THE EFFECT OF CHLORINE SOURCES AND AMMONIUM SULFATE ON THE GROWTH OF COCONUT SEEDLINGS[1]

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ABSTRACT

Of the chlorine sources, NaCl at 30 g Cl (60 g NaCl) gave the best result followed by KCl.

It was shown further that Cl significantly increased the girth circumference while sulfur greatly increased the height of seedlings.

Cl leaf levels significantly decreased with increasing sulfur. Correlation analysis between the two elements likewise revealed a certain degree of negative interaction which somehow substantiates the apparent antagonism between Cl and S.

Sixty (60) gram Cl from KCl or higher rates of NaCl significantly reduced leaf spot incidence compared with the highest rates of NH_4Cl.

INTRODUCTION

Recent studies revealed that chlorine plays an important role in the growth and development of coconuts. Reports such as those of Mendoza and Prudente (1972); Magat and Prudente (1975) showed that the chlorine content of the leaf is highly correlated with growth and production. Uexkull (1970) and Magat *et al.* (1975) mentioned that coconuts grown near the seashore where chlorine is sufficient are more productive than those found in low-chlorine inland areas. Ollagnier and Ochs (1971) and Uexkull (1970) emphasized the high requirement of coconuts for Cl and suggested to rank the element as an essential major nutrient for coconut and oil palms.

Nursery studies indicated that Cl-bearing fertilizers (KCl and NaCl) influenced the growth of seedlings and increased its resistance to diseases particularly reduction of photosynthetic activity of the palm caused by leaf spot (Abad *et al.*, 1975; Magat *et al.*, 1976).

With the above observations, this study was initiated to evaluate the response of coconut seedlings to different sources of Cl at different rates of ammonium sulfate.

MATERIALS AND METHODS

Soil. The soil used in the study was collected from within the Davao Research Center which belongs to the Tugbok clay loam type. It has an average chemical analysis of: pH 6.7; 1.22% OM; 12 ppm available P; 320 ppm K; 270 ppm Cl and 11.3, 5.1, 0.11 m.e. of Ca, Mg and Na/100 g of soil, respectively. The experimental soils were placed in black 18" x 18" x .008" polyethelene bags.

Climatic condition. The total annual rainfall in 1977, the study period, was 1767.7 mm. During the dry season (December–April) precipitation went down to 24.1 mm. Adequate sunshine prevails throughout the year with a satisfactory relative humidity.

Experimental design and treatments. The study was arranged in a 4 x 3 x 2 factorial in randomized complete block design, with 12 seedlings per treatment replicated four times. The Cl rates in g/seedling were: 0, 30, and 60 while N rates were 0 and 10 g. The fertilizers were applied in split, the first half was applied two months from polybagging; the other half, after another two months.

The following fertilizer materials were used:

(1)	NaCl	– 50%Cl; (0, 60, 120 g NaCl)
(2)	NH_4Cl	– 55%Cl; (0, 55, 110 g NH_4Cl)
(3)	KCl	– 44%Cl; (0, 67, 134 g KCl)
(4)	$(NH_4)_2SO_4$	– 21%N, 24%S (0, 50 g $(NH_4)_2SO_4$)

Data gathered. Observations on height, girth circumference, number of leaves, number of leaflets (leaf no. 3), fresh weight of the vegetative parts (less the roots), and incidence of leaf spot/blight diseases were taken.

Leaf analysis. To trace the development of the nutrition of the seedlings, leaf samples were collected for leaf nutrient analyses of N, P, Ca, K, Mg, Na, Cl, S and B.

RESULTS AND DISCUSSION

Growth Observations

Among the Cl sources used, KCl and NaCl significantly influenced the girth circumference of the

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seedlings. The 30 and 60 g chlorine levels regardless of source, significantly increased the girth over the control (Table 1). There were no significant difference that existed between these two higher rates.

