timothy leys and that consequently the yield may sometimes be a mixture of clover and timothy seed.

Figs. 1 and 2 show the extent of red clover seed production in Finland in 1950 and 1959 (as a percentage of the cultivated field area in each commune). Production is seen to be concentrated in the southern parts of the country. Only in very few communes did red clover seed fields comprise more than 1 % of the total cultivated area. In 1959, which was an especially favourable year, seed was also obtained from small areas in northern Finland.

Bumblebees are the most important pollinators of red clover in Finland, partly because honeybee-keeping is so rare. In 1959, there were only 19,500 colonies in the whole country, most of which were concentrated in South and Southwest Finland as well as in South Ostrobothnia (Fig. 3). Few communes had more than 200 colonies. The reason for the infrequency of bee-keeping in Central Finland is not known.

Table 1, which presents figures from the Agricultural Census, shows the fluctuations which have occurred during the years 1951—1962 in the area used for red clover seed production as well as in the total and hectare yields. According to these data, during this period red clover seed was harvested from an average area of 7400 hectares annually, and the total yield averaged 1.5 million kilograms (200 kg/ha). Towards the end of the 1950's, when yield estimations became more reliable, the statistics concerning red clover improved. However, since poor seed years for this crop occur quite often in Finland and since some of the threshing is not carried out until the wintertime, it is very difficult to make accurate evaluations of the seed yields.

In order to verify the official governmental seed yield estimates, the Finnish Seed Association (Kylvösiemenliitto) performs inspections on individual farms and at the same time makes detailed studies on red clover seed production, including the quality of the seed. The first such study, dealing with the 1961 seed harvest, revealed that the actual seed yield was 171 kg/ha or nearly 20 % less than the official estimate of 210 kg/ha (Kylvösiemen 3, 1962). A similar study was made on the harvest of 1962, which was one of the poorest red clover seed years in Finland for many decades. Data obtained from this study showed that while the governmental estimate of red clover seed yield was 90 kg/ha, the value obtained by the association was one-third less or only 60 kg/ha.

The quality of the red clover seed produced in Finland can be seen from the data on seed testing provided by the State Seed Testing Station. Each year minimum requirements are set up for the purity, maximum content of weed seeds and germination of red clover seed. These minimum requirements, which reveal the poor quality of the seed produced in Finland, have been as follows in the years since 1950: purity 88—90 %, maximum content of weed seeds 0.7—0.8 % and germination 60—70 %, including hard seeds.

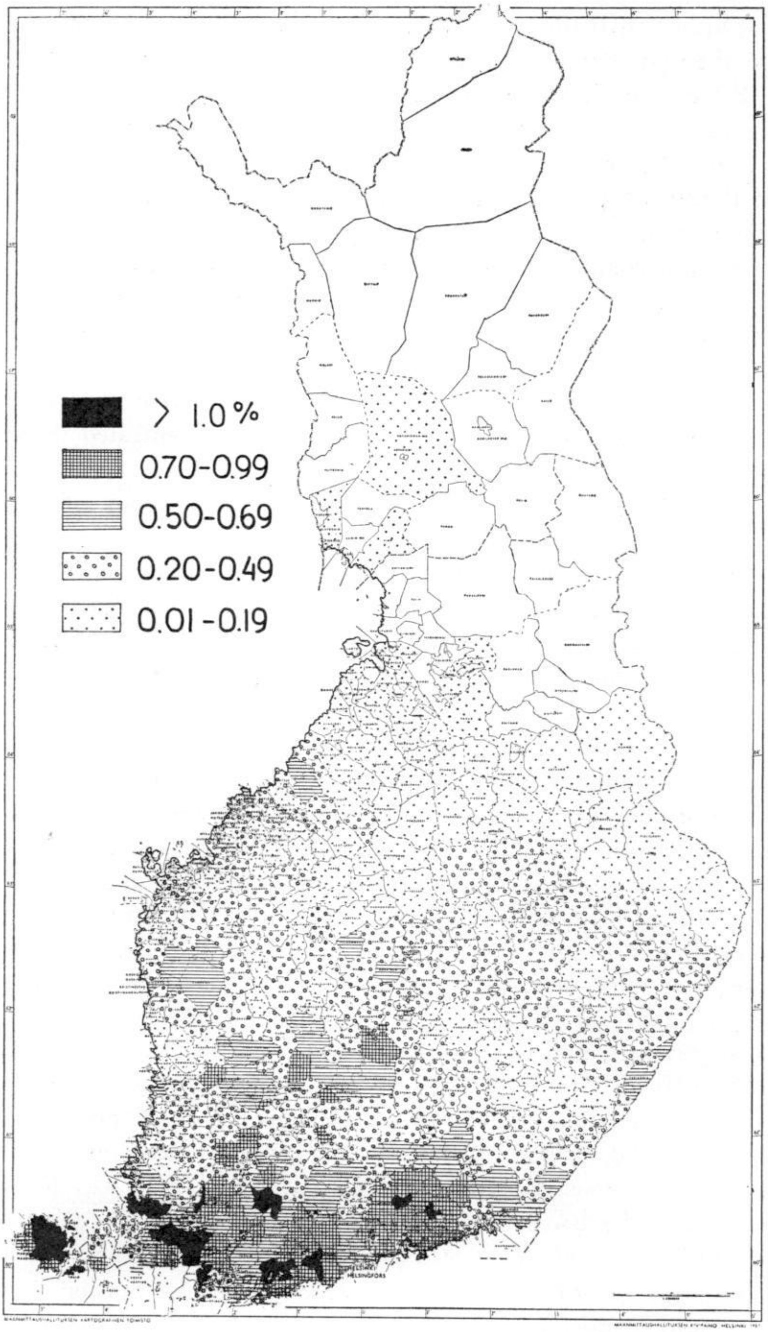

Fig. 1. Seed production of red clover in Finland in 1950 (% of the cultivated area in each commune). Seed production is concentrated in the southwestern parts of the country.

