EFFECT OF NUTRITION ON THE INCIDENCE OF *DRECHSLERA INCURVATA* LEAF SPOT OF COCONUTS

H. GALLASCH*

ABSTRACT

Recordings were made on three experiments to determine the effect of various fertilizer nutrients on the severity of Drechslera incurvata (*syn.* Helminthosporium incurvatum) *leaf spot disease on coconut seedlings. The results showed that the severity of* D. incurvata *leaf spot was related to the rate of applied nitrogen. Nitrogen fertilizers increased the susceptibility of the plant to the leaf spot disease while both potassium and phosphorus fertilizers decreased the susceptibility of the coconut seedlings. The application of sulphur fertilizer did not affect the disease severity.*

Growth of the seedlings, measured by total fresh weight at harvest, was markedly reduced when the leaf spot disease was severe for several months prior to harvest.

INTRODUCTION

A NUMBER of fungi are associated with leaf spotting of coconut seedlings on the Gazelle Peninsula of New Britain but microscopic identification revealed the major pathogenic one to be *Drechslera incurvata* (syn. *Helminthosporium incurvatum*). Often *Pestalotiopsis* spp. are also found on the diseased fronds, commonly on tissue apparently killed by *D. incurvata*, or on areas damaged by sprays. Occasionally *Epicoccum cocos* and *Curvularia* sp. are associated with these other fungi on the leaf spots.

A recent report (pers. comm.) has indicated that a loss of 73 per cent of seedling palms over three years occurred on one plantation on the Gazelle Peninsula as a result of this disease. These losses occurred despite good management and regular fertilizing with nitrogenous and sulphur fertilizers.

Drechslera incurvata leaf spot disease has been noted affecting palms in many other coconut growing regions. Zaiger (1967) recorded that most coconut nurseries on Ponape in the Caroline Islands had to be abandoned because of seedling defoliation by this leaf spot. In the British Solomon Islands this disease was more devastating on some varieties of coconuts, especially on the heavy soil types (Foale 1964). *D. incurvata* has been noted, along with several other leaf spotting fungi, on coconuts in other areas of Papua New Guinea (Shaw 1963, 1965). Kirthisinghe (1963) recorded seedling losses of up to 20 per cent in Sri Lanka caused by *D. incurvata* and it is a common but not serious disease of coconuts in Thailand (Meksongsee 1963).

The major plant nutrients N, P and K have often been reported as affecting plant resistance to disease. For example, an inbalance of nitrogen and potassium, resulting in a physiological deficiency of potash, considerably increased the incidence of *Helminthosporium* sp. leaf disease of rice (Akai and Mori 1954). In Africa the manuring of oil palm seedlings in the nursery with phosphate and especially with potassium reduced the incidence of leaf spot disease (*Cercospora* sp.) while nitrogen dressings increased the incidence (Ehsanullah 1970). Menon *et al.* (1950) in India established that low potash increased the incidence of leaf spot and other leaf diseases of coconuts and regarded as particularly important the ratio of potassium to nitrogen. Experiments at Kasarogod showed that a balanced NPK fertilizer treatment would aid in recovery of the palm from leaf spot disease. On a fertilizer experiment in Jamaica, Smith (1966) reported that young palms receiving nitrogen were highly susceptible to attack by the leaf spot fungus *Pestalotia palmarum*,* but that the increased

* Agronomist, Lowlands Agricultural Experiment Station, Keravat, East New Britain, P.N.G.

* The fungus may in fact have been *D. incurvata* (pers. comm.).

susceptibility could be offset when potassium was also applied. A trial in Sri Lanka (Kirthisinghe 1963) examined the effect of rates of nitrogen, phosphorus and potassium on *Drechslera incurvata* of coconuts and found a decline in disease of 45 per cent with the most effective treatment, an application of potash plus phosphate fertilizer. Nethsinghe (1963) quotes Sri Lanka work as showing the incidence of the disease was generally associated with young palms with phosphorus deficiency receiving high levels of nitrogen.

Because of the potential seriousness of *D. incurvata* leaf spot on the early growth and survival of coconut seedlings investigations were commenced into the influence of some of the major plant nutrients on the disease.

METHODS

Recordings were made on coconut seedlings in two different maintenance-nutritional experiments at Keravat and a third experiment was planted specifically to examine leaf spot severity under the interaction of several nutrients.

Experiment 1

This experiment which was designed to examine maintenance of coconut seedlings was described by Sumbak (1971). It involved clean weeding over a wide area compared with limited ring weeding around the base of the seedlings and grass slashing, all treatments with and without the addition of ammonium sulphate. This fertilizer was applied at 30 g N per application to alternate seedlings. At an age of 16 months, after four bi-monthly applications of fertilizer, the incidence of *D. incurvata* was very high and recordings were made by the author on the degree of disease severity and frond damage.

Recording involved visual assessment of the extent of the frond area damaged by disease on the five youngest fronds of each seedling. Each frond was given a rating from 0-5 where—

0 = Zero to less than 1 per cent of area affected.

1 = 1 to 25 per cent of area affected.

2 = 26 to 50 per cent of area affected.

3 = 51 to 75 per cent of area affected.