The application of 110 g NH_4Cl (60 g Cl) significantly depressed the height of the seedlings (Table 2a) whereas treatment with 50 g $(NH_4)_2SO_4$ highly significantly increased the height of seedlings (Table 2b).

A recent study showed that growth of non-*Macapuno* embryos in *vitro* treated with chloride was significantly enhanced by KCl and highly inhibited by higher rates of NH_4Cl (Miniano and de Guzman, *et al.*, 1978).

Sixty and 120 grams of NaCl (30 and 60 g Cl respectively) significantly increased fresh weight of seedlings as compared with those without Cl. In Table 3, it can be gleaned that 110 g of NH_4Cl (60 g Cl) significantly reduced fresh weight compared with the higher rates of NaCl and KCl apparently due to severe leaf spots incurred by the seedlings during their growth. The leaf spots reduced the photosynthetic activity of the seedlings.

Observations made by Miniano and de Guzman, (1978) further support the inferiority of NH_4Cl in improving the growth of seedlings. At high NH_4Cl supply, ammonia will accumulate inside the tissues to a toxic level. Furthermore and regarding the use of NH_4Cl in embryo culture, it has been reported that immature globular embryos of cattleya supplied with NH_4Cl (primarily as N source) produced retarded seedlings in subsequent media high in $NaNO_3$ (Raghavan and Torrey, 1963). This is attributable to the toxicity of the ammonium ion.

Foliar Diagnosis

Leaf analysis showed that higher Cl-rates of NH_4Cl significantly produced higher leaf N-level compared with NaCl and KCl rates (Table 4, Fig. 1a). Apparently, the addition of 50 g $(NH_4)_2SO_4$ to NaCl and KCl fertilized seedlings improves N-level while the addition to NH_4Cl decreases S-level (Table 5, Fig. 1b, 1c). Ammonium sulfate enhanced the absorption of N and S but greatly reduced the uptake of Cl (Maravilla *et al.*, 1977).

Chlorine leaf levels significantly decreased with increasing S (Table 6). Correlation analysis between these two elements likewise revealed certain degree of negative interaction. This observation substantiates the apparent antagonism between Cl and S and which most likely, upsets the whole physiology of the seedlings (Fig. 2).

Phosphorus and sulfur are positively correlated with girth, height, and fresh weight of seedlings (Table 7). Phosphorus is found in plants as a constituent of nucleic acids, phospholipids, and co-enzyme NAD and NADP, and mostly as a constituent of ATP. Sulfur, on the other hand, is found in sulfuhydryl groups which are present in many enzymes and are necessary for enzyme activity. (Robins and Lippman, 1956).

A negative correlation between girth and leaf Boron was observed (Table 7).

Leaf Spot Occurrence

The disease that severely affected the growth of NH_4Cl treated and untreated seedlings was identified to be caused by *Pestalozzia palmarum* Cke. It generally attacks older leaves and is usually more prevalent at the distal rather than the proximal end of the leaves. The spots are characteristically circular to oblong, grayish in color and surrounded by dark brown margins.

In the advanced stage, the tips and margins of the leaf or leaflets dry up due to coalition of spots giving them blighted appearances. At a distance, the leaves appear burnt (del Rosario, 1967). Occurrences of these foliar disease in seedlings affect the early performance of the palms in the field. As shown in Figure 3, 60 g Cl and higher Cl-rates of NaCl significantly reduced leaf spot incidence. The study confirms the earlier findings on the use of common table salt (Magat *et al.*, 1977).

However, the addition of 110 g NH_4Cl (60 g Cl) per seedling together with $(NH_4)_2SO_4$, particularly at higher levels, increased the incidence of leaf spots. This severe spotting is very likely due to the following: double dosage or excessive application of N; a decrease in Cl level and an increase in S caused them to be susceptible to fungal diseases as reported on coconuts in West Africa (Backy *et al.*, 1962).