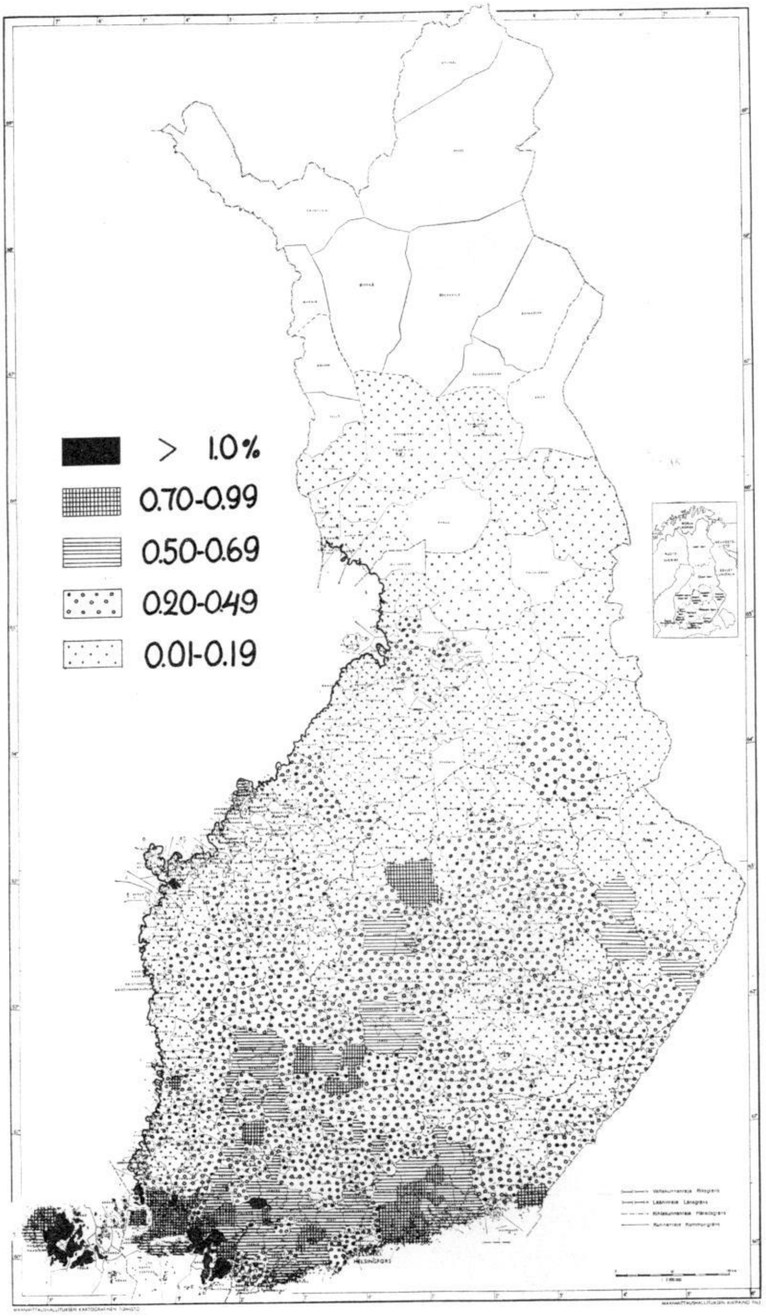

Fig. 2. Seed production of red clover in Finland in 1959 (%) of the cultivated area in each commune). Since the weather conditions in 1959 were very favourable, red clover seed production increased in the more northerly locations.

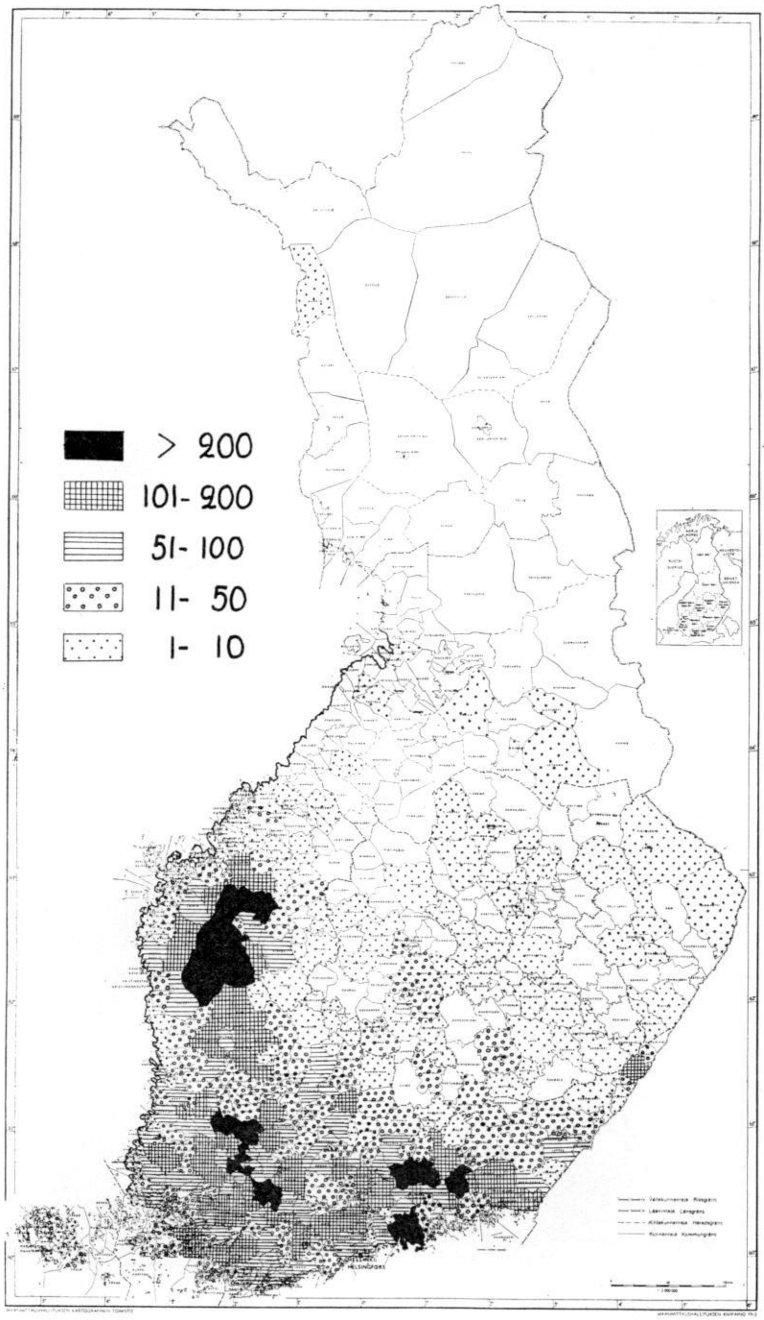

Fig. 3. Extent of honeybee-keeping in Finland in 1959 (number of bee colonies per commune). Very few communes had more than 200 colonies, and these were located in South and Southwest Finland as well as in the region of South Ostrobothnia. Only in these regions have honeybees a practical importance in the pollination of red clover.

Table 1. Acreages and seed yields of red clover seed fields in Finland, 1951—62 (Finnish Agricultural Census)

Year	Area ha	Total seed yield, tons	Seed yield, kg/ha
1951	8 593	2 121	247
1952	6 561	1 449	221
1953	8 782	1 929	220
1954	6 399	1 147	179
1955	4 906	1 087	222
1956	5 696	761	134
1957	7 821	1 256	161
1958	8 956	1 628	182
1959	8 042	2 052	255
1960	8 450	1 690	200
1961	9 000	1 800	210
1962	5 800	500	90
Average 1951—62	7 417	1 452	193

At the State Seed Testing Station inspections are made primarily on commercial red clover seed, which is of higher quality than that produced and used by the grower himself. The bulk of the red clover seed — that kept by the grower — is not tested, since such testing is difficult for the farmer himself to perform. The small numbers of red clover seed samples examined by the State Seed Testing Station and their relatively low quality are shown in the following table:

	No. of samples examined	Purity %	Other crops %	Weeds %	Germination %
1951	1 029	93.0	3.3	0.3	67+12
1952	700	90.7	3.9	0.8	53+14
1953	1 094	92.8	3.4	0.8	62+15
1954	346	92.5	3.9	0.7	64+12
1955	1 083	93.1	4.4	0.5	70+14
1956	442	92.0	5.1	0.6	66+14
1957	954	92.9	3.2	0.5	44+18
1958	1 153	92.2	5.3	0.3	59+18
1959	2 522	95.4	2.9	0.2	71+14
1960	1 455	93.4	3.7	0.6	70+ 7
Average	1 078	92.8	3.9	0.5	62+14

Taking into consideration the purity and germination of the samples tested, Finnish commercial red clover seed had an average sowing value during the 1950's of only 64 %. The sowing value of imported red clover seed in the same years was 81 %.

