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Abstracts of Publications and Research Department of Agronomy and Soil Science College of Tropical Agriculture 1960–1974

IV. Soil Science

Peter P. Rotar, Editor

PREFACE

This series of six volumes of *Abstracts of Publications and Research, Department of Agronomy and Soil Science, College of Tropical Agriculture, 1960–74* details all the published research by members of the Department of Agronomy and Soil Science, University of Hawaii, and graduate student M.S. theses and Ph.D. dissertations prepared for degrees granted by the Department.

The volumes in this series include:

I. Crop Science–(1) Crop Breeding, Genetics and Tissue Culture; (2) Crop Physiology and Metabolism; and (3) Crop Quality and Utilization .....
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III. Soil Science–(1) Soil Physics; (2) Soil Chemistry; and (3) Soil Water Management and Classification .....
IV. Soil Science–(4) Soil Microbiology and Biochemistry; (5) Soil Fertility and Plant Nutrition; and (6) Fertilizer Use and Technology .....
V. Soil Science–(7) Soil Genesis, Morphology and Classification; (8) Soil Mineralogy; and (9) Forest and Range Soils .....
VI. Agronomy–(1) Land Use and Management; (2) Climatology; and (3) Environmental Quality .....

Within each numbered section, the publications are listed in alphabetical order by senior author and date of publication, then by alphabetical order of second author, and finally by alphabetical order of title. Abstracts of theses and dissertations are longer than abstracts of published papers. The table of contents in each volume lists the complete citation–author, date, title, and publication data–for each publication.

Each abstract may be cut out and individually mounted on a 5 x 8 notecard for easier filing.

The choice of category for certain abstracts may appear somewhat arbitrary, especially since some abstracts fit well into any one of several sections. Choice of section was made by the compiler. Not all of the department's research efforts are presented in these reports: some were inadvertantly missed; others fell by the wayside as deadlines were set and changed. These will all be published in an addendum at a later date.

The preparation of these reports was partially supported by funds from a USAID-2lld grant given to the department.

P.P.R.

The Editor

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CONTENTS

Abstracts of Publications and Research
Department of Agronomy and Soil Science
College of Tropical Agriculture
1960-1974

IV. Soil Science

Peter P. Rotar, Editor

(4) Soil Microbiology and Biochemistry

Agarwal, A. S., and Y. Kanehiro. 1966. Measurement of nitrogen and carbon release under drying and rewetting conditions. Soil Biology (International News Bull.), Paris, 6:44-45.

ABSTRACT

Techniques in measuring nitrogen and carbon release in soils under drying and rewetting conditions are described. Nitrogen (ammonium and nitrate) release was measured under incubated as well as under unincubated conditions. Drying consisted of (1) air-drying, (2) oven-drying at 60 C, or (3) oven-drying at 100 C. Rewetting was done by bringing the soil back to the moisture equivalent level after a drying cycle.

The technique of measuring carbon release by trapping CO_2 evolved from soil samples in sodium hydroxide is also described. This is a volumetric method utilizing standard HCl to titrate against unused sodium hydroxide after the CO_2 entrapment.

additional index words: soil analysis, soil nitrogen release, soil carbon release, organic matter, wetting and drying in soils, methodology

Agarwal, A. S. 1967. Immobilization and mineralization of nitrogen in Hawaiian soils. Ph.D. Dissertation, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

A readily-available energy source, sucrose, accelerated and increased the magnitude of immobilization of native as well as added nitrogen in all soils. Bagasse was less effective than sucrose in this respect. Immobilization of N, with sucrose added was most rapid in the Koko and Lualualei soils. With no energy source added, the Akaka, a high organic carbon and high C:N ratio soil, immobilized the greatest amount of nitrogen. The Wahiawa and Paaloa soils were found to be the slowest immobilizers, especially in the absence of sucrose. Immobilization of nitrogen was very well reflected in the CO_2 production values.

The Koko and Paaloa soils, which have the highest total nitrogen content, with the exception of Akaka, mineralized the maximum amount of soil nitrogen. Less mineralization in the case of the Akaka was attributed to the mineralizable nitrogen that remained tied up in an inorganic-organic complex.

Drying and rewetting resulted in increased nitrogen and carbon release. The Akaka, a high organic matter soil, which dries irreversibly on dehydration, consistently displayed the greatest release of nitrogen and carbon. There was a surprisingly high magnitude of nitrogen release with air-drying in the Paaloa soil, presumably because in air-drying no appreciable ammonium fixation by this illitic soil occurred. The C:N ratio of mineralized elements increased with temperature of drying in high release soils, and decreased with temperature in the case of low release soils. Significant correlations between the data for rate of carbon and for rate of nitrogen mineralization for air-drying and oven-drying at 60 and 100 C, were found.

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Calcium hydroxide increased and calcium chloride either decreased or did not affect the immobilization of nitrogen. In all the three soils, viz., Wahiawa, Paaloa and Akaka, greatest immobilization occurred when lime was added at the highest rate.

Liming increased the mineralization of nitrogen in the Wahiawa, Paaloa and Akaka soils, while calcium chloride effected a greater release only in the last soil. It was postulated that in addition to usual microbial stimulation, $Ca(OH)_2$ may also have played a role in chemical release of ammonium from inorganic-organic complex in the Akaka soil.

The successive increases in osmotic pressures generally increased the mineralization of nitrogen. The effectiveness of different salts in releasing nitrogen decreased in the order: $CaCl_2 \cdot 2H_2O > KCl > NaCl > K_2SO_4 > Na_2SO_4 > CaSO_4 \cdot 2H_2O$. Evidently, both cations and anions were active in bringing about the observed nitrogen release from the inorganic-organic complex.

Gamma radiation, which was obtained with a Co^{60} source, significantly increased the available nitrogen content of Akaka, Koko and Lualualei soils, and significantly decreased it in the Paaloa soil. The Paaloa and Wahiawa soils when irradiated showed a significant reduction in nitrate content, with the higher doses of irradiation being more effective in this respect.

additional index words: nitrogen transformation, immobilization, mineralization, nitrification, gamma radiation, salt effect, energy source, liming

Agarwal, A. S., B. R. Singh, and Y. Kanehiro. 1971. Soil nitrogen and carbon mineralization as affected by drying-rewetting cycles. Soil Sci. Soc. Amer. Proc. 35(1):96-100.

ABSTRACT

The temperature of drying as well as drying-rewetting cycles enhanced N and C mineralization in practically all soils. There was generally greater N release when incubation after drying was included than when omitted. In all unincubated soils, save the Akaka, air-drying caused greater N release than heating at 60C, regardless of the number of drying-rewetting cycles. The organic matter-rich Akaka soil showed increased N mineralization with increased temperature of drying. Mineralization of C was greater in samples incubated after drying-rewetting cycles than those subjected to incubation only. A highly significant correlation existed between rates of N and C mineralization per cycle. Significant correlation was also noted between C/N ratio of the soils and N released during drying and rewetting followed by incubation. It is proposed that in addition to microbial stimulation through drying, heat was directly responsible for the major amount of N and C release in unincubated samples by chemical alteration of otherwise unavailable organic matter and by killing off of organisms. When incubation followed the drying and heating treatment, the direct effect of heat together with increased microbial activity and associated changes during incubation accounted for N and C release.

additional index words: ammonification, "birch effect," soil organic matter, carbon-nitrogen ratios

Agarwal, A. S., B. R. Singh, and Y. Kanehiro. 1972. Effects of calcium compounds on nitrogen transformation in tropical Hawaiian soils. Tropical Agr. (Trinidad) 49 (2):171-178.

ABSTRACT

The effects of two calcium compounds on N transformation in tropical Hawaiian soils were investigated. The CO_2 production in the Akaka soil was enhanced by lime and depressed by calcium chloride, as compared with the control, and the rate of production was not affected by the addition of NH_4-N. The results of this investigation suggest that the Ca^{2+} ions in lime play a similar role in N mineralization to those in calcium chloride. This may be regarded as contributory to the much-emphasized influence of lime on microbial stimulation in causing N mineralization. The immobilization of added N was greater in $Ca(OH)_2$-treated samples than in those receiving $CaCl_2.2H_2O$. The former accelerated but the latter curtailed nitrification.

additional index words: lime, nitrogen transformation, mineralization, immobilization, nitrification

Agarwal, A. S., B. R. Singh, and Y. Kanehiro. 1972. Note on the immediate effect of gamma-irradiation on the release of mineral nitrogen in fresh tropical soils. Indian J. Agr. Sci. 42(11):1062-1064.

ABSTRACT

Increasing dosage of gamma-irradiation increased magnitude of ammonium nitrogen release. The overall magnitude of NH_4-N decreased in the order: Akaka greater than Koko greater than Wahiawa greater than Lualualei greater than Paaloa. The pattern of nitrate nitrogen as influenced by irradiation was inconsistent. The five soils tested may be grouped in three categories: (1) NO_3 loss, Wahiawa and Paaloa, (2) NO_3 constant, Koko and Akaka, and (3) NO_3 gain, Lualualei soil.

additional index words: gamma-irradiation, mineral nitrogen, available nitrogen, ammonium nitrogen, nitrate nitrogen

Asghar, M. 1972. Effects of sugarcane trash and pineapple residue incorporation on soil nitrogen status. M.S. Thesis, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

Sugarcane trash and pineapple residue, in a finely ground state, were mixed with soil at 0, 5, 25, 50, and 100 tons/acre levels with and without nitrogen fertilization. The nitrogen treatments received 100 lbs. N/acre as ammonium sulfate. The samples were incubated for different lengths of time (up to 16 weeks) and analysed for total ammonium, nitrate and nitrate nitrogen.

There was no noticeable loss of nitrogen from the samples due to aerobic denitrification. The concentration of NH_4- and NO_3-N remained very low throughout the incubation study, probably due to immobilization by soil microflora. After 12 weeks, there was some indication of the release of mineral nitrogen from immobilized reserves. The redox potential remained well above 400 mv under all treatment. There were no drastic changes in soil pH.

By manually controlling the redox potential at different levels, it was found that in the Molokai soil, the nitrates become unstable below 400 mv redox potential values.

additional index words: nitrogen fertilizers, redox potential, tropical soils, organic fertilizers, denitrification

Balasubramanian, V. 1974. Adsorption, denitrification and movement of applied ammonium and nitrate in Hawaiian soils. Ph.D. Dissertation, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

Factors influencing adsorption, denitrification, and movement of applied ammonium and nitrate in tropical Hawaiian soils were investigated. Suggestions are incorporated to maximize crop utilization of field-applied fertilizer nitrogen and to minimize loss of mineral nitrogen through leaching and denitrification.

Some oxidic tropical soils, such as the Hydrandepts and Gibbsihumox, in Hawaii were found to adsorb nitrate significantly in pH ranges below 6. Non-specific anion adsorption is believed to be the major mechanism by which nitrate was adsorbed.

The zero point of change (ZPC), which has a close relation with non-specific anion adsorption, is defined as the pH where the net sum of charges is zero. The high ZPC of the subsoil of the Hydrandepts was attributed to the extensive hydration of their iron and aluminum oxides. Hydrolysis and polymerization of the hydrated oxides were suggested as major mechanisms for the decrease of ZPC and pH on drying the Hydrandepts.

Any change in the ZPC was shown to vary the nitrate adsorption. The significant decrease of nitrate adsorption due to dehydration of the Hydrandepts was explained by the change in the ZPC, pH, cyrstallinity, and surface area on drying. Since this dehydration process is irreversible, it was concluded that these soils should not be allowed to dry excessively by exposure to direct sun and wind so as to preserve their high exchange capacities, both for anion and cations.

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The surface of the Hydrandepts and Gibbsihumox became less positive or more negative on liming, and this was reflected in the (increased) ammonium and (decreased) nitrate adsorption by the limed soils. The finding that raising of soil pH beyond 5.5 with liming produced NO_3^- repulsion in these soils should be taken into consideration in any liming program.

Denitrification loss was found to be important only in soils with large amounts of water-soluble organic matter and nutrients. Available energy source appeared to play a dominant role in denitrification. N_2 and N_2O gases were the prime denitrification products in all the soils studied. Denitrification potential was very low in Oxisols with poor organic carbon (both water-soluble and total) content.

In an infiltration study, it was found that the practically irreversible adsorption of ammonium was responsible for its retention in the Molokai soil. It was further shown that the higher the amount of water infiltrated, the deeper was the position of nitrate peak. An explanation is given on how to take advantage of the lag of nitrate peak with respect to the wetting front in the initially moist soil during transient water flow. For soils with the same initial moisture content, the depth of nitrate peak was in direct proportion to its wetting front. Thus by controlling the wetting front, one can control the depth of maximum solute concentration, irrespective of the rate of water application.