Moreover, the application of $(NH_4)_2SO_4$ in combination with NaCl or KCl particularly at lower rates appreciably reduced leaf spots, thus a better growth and development are reflected on girth, height and fresh weight of seedlings. This suggests that a balance between anions Cl and S in addition to cationic balance provided by K, Ca, and Mg is indispensable for normal growth and development of seedlings. It also suggested that further studies in this regard be conducted to gain better understanding of the cation-anion nutritional balance.

In the review of studies on the two forms of N (NH_4 and NO_3), Djikshoorn (1969) concluded that all plants when grown with NH_4–N grow slower than when grown with NO_3–N. The form in which N is absorbed whether as a cation or an anion has an important effect on the absorption of other ions and consequently on the ionic balance in the plants which in turn determines plant growth and performance. Generally, the content of inorganic cations and cation-anion balance have been found to be lower for NH_4–N in all species (Arnon, 1939; Chouteau, 1960; Coic, Lessaint and Le Rouc, 1961; Kirkby, 1969; and Djikshoorn, 1969). Because of possible toxic effects of ammonium ion on plant growth, it is necessary to establish for each species its tolerance for ammonium ion.

SUMMARY AND CONCLUSION

Sodium chloride gave the best result among the Cl sources at 30 g Cl or equivalent to 60 g NaCl followed by KCl.

Likewise, NaCl increased significantly the girth circumference and the addition of $(NH_4)_2SO_4$ increased the height of seedlings.

The study revealed that ammonium chloride at all levels of Cl and in combination with ammonium sulfate did not statistically influence stem girth but it further aggravated the occurrence of fungal diseases which eventually resulted to very poor growth and development of the seedlings.

The results strongly showed that NaCl and KCl are effective sources of chlorine which in combination with ammonium sulfate provides the seedlings with high degree of resistance to fungal diseases.

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Table 1. Effect of chlorine sources and rates on the girth circumference of nine month old seedlings (cm).

Cl–Source	Cl–Rate			Cl–Source Mean
	0	30	60	
KCl	23.131	24.856	24.930	24.306 [a]
NaCl	22.420	25.241	25.206	24.289 [a]
NH_4Cl	22.794	22.441	23.273	23.50 [b]
Cl-Rate Mean	22.782	24.846**	24.470**	24.033

** Highly significant at 1% level.
All means having the same letter(s) subscript(s) in each treatment group are not significantly different at 5% level (HSD-test).

Table 2a. Effect of chlorine sources and rates on the height of 9 month old seedling (cm).

Cl–Source	Cl–Rate			Cl–Source Mean
	0	30	60	
KCl	162.356[a]	160.158[a]	153.165[a]	158.560[a]
NaCl	153.478[a]	165.691[a]	163.059[a]	160.743[a]
NH_4Cl	158.581[a]	158.998[a]	138.675[b]	152.085[b]
Cl–Rate Mean	158.138	161.615[ns]	151.633**	175.129

NS – Not Significant
All means having the same letter(s) subscript(s) in each treatment group are not significantly different at 5% level (HSD-test).
** Highly significant at 1% level.

Table 2b. Effect of Cl- and $(NH_4)_2SO_4$ rates on the height of nine month old seedlings (cm).

Cl–Rate	$(NH_4)_2SO_4$ Rate		Cl–Rate Mean
	0	50	
0	153.230	163.047	158.138*
30	156.105	167.126	161.615*
60	147.719	155.547	151.633
$(NH_4)_2SO_4$ – Rate Mean	152.351	161.906	–

* Significant at 5% level

Table 3. Effect of chlorine sources and rates on the fresh weight of nine month old seedlings (gram).

Cl–Source	Cl–Rate			Cl–Source Mean
	0	30	60	
KCl	1321.043^{ab}	1422.514^{a}	1369.554^{a}	1371.037^{a}
NaCl	1135.416^{b}	1537.168^{a}	1517.865^{a}	1396.816^{a}
NH_4Cl	1267.769^{ab}	1355.398^{ab}	1042.575^{b}	1227.914^{b}
Cl–Rate Mean	1241.409	1438.360*	1309.998*	1329.922

All means having the same letter(s) subscript(s) in each treatment group are not significantly different at 5% level (HSD-test).