4 = 76 to 99 per cent of area affected.

5 = Frond completely killed.

An average plant rating and hence percentage of leaf area affected was calculated for each plant.

Experiment 2

Factorial combinations of five rates of nitrogen and four rates of sulphur were applied as treatments to recently transplanted 14 weeks' old coconut seedlings. Nitrogen was applied initially at rates 0, 0.5, 2.2, 8.6, and 34 g urea per plant and sulphur as elemental sulphur at rates 0, 0.3, 2.5 and 20 g per plant. Rates of fertilizer increased with age in proportion to the estimated dry weight. Frequency of application was once per fortnight for urea and once per three months for sulphur. Treatments were applied to five seedlings per replicate and there were six replicates.

All seedlings were established in a pumiceous sandy subsoil, low in nitrogen and sulphur. Initially the spacing of seedlings was 1.8 x 1.8 m but harvest thinning during the trial increased this to 3.6 x 3.6 m. At an age of seven months there was an increase in the incidence of leaf spot and control was attempted using a regular weekly spraying of the fronds with a fungicide. For seven months a variety of fungicides was used, including copper oxychloride, Difilatan, Zineb and Captan. From October until the trial was completed Duter fungicide (.036 per cent w/v) was applied as a weekly spray. Recordings were made on the degree of leaf spot damage.

Experiment 3

Fertilizer treatments comprising zero and a high rate each of nitrogen, phosphorus and potassium, in factorial combination, were applied to coconut seedlings in polybags at five months after germination.

Rates of nutrients used were 5 g nitrogen as urea, 10 g phosphorus as monosodium phosphate and 15 g potassium as potassium chloride. Fertilizers were applied to the subsoil pumiceous sands in the polybags. Each of the eight treatments was allocated to eight seedlings in four replicates. Treatment applications were applied every six weeks for three applications and on two further occasions over the following six months.

Recordings of the leaf spot severity on the five youngest fronds of each plant were made at seedling ages of 8, 11, 15 and 20 months.

RESULTS

Drechslera incurvata leaf disease caused spotting of the fronds of coconut seedlings and the affected tissue became necrotic (*Plate* I). Under conditions conducive to the disease the spots enlarged and coalesced resulting in the eventual death of the frond (*Plate* II). The reduction in effective leaf area resulted in a substantial effect on the growth of the seedling (*Figure* 1). If a sufficient number of fronds were killed the seedlings died. Observations indicated however, that once seedlings grew taller than about 1.5 m, few deaths resulted from this disease.

In Experiment 1, where an analysis of soil samples indicated a concentration of 0.3-0.5 per cent nitrogen in the topsoil prior to planting, clean or ring-weeded seedlings which were fertilized with ammonium sulphate were severely damaged by *Drechslera incurvata* leaf spot while the unfertilized seedlings were much less affected (*Table* 1). However, seedlings growing under competitive conditions with grass (slashing treatment) showed a reversal of this effect.

The initial recordings in Experiment 2 indicated a fairly even distribution of disease through the planting and a uniform low rate of infection on all fertilizer treatments (*Figure* 2). However, as the severity of the leaf spotting increased, subsequent recordings indicated a marked correlation of damage with rate of applied nitrogen (*Figure* 2). There was a linear correlation between frond area killed and the log of the amount of applied nitrogen. Because the overall level of leaf spot severity varied during the period of the experiment (*Figure* 3) the slope of the linear regression line in *Figure* 2 varied with time.

The relationship between the cube root of the total fresh weight of the coconut seedling (harvested at 86 weeks) has been plotted in *Figure* 1 against the square root of the percentage leaf area damage (recorded seven months prior to harvest). The regression coefficient (r) = —0.74 is highly significant.

In spite of the weekly application of fungicide the disease severely affected seedlings treated with high levels of nitrogen (*Figure* 3). At the zero and lowest level of nitrogen fertilizer there appeared to be a decline in leaf spot damage after July, whereas at the higher rates of applied nitrogen a decline in the extent of leaf damage only commenced in the following January.

Rainfall may have influenced the severity of the disease and was plotted in histogram form in *Figure* 3. Over the period September to January rainfall was uniformly high as was the severity of disease. A marked decline in disease severity corresponds with a period of low rainfall in January and February.

Seedlings within the same treatment were not uniformly affected by leaf-spot disease (*Figure* 4). Without added nitrogen only four per cent of seedlings were affected to the extent of greater than 20 per cent frond necrosis but at the highest rate of applied nitrogen seedlings were affected at all degrees of severity. Although 29 per cent were affected to an extent of greater than 80 per cent of their leaf area there was still some 23 per cent of the seedlings affected to less than 20 per cent of their leaf area.

The rate of sulphur application had little effect on the degree of leaf spot on coconut seedlings (*Figure* 4). Irrespective of the amount of sulphur applied as fertilizer, 67 per cent of all seedlings were affected to less than 40 per cent of their leaf area, the large majority of these to less than 20 per cent of their leaf area.