In short, modified management practices based on the knowledge of nitrogen transformation and transport in soils as well as nitrogen uptake by crops will ensure efficient (nitrogen) fertilizer use in crop production with a minimum chance for the pollution of ground water by nitrate.

additional index words: nitrogen transport, ground water pollution, zero point of charge, nitrogen fertilizers

Boonduang, A. 1972. Some studies on slowly available nitrogen sources in Hawaiian soils. M.S. Thesis, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

Effect of temperature on mineralization of slowly available nitrogen fertilizers was studied by incubating six different sources $(NH_4)_2SO_4$, sewage sludge, Agriform, Osmocote, sulfur-coated urea and IBDU in Lualualei and Wahiawa soils at 7°C, room temperature (27°C) and 40°C.

Ammonification increased with increasing temperature. Accumulation of NH_4-N was more in the Wahiawa soil than in the Lualualei soil. Nitrification rate was higher in the Lualualei soil than in the Wahiawa soil. Osmocote released the highest amount of available nitrogen in both soils at all temperatures, followed by sulfur-coated urea, IBDU, Agriform and sewage sludge.

Green House experiments on sweet corn (Zea mays) and bermudagrass (Cynodon dactylon) showed that at 400 lbs N per acre rate, $(NH_4)_2SO_4$, IBDU and Agriform resulted in higher yields than Osmocote, sulfur-coated urea and sewage sludge. Osmocote was the most effective in increasing nitrogen uptake by corn, followed by IBDU, Agriform, sulfur-coated urea and sewage sludge were as effective as $(NH_4)_2SO_4$. In bermudagrass, the order of total yield of three cuttings was as follows:
Osmocote = sulfur-coated urea > sewage sludge > IBDU = $(NH_4)_2SO_4$ > Agriform.

additional index words: nitrogen carriers, soil mineralization, sulfur-coated urea, sewage sludge, ammonification

Bremner, J. M., D. W. Nelson, and J. A. Silva. 1967. Comparison and evaluation of methods of determining fixed ammonium in soils. Soil Sci. Soc. Amer. Proc. 31:466-472.

ABSTRACT

A comparison of methods proposed for determination of fixed ammonium in soils showed that they gave widely divergent results, the highest results being obtained by the method of Rodrigues and the lowest by the method of Mogilevkina. Studies to evaluate these methods revealed defects in all methods investigated except the KOBr-HR method of Silva and Bremner, the main defects being that pretreatments used to eliminate interference by organic nitrogen compounds are inefficient or lead to gain or loss of fixed ammonium and that procedures used to release and estimate fixed ammonium are not quantitative or lead to formation of ammonium from organic nitrogen compounds. Possible defects of the KOBr-HF method are discussed.

additional index words: fixed ammonium, soil nitrogen, soil analysis, KOBr-HF method, comparison of methods

Chakravorty, A. K. 1968. Effect of moisture and biological control chemicals on nitrogen transformation in Hawaiian soils. M.S. Thesis, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

The effect of moisture and biological control chemicals on nitrogen transformation was studied in four Hawaiian soils, the Paaloa, Maile, Wahiawa and Lualualei. The effect of two organic energy sources and moisture on nitrogen transformation was also studied in these four soils.

Though nitrate accumulation from added ammonium nitrogen was noticed at all moisture levels, the field capacity moisture was generally found to be optimum for this process. In the Paaloa, Maile and Wahiawa soils, the rate of nitrification was gradual and maximum nitrate accumulation was observed at the end of 12-week incubation. The rate of nitrification was fastest in the Lualualei soil and even after only a 2-week incubation showed considerable accumulation of nitrate nitrogen.

The overall maximum nitrate accumulation in the Paaloa soil was at twice field capacity moisture level, followed by at field capacity, after 12-week incubation. Minimum nitrate production was observed at the lowest moisture level. The maximum nitrate accumulation in the Maile soil was observed at field capacity after a 12-week incubation. Field capacity moisture was always optimum for nitrification in this soil, followed by twice field capacity and half field capacity. The Wahiawa soil also behaved in the same way in responding to the moisture levels. In the Lualualei soil the nitrifiers were very active and nitrification was a quick process. The optimum moisture level in this soil was at field capacity, followed by half field capacity.

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Mineralization of the organic nitrogen proceeded over a wide moisture range from half field capacity to twice field capacity levels. Maximum accumulation of mineral nitrogen at most of the incubation periods was observed at the field capacity level. The Wahiawa and Lualualei soils, which have poor reserve of organic nitrogen, showed a lower level of mineral nitrogen than the Paaloa and Maile soils.

The added chemicals increased ammonification in all soils, with the greatest increase found in soils treated with methyl-bromide, followed by ethylene-di-bromide and N-serve. Up to an 8 week incubation at all moisture levels, the chemicals exhibited nitrification, and to some extent even up to a 12-week period in the Paaloa and Maile soils. N-serve could not effectively check nitrification at the highest moisture level after 12 weeks of incubation. Methylbromide fumigation suppressed nitrification for a longer period at all levels of moisture in all soils, followed by EDB and N-serve. Nitrification in all soils increased with an increase in moisture.

The presence of energy sources showed marked effects on ammonification and nitrification in MB-treated soils at the three moisture levels. Sucrose immobilized mineral nitrogen more than bagasse. The amount of mineral nitrogen estimated at twice field capacity moisture was more than at the other two lower moisture levels, thus showing less inhibitory effect of MB at high moisture levels.

additional key words: nitrogen transformation, nitrification, mineralization, ammonification, moisture effect, energy source

Goswami, K. P., and R. E. Green. 1971. Microbial degradation of the herbicide atrazine and its 2-hydroxy analog in submerged soils. Environ. Sci. and Tech. 5:426-429.

ABSTRACT

Soil-applied pesticides transported by erosion from the site of application to waters and sediments are subject to conditions sufficiently different from those of aerated soils to alter pesticide persistence. Microbial degradation of ^{14}C ring-labeled 2-choro-4-ethylamino-6-isopropylamino-s-triazine (atrazine) and its 2-hydroxy analog (hydroxyatrazine) in submerged soils was studied by measurement of $^{14}CO_2$, whereas only 0.005% of atrazine-^{14}C was recovered as $^{14}CO_2$. With an energy source added to the soil, 3.8% of hydroxyatrazine-^{14}C was recovered as $^{14}CO_2$ in 60 days. Chemical hydrolysis of atrazine to hydroxyatrazine is the principal pathway of detoxication in soil and is conducive to ring cleavage and total breakdown by microbes. Biological dealkylation without dehalogination occurs simultaneously; 2-chloro-4-amino-6-isopropylamino-s-triazine was identified by TLC in the extracts from atrazine-treated soil. Ring-labeled atrazine or hydroxyatrazine in soil did not evolve $^{14}CO_2$ or $^{14}CO_4$ gas when the system was subjected to an anaerobic condition. Total breakdown of atrazine is expected to be slower in submerged sediments than in aerated soils because of the higher pH and restricted aeration of sediments.

additional index words: atrazine, hydroxyatrazine, microbiology, pesticide degradation, pesticide residue, herbicide

Goswami, K. P. 1972. Fate of ametryne in soil, nutrient solution-sugarcane and soil-sugarcane systems. Ph.D. Dissertation, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

Ametryne (2-methylthio-4-ethylamino-6-isopropylamino-s-triazine) is used in sugarcane, pineapple and banana cultivation for weed control mainly in the tropics, and very little has been published concerning its fate in soil and sugarcane. This investigation was carried out utilizing ring-^{14}C ametryne to determine its degradation and metabolism and to develop a ^{14}C-balance account for each experiment.

The major discoveries were: (1) Sugarcane plants metabolized ring-^{14}C ametryne, ring-^{14}C HA and ethyl-^{14}C HA to $^{14}CO_2$. (2) A volatile ^{14}C-metabolite was present in the condensed transpired water from ametryne treated plants. (3) Ametryne and HA were degraded by sugarcane through different mechanisms. (4) Ametryne degradation in bare soil was mainly a microbial process (N-dealkylation) with limited simultaneous chemical hydrolysis. (5) Sugarcane roots accelerated ametryne degradation by several fold in nutrient solution (N-dealkylation) and in soil (2-hydroxylation). (6) Simultaneous extraction of HA and parent triazines from soil in acidic-methanol and partitioning of HA in chloroform with added water was quantitative.

additional index words: ametryne, s-triazines, herbicide degradation, pesticide residues, sugarcane

Obien, S. R., and R. E. Green. 1969. Degradation of atrazine in four Hawaiian soils. Weed Sci. 17:509-514.

ABSTRACT

The degradation of ^{14}C ring-labeled 2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine (atrazine) was studied in the laboratory with four Hawaiian soils selected for their wide range of organic matter contents (4 to 29%), pH values (4.4. to 6.3), and different mineralogies. Atrazine concentrations of 1, 5, 10, 50 and 100 ppm in soils incubated at 30 C gave similar ^{14}C-recovery curves. Degradation was rapid in all four soils; atrazine recovery at 34 days (30 C) ranged from 15 to 30% of the quantity applied. Degradation was accelerated by a temperature increase from 30 to 50 C, suggesting a chemical rather than a biological process. The loss of atrazine from soils approached a first order reaction rate at 30 C, and deviated from this at 50 C. Hydroxyatrazine was the main degradation product with only a slight amount of an unidentified "Product B". It was concluded that chemical degradation (hydrolysis) was the major pathway of atrazine loss in these soils. This process was more closely related to pH, i.e. faster on low pH soils, than with organic matter content or adsorption. The fraction of atrazine adsorbed on soil increased with the decrease in total atrazine caused by degradation. Extraction of soils with both water and methanol and subsequent analysis of extracts by thin-layer chromatography showed that some of the methanol-extractable atrazine was not readily desorbed by water. These results indicate that some of the residual atrazine extracted chemically may not be available for uptake by plants and would be relatively immobile in soil water.

Additional index words: atrazine degradation, herbicides, metabolism, pesticide residue, chromatography

Silva, J. A., and J. M. Bremner. 1966. Determination and isotope-ratio analysis of different forms of nitrogen in soils: 5. Fixed ammonium. Soil Sci. Soc. Amer. Proc. 30:587-594.

ABSTRACT

A method of determining fixed ammonium in soils is described. The soil sample is treated with alkaline KOBr solution to remove exchangeable ammonium and organic nitrogen compounds, and the residue is washed with 0.5M KCl and shaken with 5N HF: 1N HCl for 24 hr, the ammonium released by the HF-HCl treatment being determined by steam distilling the soil-acid mixture with KOH. The KOBr treatment effects almost quantitative removal of organic soil nitrogen under conditions which preclude fixation by soil minerals of ammonium released from soil organic matter by this treatment, and evaluation tests indicate that the procedure used to estimate fixed ammonium in the KOBr-pretreatment residue is satisfactory. The method is simple and precise, and it has none of the observed defects of previous methods of estimating fixed ammonium in soils. It gives higher values than the Dhariwal-Stevenson, Bremner, and Mogilevkina methods, and lower values than the Rodrigues and Schachtschabel methods. A modification in which the HF-HCl treatment is performed at 100C for 30 min is described.

additional index words: fixed ammonium, KOBr, HF-HCl, soil nitrogen, soil analysis

Singh, B. R. 1968. Studies on nitrogen transformation and nitrate adsorption in soils. M.S. Thesis, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

There was no definite or conclusive trend of NH_4- or NO_3-N accumulation with time in the Akaka (virgin), Akaka (cultivated), Wahiawa "A", and Wahiawa "B" soils in situ. However, under laboratory conditions, both NH_4- and NO_3-N were affected; the Akaka (virgin), Akaka (cultivated), and Wahiawa "A", stored in polyethylene bags at room temperature, showed a substantial increase in NO_3-N with time but practically no change in NH_4-N. Contrary to the results obtained at room temperature, when two of the above soils (Akaka--virgin, and Wahiawa "A") were oven dried at 90 C, NH_4-N increased with time but NO_3-N remained unchanged during the entire period.

A consideration of the overall effect of cations on NH_4-N release in the Akaka and Wahiawa soils led to the series, Al > Fe > Ca > Mg > K > Na, in order of decreasing NH_4 replacing power. However, this series was true only to a concentration of 0.1 M. Beyond this, Al and Fe ions were ineffective. The added salts had little effect on the NO_3-N content of the two soils.

