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BIURET INJURY ON PINEAPPLES

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SUMMARY

Biuret added to regular urea foliar sprays induced leaf yellowing and leaf tip dieback and at higher rates reduced plant crop yield by about 6%. The biuret impurity ranged from the equivalent of 0·5 to 0·4% biuret content in urea or 105 to 837 mg biuret per plant. Fruit yield was reduced at the 3·0 and 4·0% impurity levels but there was no significant difference between 0·5, 1·0 and 2·0% biuret impurity levels.

Although the severity of the leaf symptoms increased noticeably according to treatment, especially on mature leaves, the D leaf mass shortly after flower induction was not significantly affected. Leaf symptoms developed 6 weeks after initial treatment and increased in severity with continued biuret applications.

I. INTRODUCTION

Biuret injury was first reported on pineapples in 1954 by Sanford *et al.* Leaf tip dieback and yellowing of older leaves was associated with fertilizer urea applied by foliar boom spray. The biuret content of the urea was 3% or more. Impey and Jones (1960), working with citrus, showed that biuret is not metabolized and accumulates in the leaf tips in toxic amounts. Older leaves were more severely affected.

Pan and Lee (1963) showed that the toxic effect of urea foliar sprays on pineapples varied proportionally with the biuret content of the urea, the age of the plant and the number of sprays applied. Younger plants were more seriously affected. Plant leaves were withered and fruit yield and quality reduced when the biuret impurity was 2·13% or more. There was no damage at 1·13%. Soil fertilization did not affect plant growth or yield even at 4·13% biuret. Up to 16 urea foliar sprays were applied to 1-year-old plants at 3·0 g per plant per application giving a total application of about 0·54 g biuret per plant at 1·13% biuret impurity, 1·0 g biuret (2·13%) and 1·98 g biuret (4·13%).

In Queensland, the recommended maximum biuret impurity level for urea sprays on pineapples is low at 0·25% (Cannon 1960).

Biuret damage was suspected in 1974 after the field observation of leaf tip dieback where excessive rates of urea were applied. Fertilizer grade urea then contained a maximum of 1% biuret. Experimental work to produce toxicity symptoms and to establish the tolerance of pineapple plants to biuret received from urea under current management methods is reported herein.

II. MATERIALS AND METHODS

Observation experiment

Plant crop plants 9 months old were treated with foliar sprays applied by hand and directed at the upper leaves and plant heart. Rates used per plant were biuret at 0, 12·5, 25, 50, 100, 150, 200 and 250 mg alone or with 2·5 g urea applied in 50 mL water. The urea contained a nominal biuret of impurity of 1·0% (25 mg biuret per plant). The treatments were in addition to normally scheduled monthly urea sprays (containing a maximum of 1·0% biuret). The treatments were not replicated and were applied on 10 January 1975 at the Committee of Direction of Fruit Marketing (C.O.D.) Pineapple Industry Farm at Beerwah in south-east Queensland. There were six plants per plot.

Replicated experiment

An experiment was established in mid May 1976 at the C.O.D. Pineapple Industry Farm. The planting material was farm run graded slips averaging 470 g each. Plant density was 43 000 per hectare in a double row layout. Land preparation, fumigation and fertilization were according to C.O.D. Farm standard practice. Preplant fertilizer was applied according to established soil analysis recommendations. Post plant fertilizers (P, K, Ca, Mg) were maintained at established critical levels by monitoring leaf samples from an adjacent experiment which received identical fertilization.

Five biuret treatments were applied (0·5, 1·0, 2·0, 3·0 and 4·0% biuret impurity) giving a range of 105 to 837 mg biuret per plant. The urea used contained 0·5% biuret. The other rates were obtained by adding biuret (95% a.c.) to the monthly urea foliar sprays. The experimental design was a randomized block with four replications and 70 datum plants per plot. One extra plot (a nil biuret treatment) received only solid sulphate of ammonia at rates of nitrogen equal to each urea foliar spray.

The sulphate of ammonia was applied by hand to the plant basal leaves and soil at the same times as the urea treatments. A total of 414 kg N ha^{-1} (900 kg urea ha^{-1}) was applied with 31 kg N ha^{-1} each month from August 1976 to December 1976, 41 kg N in January 1977, 62 kg N in February, 104 kg N in March and 52 kg N in April 1977. In line with recent Queensland pineapple industry practice, no fertilizers were applied after plant crop flower induction.

All post plant fertilizers (except the sulphate of ammonia) were applied as foliar sprays at 2 250 or 4 500 L ha^{-1}. The higher volume sprays were used during the hotter summer period of January to March to reduce the urea concentration in solution and the possibility of urea burn damage.