In Experiment 3 the effect of *D. incurvata* leaf spot disease was reduced by the application of potassium chloride and to a lesser extent by monosodium phosphate (*Figure* 5). Urea fertilizer markedly increased the amount of leaf damage. During the period of highest disease incidence, covered by the September and December recordings, there was around 100 per cent increase in disease damage on seedlings fertilized with nitrogen. Over the same period damage was reduced by 30 per cent on seedlings receiving phosphorus and by 32 per cent on those receiving potassium fertilizer.

DISCUSSION

Effect of D. incurvata *on Coconut Seedlings*

Colonization of the leaf by *D. incurvata* results in spotting, the tissue in these spots becoming necrotic. If the environment favours the disease a large proportion of the leaf area may be killed or rendered ineffective. This reduction in effective leaf area of the seedling affects the growth potential and the weight increase of the plant (*Figure* 1). The linear

Plate I—Drechslera incurvata leaf spot disease on frond of coconut seedling

Plate II—Severe *D. incurvata* leaf spot may result in the death of coconut seedling fronds

Table 1—The effect of nitrogenous fertilizer on the degree of frond necrosis by *D. incurvata* under different maintenance systems

	Per cent of frond area killed		
	Slashing	Ringweeding of seedling	Complete-clean weeding
No fertilizer	50	28	17
Ammonium sulphate (applied every 3 months	23	55	57

relationship of the cube root of total fresh weight to the square root of the leaf area damaged indicates an effect of the leaf spot disease on growth. An increase in the disease severity results in a corresponding decrease in the subsequent growth of the plant.

The plant nutrients nitrogen, potassium and phosphorus affect the susceptibility of coconut seedlings to *D. incurvata* leaf spot disease whereas sulphur does not.

Nitrogen

The nitrogen nutrition of the seedling is a factor affecting the severity of leaf spotting, leaf damage being proportional to the logarithmc function of the rate of fertilizer nitrogen (*Figure* 2). The actual source of the nitrogen is not important. In Experiment 1 the use of ammonium sulphate fertilizer, under conditions of adequate soil nitrogen resulted in increased leaf spotting (*Table* 1). Urea applications in Experiments 2 and 3 similarly increased the seedling susceptibility to leaf spot. Comparable results have been found in Sri Lanka (Nethsinghe 1963 and Kirthisinghe 1963) and India (Menon *et al.* 1950).

Potassium and Phosphorus

Potassium and phosphorus interact with nitrogen in its effect on seedling susceptibility to attack by *D. incurvata.* Applications of potassium and phosphorus in Experiment 3 have been effective in reducing the degree of leaf spot on coconut seedlings. This is shown graphically in *Figure* 5. By comparing the *Nil* point with the *PK* point on each graph, it can be seen that in each case there is a drop in the percentage leaf spot necrosis. Where nitrogen is included in the fertilizer treatment, the drop is even greater, as can be seen by comparing the *N* point with the *NPK* point on each graph.

A similar result was obtained by Kirthisinghe in Sri Lanka (1963), who obtained a decline of 45 per cent in lesion counts three months after a fertilizer application of phosphorus and potassium. Smith (1965) reported comparable results obtained with phosphorus and particularly potassium on the incidence of leaf spot caused by *Pestalotia palmarum.* It appears important that a balance of the major nutrients must be maintained. If it becomes necessary to fertilize with nitrogen then consideration should be given to complementary applications of potassium and perhaps phosphorus to prevent coconut seedlings becoming unduly susceptible to leaf spot disease.

Sulphur

The application of sulphur fertilizer did not influence the susceptibility of coconut seedlings to *D. incurvata* leaf spot (*Table* 2).

Effect of Fungicides on D. incurvata

At the zero and lowest rate of nitrogen fertilizer the reduction in disease incidence noted in August (*Figure* 3) is considered due to the production of new fronds partially protected by the fungicides. The degree of protection was insufficient to reduce the disease incidence on seedlings rendered more susceptible by the higher rates of nitrogen fertilizer. Only after regular spraying with Duter, a fungicide found to be effective against *D. incurvata* (report to be published), was there a dramatic decrease in disease damage. As the youngest five fronds were assessed at each recording period it would be approximately five months after treatments commenced (the time required for formation of five new fronds) before recordings were unbiased by pre-treatment condition of the fronds.

Other factors affecting the incidence of D. incurvata

Many factors undoubtedly affect the level of disease damage on seedlings. These include the genetic type, the rate of frond production, the overall vigour of the seedling and its immediate environment. It is considered that

Table 2—Per cent of frond area affected by leaf spot disease at various rates of applied sulphur

Recording Date (Weeks from Germination)	Rate of Sulphur			
	S_0	S_1	S_2	S_3
6.5.70 (34 weeks)	13	12	11	13
18.8.70 (49 weeks)	33	24	25	31
21.10.70 (58 weeks)	27	20	29	30
8.3.71 (78 weeks)	4	4	4	5

a combination of these factors resulted in the anomalous situation for the slashing treatment in Experiment 1 (*Table* 1). The lack of vigour, a somewhat lower rate of frond production and the different microclimate surrounding the unfertilized seedlings in the tall grass could have combined to result in a high level of disease damage. Ammonium sulphate, used to rectify the nutrient deficiency induced by severe grass competition increased the plant vigour but not the susceptibility to *D. incurvata.*

The commencement of a dry period in January coincided with a marked decline in assessed disease damage in Experiment 2 (*Figure* 3). It is considered that the dry weather conditions most likely contributed towards the recorded decrease in disease on the seedlings.