Increasing dosages of gamma irradiation generally increased the NH_4-N mineralization. The increase in NH_4-N content in these soils with irradiation followed the series, Akaka > Lualualei > Koko > Wahiawa > Paaloa, in order of decreasing magnitude. NO_3-N decreased with increasing irradiation dosages in the Akaka, Paaloa, and Wahiawa, and increased slightly in the Koko and Lualualei soils. In another experiment irradiated Akaka, Wahiawa,

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and Lualualei soils were incubated for different periods. The rate of NH_4-N mineralization in the Akaka soil was highest for the first seven days and declined during subsequent incubation periods. The pattern of nitrification was the reverse of ammonification at respective irradiation dosages.

The recoveries of added NH_4- and NO_3-N from irradiated soils were also investigated. With irradiation, substantially decreased recoveries of 89.5% and 88.5% of the added 200 ppm. NH_4-N were obtained in the Koko and Lualualei soils, respectively. As in the NH_4-N recovery, the NO_3-N recovery was lowest in the Lualualei (59.5%), followed by that in Koko (77.5%), Akaka (81.5%), Paaloa (90.5%), and Wahiawa (96.0%). Liming of the three acid soils, Akaka, Paaloa, and Wahiawa, decreased NH_4-N and increased NO_3-N recoveries in the irradiated soils.

Adsorption of nitrate increased with increasing concentration and decreasing pH of the electrolyte solution. The magnitude of adsorbed NO_3 was higher in the amorphous Akaka than in the kaolinitic Wahiawa soil. Sulfate was a better extractant of NO_3 than chloride.

additional index words: nitrogen transformation, mineralization, nitrification, gamma radiation, salt effect, nitrate adsorption, liming

Tamimi, Y. N., Y. Kanehiro, and G. D. Sherman. 1964. Ammonium fixation in amorphous Hawaiian soils. Soil Sci. 95:426-430.

ABSTRACT

Ammonium fixation in two hydrol humic latosols and one humic latosol was investigated. The addition of NH_4Cl to these soils did not show any formation of reaction products for periods of two days and one week standing. The addtion of H_3PO_4 with NH_4Cl and with $(NH_4)_2HPO_4$ gave taranakite as a reaction product. This occurred after two days of standing in one of the hydrol humic latosols, while it occurred in all soils tested after one week. The fixation of NH_4 in the presence of phosphate in crystalline forms such as taranakite is very possible in the hydrol humic and the humic latosols under field conditions in wet areas.

additional index words: nitrogen transformation, hydrol humic latosols, taranakite, humic latosols

Thiagalingam, K. 1967. Effect of temperature and biological control chemicals on nitrogen transformation in Hawaiian soils. M.S. Thesis, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

The effect of temperature and biological control chemicals on nitrogen transformation was studied in three Hawaiian (Paaloa, Wahiawa, and Lualualei) soils.

In a field experiment, soils buried at a warmer temperature regime nitrified added ammonium faster than soils buried at a cooler temperature regime, which shows a difference in the effect of temperature. This difference was the most noticeable in the case of the Wahiawa soil. It was also found that there is a considerable difference among soils in their nitrifying capacities at both temperature regimes.

The effect of methyl bromide (MB), ethylene dibromide (EDB) and N-serve on nitrogen transformation at 5, 25 and 40 C in three Hawaiian soils (Wahiawa silty clay, Paaloa silty clay, and Lualualei clay) was investigated. At 5 C there was no nitrification in the Wahiawa and Paaloa soils in all treatments. MB, EDB and N-serve showed inhibitory effect on nitrification in the Lualualei soil at this low temperature. Nitrification in the Wahiawa and Paaloa soils was suppressed regardless of treatments for 12 weeks at 40 C. In the Lualualei soil only the MB treatment suppressed nitrification for the same length of time at this temperature, followed in inhibition effectiveness by EDB and N-serve. At 25 C the Wahiawa soil showed complete nitrification inhibition with all three chemicals. At this same temperature the Paaloa soil showed inhibition for 12 weeks with MB and 8 weeks with EDB and N-serve. Nitrification took place in

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the Lualualei soil at 25 C after 8 weeks when treated with MB and EDB and after 4 weeks with N-serves. Thus, MB was generally found to be the most effective of the three chemicals for inhibiting nitrification of added ammonium at all three temperatures irrespective of the soil type, followed by EDB and N-serves in a decreasing order of effectiveness.

The ammonium nitrogen levels in all the soil samples treated with methyl bromide at all temperatures were generally higher than in the other treatments. The amount of ammonium nitrogen varied from soil to soil; the Paaloa showed greater accumulation than the Wahiawa or Lualualei. This can be attributed to the relatively high amount of organic matter in the former soil. The magnitude of ammonium release was also generally greater at 40 C than at the two lower temperatures. Thus the amount of ammonium nitrogen accumulating during a treatment period will depend on soil, chemical, and temperature.

additional index words: nitrogen transformation, nitrification, mineralization, ammonification, soil fumigants, nitrification inhibitors, temperature effect

Thiagalingam, K., and Y. Kanehiro. 1971. Effect of two fumigating chemicals, 2-chloro-6-trichloromethyl pyridine and temperature on nitrification of added ammonium in Hawaiian soils. Trop. Agr. (Trinidad) 48:357-364.

ABSTRACT

The effects of methyl bromide (MB), ethylene dibromide (EDB) and 2-chloro-6-trichloromethyl pyridine on nitrogen transformation at 5, 25 and 40 C in three Hawaiian soils (Wahiawa silty clay, Paaloa silty clay and Lualualei clay) were investigated. At 50 C there was no nitrification in the Wahiawa and Paaloa soils in all threatments. MB, EDB and 2-chloro-6-trichloromethyl pyridine showed an inhibitory effect on nitrification in the Lualualei soil at this low temperature. Nitrification in the Wahiawa and Paaloa soils was suppressed, regardless of treatments, for 12 weeks at 40 C. In the Lualualei soil only the MB treatment suppressed nitrification for the same length of time at this temperature, followed in inhibition effectiveness by EDB and 2-chloro-6-trichloromethyl pyridine. At 25 C the Wahiawa soil showed complete nitrification inhibition with all three chemicals. At this same temperature the Paaloa soil showed inhibition for 12 weeks with MB and for eight weeks with EDB and 2-chloro-6-trichloromethyl pyridine. Nitrification took place in the Lualualei soil at 25 C after eight weeks when treated with MB and EDB and after four weeks with 2-chloro-6-trichloromethyl pyridine. Thus, MB was generally found to be the most effective of the three temperatures irrespective of the soil type, followed by EDB and 2-chloro-6-trichloromethyl pyridine in a decreasing order of effectiveness.

The ammonium nitrogen levels in all the soil samples treated with methyl bromide at all temperatures were generally higher than in the other treatments. The amount of ammonium nitrogen varied from soil to soil; the Paaloa showed greater accumulation than the Wahiawa or Lualualei. This can be attributed to the relatively large amount of organic

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matter in the former soil. The magnitude of ammonium release was also generally greater at 40 C than at the two lower temperatures. Thus the amount of ammonium nitrogen accumulating during a treatment period will depend on soil, chemical and temperature.

additional index words: fumigants, nitrification inhibitor, nitrogen transformation, methyl bromide, ethylene dibromide, "N-serve"

Thiagalingam, K., and Y. Kanehiro. 1973. Effect of temperature on nitrogen transformation in Hawaiian soils. Plant and Soil 38(1):177-189.

ABSTRACT

In a field experiment soil samples buried at the warmer temperature regime nitrified added ammonium faster than soils buried at the cooler temperature regime. Nitrification occurred more rapidly under both regimes in a soil which had developed in a warm climatic zone than in two other soils developed under cooler conditions.

The rate of nitrification of added ammonium in soils incubated at 5, 15, 25 and 40 C in the laboratory increased with increase in temperature up to 25 C in three out of four soils. In the fourth soil nitrification was as active at 40 C as at 25 C. The temperature range for appreciable nitrification to occur in a soil was related to the environmental conditions where the soil was formed.

Mineralization of organic nitrogen occurred to a greater extent at 40 C than at three lower incubating temperatures of 5, 15, and 25 C. Rapid and active mineralization was associated with high organic matter and C/N ratio in soils.

additional index words: soil temperature, buried soils, nitrification, nitrogen transportation mineralization, C/N ratio

Vasuvat, Y. S. 1970. Effect of temperature on different concentrations of chlor ide salts on available nitrogen and carbon dioxide release in Akaka soil. M.S. Thesis, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

The magnitude of available nitrogen and CO_2 release started to decrease in NaCl-treated soil at a concentration beyond 1.0 M, in $CaCl_2$-treated soil at 0.7 M, and in $AlCl_3$-treated soil at 0.1 M. An exception, was at the last two weeks of incubation, when NH_4-N release in $AlCl_3$-treated soil was substantially higher at 0.3 M than at 0.1 M concentration. Based on this and previous results, it can be concluded that at room temperature, when soils are amended with chloride salts, the amount of available nitrogen accumulation and CO_2 evolution in the salt-treated soil, will be decreased when the concentration of salt added is beyond the optimum concentration.

Nitrification which occurred in amended soil generally did not show a highly significant difference when different salt concentrations were added; also, the amount of NO_3-N release was nearly the same as that liberated from unamended soil.

To study the effect of temperature on soil nitrogen and CO_2 release in soil, three temperature levels of 30, 45, and 65 C were conducted for this experiment, and concentrations of NaCl, $CaCl_2$ and $AlCl_3$ were added, ranging from 0.0, 0.001, 0.01, 0.1, and 1.0 M. The results of this experiment showed increasing amounts of NH_4-N and CO_2 release with increasing temperature at any concentration of cation valence of chloride salts added. At the same time these temperatures were detrimental to nitrification.

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Ammonification was generally enhanced by an increase in temperature, even at 65 C, a temperature at which most microorganisms, except spore-forming bacteria, are killed.

In a sterile soil (by autoclaving), NH_4-N and CO_2 were still released from the soil, whereas NO_3-N was lost. This shows that NO_3-N production is the result of microbial activity in soil and no nitrate will be produced in soils lacking in microorganisms once volatilization of nitrate occurs. Ammonium nitrogen production was concluded to be mainly the result of microbial activity in the soil and less the result of chemical activity, because the amount of NH_4-N release in sterile soil was less than that released in nonsterile soil at the same environment.

additional index words: nitrogen transformation, ammonification, nitrification, salt-effect, CO_2 evolution, thermal effect, sterile soil

Yang, C. H. 1965. Residual effects of herbicides in soils and methods for their evaluation. M.S. Thesis, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

This investigation was undertaken to study the persistence of monuron and atrazine in three Hawaiian soils. The indicator plant, oats, was grown in pots in the greenhouse, and rates of 2, 4, 8 and 16 lbs per acre of active herbicides were applied pre-emergence on a surface area basis. Plant yield was measured as grams of dry matter and expressed in terms of percent of control in order to compare plant response to various levels of herbicides and different types of soils. Herbicide residues were determined in two ways: by chemical analysis and by a bioassay test on soil extracts. A semi-quantitative bioassay test was developed for determination of herbicide residues in soils in a relatively short period of time. The results are summarized.

additional index words: monuron, atrazine, oats, preemergence, herbicide residues, bioassay, soil analysis, plant analysis

(5) Soil Fertilizer and Plant Nutrition

Ahmed, T., Md. 1969. A study on the effect of chelates and chelating agents in releasing zinc and other micronutrients in Hawaiian soils. M.S. Thesis, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

Studies were made of the release of native zinc, iron and manganese in Hawaiian soils as affected by treatment with two chelating agents. Of the five soils studied, there was an increased release of zinc in the Wahiawa and Maile soils because of treatment with EDTA and Na-Salicylate. The Akaka soil which is comparatively high in extractable zinc did not show any increase in the release of zinc up to the first 7 days of incubation with the chelating agents. Over the extended period of incubation there was a definite decrease in the amount of extractable zinc, especially because of treatment with Na-Salicylate. In the Paaloa surface and subsoil, which are low in extractable zinc, release of zinc was least affected by such incubation with the chelating agents.

Application of lime as a means of increasing pH before treatment with the chelating agents resulted in a considerable increase in the amount of extractable zinc in most soils.

Incubation of soils with chelating agents, especially EDTA, brought about a large increase in the amount of extractable iron in all unlimed soils, and the amount increased with increasing periods of incubation. It was also found that the release of iron was greatest in Paaloa surface soil. The Na-Salicylate appeared to have very little effect on the release in all soils. Application of lime to these soils reversed the increasing trend of iron release.

The release of Mn because of incubation of unlimed soils with chelating agents was not considerable; only in the Wahiawa soil was a large amount of Mn released during the first 3 days of incubation.