Production regions of commercial red clover seed

For nearly 20 years (since 1944) the Department of Plant Husbandry of the Agricultural Research Centre has collected data on the location of the main regions producing commercial red clover seed and their annual productions. The

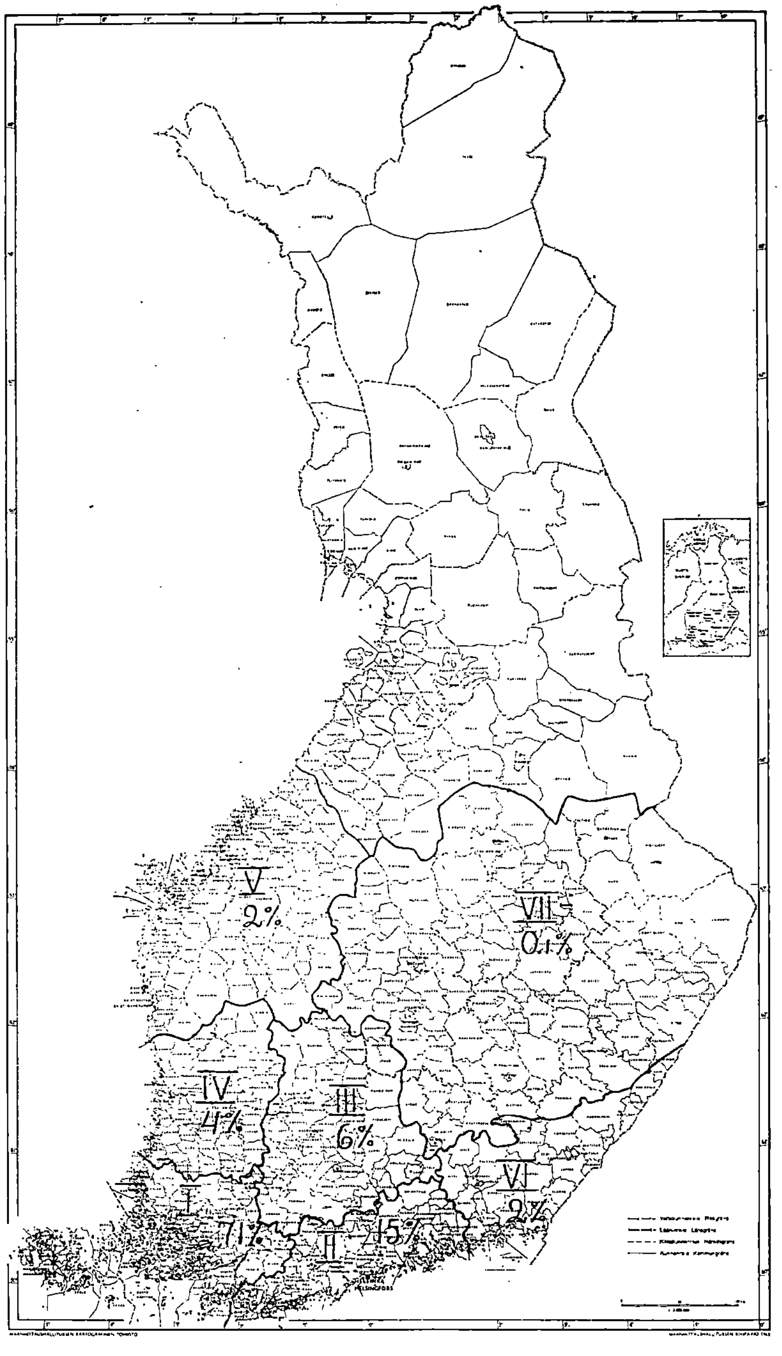

Fig. 4. Regions of commercial red clover seed production in Finland. Southwest Finland is the most important region.

principal agricultural wholesale firms in the country (Central Cooperative Hankkija, Kesko Oy, Suomen Maanviljelijäin Kauppa Oy, Centrallaget Labor, Tukkukauppojen Oy and Osuustukkukauppa) provide information every year on their purchases of red clover seed in various parts of the country. These purchases, which comprise over 90 % of the wholesale trade of Finnish red clover seed, are distributed into seven production regions (Fig. 4):

I	Southwest Finland	V	Ostrobothnia
II	Uusimaa	VI	Kymenlaakso and West Karelia
III	Häme	VII	Lake District and North Karelia
IV	Satakunta		

Table 2 shows the annual amounts of seed purchased in the years 1944—62 and their distribution according to production region.

Large annual variations have occurred in the amounts of red clover seed purchases. The most favourable seed-producing years after 1944 were 1945, 1946, 1949, 1950, 1958, 1959, 1961 and 1963.[1]) The best year was 1959, when 547 500 kg of seed was purchased, whereas poor years were 1962 (39 200 kg) and 1956 (38 800 kg). The entire period 1951—1957 was characterized by

Table 2. Annual purchases of red clover seed by Finnish agricultural wholesale firms, 1944—62, and their distribution according to production region.

Year	Total purchases kg	I Southwest Finland %	II Uusimaa %	III Häme %	IV Satakunta %	V Ostrobothnia %	VI Kymenlaakso %	VII Lake District %
1944	84 770	51.9	16.1	0.2	10.2	18.2	3.4	—
1945	262 740	54.9	16.9	3.1	8.7	13.8	2.4	0.2
1946	228 080	44.2	17.7	3.9	5.7	22.4	5.9	0.2
1947	56 320	33.8	14.9	0.7	6.0	44.2	0.3	0.1
1948	164 280	62.1	8.4	1.0	8.0	20.3	—	0.2
1949	338 250	78.0	10.2	2.2	6.0	3.5	0.1	—
1950	251 050	52.6	10.2	2.6	12.9	20.7	0.5	0.5
1951	119 490	48.4	14.7	3.1	10.4	19.2	2.9	1.3
Average 1944—51	188 120	57.4	13.2	2.4	8.4	16.4	1.9	0.3
1952	44 440	71.2	5.1	7.1	8.4	8.2	—	—
1953	152 560	86.2	7.6	2.0	2.0	0.6	1.3	0.3
1954	67 190	85.4	11.2	0.6	2.7	—	0.1	—
1955	118 960	71.2	14.9	4.1	2.0	4.5	3.3	—
1956	38 790	81.8	7.4	2.7	2.3	3.5	2.3	—
1957	147 620	80.8	9.2	3.9	3.0	2.2	0.9	—
1958	275 180	81.9	7.2	4.5	4.5	1.2	0.6	0.1
1959	547 480	59.1	24.7	8.4	4.5	0.5	2.6	0.2
1960	79 070	50.0	31.7	5.5	5.1	1.1	6.4	0.2
1961	254 110	72.1	10.9	8.2	5.7	2.3	0.6	0.2
1962	39 210	92.1	4.5	—	—	3.4	—	—
Average 1952—62	160 420	71.5	15.0	6.0	4.1	1.6	1.7	0.1

[1]) Estimated purchases in 1963: about 400 000 kg.

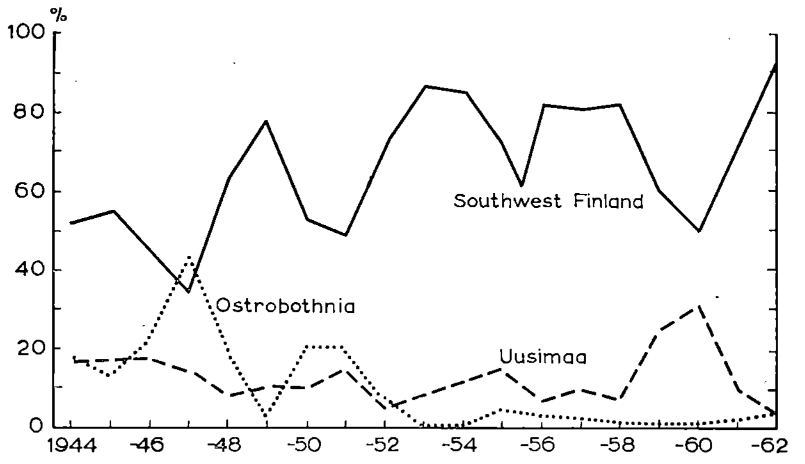

Fig. 5. Percentage of total Finnish commercial red clover seed production in three regions during the years 1944—62. Southwest Finland has constantly been the most important region, Uusimaa is in second place, while the significance of Ostrobothnia has steadily decreased.

repeated poor years for red clover seed production, and consequently 200—300 tons of seed had to be imported annually, mostly from Canada but also from Sweden and the Soviet Union (Valle 1957, 1958, 1961). In the 1950's, 52 % of the red clover seed sold by commercial firms was imported from abroad.

The most important production area for commercial red clover seed is Southwest Finland (Fig. 5). In the 1950's an average of 72 % of the wholesale seed purchases were made in this region. In the 1940's Ostrobothnia was the second most important producing area, but subsequently the amounts of red clover seed entering the commercial trade from this region have greatly decreased. On the other hand, the province of Uusimaa has, especially in recent years, become significant as a red clover seed producing area. Very little commercial seed comes from the regions III and IV (Häme and Satakunta), while the regions VI (Kymenlaakso and West Karelia) and VII (Lake District and North Karelia) are typical areas of underproduction.