* Significant at 5% level.

Table 4. Effect of chlorine sources and rates on the leaf nutrient levels of nine month old seedlings, leaf no. 3.

Treatments		% Leaf Nutrient			
Cl–Source x	Rate	N	K	Na	S
KCl	0	2.000^{a}	2.270^{ab}	0.050^{a}	0.207^{ab}
	30	1.990^{a}	2.242^{bc}	0.050^{a}	0.213^{ab}
	60	2.184^{a}	2.597^{c}	0.060^{a}	0.235^{b}
NaCl	0	2.020^{a}	2.310^{abc}	0.077^{a}	0.213^{ab}
	30	1.966^{a}	2.130^{ab}	0.162^{b}	0.210^{ab}
	60	2.166^{a}	2.074^{a}	0.140^{b}	0.220^{b}
NH_4Cl	0	2.077^{a}	2.361^{abc}	0.046^{a}	0.225^{b}
	30	2.641^{b}	2.152^{ab}	0.052^{a}	0.195^{ab}
	60	2.776^{b}	2.124^{ab}	0.052^{a}	0.163^{a}

All means having the same letter(s) subscript (s) in each treatment group are not significantly different at 5% level (HSD-test).

Table 5. N leaf levels of seedlings (9 month old) fertilized with different sources of Cl in combination with $(NH_4)_2SO_4$ (% dry matter, leaf no. 3).

$(NH_4)_2SO_4$ – Rate	Cl–Source			$(NH_4)_2SO_4$-Rate Mean
	KCl	NaCl	NH_4Cl	
0	1.924^{a}	1.940^{a}	2.608^{c}	2.158
50	2.192^{b}	2.162^{b}	2.388^{b}	2.247
Cl–Source Mean	2.058	2.051	2.490	2.202

– Not :Significant

means having the same letter subscripts in each treatment group are not significantly different at 5% level (HSD-test).

Table 6. Cl leaf levels of seedlings (nine month old) fertilized with Cl-rates in combination with $(NH_4)_2SO_4$ (% of day matter, leaf no. 3).

Cl–Rate	$(NH_4)_2SO_4$ – Rate		Cl-Rate Mean
	0	50	
0	0.204^a	0.347^b	0.275
30	1.234^c	0.894^c	1.064
60	1.202^c	0.955^d	1.078
$(NH_4)_2SO_4$ Mean	0.880	0.732	0.806

All means having the same letter subscript in each treatment group are not significantly different at 5% level (HSD-test).

Table 7. Correlation coefficient (r) of growth character and leaf nutrient level of nine month old seedlings.

	Girth	Height	Fresh wt.	N	P	K	Ca	Mg	Na	Cl	S
N	0.179	–0.013	0.044	1.00							
P	0.382**	0.348**	0.390**	0.179	1.000						
K	–0.116	–0.047	–0.132	–0.268*	0.013	1.000					
Ca	–0.018	0.006	–0.040	–0.383**	–0.049	–0.044	1.000				
Mg	0.068	0.105	0.145	–0.414**	0.160	–0.340	0.528**	1.000			
Na	0.257*	0.183	0.237*	–0.201	0.208	0.417	0.158	0.517	1.000		
Cl	0.241*	–0.171	0.169	0.297*	0.082	–0.130	–0.148	0.029	0.208	1.000	
S	0.379**	0.508**	0.412**	–0.035	0.137	0.259*	0.085	–0.092	–0.028	–0.321**	1.000
B	–0.236*	–0.095	–0.223	–0.033	–0.249*	0.064	–0.150	–0.133	–0.135	–0.250*	0.127

*Significant at 5% level.
**Highly significant at 1% level.