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In a greenhouse experiment with oats, application of chelating agents EDTA and Na-Salicylate considerably increased the uptake of Zn by oats in all soils, except in the Paaloa subsoil. The zinc content of oats decreased because of the application of $CaCl_2 \cdot 2H_2O$ in four soils. There was an increased uptake of Zn due to application of Fe chelate in five of the six soils.

The oat plants growing in Zn deficient soil showed greater uptake of this element than those growing in other soils because of the application of Zn chelate.

The concentration of iron in oats greatly increased with application of Na_2EDTA and Na-Salicylate in all soils and at all rates.

The application to soils of the two chelating agents increased Mn uptake by plants at the first two rates of application. At the highest levels, the concentration of Mn showed a decreasing trend. The iron chelate at the low rate of application increased Mn uptake, but at higher rates of application, the concentration of this element decreased gradually. In general, this association of Mn and high Fe concentration indicates a possible relationship between these two elements.

additional index words: soil, zinc, chelates, EDTA, zinc deficiency, oats, micronutrients, iron, manganese, liming, fertilization

Daigger, L. A., and R. L. Fox. 1971. Nitrogen and sulfur nutrition of sweet corn in relation to fertilization and water composition. Agron. J. 63:729-730.

ABSTRACT

Critical levels of S and N in the ear leaf of field grown sweet corn were about 0.24% and 2.9% respectively. Yields were closely associated with N percentage of the ear leaf and N percentage of the ear leaf was increased by both N and S fertilization. A case for the usefulness of N:S ratios could not be made from the data examined. The probability that S was borderline deficient under these conditions suggests that the external requirement for SO_4-S in the soil solution is about 3 ppm.

additional index words: sulfur, nitrogen, corn

de la Pena, R. S. 1967. Effects of different levels of N, P, and K fertilization on the growth and yield of upland and lowland taro. Ph.D. Dissertation, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

Nitrogen, phosphorus, and potassium were applied separately from 0 to 1120 kg/ha to upland and lowland taro. A 2 x 2 x 2 N-P-K interaction experiment was also conducted in pots using 0 and 15 grams of each element per plant.

Nitrogen fertilization increased the N contents of the taro leaves but decreased both the P and K contents. Applications of P fertilizer increased the P content in the leaves but decreased the K content. Potassium fertilization increased K and decreased Ca and Mg contents of the taro leaves. The N content of upland taro leaves increased with K fertilization but the N content of the lowland taro leaves decreased. Potassium in the leaves of lowland taro regardless of treatments was lower than the K content of upland taro due to the higher Ca and Mg contents of the lowland soil. Both upland and lowland taro plants exhibited luxurious P and K consumptions. The N, P, and K contents of the leaves, regardless of treatments, decreased with age.

The total N content of the soils was negatively related to the N fertilization, while soluble P and exchangeable K were directly related to the rates of P and K fertilizers applied.

Yields of both upland and lowland taro were significantly increased by N and P fertilization. Potassium fertilization increased the yields of upland taro only. Delayed harvesting up to 15 months increased the yields of lowland taro, while yields of the upland taro at 12 to 15 months did not differ significantly. In the lowland taro, the significant

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yield increase because of fertilization was attributed to the increase in number and weight of the sucker corms. In the upland taro, however, yield differences among fertilized plots were attributed to the main corms.

Nitrogen fertilization decreased the density of both upland and lowland taro corms significantly. Phosphorus fertilization did not have significant effects on the corm density. Potassium fertilization increased the corm density, especially in the lowland. Protein content of the corms of upland and lowland taro which were fertilized with N increased by 53.5% over the control. In the pot experiments, the increase in protein content was 250%. The P and K contents of the corms also increased with P and K fertilization.

additional index words: taro, nitrogen fertilization, phosphorus fertilization, potassium fertilization, plant analysis, soil analysis, nitrogen deficiency

de la Pena, R. S., and D. L. Plucknett. 1970. Fertilizer studies on taro (Colocasia esculenta). Hawaii Farm Sci. Vol. 19.

ABSTRACT

Tests conducted on upland and lowland taro showed that taro responds to heavy fertilization of N, P, and K. In all trials, lowland taro gave higher yields than upland taro because of ample and regular water supply in the lowlands compared to the uplands, which relied only on rainfall for water. Highest yields in lowland taro were obtained from plots which received high rates of N (500 and 1000 lbs/A), while in the uplands the highest yields were obtained from the 500 lbs/A P plots.

Analysis of plant samples showed that the range in percent N for the petiole is 0.98 to 2.28%, for percent P the range is 0.12 to 0.67%, and for percent K, 2.7 to 11.3%. In the blade, the ranges of concentration are 3.3 to 5.0% N, 0.20 to 0.57% P, and 3.20 to 6.35% K. All values are expressed on oven-dry basis, and the lower values represent deficient or near deficient levels and the higher values represent ample to excess levels.

additional index words: taro fertilization, plant analysis

Fox, R. L., S. K. De Datta, and G. D. Sherman. 1962. Phosphorus solubility and availability to plants and the aluminum status of Hawaiian soils as influenced by liming. Trans. Int. Soil Conf., New Zealand. Int. Soc. Soil Sci. p. 574-583.

ABSTRACT

Because of great mineralogical diversity among these soils, as well as differences in active-Al content, there were very large differences in the degree to which they fixed P. In general, the more aluminous and less crystalline soils retained P most strongly. Soils with 2:1-type clays fixed much less of the added phosphate. In general, the intensity of P fixation for the various mineralogical systems was as follows: amorphous hydrated oxides > goethite-gibbsite > kaolin > 2:1 clays.

Sudan grass utilized 63 times as much fertilizer P from the limed Hilo soil as it did from the unlimed Hilo soil. There were similar but overall relatively small effects of lime on fertilizer P uptake from the Kapaa and Halii soils.

The extreme unavailability of early-applied P in the Halii soil is probably related to the abundance of the small nodules which constitute a large fraction of the soil. These nodules react with relative slowness at first because of the small surface area which they present; thus, in the Halii soil late-applied P is taken up in relative abundance, when compared with uptake by the amorphous Hilo soil or by the less nodular Kapaa soil. As time progressed, phosphorus evidently penetrated the nodules of the Halii soil and became positionally unavailable so that utilization of fertilizer P declined sharply in the Halii soil compared with the other soils.

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The modifying of the active-Al status of soils by liming had a beneficial effect on solubility of P which was in turn related to uptake of P by plants. Interesting features of the data presented are: (1) The optimum level of liming for improved P solubility was between pH 5.0 and 6.0. (2) The effect of lime varied greatly on the different soils. (3) Most of the exchangeable Al was precipitated by low levels of liming on most soils. (4) The close relationship between fertilizer P remaining in solution after two days and fertilizer P uptake by the plant indicated that factors such as Al accumulation and differential root growth did not seriously influence the short-term extraction of P by Sudan grass. (5) Although active Al did influence fertilizer P solubility, the effect of soil mineralogy was apparently overriding. Even when active Al was reduced to virtual zero by liming, soils differed as much as forty-fold in P solubility.

additional index words: phosphorus, lime, aluminum, pH, sudangrass

Fox, R. L., A. Aydeniz, and B. Kacar. 1964. Soil and tissue tests for predicting olive yields in Turkey. Empire J. of Exp. Agr. 32:84-91.

ABSTRACT

Samples of leaves approximately one-year old were taken from mature olive trees in late July. The percentages of nitrogen, phosphorus, and potassium in the leaves were compared with mean yields of groves for the previous six crops.

A very close relationship was found between the productivity of the groves and the potassium content of the leaves, which ranged from 0.72 to 1.46 percent. Phosphorus percentage in the leaves was not closely related to yield; probably because there was no general phosphorus deficiency and because potassium was a more limiting factor. Nitrogen percentage did not bear any relationship to yield.

Leaf composition was better correlated with past yields than were soil tests. There was a relationship between soil tests for phosphorus and potassium, and olive-leaf composition.

The possibility of a relationship between the surface properties of carbonates and the phosphorus and potassium nutrition of the olive is discussed.

additional index words: soil tests, plant analyses, olives, nitrogen, phosphorus, potassium

Fox, R. L., S. K. DeDatta, and J. M. Wang. 1964. Phosphorus and aluminum uptake by plants from latosols in relation to liming. 8th Int. Congr. Soil Sci. 4:595-602.

ABSTRACT

Phosphorus uptake by Al sensitive plants was scarcely detectable from strongly acid aluminous soils. Small applications of $Ca(OH)_2$ were accompanied by greatly increased P uptake and decreased Al uptake. When the pH of acid aluminous soils was adjusted to about 7, P uptake was drastically decreased. In some species this was accompanied by increased Al in the tissues. The fraction of plant P derived from fertilizer by the several plant species differ substantially for an alkaline soil which contained much acid soluble P. Continued P extraction following fertilizer P depletion from zones of high root concentration is suggested. Movement of leaf-applied P^{32} to sudan grass roots was increased by liming.

additional index words: lime, phosphorus, aluminum, pH, leucaena, desmodium, sorghum, panicum, medicago

Fox, R. L., R. A. Olson, and H. F. Rhodes. 1964. Evaluating the sulfur status of soils by plant and soil tests. Soil Sci. Soc. Amer. Proc. 28:243-246.

ABSTRACT

Several methods for evaluating the sulfur status of soils were compared. Among chemical procedures used, water and phosphate extractions gave the best agreement with sulfur A values and total sulfur uptake by alfalfa from Nebraska soils. Water was an inefficient extractant of sulfate from a Hawaiian Latosol. Calcium phosphate solution was a more convenient extractant than KH_2PO_4 for both Nebraska and Hawaii soils.

Limited data are available at this time for field calibration of the soil S tests. Indications are that soil test values of 7 ppm. sulfate-sulfur by phosphate or water extraction and 16 ppm. heat soluble sulfur will provide sufficient S to grow first cutting alfalfa in Nebraska with 0.22% S. Alfalfa with lower S concentration has been shown to respond to S fertilization.

additional index words: sulfur, extractable soil sulfate, plant sulfur, alfalfa, corn

Fox, R. L., and D. L. Plucknett. 1964. Overliming Hawaiian soils creates problems. Hawaii Farm Sci. 13(3):9-10.

ABSTRACT

Liming may hasten the onset of one or more deficiencies through an increase in soil pH or cause imbalance among nutrients because of the large amounts of calcium added. However, the favorable conditions resulting from suitable pH adjustments usually exceed undesirable side effects from liming. Since undesirable side effects usually become more pronounced as soil pH increases, close attention should be given to the liming rate. Chlorosis, believed to be zinc deficiency, in Desmodium growing in field plots at the Kauai Branch Experimental Station, developed as soil pH approached 7.0 and was severe at pH 7.6 - 7.8. Phosphorus uptake by several plant species growing in Hilo soil was maximum at a distinctly acid soil pH. It is reasonable to suppose that liming tropical soils is often unsatisfactory because of overliming rather than because no lime at all was needed. Liming to neutral pH creates more problems than it solves for some crops in Hawaii.

additional index words: liming, pH, zinc, Desmodium

Fox, R. L., and B. Kacar. 1965. Mobilization of non-exchangeable potassium and sodium in a calcareous soil during plant growth. Plant and Soil 22:33-44.

ABSTRACT

Several grasses and legumes having roots of greatly different cation exchange capacities were grown in pots on a calcareous soil from Central Anatolia, Turkey. Length of cropping was for 4 and 6 months. Exchangeable sodium and potassium were measured in the original soil and again in the soils after cropping. Removal of the sodium and potassium in harvested plant material was determined. The amounts gained of these elements was considered to have been mobilized from non-exchangeable sources.

Mobilization of non-exchangeable potassium was closely related to the amount of potassium extracted by the plants. Non-exchangeable potassium accounted for about 50 percent of the total potassium taken up. Per unit of potassium taken up, legumes were more effective in releasing non-exchangeable potassium than were grasses. There was evidence that potassium mobilized from non-exchangeable forms was related to the cation exchange capacity of the root systems.

More non-exchangeable sodium than potassium was mobilized during plant growth. When legume roots were the weathering agent, there was a close relationship between non-exchangeable potassium and sodium mobilized. The relationship was very poor when grass roots were the extracting agent. These data indicate that the primary mechanism for sodium and potassium release is not the same for these two groups of plants. Sodium mobilization during plant growth was more closely related to root cation exchange capacity than was potassium.

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The data presented seem to support the concept that there are two mechanisms for release of non-exchangeable potassium. The first is by virtue of depletion of potassium on the exchange complex with a concomitant shift in the equilibrium with nonexchangeable forms. A second is the weathering of primary minerals by the acid roots.

additional index words: non-exchangeable potassium, sodium, legumes, grasses

Fox, R. L., and B. Kacar. 1965. Soil testing as a guide for fertilizer use. Annales de L'Universite D'Ankara 11:97-109.