There are several reasons for the concentration of commercial red clover seed production in Southwest Finland. In the first place, red clover grows less profusely on the typical clay soils of this region than on the other soil types found to the east and north. A low-growing, relatively sparse stand of clover is more suited for seed production than a profusely growing stand which easily lodges and is difficult to dry in the autumn. Another advantage in Southwest Finland is the long growing season, which promotes seed ripening. Further, pollinating insects are obviously sufficiently abundant in Southwest Finland, since as much as 50—80 % of the red clover seed handled by the trade originates from this rather small region.

The Seed Law guaranteeing the price of Finnish clover and grass seed

Since the end of the war attempts have been made in Finland to protect and promote domestic clover and grass seed production by means of a special seed law which is in force for five years at a time. In the case of red clover, this law guarantees the sale of all seed produced in Finland which meets the established minimum quality requirements. A higher price is paid for seed of certain varieties (Tammisto, Jokioinen, Haapaniemi) produced under contract than for ordinary commercial seed. For example, according to the present seed law (Laki kotimaisen kylvösiementuotannon edistämisestä vuosina 1960—1964. N:o 308/59), the guaranteed price of commercial red clover seed produced in 1963 was 7:30 marks per kilogram and that of contract seed 7:60 mk/kg. One of the purposes of this law is to promote the storage of clover seed during favourable years in order to meet the requirements in subsequent poor years. However, only once, in the especially good year 1959, was the red clover seed harvest sufficient to allow approximately 100 tons to be stored by the State Granary for future use.

Measures to ensure the adequacy of red clover seed in Finland

Since the production of red clover seed in Finland is very uncertain and greatly dependent upon weather conditions, such seed production has been more a matter of seed collecting than actual seed growing. Farmers having no livestock would be interested in producing red clover seed, because in this way they would be able to keep part of their land in leys, which would benefit their crop rotation system. However, as a consequence of many unfavourable clover seed years, the production of red clover seed has been very limited.

Since the weather conditions in different parts of Finland may vary considerably during the same growing season, it would be desirable for commercial red clover seed to be produced in different areas. It would also be useful to investigate the reason for the decline of red clover seed production in Ostrobothnia during the past decade.

In recent years it has become evident that in the lake district of Finland, in the region of Mikkeli, Jyväskylä and Kuopio, large red clover seed yields can be obtained when boron is applied to the soil (Hänninen 1958, Salminen 1959). Abundant numbers of pollinating bumblebees are common in this area, and thus seed set is generally good. Although the clover fields in this region are relatively small and although the heavy growth of the stands causes difficulties in harvesting the seed, nevertheless attempts should be made to increase the seed production of red clover in this interior region of Finland.

The present seed law guaranteeing the price of red clover seed will undoubtedly help to keep the seed price level stable in the case of overproduction. However, if a long period of favourable seed years should occur, as in the 1930's, it might be difficult to utilize the excess seed. For this reason, it would perhaps be recommendable in the new law (1965—1969) to limit the guaranteed price to those seed lots of Finnish varieties which are produced under contract.

Seed production of red clover in Finland could in many ways be promoted by directing agricultural research to problems concerning the methods of cultivation of this crop. For example, investigations might help to improve the pollination of red clover. Another important matter would be to increase the efficiency of harvest techniques, which would appreciably reduce the costs of seed production. In addition, attempts should be made to encourage combine harvesting together with the use of defoliants, especially in southern Finland, a measure which would simplify and rationalize the seed production of red clover.

In order to ensure adequate amounts of red clover seed in Finland, another measure to be considered is the production of seed of Finnish varieties in other countries. Field trials made in the 1950's showed that red clover imported from Canada (Altaswede), Sweden and the Soviet Union was inferior in persistence and yield to the Finnish variety Tammisto (Valle 1957, 1958; Hiivola 1961). Such unsuitable foreign seed should be replaced by seed of Finnish varieties which would be produced abroad. According to the present view, such production should be undertaken in Canada and in the USA. In this way, stocks of high-quality Finnish red clover seed could be accumulated and would provide an adequate supply for future needs. As long as a special seed law with its guaranteed price of red clover seed is in effect, such foreign seed production will in no way endanger the Finnish grower.

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SELOSTUS

Puna-apilan siementuotanto Suomessa

OTTO VALLE

Maatalouden tutkimuskeskus, Kasvinviljelylaitos, Tikkurila

Puna-apilan siemenviljelyvaikeuksien vuoksi tuotetaan Suomessa valtaosa puna-apilan siemenestä tavallisilta niittonurmilta. Vuosina 1951—62 korjattiin siementä keskim. 7 400 ha:lta vuosittain (taul. 1) ja keskisato oli maataloustilaston mukaan 193 kg/ha. Todellinen sato oli Kylvösiemenliiton suorittamien selvitysten mukaan jopa 30 % maataloustilaston satoarviota pienempi. Kartat 1 ja 2 osoittavat puna-apilan siementuotannon laajuutta vuosina 1950 ja 1959.

Suomessa ovat kimalaiset puna-apilan tärkeimpiä pölyttäjiä. Kun mehiläishoito Suomessa rajoittuu Etelä- ja Länsi-Suomeen (kartta 3), on vain tällä alueella puna-apilan siemennurmille apua myös mehiläisistä.

Kasvinviljelylaitoksella on vuodesta 1944 lähtien vuosittain koottu suurimmilta tukkuliikkeiltä tietoja suomalaisen puna-apilan kauppasiemenen hankinta-alueista (taul. 2 ja kartta 4). Suurin ostettu määrä on ollut 547 480 kg (vuoden 1959 sadosta) ja pienin vain 38 790 kg (1956). Vuosina 1952—62 tuotettiin yli 70 % siemenestä Lounais-Suomessa, 15 % Uudellamaalla ja 6 % Hämeessä. Pohjanmaalla, jossa vuosina 1944—51 tuotettiin 16 % puna-apilan kauppasiemenestä, on kauppasiemenen tuotanto taantunut vuoden 1952 jälkeen. Laaja Sisä- ja Itä-Suomen alue on ollut puna-apilan siemenen alituotantoaluetta.

Vaikka toisen maailmansodan jälkeen on ollut 5-vuotiskausittain voimassa kotimaisen kylvösiementuotannon edistämistä koskeva laki, joka on määrännyt takuuhinnan kaikelle Suomessa tuotetulle puna-apilan siemenelle, on sattuneiden heikkojen siemenvuosien takia vain vuoden 1959 sadosta saatu varastoiduksi kotimaista puna-apilan siementä heikkojen siemenvuosien varalle.

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Seria AGRICULTURA N. 12 — Sarja KASVINVILJELY n:o 12

THE POSSIBILITIES OF SEED PRODUCTION OF TETRAPLOID RED CLOVER IN CENTRAL FINLAND

OTTO VALLE

Agricultural Research Centre, Department of Plant Husbandry, Tikkurila, Finland

ERKKI HUOKUNA

Agricultural Research Centre, South Savo Agricultural Experiment Station, Mikkeli, Finland

TOIMI PUUMALAINEN

Mikkelin läänin maanviljelysseura, Mikkeli, Finland

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In the year 1960 investigations on seed production of Finnish tetraploid red clover were begun on an experimental basis in Finland. This tetraploid variety, developed at the Department of Plant Breeding at Jokioinen from the single-cut diploid variety Tammisto, was originally given the provisional name Jo TPA 1, but in 1964, at the time of its introduction to the market, its name was officially changed to Tepa. The initial investigations in 1960 were located at the Department of Plant Husbandry at Tikkurila (60° 18' N.), the South Savo Agricultural Experiment Station at Karila near Mikkeli (61° 41' N.), the Central Finland Agricultural Experiment Station at Laukaa near Jyväskylä (62° 28' N.), the North Savo Agricultural Experiment Station at Maaninka (63° 09' N.) and several other places. The studies in 1960 showed that the numbers of pollinating bumblebees in the central parts of Finland were much greater than at the locations in South Finland, and as a result the seed set of tetraploid red clover was better in the former region than in the latter (Valle, Salminen and Huokuna 1960, Valle 1961, Hänninen 1962). The numbers of seeds per flower head of the tetraploid were less, however, than those of the diploid.