As the seedling age increases the rate of leaf area production increases rapidly (Foale 1968). Because of this rapid increase in total area of the seedling the significance of *D. incurvata* leaf spot on leaf area decreases with increasing age of the seedling. The final recording on disease damage in Experiment 2 (*Figure* 3) was made at an average seedling age of 18 months, at which stage the disease was less effective in substantially reducing the leaf area of the plant. In Experiment 3 the level of disease damage at age 21 months was less than half that at age nine months but the extent to which this is due to age or to environmental conditions is not known. For the three experiments a seedling height of about 1.5 m corresponded to the stage of growth at which new leaf production was sufficient to minimize the effects of leaf spot necrosis.

CONCLUSIONS

Drechslera incurvata can be a serious disease of coconut seedlings and can result in substantial growth reductions or even death of the seedlings if conditions are conducive for the growth and spread of the disease. This disease is usually only of consequence while the seedlings remain comparatively small. Overseas work, confirmed here, shows that nitrogen fertilization may accentuate the disease while potassium and phosphorus tend to retard it. Consequently care must be exercised in the use of nitrogenous fertilizers on coconut seedlings. In many cases an adequate nitrogen nutrition of seedlings can be maintained by cleanweeding around the seedlings (Sumbak 1971) and the application of fertilizer cannot fully compensate for the lack of clean weeding. If additional nitrogen is required on some soil types it should be used sparingly and the recommended application rates not exceeded. Should the *D. incurvata* leaf spot still become a problem it can be alleviated by the application of 150 g of potassium chloride per year. This is applied every four months during the critical period when the seedlings are less than 1.5 m tall. This added cost is relatively small when compared with the alternative cost of replanting seedlings killed by a bad outbreak of the leaf spot disease.

This method involving the adjustment of plant nutrition by fertilizer applications to reduce susceptibility to disease can be readily applied in the field as well as in the nursery. Alternative methods of control using fungicidal spraying may be quite effective in the nursery but there are practical difficulties involved in using them in control of leaf spot on a large scale in the field.

ACKNOWLEDGEMENTS

The help of the Plant Pathology Section, Department of Agriculture, Stock and Fisheries, in identifying the leaf spot pathogens was appreciated.