ABSTRACT

This paper discusses the basic philosophy of soil testing. The following points must be given close attention if soil tests are to be useful.

1. The soil sample must be representative.
2. Proper tests must be employed.
3. The test must be correlated, under field conditions.
4. Fertilizer applications must be effectively made.
5. Other cultural operations must be carried out.

The paper illustrates these major points using data which applies best to calcareous soils.

additional index words: soil testing, soil phosphorus, soil nitrogen

Fox, R. L., D. G. Moore, J. M. Wang, D. L. Plucknett, and R. D. Furr. 1965. Sulfur in soils, rainwater, and forage plants of Hawaii. Hawaii Farm Sci. 14(3):9-11.

ABSTRACT

Highly weathered and leached soils frequently contained large quantities of sulfate especially in the subsoil. This sulfate has low water solubility but can be extracted with phosphate solutions. Sulfur in rain varies with distance from the ocean. The influence of the ocean is relatively minor more than one mile inland. Typical concentrations of sulfate sulfur in the rain is 1 ppm. Sulfur content of kikuyugrass (leaves 1 to 3 and associated stem) varied from 0.061% to 0.28%. Low sulfur in vegetation and soils and growth response to sulfur fertilizers were associated with elevation greater than 4000 feet.

additional index words: soil sulfur, rainwater composition, plant sulfur, sulfur deficiency, kikuyugrass

Fox, R. L., J. A. Silva, D. Y. Teranishi, M. H. Matsuoka, and P. C. Ching. 1967. Silicon in soils, irrigation water and sugarcane of Hawaii. Hawaii Farm Sci. 16(4):1-4.

ABSTRACT

An important feature of sugarcane experiments with calcium silicate was the disappearance of a disorder called "freckle disease" which is common to sugarcane growing on highly weathered soils. Freckling is characterized by small rust-colored or brownish spots on the leaves. In general, the disease is worst in higher elevation fields during the cooler months. In a study of sugarcane growing on Oahu, high rainfall (65-90 inches) was associated with advanced weathering (Gibbsite and Goethite in soil), low water extractable Si (about 0.6 ppm), low plant Si (less than than 0.6%) and freckling disease. In irrigated fields, soil and plant Si was closely related to Si in irrigation waters. Soils irrigated with pump water (contained 6 ppm extractable Si) and plant Si was high. Sugarcane growing on such soil was free of freckling disease. In a general way, solubility of soil Si corresponded to the great soil groups and to soil mineralogy.

additional index words: soil silicon, soil mineralogy, water quality, plant silicon, sugarcane

Fox, R. L., J. A. Silva, O. R. Younge, D. L. Plucknett, and G. D. Sherman. 1967. Soil and plant silicon and silicate response by sugarcane. Soil Sci. Soc. Amer. Proc. 31:775-779.

ABSTRACT

Calcium silicate slag increased sugar yields 12 tons/hectare in a field where phosphate extractable soil silicon and tricholoroacetic acid (TCA) extractable silicon of sugarcane (Saccharum officinarum) leaf sheaths were about 20 ppm. Large amounts of P or lime did not alleviate leaf freckle whereas slag did so to a marked degree. Acid solutions of phosphate, sulfate, acetate, and water can be used successfully as extractants for soil silicon. The general order for extractable silicon from soils developed on basalt and alluvium was: Humic Feruginous Latosol < Humic Latosol < Low Humic Latosol < Dark Magnesium Clay. This is also the order of decreasing weathering for these soils as indicated by total soil silicon and occurrence of secondary minerals. Leaf sheath silicon (TCA extractable) was especially well correlated with log extractable soil silicon ($r = 0.97$ for water extraction). Irrigation waters may contain much silicon and contribute greatly to the supply of extractable soil silicon and to plant silicon.

additional index words: silicon, slag, irrigation, water composition, sugarcane

Fox, R. L., D. L. Plucknett, and A. S. Whitney. 1968. Phosphate requirements of Hawaiian latosols and residual effects of fertilizer phosphorus. 9th Int. Congr. Soil Sci. Trans. 11:301-310.

ABSTRACT

Sorbed P at 0·2 ppm P in the supernatant (P requirement) was determined for several latosols. Two of these soils had previously received massive applications of phosphate fertilizer. It was necessary to equilibrate some soils with phosphate solutions for 6 days. In general, the phosphate requirement for the various mineralogical systems was in the following order: amorphous hydrated oxides > gibbsite-goethite > kaolin $\geq$ montmorillonite. One amorphous soil required 1800 ppm P to give 0·2 ppm P in the supernatant after one week. Phosphate applied to a soil rich in gibbsite effectively reduced the phosphorus requirement of the soil nine years later. Based on the estimated amount of fertilizer P remaining, the mean residual efficiency for the fertilizer was greater than 100% for subsurface material and 80% for surface soil. An amorphous soil which has received recent ash deposits provided alfalfa with reasonably good P nutrition even though the soil P requirement was high. Phosphate adsorption maxima, as calculated from the Langmuir isotherm, for these soils was about 2500 ppm. Apparently these soils supply adequate phosphate to established forage crops when they are a quarter saturated.

additional index words: phosphorus, phosphate adsorption, phosphate fertilizer requirement, phosphate fertilizer efficiency

Fox, R. L. 1969. Fertilization of volcanic ash soils in Hawaii. Panel on soils derived from volcanic ash of Latin America. Turrialba, Costa Rica. C.6.1-13.

ABSTRACT

As a result of intense P retention by volcanic ash soils of Hawaii, high phosphate fertilization rates are required for good crop production. Even after many cycles of fertilizer use about 175/kg/ha P is used for the plant crop of sugarcane. Potassium fertilization also runs high for soils which are highly weathered and leached. Potassium applied is usually within the range 250-400 kg/ha. Organic matter is very stable so that N and S deficiencies can occur on soils very high in organic matter. Nitrogen is applied at 300 to 400 kg/ha. Much adsorbed sulfate is retained by the most highly leached soils. Permanent charge of the amorphous colloids is low. Under acid conditions positive charge may equal or exceed negative charge. The nutrient cations are held with very little energy. Large amounts of exchange cations are not necessary for adequate nutrition but leaching of cations is a problem. To minimize leaching, it is not unusual to apply K and N together 4 or 5 times during the first year of sugarcane growth.

additional index words: phosphorus, sulfur, phosphate adsorption, sulfate adsorption, fertilization, potassium, nitrogen, sugarcane

Fox, R. L. 1971. Growth response curves - the "Law of diminishing returns." Illustrated Concepts in Trop. Agr. 2:1.

ABSTRACT

The classical growth response curve of Mitscherlich predicts that each succeeding increment of growth factor will produce a smaller increment of growth than the preceding increments and that yields approach but do not attain maxima. Actual yield response curves always pass through a maximum and, excess nutrient depresses yield. Sometimes initial increments of added nutrient are so immobilized by the soil or utilized by soil organisms or weeds that they increase growth less than later increments. A pictorial graph showing a sigmoid yield response curve is presented for corn growing on a Wahiawa soil (Tropeptic Eutrustox) which had been fertilized with various rates of phosphate.

additional index words: yield response curves, phosphorus, corn

Fox, R. L., and Tamimi, Y. N. 1971. Symptoms of plant malnutrition--multiple deficiencies and "The law of the minimum." Illustrated Concepts in Trop. Agr. 1:1.

ABSTRACT

Liebigs "Law of the minimum" is illustrated by corn growing in a soil developed from highly weathered volcanic ash of Hawaii (Honokaa series). Corn growing on soil which had not been limed or phosphate fertilized was deficient in calcium. Modest applications of superphosphate were more effective for correcting calcium deficiency than for phosphorus deficiency because the soil immobilized most of the phosphate. Larger applications of superphosphate eliminated phosphorus deficiency but led to a deficiency of zinc.

additional index words: phosphorus, calcium, zinc, corn, deficiency symptoms, charge

Fox, R. L., and R. M. Warner. 1971. Excess phosphate and micronutrient deficiency in macadamia. Hawaii Farm Sci. 20(4)1-4.

ABSTRACT

Excess phosphate fertilization can lead to excess foliage development which in turn is associated with chlorosis of macadamia. In one case, the chlorosis was partially corrected by iron chelates applied to the foliage. There is no unique critical leaf-phosphorus concentration for macadamia. Concentrations of P in the leaves associated with maximum short-term growth will likely lead to chlorosis in the long run. Phosphorus levels should be a compromise between optimum P nutrition and acceptable iron nutrition. As a first approximation, the limits for P in the soil solution should be between 0.05 and 0.1 ppm. It is probable that optimum leaf P is in the range 0.065 to 0.070%. Little confidence can be placed in foliar analyses for iron.

additional index words: phosphorus, iron, macadamia, nutrient mobility

Fox, R. L., and R. M. Warner. 1971. Symptoms of plant malnutrition--influence of nutrient mobility on iron deficiency. Illustrated Concepts in Trop. Agr. 3:1.

ABSTRACT

The least mobile elements are retained by old leaves, while in young leaves accumulation may be so retarded that severe symptoms develop there. Calcium, manganese, boron and iron are among the less mobile nutrients in macadamia. Sometimes a deficiency of an immobile nutrient is intensified by an over-supply of another nutrient. An example is phosphorus-induced iron deficiency. A chlorosis of macadamia was produced by heavy phosphate fertilization even though the iron content of heavily fertilized leaves was greater than leaves of trees that had been moderately fertilized.

additional index words: iron, manganese, phosphorus, chlorosis, macadamia, nutrient mobility

Fox, R. L. 1972. Solubility, uptake and leaching of plant nutrients: Phosphate, sulfate and calcium. Proc. 5th Annual Hawaii Fertilizer Conf. Univ. of Hawaii, Coop. Ext. Serv., Misc. Pub. 86. p. 25-32.

ABSTRACT

Phosphates and sulfates are adsorbed by highly weathered soils so that amounts in solution are small in comparison with amounts adsorbed. Except for soils with organic colloids, phosphate leaching in Hawaii soils cannot be a significant factor in any reasonable agronomic system. Sulfate leaching can be accelerated by liming and phosphate fertilization. Calcium leaching can be demonstrated in typical agricultural situations in Hawaii. This results from the near complete lack of permanent negative charge in many soils. This fact permits the use of small amounts of lime or calcium fertilizers for correcting calcium malnutrition. It now seems practical to describe soil fertility in terms of the concentration of nutrients in the soil solution and fertilizer requirements in terms of amounts of nutrients soils adsorb to give these required concentrations.

additional index words: calcium, phosphate, sulfate, leaching, nutrient availability

Fox, R. L. 1972. Symptoms of plant nutritional deficiency--visual symptoms and incipient malnutrition. Illustrated Concepts in Trop. Agr. 4:1.

ABSTRACT

Obvious N deficiency symptoms in corn gradually disappeared as the rate of N fertilization increased from 0 to 120 pounds per acre, however, yields continued to increase with increasing increments of added N to the highest rate of N used, 200 pounds N per acre.

additional index words: nitrogen, corn, deficiency symptoms

Fox, R. L. 1973. Agronomic investigations using continuous function experimental designs--nitrogen fertilization of sweet corn. Agron. J. 65:454-456.

ABSTRACT

Simple experimental designs are needed for exploratory field studies and for generating data for well defined yield response curves and surfaces. A design was developed by which a variable was increased in many small increments along corn (Zea mays L.) rows. Individual plants were handled as plots. Sweet corn was grown in rows 12 m long, along which rates of N fertilization increased in 40 increments from 0 to 220 kg/ha. Replication was obtained by repeating the layout but rotating it through 180 degrees. "Border effects" along the row could be ignored because the incremental change of applied N was very small and because the N rate increased in one direction and decreased in the other. Because there are many experimental points it was possible to show that low rates of N produced a "diluting effect" on leaf N, that N deficiency symptoms disappeared and second ear development began at about 140 kg N/ha, that lower corn leaves are the most sensitive indicators of the N status of corn, and that yield response to applied N was linear to 200 kg/ha of N applied. If a second factor is varied at right angles to the first, a well defined response surface can be obtained.

additional index words: field plot design, corn, nitrogen, plant composition

Gamido, R. B. 1964. Correlation of chemical tests for phosphorus with crop response to phosphorus fertilization in Hawaiian soils. M.S. Thesis, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

Correlations between P extracted from 24 soils by several extractants and P uptake (P yield) by para grass growing on those soils was as follows:

Extractant	r
0.03N H_2SO_4 + $(NH_4)_2SO_4$	.843
0.02 N H_2SO_4 + $(NH_4)_2SO_4$	.754
0.1N HCl + NH_4F	.753
0.25N HCl	.653
0.002N H_2SO_4 + $(NH_4)_2SO_4$	.559
$NaHCO_3$	.519
0.025N HCl + NH_4F	.504

Thus the method used by the Soil Testing Service seems to be inferior to some methods which could be selected.

additional index words: phosphorus, soil testing, extractable phosphorus, para grass

Gangwar, M. S. 1967. Aluminum sorption by plants as influenced by calcium and potassium. Ph.D. Dissertation, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

Cation exchange properties of pineapple, sugarcane, corn and Desmodium canum roots were investigated to see if these properties were related to the absorption of cations by roots.