Pollination and seed set studies at the South Savo Agricultural Experiment Station

Investigations on pollination and seed set of tetraploid red clover have been continued since 1960. At the South Savo Agricultural Experiment Station these

Table 1. Results of pollination and seed setting studies on Finnish tetraploid red clover Tepa at the South Savo Experiment Station 1960—63. Diploid results are also shown for comparison.

Variety	Year of sowing	Area m^2	No. of insects per 100 m^2 during the flowering period				Pollinating bumblebee species, %					Date of full bloom	Average seed set per 100 florets	Total seed yield kg/ha
			pollinating		robbing		Bombus							
			bumble-bees	honey-bees	bumble-bees	honey-bees	hort.	dist.	lapid.	agr.	others			
1960														
Local strain (diploid) ...	1959	1 200	1 502	36	478	4	41	19	23	14	3	July 28	56	147
Tepa (tetraploid)	1959	257	1 250	36	354	4	60	21	12	6	1	» 25	24	appx. 600
1961														
Local strain (diploid) ...	1959	2 700	2 076	44	256	—	49	6	3	41	1	July 20	55	514
Tepa (tetraploid)	1959	90	1 136	—	88	—	69	10	5	16	—	» 22	39	299
1962														
Tammisto (diploid)	1961	12	310	30	600	—	58	7	19	13	3	Aug. 22	20	—
Tepa (tetraploid)	1961	12	410	20	460	—	71	2	20	7	—	» 18	8	—
» seed field	1961	4 900	264	4	460	—	49	15	6	30	—	» 19	6	—
1963														
Tammisto (diploid)	1961	12	1 370	—	240	—	20	2	12	64	2	July 27	77	142
Tepa (tetraploid)	1961	12	1 370	—	130	—	41	1	3	55	—	» 24	41	110
» seed field	1961	4 900	1 340	—	852	—	33	3	4	60	—	» 20	55	379
» seed field	1962	5 000	1 168 [1]	42	928	—	36	1	4	57	2	» 25	—	726

[1]) Insect observations on this field made by Mr. E. Ruuttunen.

investigations have been concentrated on the Finnish variety Tepa. During the summers 1960—63 daily observations were made by Mrs. Kirsti Huokuna on the insects visiting the clover during its flowering period. By marking flower heads at different times and later determining the numbers of seeds formed, it was possible to establish the extent of seed set at different times of flowering and its dependence upon the numbers of pollinating bees.

Some of the results of these studies in the years 1960—63 are shown in Table 1. The fields were regularly given boron dressings, and control measures against clover seed weevils were taken before flowering.

Attempts have been made in these investigations to compare the seed set of tetraploid red clover with that of diploid. In 1960 and 1961 the diploid used for comparison (Karila red clover) grew on a different field at the station than the tetraploid. In 1962 and 1963, on the other hand, the diploid Tammisto red clover grew in the same trials as Tepa. When tetraploid and diploid red clover grow near to each other, seed set may be reduced, since pollen may be transmitted by bees from the one kind of clover to the other without causing fertilization and seed formation. In 1962 and 1963 part of the tetraploid investigations were also made on isolated fields.

Observations on the pollinating bees visiting red clover were made twice daily. The results for the entire flowering period were obtained by using only one of the daily observations and calculating from it the total numbers of bees per 100 m^2. If during the entire flowering period the total number of pollinating bumblebees is around 500 per 100 m^2, pollination can be considered very effective. Since beekeeping is rare in the central parts of Finland, pollination of the red clover fields in the present trials was almost wholly dependent upon bumblebees.

The daily bee observations also included the numbers of non-pollinating, or robber bees. From the standpoint of red clover pollination, these are harmful because they remove the nectar by making a hole in the corolla tube and consequently do not pollinate the flowers.

Three of the four summers described were favourable for pollination. The one exception was the cool and rainy summer of 1962, when flowering was delayed and seed set poor. Whereas the time of full bloom generally falls towards the latter part of July, in 1962 it was delayed by about 3 weeks to the middle of August.

With the exception of 1962 there were very large numbers of pollinating bumblebees — over 1000 per 100 m^2 — on both tetraploid and diploid red clover. Such great numbers are very rare in the southern parts of the country. Robbing bumblebees, of which *Bombus lucorum* was the principal species, were also observed, but were less abundant than the pollinating species (with the exception of 1962, when bumblebees in general were very scarce). As is shown by the

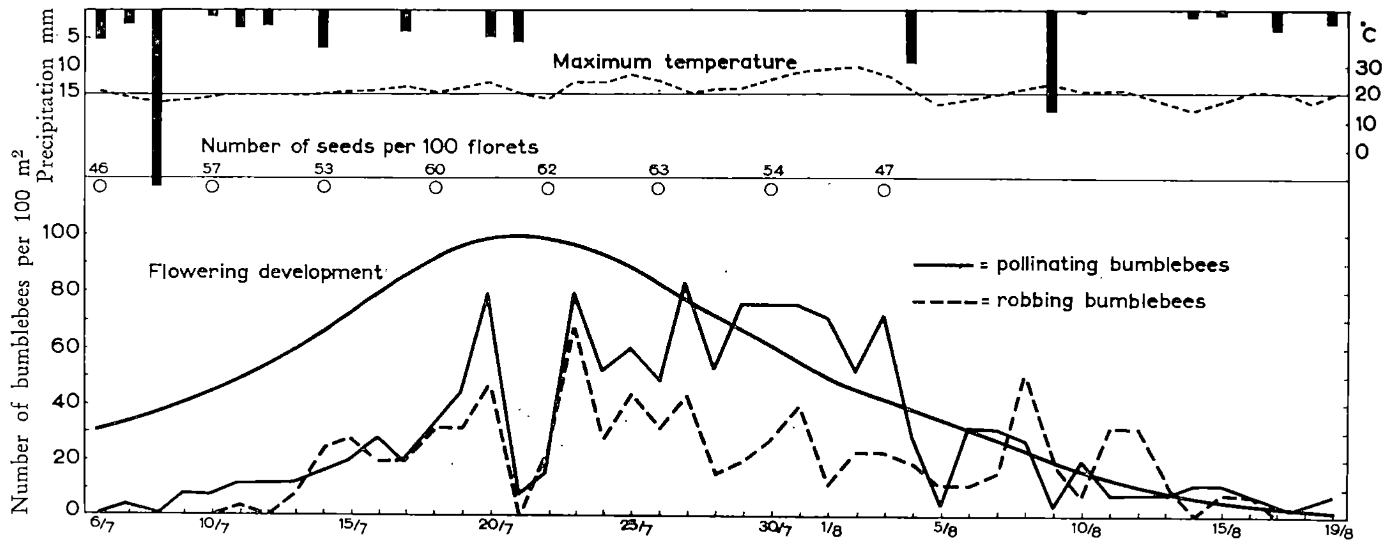

Fig. 1. Results of daily observations on the numbers of pollinating and robbing bumblebees visiting single-cut tetraploid red clover Tepa (second-year field) at the South Savo Agricultural Experiment Station at Mikkeli in 1963. At the top of the figure are also indicated the daily precipitation and maximum temperature. The numbers of pollinating bumblebees are seen to be quite high in the latter part of the flowering period. Seed setting was investigated by marking flowering heads at various times and subsequently determining the number of seeds formed in each head. The figures obtained from this field show that there was a good seed set even at the beginning of flowering. The total seed yield was 379 kg/ha.

1963 observations, the numbers of robber bees may vary considerably on different fields on the same farm. Honeybees were found on red clover only in the year 1960. Pollination of red clover at the South Savo Experiment Station is entirely dependent upon bumblebees.