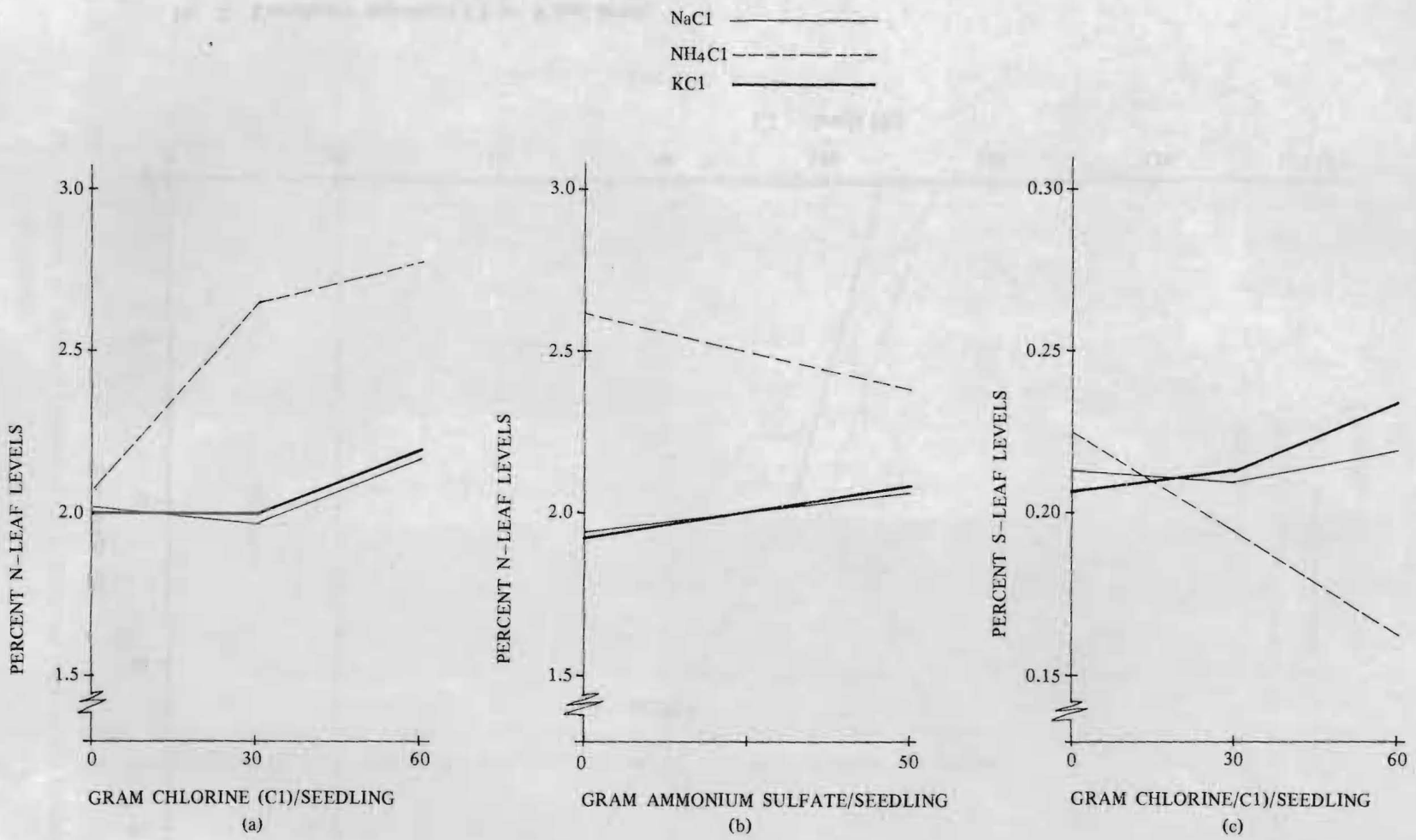

Fig. 1. Nitrogen - N - leaf levels of 3-C1 sources at different rates (a) and with or w/out Ammonium Sulfate (b), and Sulfur - S - levels of 3-C1 sources of different rates (c), fertilized coconut seedlings.

