

# EFFECT OF INORGANIC FERTILIZERS ON THE INCIDENCE OF POTATO BLACKLEG DISEASE

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*Zusammenfassung, Résumé p. 144*

## SUMMARY

In assessing disease levels in a number of potato fertilizer trials in south-east Scotland it was found that an increase in the rate of application of complete fertilizer or nitrogen alone resulted in a decrease in the proportion of stems affected by potato blackleg.

## 1. INTRODUCTION

The attention which has been given to correlation between host plant nutrition and the incidence of attack by pathogenic micro-organisms has been reviewed by GAUMANN (1950) and YARWOOD (1959), especially in the context of host-parasite relations. The evidence which they cite does not support the commonly held opinion that disease susceptibility is favoured by an increase in the supply of nitrogen or a reduction in the supply of potassium (e.g. RUSSELL, 1961 and many elementary textbooks). Once above the nutrient level where deficiency symptoms are manifest, some host-parasite associations show a decrease and others an increase in disease incidence which varies according to the supply of the three major elements, nitrogen, phosphorus and potassium.

Such a relationship has been described for cracking and soft rot of potato tubers caused by the blackleg organism (*Pectobacterium carotovorum* var. *atrosepticum*), in which an increase in the supply of a complete fertilizer can be accompanied by an increase in the proportion of affected tubers (HARPER et al., 1963). The same organism causes the well known potato blackleg disease affecting the stems, which is responsible for considerable losses in yield in Scotland every year. Because there was little information on the effect of fertilizers on the incidence of blackleg, opportunity was taken to assess the amount of disease in a number of fertilizer yield trials in south-east Scotland during 1963, 1964 and 1965.

## 2. FIELD OBSERVATIONS

The observations were made on five field experiments laid out in randomized blocks

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or latin square designs, in which the variable was either the rate of application of a concentrated complete fertilizer or of nitrogen alone. The experiments were done on three widely separated farms, the soils varying from a fine sandy loam to a clay loam. Blackleg-infected plants were counted in each plot of each treatment on two occasions, once during mid-season and once near the end, because blackleg develops throughout the whole of the growing period. It was necessary to mark infected plants with canes

Table 1. Effect of concentrated complete fertilizer on blackleg incidence

Year <sup>1</sup>	Variety and number of tubers planted per treatment <sup>2</sup>	Percentage of N, P <sub>2</sub> O <sub>5</sub> and K <sub>2</sub> O in fertilizer <sup>3</sup>	Fertilizer <sup>4</sup> (kg/ha)	Percentage blackleg <sup>5</sup>		
				count 1	count 2	
1963	Majestic	13 : 13 : 18	0	3.5 N.S.	10.8*	
			377	2.1	7.9	
			720	1.9	5.0	
			1,130	0.8	6.2	
			1,506	0.4	3.4	
1964	Home Guard	13 : 13 : 20	0	3.5 N.S.	11.7**	
			377	3.3	7.8	
			720	1.0	4.9	
			1,130	1.1	3.9	
			1,506	1.1	3.9	
1964	Redskin	10 : 10 : 18	0	3.5*	7.9*	
			314	6.8	10.6	
			960	6.28	5.5	9.4
			941	3.0	6.7	
			1,255	2.3	7.0	
1965	Majestic	17 : 11 : 22	0	1.4 N.S.	9.6**	
			377	1.0	10.0	
			720	1.5	8.2	
			1,130	0.4	7.2	
			1,506	0.4	5.7	

\* Significant difference between rates of fertilizer at 5% level – signifikanter Unterschied zwischen Düngergaben bei 5% – différence significative entre les quantités de fertilisants appliqués au seuil de 5%

\*\* Significant difference between rates of fertilizer at 1% level – signifikanter Unterschied zwischen Düngergaben bei 1% – différence significative entre les quantités de fertilisants appliqués au seuil de 1%

N.S. not significant – nicht signifikant – non significatif

1 kg ha = 0.892 lb acre

<sup>1</sup> Jahr – année

<sup>2</sup> Sorte und Anzahl ausgeplanter Knollen pro Verfahren – variété et nombre de tubercules plantés par traitement