The long-tongued species *Bombus hortorum* is the commonest of the pollinating bumblebees at this station. The proportions of various species of pollinators may vary considerably from field to field, and the fluctuations from year to year are also very great. *B. distinguendus* and *B. lapidarius* are not as common in Savo as in South Finland. On the other hand, *B. agrorum*, which is a characteristic species in central Finland, was the most frequent pollinator of red clover in South Savo in 1963.

In 1962, the scarcity of bees as well as the unfavourable weather conditions were the factors causing an exceptionally poor seed set (only 6—8 %). In the other three years, on the contrary, seed set in tetraploid red clover was good, amounting to 24 % of the flowers in 1960, 39 % in 1961 and 55 % in 1963. This latter figure was a record, since the highest average seed set of tetraploid red clover previously found in Finland was 42 %. Figure 1 presents the results for 1963 and shows the exceptionally high seed set already at the beginning of flowering.

An investigation carried out in 1959 at the Department of Plant Husbandry at Tikkurila (VALLE 1959) showed that a profusely-flowering stand of the Swedish tetraploid red clover Ulva produced 500—600 kg/ha seed, even though the average seed set was only 38 %. In the light of this figure, the results obtained at the South Savo Agricultural Experiment Station in 1961 and 1963 with the Finnish Tepa (39 and 55 %) can be considered very good.

In all the four years of investigation the seed set of diploid red clover was better than that of the tetraploid. The data in Table 1 from the years 1960, 1961 and 1963 reveal that the seed set of tetraploid red clover averaged about 40 % less than that of diploid. This does not mean, however, that there was a similar difference in actual seed yield, since the size of the tetraploid seed is greater than that of the diploid. The 1000-seed weight of diploid red clover is about 1.6 g, whereas that of Tepa is about 2.8 g, or 75 % greater. Thus these figures indicate that there is no net difference at all in the final seed yield. Other factors which influence the seed yield are the numbers of flower heads per unit area of field and the numbers of flowers per head. It is generally assumed that tetraploid red clover produces fewer flower heads per plant than the diploid. On the other hand, this is compensated by the fact that the tetraploid has a better winter survival and persists longer in the ley, and thus its smaller number of flower heads per plant is not a serious handicap. Taking all these factors into consideration, it appears very probable that tetraploid red clover is able to give seed yields as high as the diploid. Many instances from favourable clover years in Finland show that tetraploid seed yields may be as high as 500—600 kg/ha, which can be considered an excellent result.

Seed fields of Tepa in the region of Mikkeli

Because of difficulties in seed production of tetraploid red clover in South Finland, arising mainly from the scarcity of bumblebees, it was decided in 1961 to concentrate the seed production of Tepa in the region of Mikkeli. The main reason for this decision was the fact that good results had been obtained at the South Savo Agricultural Experiment Station. Another reason was the fact that this region, especially in the 1950's, proved to be very favourable for seed production of diploid red clover when boron was applied to the soil. As an example of the high yields obtained, it may be mentioned that in the red clover seed production competitions arranged by Mikkelin läänin maanviljelysseura (Mikkeli Province Agricultural Society) in the years 1958—61, the average seed yield was 300 kg/ha (Puumalainen 1963).

The first ordinary seed field of tetraploid red clover at the South Savo Agricultural Experiment Station (0.5 ha) was established in the spring of 1961 with a nurse crop of rye sown the previous autumn. The clover stand became well established, and the rye crop was harvested in August 1961. In the following year observations were made on the bees visiting the red clover flowers and determinations were made on seed set at various times during the flowering period (Table 1). Although it was intended to harvest seed in the autumn of 1962, the weather conditions were so unfavourable and the seed yield consequently so low that no attempts were made to harvest the seed. The clover stand survived the winter satisfactorily and in the following year grew well and produced a good seed yield (379 kg/ha). Fig. 2 shows this second-year seed field in June 1963 before the beginning of flowering.

Fig. 2. Second-year seed field of tetraploid red clover Tepa at the South Savo Agricultural Experiment Station. Clover sown under rye in 1961; failure of seed crop in 1962 due to cool and rainy weather; yield in 1963 379 kg/ha. Photo June 10, 1963.

Table 2. Seed fields of tetraploid red clover Tepa in the region of Mikkeli, harvested in 1963.

No.	Farm	Area ha	Row distance cm	Nurse crop 1962	Previous crops 1961	1960	1959	1958
1.	Otava Agric. School	0.50	45	spr.wheat	sugarbeet	sugarbeet	sugarbeet	spr.wheat
2.	Tuukkala (M. Valkonen)	0.45	48	barley	sugarbeet	sugarbeet	sugarbeet	sugarbeet
3.	Heimari (V. Piippo)	0.35	48	spr.wheat	spr.wheat	spr.wheat	spr.wheat	spr.wheat
4.	Moisio (Mental Hosp.)	0.40	48	spr.wheat	sugarbeet	sugarbeet	sugarbeet	potato
5.	Hovinsaari (Y. Väisänen)	0.26	45	barley	sugarbeet	sugarbeet	sugarbeet	oats
6.	South Savo Exp. Station	0.49	45	barley	potato	rye	fallow	potato
7.	—»—	0.50	45	—[1]	rye	fallow	barley	spr.wheat

[1]) Red clover sown under rye in 1961, second-year stand in 1963.

In the spring of 1962 six new seed fields of Tepa were established in the region of Mikkeli. They were approximately 0.4 hectare in size, and barley or spring wheat was used as nurse crop. The clover was sown (rate 3 kg/ha) with at row distance of about 45 cm, so that mechanical weeding could be carried out easily and any diploid plants could be removed. In order to further prevent the appearance of diploid red clover in the tetraploid fields, locations were chosen where no clover had been grown for the previous 4 years at least. On some of the farms these seed fields were located where sugar beets had been grown for several years. The soil type on all 6 fields was fine sand. Since clover rot (*Sclerotinia trifoliorum*) often occurs in this region and may cause severe damage to clover stands, including tetraploid red clover, some of the fields were treated in the autumn with PCNB (pentachloronitrobenzene). Data concering the establishment of these seed fields are listed in Table 2.

Although the clover stands were quite weak in the autumn of 1962 as a result of the late nurse crop harvest, they survived the winter of 1962/63 satisfactorily. In spring 1963 most of the fields were mechanically hoed.

In the region of Mikkeli, as in the whole country, the weather conditions during the flowering period of red clover in 1963 were very advantageous for its seed production (Fig. 1). Spring was warmer than normal and consequently accelerated the early growth of the clover, the flowering period was fairly warm and relatively dry, and the harvest time was without excessive rainfall. Numerical data on these weather conditions (long-term values and deviations from long-term) are shown below:

	Temperature °C						*Precipitation mm*				
	May	June	July	Aug.	Sept.		May	June	July	Aug.	Sept.
Long-term	9.0	13.6	16.9	14.6	9.4	Long-term	48	64	64	72	68
Deviation	+3.6	—0.7	—0.9	+0.2	+2.0	Deviation	—18.6	—33.8	+1.9	—4.4	—19.1

Attemps were made to obtain as complete a picture as possible of the various factors affecting the seed yield on each of the fields. Even at the end of July, just efter the time of full bloom, large numbers of seed were observed developing in the flower heads. In August, just before the harvest, the numbers of seed heads per square metre were determined. At the same time samples consisting of 25 seed heads which had flowered at different times were collected from each field. Counts were later made of the number of flowers and of seeds in each head. In addition, determinations were made of the extent of damage by the larvae of *Apion* weevils as well as of the amount of brown seed, which gave an indication of the detrimental effect of rainfall on the quality of the seed.

The results of these investigations, presented in Table 3, show that the number of seed heads per square metre was generally 500—600. The highest figures were found in the fields at Heimari and at Hovinsalo (ca. 900), the

Table 3. Results of seed head analyses of tetraploid red clover Tepa harvested in 1963 in the region of Mikkeli.