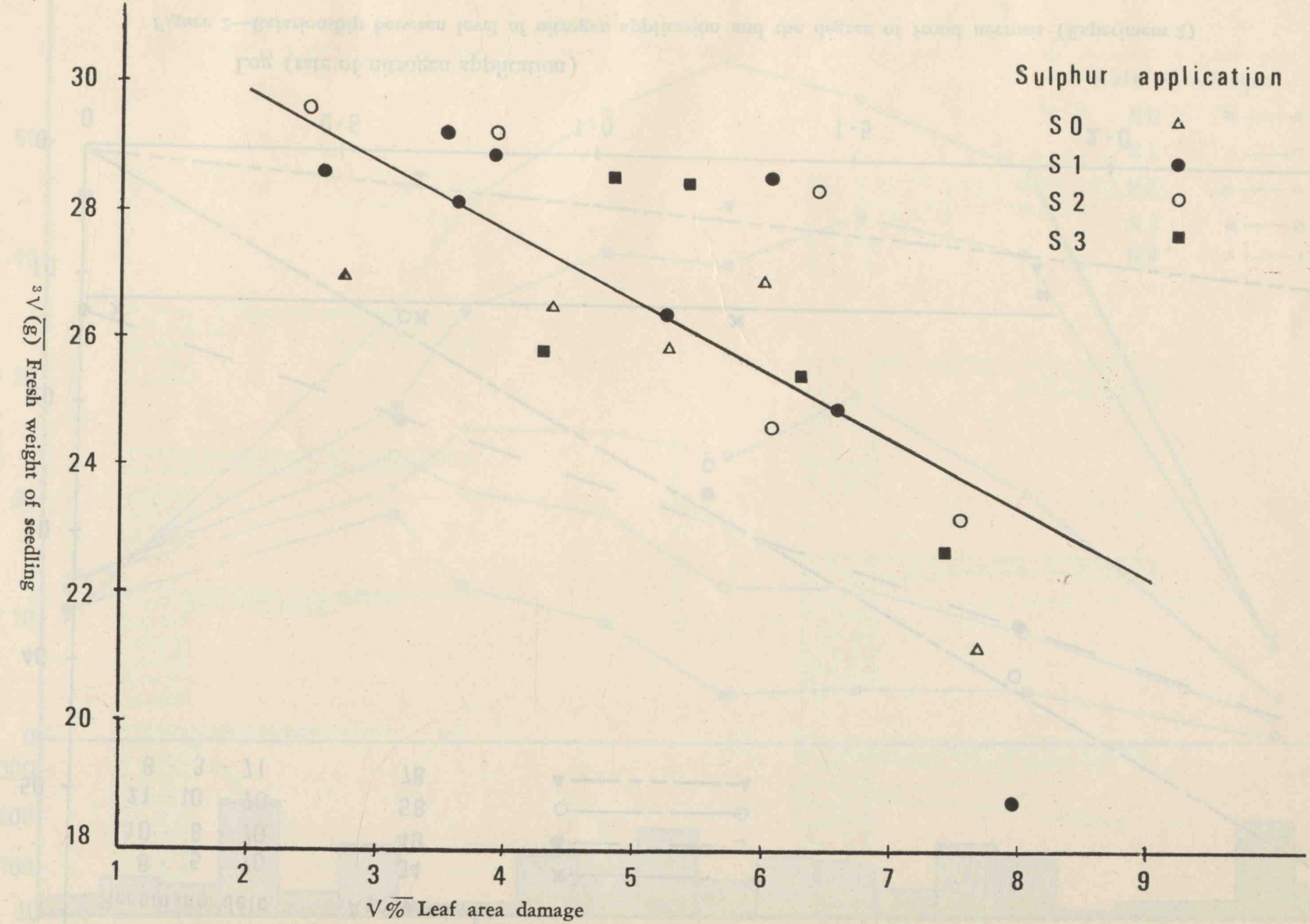

Figure 1—Relationship between total fresh weight of seedling (at age 86 weeks) and previous leaf spot damage: the regression of $\sqrt[3]{(\text{fresh weight})}$ on $\sqrt{(\%\ \text{leaf area damage})}$ (Experiment 2)

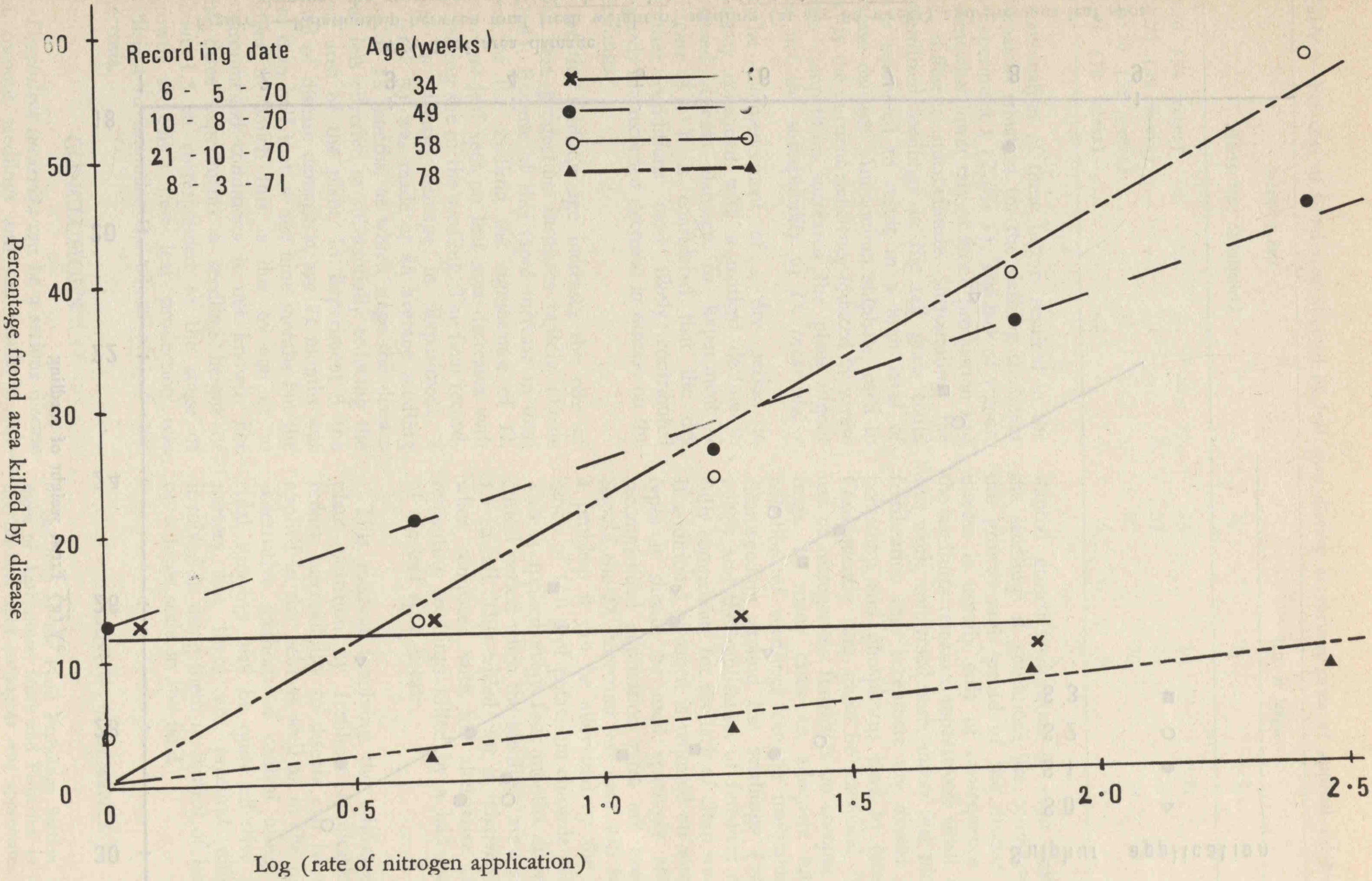

Figure 2—Relationship between level of nitrogen application and the degree of frond necrosis (Experiment 2)