In early July 1977, the experiment received a flower induction treatment of a 10 p.p.m. a.c. solution of the sodium salt of alpha-naphthalene acetic acid applied at 2 250 L ha^{-1}.

III. RESULTS

Observation experiment

There were no symptoms until yellowing developed about 6 weeks after treatment. After 8 weeks, symptoms ranged from no yellowing and about 1 cm leaf tip dieback on the no biuret no urea plot (but biuret received from scheduled urea foliar sprays) up to severe leaf tip dieback of 8 cm plus 25 cm of yellowed leaf.

Symptoms were present mostly in the D leaves (the most recently fully matured leaves) and older leaves. Yellowing was below the dead leaf tip tissue and extended down the leaf margins. Only at the highest biuret rates were the younger heart leaves yellowed. The effects were more apparent where 100 mg biuret or more was applied.

Replicated experiment

The leaf tip dieback rating in December 1976 is based on the length of yellowing and tip dieback. A rating of 10 is equivalent to a leaf tip dieback of about 2·5 cm plus yellowing of about 2·5 cm (table 1). Differences were obvious during most of the trial and treatments were easily identified by the amount of leaf damage. By August 1977, practically all the tissues which had yellowed during the growing season had died and leaf tip dieback was about 15 cm on the older leaves of plants receiving the highest rate of biuret. There was less effect on younger leaves.

TABLE 1

EFFECT OF BIURET, AN IMPURITY OF FERTILIZER UREA, ON PINEAPPLE PLANT GROWTH AND FRUIT YIELD

Biuret Impurity %	Biuret applied mg/plant	Leaf tip dieback rating Dec. 1976	Mean D leaf mass (g) Aug. 1977	Mean fruit mass (kg) March 1978
0·5	105	0·8	99	1·74
1·0	210	1·8	99	1·70
2·0	420	5·3	98	1·68
3·0	630	6·5	98	1·59
4·0	840	9·0	90	1·59
Nil*	Nil	0	100	1·59
L.S.D.		2·1 5%	N.S.	0·07 5%
		2·9 1%		0·10 1%

* Not replicated—not comparable with other data.

Leaf samples taken in August 1977 showed no significant differences in D leaf mass (table 1) which is strongly correlated to plant mass up to flower induction or in the leaf analyses of the basal white tissue of the D leaves for P, K, Ca, Mg.

The mean fruit mass was significantly decreased ($P < 0·01$) by the highest biuret impurity rates of 3·0 and 4·0% (i.e. over 600 mg biuret per plant) (table 1). The fruit mass reduction of approximately 6% is equivalent to over 4 tonnes of fruit per hectare and is economically significant. The proportion of fruit harvested to plants planted was 92% for all treatments.

Slip and sucker counts showed no significant differences due to treatment. Sucker numbers averaged 0·76 per plant and slip numbers 0·36 per plant.

IV. DISCUSSION

The effects of increasing amounts of biuret applied were readily apparent in the field from the degree of leaf tip dieback and yellowing of older leaves. While plant appearance was inferior, plant growth up to induction, as indicated by D leaf mass, was not greatly affected. However, the leaf dieback was mainly on leaves older than D leaves. Also biuret was applied in increasing amounts later in the growing period as nitrogen (urea) rates increased.

During the winter at the start of the fruit growing period, all the biuret-yellowed leaf tissue died leaving up to half of some older leaves non-functional. Thus the cumulative effects of biuret toxicity became apparent with average fruit mass reduced significantly at 3% biuret impurity or more.

In contrast to the work of Pan and Lee (1963) who applied nearly 40% of their biuret on developing fruit, fertilizer was not applied in this experiment during fruit growth. Additional biuret from urea during this period would be expected to increase leaf tissue dieback and therefore adversely affect sucker growth and further reduce fruit yield.

The potential of the first ratoon crop as measured by sucker numbers was not affected despite the fruit yield reduction in the plant crop. Differences in sucker size were not apparent although it is reasonable to expect a reduction in ratoon yield because of the amounts of dead leaf tissue on plants receiving the higher biuret rates and the additional biuret which would be applied during ratoon crop fertilization. The lower than normal sucker numbers are attributed to seasonal influences.

In conclusion, a pineapple industry standard of a maximum of 1.0% biuret impurity in fertilizer urea is acceptable. Plant growth and fruit yields are not significantly affected when urea is applied at the recommended rates and times. However, the biuret impurity should not be over 1% as plant tolerance is close to the acceptable limit. Despite the lack of significant differences at the 2% biuret level, this level cannot be recommended because of the effects on plant leaf dieback and the potential for yield reduction.

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