Cation exchange capacities of roots were in the following order: Desmodium > corn > sugarcane > pineapple. More K was adsorbed than Al or Ca by roots of all four plant species in solution. Adsorption of Al and Ca was greater from salt solutions than from soil suspensions with equivalent concentrations of Al and Ca. Competition from iron and manganese in the suspensions were probably responsible for this result. Roots adsorbed more Al than Ca from soil suspensions even though Ca concentrations in supernatant solutions was as much as 50 fold greater than Al. Calcium and K uptake by excised roots of pineapple and Desmodium was closely related to adsorption of these cations by the roots. Aluminum and calcium uptake from solution was very sluggish for pineapple as compared with Desmodium roots. Potassium uptake was very sluggish for Desmodium as compared with pineapple. For Desmodium uptake was nil until adsorption was about 10 me/100 g dry roots.

additional index words: aluminum, calcium, potassium, roots, Desmodium, corn, pineapple, sugarcane

Gomez, E. J. R. 1966. The use of olivine for the correction of magnesium deficiency in sugarcane. M.S. Thesis, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

From critical analysis of the date of magnesium content in soil and in plant, and from the statistical analysis of yield of cane and sugar per acre, it is concluded that there was no magnesium deficiency under the conditions of the experiment, or else, that sugarcane was unable to show it.

As Si is present in olivine in high amounts, and as it was shown that increasing amounts of olivine applied did not increase the soil and plant levels of available Si, it is suggested that either Si is not released in measurable quantities, or if it is released in considerable amounts, it is not in a form useful to the plant.

Clements (1965) found that in pot experiments planted to sugarcane there was no response to magnesium silicate bearing materials (olivine and cinder), while outstanding responses were obtained with calcium silicate slag. The above-mentioned finding seems to be corroborated by the fact that olivine, a magnesium bearing material, failed to overcome the freckling problem.

The magnesium levels of the cane sheath and 8-10 internode had a considerable increase with increasing age of the crop.

In general, the nutritional status of sugarcane was good for the whole crop cycle, except for the fact that the levels of available Si in plant and soil were very low.

additional index words: latosols, plant analysis, leaf freckle, silicon, olivine, sugarcane, magnesium deficiency

Green, R. E. 1965. Head cabbage yield and leaf calcium as influenced by liming a latosolic reddish prairie soil. Hawaii Agr. Exp. Sta. Tech. Prog. Rep. 145. 12 p.

ABSTRACT

A field experiment was conducted with head cabbage on Kula loam soil (Maui) to determine the effect of lime application on cabbage yield and calcium uptake. Measurements were made on two successive crops on a field that had been cropped to cabbage almost continuously for over 10 years.

There was no cabbage yield response to lime applications at either low or high rates with either crop. The supplemental phosphorus application increased yields on the first crop but not on the second. The yield response to phosphorus on the first crop was greatest on the high-lime plots where an increase of about 17 percent or 11,000 pounds of fresh cabbage per acre was obtained.

Cabbage leaf samples were taken just prior to harvest. There was a trend of increased calcium in the leaf with both lime and phosphorus applications on the first crop, but no treatment effects were evident on the second crop.

It is doubtful that lime applications will increase head cabbage yields on the Kula soil under normal cabbage culture. Exchangeable calcium levels are quite high on this soil so that calcium deficiency is unlikely.

additional index words: ash-derived soils, calcium uptake, liming, pH, phosphorus fertilization, cabbage, latosols

Green, R. E., M. Mori, and W. W. McCall. 1967. Soil acidification under flower culture in the Kula area. Hawaii Farm Sci. 16(4):4-8.

ABSTRACT

A survey of fertilizer practices on field-grown flowers in the Kula area revealed that growers used a wide range of nitrogen application rates. Over one-third of the flower growers reported nitrogen rates exceeding 1000 pounds N per acre per year. Soil tests showed that fertilizer application at high rates, or over extended periods, reduced soil pH to levels that might be deleterious to flower growth. The acidifying effect is probably the result of hydrogen released from the biological oxidation of ammonia to nitrate. A decrease in calcium and magnesium in the surface 6 inches of the soil was found to accompany soil acidification.

Predictions of decreases in soil pH because of ammonia or urea application, are possible from laboratory measurements of the soil's buffering capacity. The amount of lime needed to correct soil acidity can also be determined easily. This will allow growers to plan a liming program that will maintain the optimum pH under a given nitrogen fertilization system. The high cost of nitrate fertilizers will probably discourage growers from using these non-acidifying nitrogen carriers. Ammonium sulfate and urea will continue to be the most important nitrogen carriers both in single-nutrient and mixed fertilizers. Therefore, good management will require the application of lime at regular intervals to control the pH.

additional index words: flower culture, fertilization, nitrogen fertilization, potassium fertilization, cations, liming, soil acidity

Hirunburana, N. 1971. Boron status of Hawaiian soils and inter-relationship of boron with manganese in plant nutrition. M.S. Thesis, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

Boron adsorption by Hawaiian Latosols were studied by equilibrating soils with graded amounts of boric acid dissolved in several salt solutions. More boron was adsorbed in the presence of Na ion than Ca or Mg in equilibrating solutions. Phosphate increased whereas sulfate depressed boron sorption.

The capacity of volcanic ash soils to adsorb boron was greater than those of basaltic and alluvial soils. Hot water-soluble boron and resin-extractable boron was related to rainfall, degree of weathering and soil pH.

D. canum grown in pots on soils with high manganese content indirectly responded to boron applications. Plants grown on soils low in boron and low boron adsorption capacity absorbed greater amounts of boron when the soil was fertilized with boron. Boron application had no effects on P, K, Ca, and Mg contents of plant while it decreased Na content in many soils. The Mn content was also markedly depressed. The results from a field survey of boron status of Hawaiian soils showed no correlation between hot water-soluble soil boron and boron content of D. canum.

additional index words: soil pH, fertilizer interactions, soil extraction solutions, volcanic ash soils, cation exchange capacity

Ibrahim, A. A. B. 1968. Effect of N and Si on growth and yield of rice. M.S. Thesis, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

Nitrogen increased both straw weight and grain weight. It increased straw weight by inducing better growth of mother culms and possibly also by higher tillering rate. Excellent growth of mother culms increased production of fertile tillers and spikelet number per panicle. Individual grain weight might be reduced because of increase in intra-plant competition at seed-development stage. However, all the three components together accounted for 85% of grain yield, though tillering and production of spikelets appeared to be the two most important components.

Straw weight, including tillers, influenced yield components. It increased fertile tillers when plant growth was excellent. On the other hand, it tended to reduce individual grain weight when growth was excessive. However, it was also possible to reduce the decrease in individual grain weight if nitrogen fertilizers were applied just prior to floral formation. It influenced more directly on individual grain without actually increasing straw weight.

Nitrogen seemed to exert some effect on mineral composition of rice plants. Nitrogen concentration tended to be higher under greater supply, but plant physiological stage also influenced nitrogen concentration. During active growth and tillering stages, nitrogen concentration was high and dropped considerably at harvest.

additional index words: tillering, liming, phosphorus fertilization, slag, rice, nitrogen fertilization

Jones, R. C. 1972. New methods of elemental analysis for soil and plant tissue at the College of Tropical Agriculture. Proc. 5th Annual Hawaii Fertilizer Conf. Univ. of Hawaii, Coop. Ext. Serv., Misc. Pub. 86. p. 39-41.

ABSTRACT

Total elemental analysis can now be simultaneously preformed for Na, Mg, Al, Si, P, S, Cl, K, Ca, Ti, Mn, Fe, Cu, Zu, Br, Zr, and Mo by the X-ray fluorescence quantometer at the Department of Agronomy and Soil Science. In the case of plant tissues the samples are dried at 60^{o}C, ground to a face powder consistency and pressed into a pellet with high pressure. Although sample preparation is simple and fast it is the most lengthy procedure compared to the thirty seconds required for the simultaneous analysis of the seventeen elements listed above. The quantometer is capable of analyzing any element above sodium on the periodic table providing that the sample can be pelletized. Boron and nitrogen cannot be determined by the quantometer.

additional index words: total elemental analysis, quantometer, tissue testing

Jones, R. C., G. T. Shigeura, and G. Uehara 1972. Microprobe investigation of phosphorus induced chlorosis in macadamia. Hawaii Farm Science 21(2):2-3.

ABSTRACT

Soil aggregates containing roots from healthy and chlorotic macadamia nut trees were studied by electron microprobe. The distribution of phosphorus and iron was simultaneously determined on each aggregate. The elemental distribution patterns showed an inverse relationship between the occurrence and concentration of phosphorus with iron. The data indicated that phosphorus was not precipitating iron as was first thought but that it produces iron complexes which are water soluble and hence lost by leaching.

additional index words: electron microprobe, macadamia, phosphorus induced chlorosis, roots, iron chorosis

Juang, T. 1971. Soil plant relations in the mineral nutrition of sugarcane with special reference to zinc and related elements. Ph.D. Dissertation, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

The primary purpose of this dissertation was to study the soil-plant relationship in Hawaiian sugar cane soil with special reference to zinc nutrition.

Six chemical extracting methods for assessing zinc in soil were used on 39 sugar cane soils. The 0.1 N HCl extraction method was judged to be the best among the six methods for estimating the adequacy of soil zinc for plant growth. Soil zinc extracted by the five other methods was highly correlated with zinc extracted by 0.1 N HCl method. The widest range of zinc concentration was obtained by 0.1 N HCl extraction.

Nutrient culture studies were conducted on corn and two sugar cane varieties to study the nutritional interaction among zinc, iron, and manganese. Culture solutions were prepared so that the iron-manganese ratio was 20:1 and 4:1. The 4:1 Fe/Mn ratio was further adjusted to obtain two levels or iron and manganese concentrations. In addition two sets of the Fe/Mn treatment were prepared; one set received zinc and the other received no zinc. In both sugar cane and corn the highest dry weight yield were obtained in the pots with the Fe/Mn ratio of 20:1 containing zinc. A sugar cane variety noted for its non-sensitivity to zinc, responded to zinc when the Fe/Mn ratio was maintained at 20:1.

The highest dry weight yield for sugar cane growing in culture solution containing zinc associated with a tissue Fe/Mn ratio between 3-4. In corn and sugar cane the highest tissue zinc contents were measured in the nutrient culture solution containing zinc and having an Fe/Mn ratio of 20:1.

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In corn the tissue iron content increased with increasing zinc content. In sugar cane the reverse was true.

For corn an adequate leaf zinc content at plant age between 3-4 weeks is believed to be between 25-40 ppm. A leaf zinc content of less than 20 ppm for plants between 3-4 weeks old is considered to be inadequate. A zinc content of 25-40 ppm in young sugar cane leaf blades of 3 months old plants is considered adequate. Deficiency of zinc in sugar cane is believed to occur when the zinc content falls below 20 ppm.

In a greenhouse experiment it was established that a 25 percent increase in corn dry weight yield could be obtained when zinc was applied to soils containing less than 7.6 ppm zinc.

A tentative critical soil zinc level of 3 ppm zinc was selected for sugar cane.

Addition of zinc to low zinc soils resulted in an 2-3 fold increase in tissue zinc content of corn. The tissue iron remained unchanged or was reduced when zinc was applied to soils with high levels of soil zinc.

In a greenhouse experiment to measure the effect of soil pH, phosphorus and zinc application rates on two soils, it was found that dry weight yield of corn was highest when soil pH was near 6.5 in both soils. Phosphorus application had no effect on dry weight yield in both soils, but zinc application increased dry weight yields in the soil with low soil zinc. Zinc application resulted in decreased phosphorus in tissue of corn growing on the soil with low soil zinc.

additional index words: soil extraction, nutrient culture, corn nutrition, soil pH, phosphrus fertilizer, plant micronutrients

Kanehiro, Y. 1964. Status and availability of zinc in Hawaiian soils. Ph.D. Dissertation, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

The highest concentrations of 0.1 N HCl-extractable zinc was found in the soil surface horizons. There is a general decrease in extractable zinc with soil depth. The range of extractable zinc was found to be between 0.1 and 18 ppm.