<sup>3</sup> Prozent N, P<sub>2</sub>O<sub>5</sub> und K<sub>2</sub>O im Düngemittel – pourcentage de N, P<sub>2</sub>O<sub>5</sub> et K<sub>2</sub>O dans la fumure

<sup>4</sup> Düngergabe – fumure

<sup>5</sup> Prozent Schwarzbeinigkeit (Auszählung 1 und 2) – pourcentage de "jambe noire" (comptage 1 et 2)

Tabelle 1. Einfluss von konzentriertem Volldünger auf das Vorkommen von Schwarzbeinigkeit

Tableau 1. Effet d'une fumure complète concentrée sur l'incidence de la "jambe noire"

## EFFECT OF INORGANIC FERTILIZERS ON THE INCIDENCE OF POTATO BLACKLEG DISEASE

at the first count to avoid missing those which had died and become buried beneath the foliage of adjacent plants during the time between the first and second counts.

Table 1 summarises the results from the concentrated complete fertilizer trials. These show that, in general, the greater the amount of fertilizer applied the less blackleg occurred. The effect was quite striking, and in two cases less than half as many plants were affected at the highest rate of application as compared with the lowest. Table 2 shows that a similar effect was obtained by increasing nitrogen levels when adequate supplies of potassium and phosphorus were available.

In the 1964 *Home Guard* trial, two identical experiments were laid down side by side, one irrigated with pipes placed in the drills, the other not irrigated. The summer was dry and irrigation frequently applied, but there was no significant difference in the amounts of blackleg between the two treatments. It is also noteworthy that in the 1964 *Redskin* trials, potassium was applied either as sulphate or chloride, but statistical analysis revealed that the form in which the potassium was available did not affect the amount of blackleg.

Table 2. Effect of nitrogen on blackleg incidence, 1963

Variety and number of tubers planted per treatment <sup>1</sup>	N as (NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> (kg/ha)	Percentage blackleg		
		count 1	count 2	
Kerr's Pink	0	17.5**	28.5*	
	56	20.5	32.0	
	330	112	17.5	33.0
	168	14.0	28.0	
	224	7.0	20.5	
Majestic	0	16.5**	21.5*	
	56	14.5	24.0	
	330	112	11.0	18.5
	168	10.5	15.0	
	224	6.5	15.0	
Arran Consul	0	7.5**	17.5*	
	56	10.0	19.5	
	330	112	3.0	16.5
	168	2.0	11.0	
	224	1.5	12.0	

<sup>1</sup> See Table 1 - siehe Tabelle 1 - voir Tableau 1

The difference between varieties is significant at 1% level for first count and at 5% level for second count. There is no N × variety interaction, i.e. the three varieties all behave in the same manner. Der Sortenunterschied ist für die erste Auszählung bei 1% und für die zweite bei 5% signifikant. Es gibt keine Interaktion N × Sorte, d.h. die drei Sorten verhalten sich gleich. La différence entre les variétés est significative au seuil de 1% lors du premier comptage et au seuil de 5% pour le second. Il n'y a aucune interaction "N variété", c'est-à-dire que les trois variétés se comportent toutes de la même manière.

TABELLE 2. Einfluss von Stickstoff auf das Vorkommen von Schwarzbeinigkeit, 1963

TABEAU 2. Effet de l'azote sur l'incidence de la "jambe noire", 1963

## 3. DISCUSSION

Stem infection usually takes place when blackleg bacteria in the decomposing mother tuber migrate through the connections between stem and tuber. There must be some mechanism in plants receiving a high plane of nutrition which delays the passage of the bacteria into stems or increases the resistance of the host tissue, or perhaps both. Such plants are taller than those on a low plane of nutrition, have a larger leaf area, a greater bulk of tissue, with a deeper green colour and whereas lower leaves are shed earlier, new leaves are produced over a longer growing period. Thus it seems that so long as plants grow vigorously and photosynthesize actively, they are not so readily attacked. This would account for the fact that the difference in disease incidence between low and high rate plots in the 1963 nitrogen trial (Table 2) was greater at the first count earlier in the season, but later, as the photosynthetic efficiency of high rate plants fell towards the same level as low rate plants, the difference in the amount of disease became less marked. In a number of instances, the amount of blackleg in plots to which no fertilizer had been applied was less than in those which received the lowest amount of fertilizer. This apparently anomalous result is difficult to explain, but it may be that on some soils the nutrient level was so low that plants were suffering a degree of deficiency which reduced blackleg susceptibility, perhaps through lack of readily available food material for the pathogen.