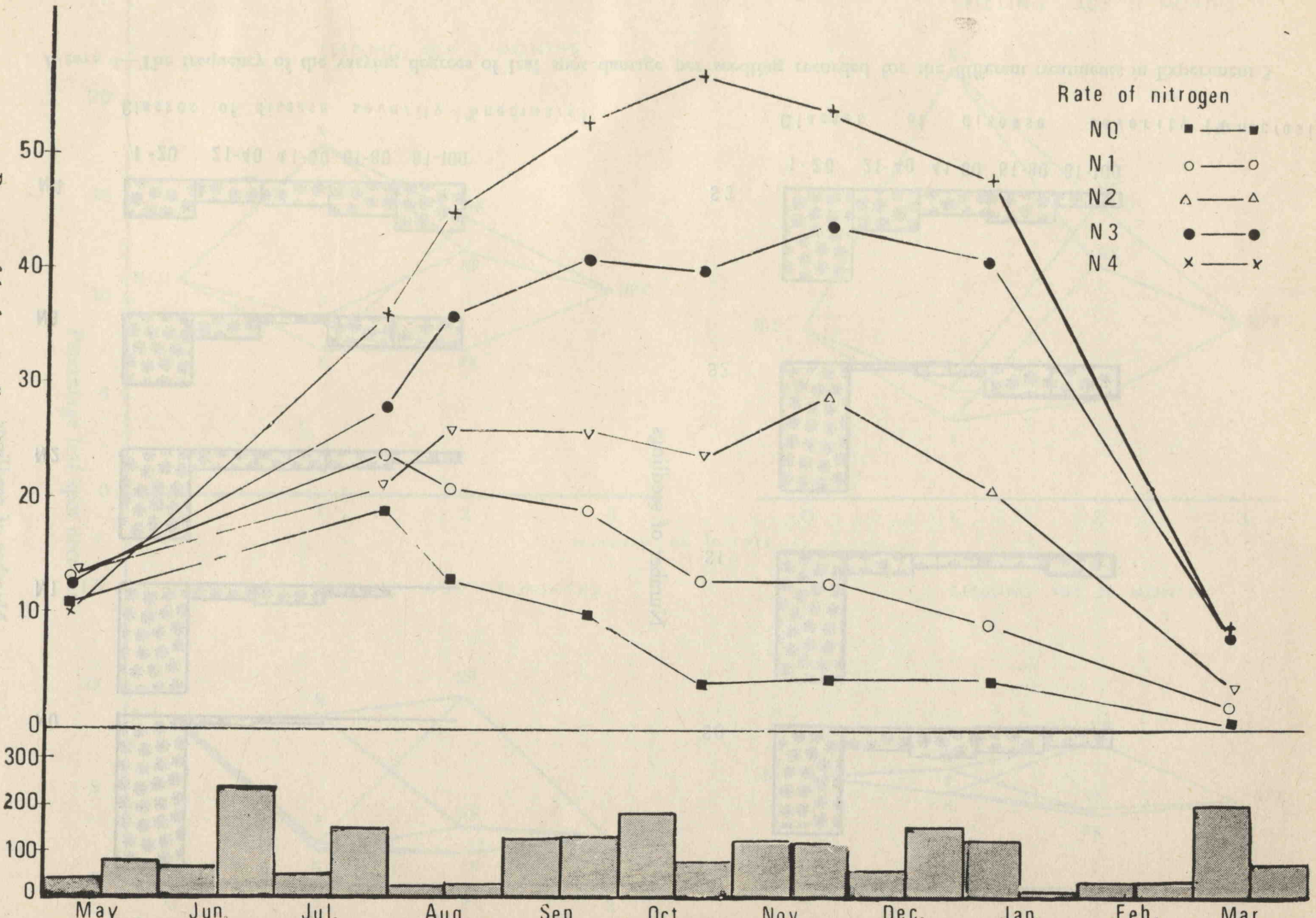

Figure 3—Variation in disease severity with time and level of applied nitrogen (Experiment 2), and rainfall during the period of recording