The range of total zinc in soil profiles was found to be between 51 and 288 ppm, with an average of 131 ppm. A general decrease in total zinc with depth was noticed in most profiles; however, this trend was reversed in certain profiles.

There is a relationship between total and 0.1 N HCl-extractable zinc (significant at the 5 percent level). Such a relationship must be viewed with caution, however, because of variations in individual profiles. No relationship was found between soil pH and extractable zinc.

Zinc deficiency in plants is better correlated with extractable zinc than with total zinc. Most soils on which zinc deficiency is found are acidic latosols that are intensively weathered and/or where subsoils have been exposed. Corn was found to be the most sensitive plant when testing for zinc deficiency; the application rate of 18 pound zinc/A. was apparently in the optimum range for most soils. No specific zinc deficiency symptom was observed in either tomato or alfalfa, although general chlorosis and stunted growth were noticed for both plants. "White bud" symptoms were observed with corn when the plant was acutely zinc deficient. Some purpling of leaves and sheaths was also associated with zinc-deficient plants.

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Older corn plants had lower concentrations of zinc in their tissues than did younger plants. Also, mature portions of plants contained less zinc than did younger portions. Another observation was that plants in which growth is restricted by adverse conditions have unusually high zinc concentrations in their tissues.

Since most zinc-deficient soils are already acid, lime must usually be added with the zinc sulfate to correct zinc deficiency of most plants (corn was an exception to this rule). Calcium sulfate was much less effective than lime as an additive.

High P fertilizer applications also depressed uptake of zinc. This was shown in a corn test with Hoolehua soil where growth response to P was obtained only when zinc was added concurrently with P. Conversely, there was a yield response to zinc only when P was added together with the zinc fertilizer. Zinc uptake was decreased by P fertilization and P uptake was likewise decreased by zinc fertilization.

The greatest amount of zinc sorption took place in the Lualualei soil, followed by that in the Honokaa and Wahiawa soils, respectively.

additional index words: zinc deficiency, micronutrients, liming, fertilizers

Kanehiro, Y. 1968. Micronutrients in plants and soils. Proc. 4th Annual Turfgrass Management Conf., Univ. Hawaii, Coop. Ext. Serv., Misc. Pub. 57. p. 9.1-9.6.

ABSTRACT

The role of micronutrients in plants is discussed. Some of the general soil situations where micronutrients are most likely to be a problem are presented. Further, causes of micronutrient deficiency and toxicity are taken up. Micronutrient deficiency symptoms are listed for six elements - iron, manganese, zinc, copper, molybdenum and boron. Finally, the correction of micronutrient deficiencies by treatment by soil or foliar application of micronutrient is discussed. Suggested rates for soil application and concentrations for foliar application are presented in tables.

additional index words: micronutrients, micronutrient deficiency and correction, deficiency symptoms, spray vs. soil application

Khalid, R. A. 1974. Residual effects of calcium silicate on the movement and availability of nutrients in tropical soils. Ph.D. Dissertation, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

Residual effects of calcium silicate on plant uptake and movement of nutrients in Typic Gibbsihumox were studied in a series of three experiments. First, kikuyu grass and desmodium were grown in the field to determine the magnitude of response to residual Si applied several years earlier at various P and pH levels. The combined yields of seven harvests of kikuyu grass and desmodium increased significantly with increasing residual P levels, but was not significantly affected by residual Si or soil pH. The relative yield differential between the three Si treatments decreased sharply with time and at the end of 56 months yield from 1660 Si was only 2.5% higher than that without Si, whereas yield from 830 Si was less than the yield without Si. The decline with time in relative yield response to P applications, was small indicating a continued efficiency of P applied 56 months earlier in increasing yields on a Gibbsihumox. Although residual Si produced highly significant increases in water-extractable soil Si, the levels at the end of the experiment were low which suggests that supplemental amounts of calcium silicate may be required to maintain yield response to Si. Modified Truog-extractable P was significantly higher at 1600 Si than at zero Si five years after Si applications. Phosphorus requirements of a Gibbsihumox were decreased significantly by residual Si and P in samples collected after 5 years of cropping. However, residual P was about 7 times more effective than residual Si in reducing P requirements. Multiple regression analysis indicated that in addition to the initially applied treatments, soil P and Al and plant P, K, Mg, and possibly also Mn, Zn, Al, and Ca were important to plant growth in both species.

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Second, the partial recovery of applied Si during five years of cropping was determined at 3 pH levels. Plant uptake by the sugarcane plant and ratoon crops, corn, and seven harvests of kikuyu grass accounted for 12 to 21 percent of the applied Si while exhaustive extraction of profile samples taken at the end of five years with 0.1N acetic acid, adjusted to pH 3.5 and containing 50 ppm P, recovered 14 to 28 percent of the applied Si. There was no evidence that applied Si moved below 30 cm. Total recovery of applied Si ranged from 28 to 43 percent which means that 57 to 72 percent of the applied Si remained in the soil in some form not readily displaced by phosphate solution.

Third, uptake of residual Si by rice grown on soil collected from the field experiment at the end of five years was studied in a growth chamber. Rice plants extracted proportionately more native Si than did phosphate solution which resulted in comparable amounts of added Si being recovered by the two methods. Silicon uptake by rice accounted for 8 to 30 percent of applied Si and exhaustive phosphate extraction recovered 13 to 23 percent of applied Si.

The amount of Al extracted by various solutions decreased in the order of 1N ammonium acetate + 0.2N barium chloride, pH 4.8 > 1N ammonium acetate, pH 4.8> 1N barium chloride ≥ 1N potassium chloride ≥ water ≥ 0.01M calcium chloride. Aluminum extracted from five soils was in the order: Akaka (Typic Hydrandept) > Halii (Typic Gibbsihumox) > Wahiawa (Tropeptic Eutrustox) > Lualualei (Typic Chromustert) = Kawaihae (Ustollic Camborthid) which was related to the degree of weathering and the amount of rainfall affecting the soil. Soil Al extracted with unbuffered solutions, especially 1N potassium chloride, was more closely related to plant Al whereas Al extracted with buffered solutions, especially 1N ammonium acetate, pH 4.8, was more closely related to plant yield

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than that extracted with other methods. However, R values for the soil Al-yield relationships were generally lower than those for soil Al-plant Al relationships suggesting that while soil Al has a strong influence on plant Al, it has considerably less effect on yield.

additional index words: residual effects, calcium silicate, Si and P movement, soil nutrients, plant nutrients, Si, P, pH, Si uptake, Si recovery, Si extraction, kikuyu grass, desmodium, soil Al extraction, tropical soils-Al crop response

Kurmarohita, K. 1964. Molybdenum content of pasture species and some factors that affect it. M.S. Thesis, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

Rainfall was found to exert a dominant effect on the Mo content of pasture species at some locations. The Latosolic Brown Forest soils tented to give a higher Mo supply than the Humic Latosol and Reddish Prairie soils as indicated by plant uptake of Mo.

Survey of the Mo and Cu levels in some pasture species and associated soils from the Island of Hawaii showed the highest value of 39 ppm Mo in orchard grass collected at 7000 feet elevation. Average total soil Mo was 4.67 ppm and total Cu content was 83.2 ppm.

Mo uptake by Desmodium tortuosum was influenced by phsophate and sulfate application. Application of phosphate resulted in a tremendous growth response on some soils. Sulfate decreased Mo uptake through direct completion.

The pH of the soil was the most dominant factor in regulating the availability of Mo in soil solutions. Akaka soil exhibited the lowest availability of Mo because of its adsorption on amorphous constituents. Application of phosphate increased Mo in soil solution.

additional index words: soil genesis, soil fertility, tropical forages, soil pH, clay minerals

Mahalim, B. C., R. L. Fox, and J. A. Silva. 1970. Residual effects of liming volcanic ash soils in the humic tropics. Soil Sci. 109:102-109.

ABSTRACT

The effects of liming soils developed in highly weathered volcanic ash (Hydrandepts) was measured over a period of up to 7.5 years. Every aspect of the study suggests that Ca leaches in these soils except, perhaps, the first small increment of Ca on the exchange complex. Five years after liming to attain pH 7 in the surface soil, pH had been increased to a depth of 4 ft. Soil pH did not exceed 6.8 in field plots although free $CaCO_3$ persisted in plots which were limed at 17 tons per acre. Potassium leaching was retarded by liming. Exchangeable Al was replaced by approximately equivalent amounts of Ca up to about 2 me per 100 g of soil. Apparently once displaced, Al did not readily reoccupy exchange sites even when the Ca disappeared from the soil. Permanent charge of the Akaka soil is estimated at about 4 me/100 g. The unlimed soil is about 12% Ca saturated and this supported a near normal growth of sugarcane.

additional index words: soil acidity, aluminum, calcium, liming, pH, permanent charge (soil), specific adsorption (calcium), sugarcane

Manuelpillai, R. George. 1967. Influence of silicon and phosphorus and their interaction on yield and chemical composition of plants. M.S. Thesis, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

The P x Si interaction was studied for six different plant species grown on Kapaa (Gibbsihumox) soil; the effects of fertilizer placement was also included.

Si increased corn and kikuyu grass yields and in some crops decreased P requirements. P increased yields for all tested plants. Especially in later growth stages the beneficial effects of Si could be attributed to increased availability of fertilizer P.

The P:Si ratio in the plant was not related to yields; this ratio decreases for older plants. For corn, silicon was concentrated in sheaths, whereas most P occurred in the roots.

additional index words: silicon nutrition, phosphorus nutrition, P fixation, fertilizer placement

Misra, M. K. 1970. Influence of liming and potassium fertilization on the nutrition of sugarcane and Desmodium species. Ph.D. Dissertation, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

Growth and Ca, K, Al and Mn concentration in sugarcane and Desmodium species are related to liming, percent Ca and percent K saturation for four Hawaiian soils.

Sugarcane took up little Al and Mn even at low Ca saturation levels. Available Ca in the root zone is probably a more realistic criterion to evaluate Ca requirements than pH and percent Ca saturation. However, Desmodium accumulated large (toxic) quantities of Mn and perhaps Al. To eliminate these toxicities pH control by liming is required.

An attempt to use Woodruff's free energy of exchange for evaluating K:Ca balance was not successful.

additional index words: sugarcane nutrition, Desmodium nutrition, liming, K fertilization

Monteith, N. 1967. The relationship between soil classes, soil properties, plant growth and soil management treatments in the Goodi Mill area of Queensland, Australia. Ph.D. Dissertation, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

Most definitions of soil have included references to its function as a medium for plant growth. Several investigators believe that because correlations between soil classes and crop yield are weak, conventional soil surveys are of little value. According to these workers, soil groupings based on "edaphic" trials are more useful for predictions of crop yields.

Argument is presented in this dissertation to show that soil properties are most unlikely to correlate directly with crop yield but relationships between soil properties and plant growth responses to management treatments should be feasible. The study reported here sets out to establish the following hypotheses:

1. That each soil class based on a combined morphological-genetical system of classification has a different group of "key" properties.
2. That each different group of properties has a different influence on plant growth and the response to management techniques.

The hypotheses are examined by studying soils growing Sugar Cane (Sacharrum offinarum) in the Goondi area of North Queensland, Australia.

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The geology and physiography of the area is described. Soils of the area are described, classified, and mapped. The more important soil types are selected for further study and for quantifying those soil properties which are related to the root environment and plant growth. Charge characteristics, charge population, clay mineralogy, and "free" iron oxide content assist in predicting the nature of nutrient pools within soils and the wastage of plant nutrients through chemical reaction or leaching. Afferberg limits are related to water retention characteristics, and soil aggregate strength. Macroporosity and Atterberg limits are related to permeability. The important soils are characterized in terms of these factors.

Methods for recognizing the possibility of root impedance, the degree of oxygen shortage for root respiration, and the relationship of root impedance and oxygen shortage to root and plant growth have not been clarified, according to the available literature. Experiments are therefore undertaken to show that macroporosity, bulk density, and soil strength can all be related to root growth but the measurement of soil strength (using a penetrometer with a fine tip) is a satisfactory means of predicting root growth restriction.

Several workers have shown that for unsaturated conditions, soil strength is more likely to limit root growth than a shortage of oxygen. If this is so the problem of a shortage of oxygen in soils only occurs under saturated or near-saturated conditions. Preliminary experiments indicated that oxygen in saturating waters was used rapidly although metabolic processes continued to operate. Oxygen may be supplied to the plant roots by transfer from the air through the plant stem. Morphological characteristics of soil profiles can be related to water table fluctuations but water table movement can only be related to plant growth in general terms.