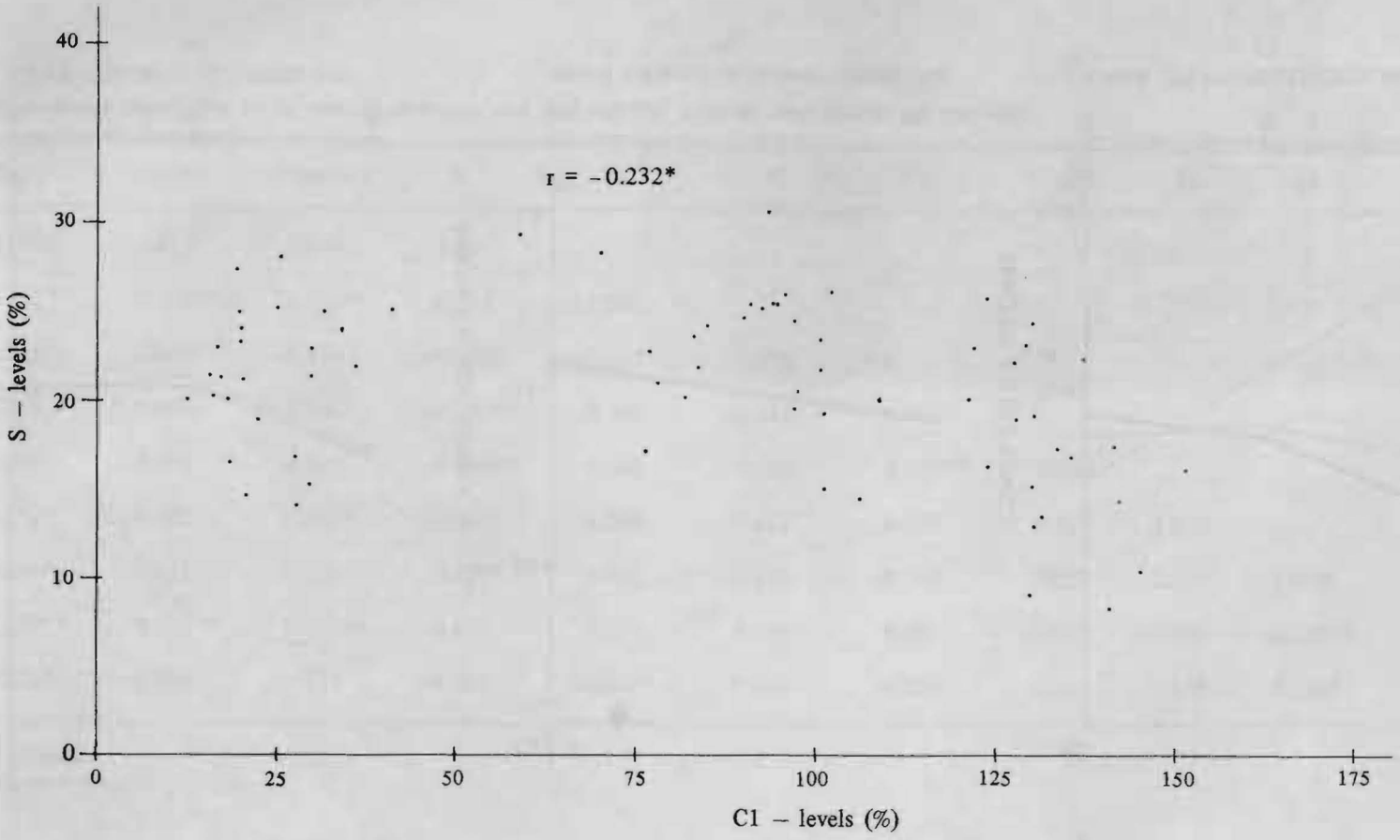

Fig. 2. Correlation regression C1 vs. S leaf levels.