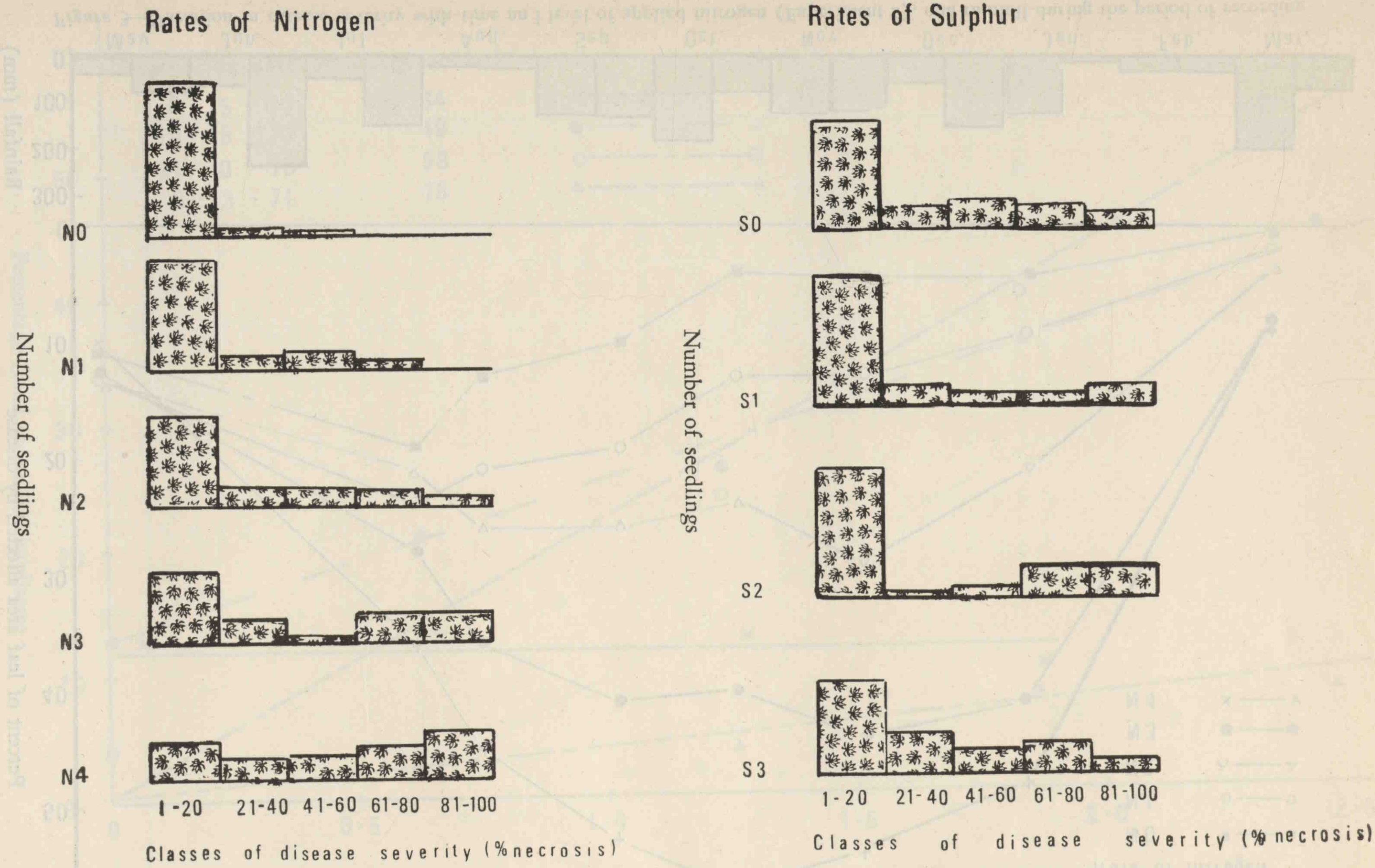

Figure 4—The frequency of the varying degrees of leaf spot damage per seedling recorded for the different treatments in Experiment 3