Another aspect of the results is that they help to explain why the amounts of blackleg in plants grown from the same stock of tubers can vary considerably from farm to farm, since the nutrient level in the fields is likely to be different.

One of the most interesting features of the blackleg soft rot complex is that whereas fertilizers decrease blackleg they can increase soft rot in tubers (HARPER *et al.*, 1963), although both are usually caused by the same organism in Scotland. Therefore it could be argued that there should be a certain rate of application of fertilizer where decreases in one disease are counterbalanced by increases in the other in such a way that losses in yield are at a minimum. In practice this cannot be so, because development of tuber soft rot depends not only on fertilizer rate, but also on other factors such as the weather during the growing season, amount of mechanical damage at lifting and the storage conditions.

Observations are continuing on a series of factorial experiments to discover more about how the interactions of nitrogen, potassium and phosphorus influence blackleg incidence.

## ZUSAMMENFASSUNG

EINFLUSS ANORGANISCHER DÜNGEMITTEL AUF DAS VORKOMMEN  
DER SCHWARZBEINIGKEIT AN KARTOFFELN

Der Umfang der Schwarzbeinigkeit an Kartoffeln wurde in fünf Düngerversuchen in Südost-Schottland festgestellt. In diesen Versuchen wur-

de entweder die Gabe eines konzentrierten Volldüngers oder aber des Stickstoffs allein geändert. Da Schwarzbeinigkeit zu jeder Zeit während der

## EFFECT OF INORGANIC FERTILIZERS ON THE INCIDENCE OF POTATO BLACKLEG DISEASE

Wachstumsperiode auftreten kann, wurden zwei Auszählungen vorgenommen, eine in der Mitte und eine gegen das Ende der Vegetationszeit. Die Ergebnisse der Volldüngerversuche sind in Tabelle 1 und jene des Stickstoffversuches in Tabelle 2 wiedergegeben. Es wird gezeigt, dass im allgemeinen eine Erhöhung der Volldünger- oder Stickstoffgaben eine signifikante Abnahme des Anteils an Schwarzbeinigkeit verursachte, aber die Art und Weise, wie die Düngemittel das

Krankheitsvorkommen vermindern, ist nicht klar. Mit Hilfe der Ergebnisse kann eine Erklärung gefunden werden, warum der Umfang an Schwarzbeinigkeit in Beständen mit Knollen gleicher Herkunft von Betrieb zu Betrieb beträchtlich variieren kann. Da der Nährstoffspiegel in den Feldern unterschiedlich zu sein scheint, wirkt sich dies im Ausmass des Auftretens der Krankheit aus.

## RÉSUMÉ

### L'ACTION DE FERTILISANTS INORGANIQUES SUR L'APPARITION DE LA MALADIE DE LA "JAMBE NOIRE" DE LA POMME DE TERRE

On détermine les manifestations de "jambe noire" dans cinq essais de fumure situés dans le sud-est de l'Ecosse; dans ces essais on fait varier soit la quantité de fumure concentrée complète, soit l'azote seul. Etant donné que la "jambe noire" peut apparaître à tout moment pendant la période de croissance, les comptages de "jambe noire" sont faits deux fois, la première fois au milieu et la seconde vers la fin de saison. Les Tableaux 1 et 2 donnent respectivement les résultats obtenus avec la fumure complète et avec l'azote. Ceux-ci montrent que, généralement, une

augmentation de la quantité de fumure complète appliquée, ou d'azote seul, amène une diminution significative du nombre de tiges atteintes de "jambe noire", mais le mécanisme par lequel les fumures réduisent l'indidence de la maladie n'est pas clair. Ces résultats aident à comprendre comment le nombre de "jambe noire" peut varier considérablement de ferme à ferme dans des récoltes provenant de plants de même origine; en effet le niveau de nutrition dans les champs est probablement différent, ce qui se reflète dans l'importance de la maladie.

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