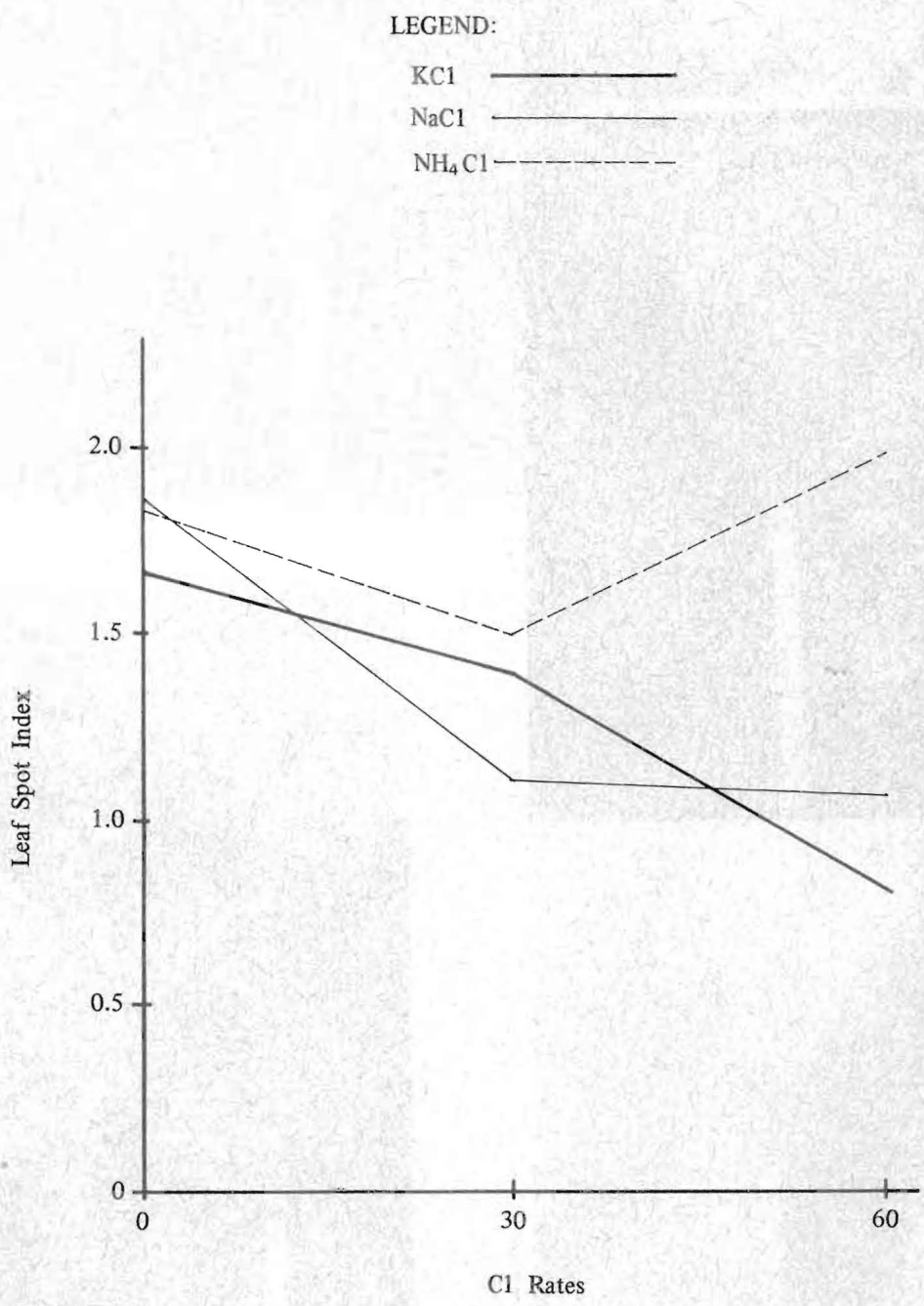

Fig. 3. Effect of different sources of C1 at different rates on the incidence of leaf spot/blight.