No.	Farm	Heads per sq. m.	Florets per head	Seed per 100 florets normal	Seed per 100 florets small	Max. seed set per 100 florets	Brown seeds %	*Apion* damage[1]) %
1.	Otava Agric. School	650	133	53	4	80	4	—
2.	Tuukkala (M. Valkonen) ..	580	163	54	3	77	3	4
3.	Heimari (V. Piippo)	970	128	49	3	74	3	—
4.	Moisio (Mental Hosp.)	550	141	57	2	84	3	8
5.	Hovinsalo (Y. Väisänen) ..	920	138	49	3	84	6	4
6.	South Savo Exp. Station ..	480	125	45	13	66	4	4
7.	—»— ..	320	136	49	1	70	4	12

[1]) Percentage of heads damaged by *Apion* larvae.

lowest in the second-year seed field at the experimental station (ca. 300). The number of florets per head was very great, averaging 138 and with a maximum of 163 at Tuukkala. The seed set in all the fields was higher than had been expected, and there were relatively small differences between the various fields. The average seed set was 55 %, ranging from 45 to 57. Such high figures can be considered excellent for tetraploid red clover in ordinary seed fields. These high seed set values, as well as their similarity

Fig. 3. The usual method of clover seed harvest in central Finland is to dry the heavy, leafy clover outdoor on stakes; drying lasts about one month. Ketunniemi farm near Mikkeli. Photo Sept. 17, 1963.

Table 4. Seed yield data of tetraploid red clover Tepa harvested in 1963 in the region of Mikkeli. Analyses made at the State Seed Testing Station.

No.	Farm	Date mown	Date threshed	Seed yield[1] kg/ha	1000-seed weight g	Brown seeds %	Purity %	Other crops %	Weeds %	Germination %	Broken seedlings %
1.	Otava Agric. School	Aug. 19—20	Sept. 2—3	455	2.99	5	99.2	+	0.1	79+12	5
2.	Tuukkala (M. Valkonen)	Sept. 2	Sept. 16	568	3.10	23	97.1	+	0.2	63+ 8	17
3.	Heimari (V. Piippo)	Aug. 10—23	Sept. 18	220	3.08	8	91.2	0.6	0.1	58+ 6	31
4.	Moisio (Mental Hosp.)	Sept. 9—10	Sept. 24	342	2.96	14	98.4	+	0.4	68+18	7
	—»—		Dec. 12		3.02	13	98.9	+	0.2	73+ 4	9
5.	Hovinsalo (Y. Väisänen)	Aug. 10 — Sept. 15	Oct. 2	408	3.08	8	99.0	+	0.2	69+23	3
6.	South Savo Exp. Station	Aug. 22	Sept. 21	726	2.87	4	99.5	—	+	63+24	4
7.	—»—	Aug. 22	Sept. 21	379	2.88	4	99.3	0.1	0.1	67+17	4

1) Calculated for 98 % purity.

on the different fields, indicate that there were abundant pollinating bees at all the locations and that conditions in general were favourable for seed formation. Detailed studies of the daily bumblebee numbers and the amount of seed set at various times of flowering were made only at one location, the second-year field at the South Savo Agricultural Experiment Station (Fig. 1 and Table 1). Seed set here was as high as 49 %, even though nearly 40 % of the bumblebees were robbing species.

In Table 3 is also indicated the maximum seed set found in individual heads at each location. The highest figure exceeded 80 %. The number of small, poorly-developed seeds was generally very low (1—4 %). *Apion* damage was completely absent in some of the fields, and in the others it was very slight, being at a maximum in the second-year field at the station (12 % of the heads damaged). The low percentage of brown seed (4 % on the average) is an indication that the weather conditions were favourable for ripening of the seeds.

In accordance with the custom in the region near Mikkeli, the crop harvested from the tetraploid red clover seed fields in 1963 was dried in the field on stakes (Fig. 3). During threshing and hulling, clover seed may easily be damaged if the speed of the threshing machine is too great or if the drum and flail are too close to one another. The result of such damage is an increase in the number of broken seedlings during the germination tests. In 1963 some of the seed lots were properly handled during threshing and hulling while others were not. Table 4 gives data on the harvesting of the various seed lots and their amounts and quality.

Fig. 4. First-year seed field of tetraploid red clover Tepa at the South Savo Agricultural Experiment Station. Sown under barley in 1962, seed rate 3 kg/ha, row distance 45 cm. Photo June 10, 1963.

Since red clover generally grows very profusely on the warm sandy soils of South Savo, the coarse, leafy foliage of clover dried very slowly on stakes. Drying can be accelerated by pre-cut treatment with defoliants, but this method was not used in 1963 in the fields in question. Most of the fields were cut during the latter half of August and the seed threshed immediately after being brought in from the field. It can be seen from the dates of threshing that the drying period outdoors lasted nearly a month.

Very high seed yields of Tepa were obtained in 1963 from all the fields. This confirmed the results of the seed head investigations, which had indicated a good seed set. The average seed yield was as high as 440 kg/ha, which can be considered an excellent achievement on ordinary seed fields. The yields of the different fields ranged from 220 to 726 kg/ha. Larger amounts would have been obtained if certain of the lots had not been damaged during the processes of threshing and hulling. The largest seed yield, 726 kg/ha, was obtained at the South Savo Experiment Station. Pollination observations made on this clover stand are presented in Table 1, and data on seed set and quality are shown in Tables 3 and 4. The vigorous growth of this seed field is seen in Figures 4 and 5.

The quality of many of the lots was poor, resulting from lack of experience on the part of the growers in handling the seed. The low germination was mainly a consequence of the large numbers of broken seedlings. In some cases the reduced germination was partly caused by excessive moisture content, as was indicated by the large amounts of mouldy seed in these lots. The germination of the Tepa seed harvested in the region of Mikkeli in 1963 varied from 64 to 91 % (including hard seeds) and the 1000-seed weight from 2.87 to 3.10 g. The

Fig. 5. First-year seed field of Tepa at the South Savo Agricultural Experiment Station; same field as in Fig. 4. Stand in full bloom, nearly 500 flower heads per m^2. Many pollinating bumblebees present (see Table 1); very high seed yield obtained, 726 kg/ha. Photo July 24, 1963.

amount of brown seed, averaging 10 %, indicates that, although ripening occurred under favourable conditions, rain during the period of outdoor drying caused appreciable damage to the seed.

The seed harvested in the region near Mikkeli in 1963 was analyzed for genetical purity, i.e. its content of diploid clover contamination. Even before genetic analysis, the large 1000-seed weights of all the lots gave an indication of their small diploid content. This was confirmed by the analyses, which showed that most of the lots contained no diploid at all, while some of them had extremely small amounts of diploid contamination. In order to facilitate the analyses, the lots are generally screened into about 10 % small seeds, and this portion is then analyzed for its diploid content. The scarcity of diploid red clover in the tetraploid seed lots produced in the Mikkeli region is due partly to the fact that very little diploid seed has previously been produced in this area, and also to the fact that the tetraploid seed fields were sown in rows, which made it easy to remove possible diploid volunteer plants.

Discussion

The very high seed yields of the Finnish tetraploid red clover variety Tepa which were obtained in 1963 in the region of central Finland near Mikkeli (61° 40' N.) indicate that this region is especially well suited for foundation seed production of tetraploid red clover. These seed yields, which were nearly as high as those of diploid red clover, were mainly a consequence of the abundance of pollinating bumblebees, a fact which was confirmed by the observations on bees made at the South Savo Agricultural Experiment Station. Although the growing season of 1963 was especially favourable for clover seed production throughout Finland, it is probable that even in less favourable years the region of Mikkeli would be able to produce satisfactory seed yields of tetraploid red clover.