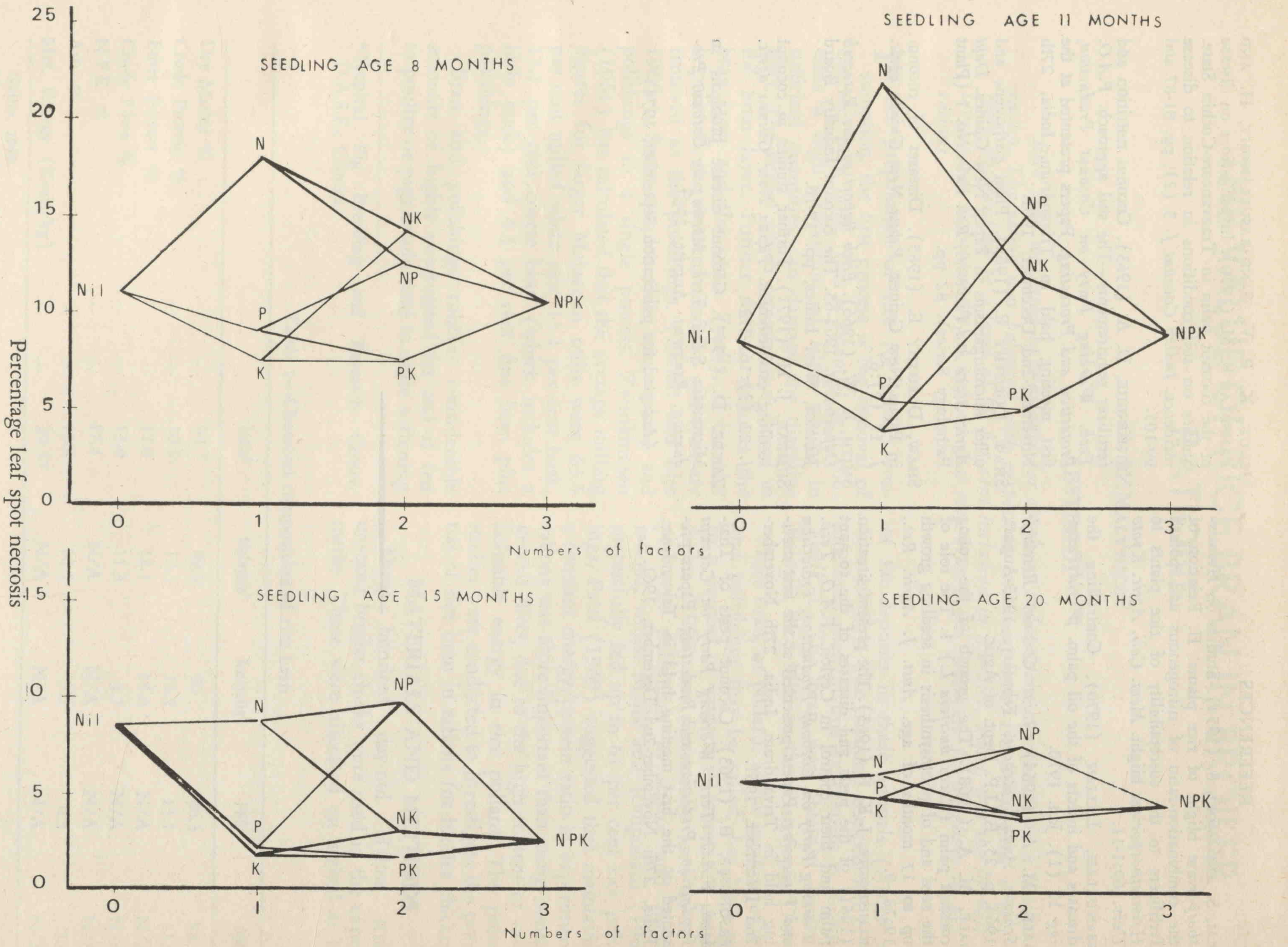

Figure 5—The interaction of nitrogen with potassium and phosph orus in the effect on seedling susceptibility to attack by *D. incurvata* (Experiment 3)

REFERENCES

AKAI, S. AND MORI, S. (1954). Studies on *Helminthosporium* blight of rice plants. II. Relation of the combination-ratio of nitrogenous and potash fertilizers to the susceptibility of rice plants to *Helminthosporium* blight. *Mem. Coll. Agric. Kyoto Univ.* 69:1-11.

ENSANULLAH, LILLIAN (1970). Controlling the diseases and insects of the oil palm. *World Farming* 12 (1). Jan. 1970.

FOALE, M. A. (1964). *Joint Coconut Research Scheme Annual Report.* February, 1963-August, 1964. p. 25, B.S.I.P. Dept. of Agric.

FOALE, M. A. (1968). The growth of the young coconut palm (*Cocos nucifera L.*) 1. The role of the seed and of photosynthesis in seedling growth up to 17 months of age. *Aust. J. Agric. Res.*, 19:781-9.

KIRTHISINGHE, J. K. F. (1963). The present situation (1961) of the pests and diseases of the coconut palm and their control in Ceylon. *F.A.O. Tech. Working Party on Coconut Production, Protection and Processing.* Papers presented at the first meeting held in Trivandrum, India, 27th November-2nd December, 1961.

MEKSONGSEE, B. (1963). Coconut pests of Thailand. *F.A.O. Tech. Working Party on Coconut Production, Protection and Processing.* Papers presented at the first meeting held in Trivandrum, India, 27th November-2nd December, 1961.

MENON, K. P. V., SANDARASUBRAMONY, H. AND PANDALAI, K. M. (1950). Investigations on disease of the coconut palm in Tranvancore-Cochin State. Studies on soil conditions in relation to disease incidence. *Indian Coconut J.* 3 (2), pp. 81-87 and 99-105.

NETHSINGHE, D. A. (1963). Coconut nutrition and fertilizer requirements—The soil approach. *F.A.O. Tech. Working Party on Coconut Production, Protection and Processing.* Papers presented at the first meeting held in Trivandrum, India, 27th November-2nd December, 1961.

SHAW, DOROTHY E. (1963). Plant pathogens and other microorganisms in Papua New Guinea. *Dept Agric. Stock and Fisheries, Res. Bult. No.* 1 (Plant Pathology Series). 82 pp.

SHAW, DOROTHY E. (1965). Diseases of coconut in Papua New Guinea. *Papua New Guinea agric. J.* 17 (2):67.

SMITH, R. W. (1966). *Fifth Report of the Research Department*, 1964-65. The coconut Industry Board Jamaica, West Indies, pp. 15-16.

SUMBAK, J. H. (1971). Further studies in coconut seedling establishment. *Papua New Guinea agric. J.* 22 (3):167-173.

ZAIGER, D. (1967). Coconut disease problems in Micronesia. *S.P.C. Tech. Meeting on Coconut Production, Rangiroa.* August, 1967.

(Accepted for publication September, 1974)