The experiences obtained in 1963 show that the greatest difficulties occurred in the harvesting, threshing and handling of the seed. Tetraploid red clover seed fields should be cut as early as possible so that drying on the field will take place under favourable conditions before the onset of the autumn rains. Threshing should be carried out as soon as possible after the clover has dried, preferably in dry weather. It is important that much attention be given, especially in rainy autumns, to proper drying of the stored seed both before and after hulling. Since most of the mistakes in 1963 were made in connection with threshing and hulling, these processes should be performed with particular skill and care, especially because the large size of the tetraploid seed makes it very susceptible to injury during processing.

Although crossing between tetraploid and diploid red clover is not possible, mixing of the seed of these two kinds of clover may occur in many ways. The greatest risk in this respect is the possibility of contamination occurring during the time of cultivation. To prevent such contamination, tetraploid red clover should be grown only on fields where there has been no diploid clover for at least 4—5 years. This precaution is necessary, since hard seeds retain their viability in the soil for many years. In order to keep the tetraploid stand as pure as possible, it is recommended that the field should be seeded in rows so that hoeing can easily be carried out and any volunteer clover plants eliminated. Another important factor is the genetic purity of the stock seed used in establishing the field. If the seed lot of tetraploid red clover contains as little as 2 % diploid seed, it is possible that within one generation it may become so badly contaminated with diploid that it is unfit for use as tetraploid seed.

In Finland there are so far no regulations on the amount of diploid contamination allowed in commercial lots of tetraploid red clover. Basic seed used in establishing new seed fields should preferably contain no diploid seed at all, while seed intended for forage production may contain perhaps as much as 5 % diploid seed during the beginning phase of production.

In the seed production of tetraploid red clover it is imperative that the genetic purity of all seed lots be investigated. Since there is a considerable difference in seed size between the tetraploid and the diploid, it is relatively easy to separate the seed on this basis. By using only large-sized tetraploid seed for establishing new seed fields, the genetic purity of tetraploid red clover can be better preserved.

In the region near Mikkeli conditions are good for producing seed of tetraploid red clover. However, it is important that tetraploid and diploid clover seed should not be produced on the same farm. If the mistakes made in 1963 can be avoided, the district of Mikkeli has good prospects of becoming an important region for the seed production of tetraploid red clover.

These investigations were planned and directed by the Department of Plant Husbandry (V a l l e). The seed production trials were carried out at the South Savo Agricultural Experiment Station (H u o k u n a). Seed production on private farms in the region of Mikkeli was supervised by the local agricultural society (P u u m a l a i n e n). Financial assistance for these studies was obtained from the State Agricultural and Forestry Commission.

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SELOSTUS

Tetraploidin puna-apilan siemenviljelymahdollisuuksista Sisä-Suomessa

Otto Valle

Maatalouden tutkimuskeskus, Kasvinviljelylaitos, Tikkurila

Erkki Huokuna

Maatalouden tutkimuskeskus, Etelä-Savon koeasema, Mikkeli

Toimi Puumalainen

Mikkelin läänin maanviljelysseura, Mikkeli

Tetraploidin puna-apilan siemenviljelymahdollisuuksia tutkittaessa on todettu, että Sisä-Suomessa on pölyttäviä kimalaisia paljon runsaammin kuin Etelä-Suomessa. Tämän takia on myös tetraploidin puna-apilan siemenmuodostus ollut näillä alueilla runsasta.

Keväällä 1962 perustettiin Mikkelin ympäristöalueelle useita tetraploidin puna-apilan siemennurmia tarkoituksena tutkia Jokioisten Tepa -jalosteen (aikaisempi merkki Jo TPA 1) siemenviljelymahdollisuuksia. Kysymystä on tutkittu yhteistyönä Kasvinviljelylaitoksen (Valle), Etelä-Savon koeaseman (Huokuna) ja Mikkelin läänin maanviljelysseuran (Puumalainen) kesken.

Kasvinviljelylaitoksen toimesta on Etelä-Savon koeasemalla suoritettu vuosina 1960—63 puna-apilan pölytystä ja siemenmuodostusta koskevia tutkimuksia (taul. 1). Kasvukausi 1963 osoittautui erittäin suotuisaksi tetraploidin puna-apilan siemenmuodostukselle Mikkelin ympäristöalueella. Talousviljelyksiltä (ala 0.3 — 0.5 ha) korjattiin 1963 siemensato 7:ltä eri siemennurmelta. Näistä viljelyksistä on tietoja koottu taulukoihin 2—4.

Tetraploidin puna-apilan siemensadot olivat 1963 yllättävän runsaita, keskim. 440 kg/ha. Runsain siemensato, 726 kg/ha, saatiin Etelä-Savon koeasemalla (kuvat 4 ja 5). Eräillä tiloilla jäi sato suhteellisen pieneksi siemensadon käsittelyssä sattuneiden virheiden, esim. varomattoman hankauksen vuoksi.

Vaikkakin kasvukauden 1963 saavutuksia tetraploidin puna-apilan siemenviljelyssä Mikkelin ympäristöalueella on pidettävä poikkeuksellisen hyvinä, on tällä alueella ilmeisesti syytä lisätä tetraploidin puna-apilan siemenviljelyä. Tarkoituksena onkin laajentaa lähivuosina suomalaisen tetraploidin puna-apilan siemenviljelytoimintaa Etelä-Savossa.

AIKAKAUSKIRJAN KIRJOITTAJILLE

Käsikirjoitukset kirjoitetaan koneella vain liuskan toiselle puolelle käyttäen A 4-kokoista paperia. Liuskan vasempaan laitaan jätetään n. 4 cm:n levyinen marginaali, ja kullekin liuskalle kirjoitetaan keskimäärin 30 riviä.

Artikkelit, joiden tulee olla lyhyehköjä ja keskitettyjä, laaditaan joko kotimaisella kielellä englannin- tai saksankielisine selostuksineen tahi päinvastoin. Kieliasun tulee olla huoliteltua ja tiivistä, taulukkojen ja piirrosten yksinkertaisia ja selviä.

Taulukot kaksikielisine teksteineen kirjoitetaan erillisille liuskoille ja numeroidaan juoksevasti. Samoin menetellään kuvatekstien suhteen. Taulukkojen ja kuvien sijoituspaikat merkitään käsikirjoituksen marginaaliin.

Valokuvien tulee olla teknillisesti moitteettomia ja mieluummin kovakiiltopaperille valmistettuja. Piirrokset laaditaan vähintään 1 ½ — 2 kertaa lopullista painoasua suurempaan kokoon, graafiset esitykset millimetripaperille. Toimitus piirrättää ne tarpeen vaatiessa puhtaaksi.

H a r v e n n e t t a v a t kohdat alleviivataan käsikirjoituksessa katkoviivalla (— — —) ja *kursivoitavat* kohdat yhtenäisellä viivalla. Kursivointia käytetään lähinnä vain kasvien ja eläinten latinankielisissä nimissä sekä kaksikielisten taulukkojen ja kuvien toissijaisissa teksteissä. Pitkiä harvennuksia ja kursivointeja on syytä välttää.

Desimaalimerkkinä käytetään pistettä. Tuhannet, miljoonat jne. erotetaan toisistaan tyhjin välein.

Kirjallisuusluettelon laadinnassa ja lyhennysmerkinnöissä noudatetaan Maatalouden koetoiminnan keskusvaliokunnan 1956 julkaisemaan kirjaseen "Maataloustieteellisten julkaisujen kirjallisuusluettelojen laatiminen" sisältyviä ohjeita. Jakaja: Valtion julkaisutoimisto, Annankatu 44, Helsinki.

Käsikirjoitukset liitteineen lähetetään toimitukselle osoitteeseen: MAATALOUDEN TUTKIMUSKESKUKSEN AIKAKAUSKIRJA, Erottajankatu 15—17, Helsinki. Vedokset toimitetaan kirjoittajien tarkastettaviksi ja korjattaviksi. Korjaukset tehdään vedoksen marginaaliin yleisesti käytetyin merkinnöin.

Kaikki yhteydet kirjapainoon hoidetaan toimituksen kautta.

SISÄLLYS — CONTENTS

Helsinki 1964, Kirjapaino Oy Versal