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It is shown that each group of properties has a different influence on plant growth and soil management and that, by correlation methods, each soil class has a different group of properties. Therefore, each soil class has a different influence on plant growth and the response to management practices.

additional index words: plant-soil interactions, sugarcane, clay mineralogy, iron oxide, soil porosity, Atterberg limits, soil water

Nishimoto, R. K., and R. L. Fox. 1972. Comparative phosphorus needs of lettuce and chinese cabbage. Hawaii Farm Sci. 21(3):8.

ABSTRACT

Head lettuce and chinese cabbage were grown in field plots (Wahiawa soil). Soil P was adjusted to various concentrations in the soil solution. Head lettuce made maximum growth when P in solution was about 0.4 ppm while for chinese cabbage maximum yield was obtained at about 0.2 ppm. At suboptimal P levels, lettuce growth is much inferior to chinese cabbage.

additional index words: lettuce, chinese cabbage, phosphorus

Nishina, M. S. 1974. The composition of Mekong River silty and its possible role as a source of plant nutrient in the delta. M.S. Thesis, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

It is alleged that the flood waters which annually innundate most of the Mekong Delta add nutrient-rich sediment to Delta soils. To test the validity of this allegation, the mineralogical and chemical composition of Mekong River sediment as well as soils of the Mekong Delta of Viet Nam was examined to establish the relationship between sediment deposition and soil fertility.

River sediment was collected at regular intervals from October 1972 to May 1973 at Long Xuyen, Cantho, and My Tho in South Viet Nam. Soils were collected along transects running perpendicular to the river at locations near the sediment sampling sites.

Small but significant differences in mineral, chemical, and acid-extractable nutrient content were measured between sediment and soil. The sediment samples were higher in mica, hematite, kaolinite, feldspar, and chlorite-montmorillonite and lower in quartz contents. The sediment samples were also higher in magnesium, phosphorus, potassium, calcium, and manganese and lower in aluminum contents. The readily extractable phosphorus, porassium, and calcium content were also higher in the sediment than in soil samples.

Based on these data, the quantity of phosphorus, potassium, magnesium and calcium added to a soil each year by sediment was computed. A one millimeter thick deposit of one g/cm^3 bulk density was assumed. The readily

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soluble nutrient added to a one Hectare area as measured by mild acid extraction amounted to 1.0 kilogram P, 3.2 kilogram K, 4 kilogram Mg, and 50 kilogram Ca per hectare. It was concluded that even if these computed values were doubled, the deposit could not significantly increase the fertility of Delta soils.

Careful examination of the soil data confirmed the above conclusion. Soil data was examined on the assumption that soils which occur near the river bank would receive a larger quantity of sediment and therefore would contain a higher soluble nutrient content than soils which occur some distance from the river. The soil data did not bear this out. Soil texture and soil moisture release data also did not vary with distance from the river channel.

Based on mineralogical, chemical, and physical analyses of sediments and soils of the Delta, it was concluded that the annual deposition of sediment does not measurably increase the fertility of Mekong Delta soils.

additional index words: soil taxonomy, delta soils, soil fertility, river sediment, sedimentary deposits

Oya, K. 1964. Response and nutrient uptake of peanut on Hawaiian latosols treated with potassium and calcium. M.S. Thesis, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

The effects of varying K and Ca rates on peanut yield was studied using three Hawaiian Latosols in a pot experiment. Total vegetative yield increased significantly with K treatment in the Paaloa soil. In the Wahiawa soil, no significant effect was noted. Where no K was added, increasing Ca levels seriously depressed the shelled peanut yield and shelling percentage in the Waimanalo soil.

A significant correlation was established between shelled peanut and total vegetative yield. It was presumed that the ratio of $K/\sqrt{\frac{Ca+Mg}{2}}$ of plant was a sensitive indicator of the shelled peanut yield. The K and Ca treatments had a significant effect on the K, Ca and Mg uptake of the peanut plant. An antagonistic trend between K and Ca uptake was evident in the Paaloa and Wahiawa soils. In Waimanalo soil, the Ca treatment significantly affected the K uptake.

additional index words: soil pH, plant nutrients, fertilizer responses, tropical soils

Plucknett, D. L., and R. L. Fox. 1965. Effects of phosphorus fertilization on yields and composition of pangolagrass and Desmodium intortum. Proc. 9th Int. Grassland Congr., Sao Paulo. 2:1525-1529.

ABSTRACT

Pangolagrass and Desmodium intortum required high P fertilization for rapid stand establishment on an Aluminous Ferruginous Latosol of Hawaii. Later, the P requirement of pangolagrass seemed to be quite modest; the P concentration of the plant approached 0.05% with little indication of yield response from applied P. Lack of yield response could be the result of residual P from previous pineapple production or the high calcium status of the test area (pH 7.0). Phosphorus in unfertilized D. intortum remained at about 0.11% for 2 years; this is suggested as a minimum value for this species. Modest rates of P increased P concentrations of both grass and legume more, per unit P applied, than did high rates. The residual effects of P fertilizers were easily detected by soil tests and plant composition two years after fertilization.

additional index words: tissue analysis, soil analysis, phosphorus fertilization, latosols, forage crops, grasses

Poole, R. T., B. A. Greaves and J. A. Silva. 1968. Effect of soil media on container grown hibiscus and aralia. Proc. Florida State Hort. Soc. 81:443-447.

ABSTRACT

Hibiscus and aralia were grown in nine soil or amended soil mixes. Combinations of two levels each of soil, organic amendments (peat or wood shavings) and inorganic amendments (cinders or perlite) were used in making the mixes. Two fertilization levels were used also. Grade and growth of plants, infiltration rates, water holding capacity, available water and bulk density data were taken.

The observed differences in grade and growth due to the effects of soil amendments were not consistent in the two species. However, the percentage of soil in the mixes did have an effect on grade or growth and generally plants in the lower percentage of soil were better than those in the higher percentage of soil and plants in amended soil were generally better than those in soil alone. Infiltration rate and available water were significantly higher in amended soil than in soil alone. Bulk density and water holding capacity were significantly lower in amended soil than in soil alone.

additional index words: media, hibiscus, aralia, container grown plants, soil physical properties

Poole, R. T., R. Sakuoka and J. A. Silva. 1968. Nutrition of Anthurium andraeanum. Proc. Tropical Region, Amer. Soc. Hort. Sci. XVI Annual Meeting 12:284-287.

ABSTRACT

Seven commercial fertilizers, including liquid and solid, inorganic and organic, were applied to Anthurium andraeanum "Marian Seefurth" and "Uniwai". Data collected included flower yield, spathe size and flower stem length. Of the seven fertilizers applied, all produced satisfactory results and were better than the control (no fertilizer) except one. The six fertilizers gave equally good results. Plant tissue was also analyzed for N, P, K, Fe and Zn. Plants producing satisfactory yields contained an average of 2.00% nitrogen compared to 1.11% for low yielding plants. Percent P and K were higher or approximately the same in the poor plants as in plants producing adequate yields. Fe and Zn were low in plants that were not fertilized, but Fe was high in plants fertilized that produced low yields.

additional index words: nutrition, Anthurium andraeanum, fertilizers, tissue analysis

Rana, S. K. 1964. Effects of dehydration and heavy liming on plant nutrition in the amorphous and crystalline tropical soils of Hawaii. Ph.D. Dissertation, Department of Agronomy and Soil Science, University of Hawaii.

The effects of heavy liming were investigated on the undried and air-dried Akaka (Hydrol Humic Latosol) and Puhi (Humic Ferruginous Latosol) soils. Lime in the form of calcium silicate and ground coral stone was applied at the rates of 0, 4, 8, and 16 tons per acre with phosphate fertilizers of different solubilities supplying 500 lbs of P_2O_5 per acre. Sudan grass was used as a test crop in pots under greenhouse conditions, with two cuttings taken at intervals of 6 weeks. Soil samples were analyzed for extractable Al, extractable P, exchangeable Ca and Mn, while plant shoot samples were analyzed for P, Al, Ca, and Mn. Without liming, the plants were severely stunted under undried and air-dried conditions in both the Akaka and Puhi soils. With liming, the yield increased sharply up to the 8-ton application, especially in the air-dried soils. A decline was noted in most cases at the 16-ton application. The soil P/Al ratio increased with dehydration, and it increased further with liming in both soils up to the 8-ton application, thus showing a reduction in reactive Al and an increase in P release. The extractable Al showed high negative correlations with extractable P in soil and with P yields as shown by plants. Ca silicate was a more superior liming material than coral stone and its effect was more distinct in the undried soils. The P carriers did not demonstrate any definite differences except in the first cutting. It is concluded that dehydration, especially in the case of the Akaka soil, may be advantageous as far as P release is concerned. A need for liming was indicated in both soils but the response was greatest in the air-dried Akaka soil. Plant concentrations of P, Al, Ca, and Mn did not fully explain plant failures under unlimed conditions. Precipitation of Al and P in or on the roots may be the probable cause.

additional index words: latosols, liming, dehydration, plant nutrition, silicate, phosphate fertilization, plant analyses, soil analyses

Reddy, G. G. 1964. Influence of associated anion on the effects of calcium on nutrient uptake by sudan grass on two tropical soils. Ph.D. Dissertation, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

Two soils containing varying proportions of aluminum in the amorphous and crystalline forms were used in this investigation. Akaka soil, a Hydrol Humic Latosol, contains large amounts of amorphous hydrated oxides of aluminum. Halii soil, an Aluminous Ferruginous Latosol, contains a large proportion of crystalline compounds. The Akaka soil exhibits certain distinctive properties that are not usually found in soils of other groups. They possess an unusually low bulk density, a very high water holding capacity and dry irreversibly, thus effecting changes in their amorphous nature.

Two separate pot experiments were conducted using air-dried Halii, air-dried Akaka and undried Akaka soils. The objectives of this investigation was to study the effects of drying Akaka soil and of various anions associated with calcium on yield and composition of Sudan grass. Six calcium materials were used at three different rates and these are as follows: dicalcium phosphate; calcium silicate (T.V.A. Mix 398, Electric phosphorus furnace slag, 60 mesh); calcium sulfate (gypsum); calcium hydroxide; calcium carbonate; and calcium chloride.

In the first experiment no fertilizer materials other than the sources of calcium were used, whereas in the second experiment, a blanket fertilizer application supplying 500 pounds of P_2O_5, 300 pounds of K_2O and 150 pounds of nitrogen per acre (calculated on surface area basis) was included. Four replications were used for all treatments.

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Without blanket fertilizer application the dry matter yields on Halii were significantly higher than on Akaka soils. However, with blanket fertilizer application air-dried Akaka soil gave highest yields, undried Akaka gave lowest yields and the yields were intermediate on air-dried Halii soil. The six calcium materials may be listed according to their effects on yield in order of decreasing yields as follows: dicalcium phosphate > calcium silicate > calcium sulfate > calcium hydroxide and calcium carbonate > calcium chloride. Results indicate that 4 ton rate of application was better than either the 2 ton or 8 ton rate except with calcium chloride where the 2 ton rate was best. There was a depression in yield at the 8 ton rate for all materials except calcium silicate. Yields from control pots were too low to undertake any chemical analyses. The effect of these calcium materials on phosphorus content in sudan grass was very similar to their effect on dry matter yields. In general, uptake of calcium, magnesium and potassium increased with increasing rates of application, but there was a depression of potassium and magnesium uptake above pH 6.8. Aluminum uptake decreased with increasing rates of calcium application up to pH 6.8; above this pH value the uptake of aluminum increased.

Application of increasing rates of calcium materials decreased extractable soil aluminum and increased soluble phosphorus with two exceptions. With application of calcium chloride and calcium sulfate there was an increase in extractable aluminum. Extractable aluminum was inversely and significantly correlated with soil pH. On drying Akaka soil the increase in soluble phosphorus was two-fold. The data indicate that the P/Al ratio in plant tissue significantly influences dry matter yields. There was no correlation between extractable aluminum and aluminum uptake.

additional index words: aluminum uptake, phosphorus uptake, liming materials, calcium carriers, fertilizers

Rixon, A. J., and G. D. Sherman. 1966. Mineral composition of sugarcane tissues as affected by applications of lime and phosphate in Hawaii. Trop. Agr. (Trinidad) 43:295-302.

ABSTRACT

The effects of lime and phosphorus, applied separately and together to three soils, on the mineral composition of roots and basal nodes of sugar cane, were determined. In response to liming there was a reduction in aluminium concentration and an increase in calcium concentration in sugar cane roots. Whereas these changes were significant for the Akaka series and Hilo series, which are Hydrol Humic Latosols, they failed to be significant for the Kaumoali series which is a Humic Latosol. None of the treatments had any significant effects on the phosphorus silicon and iron concentrations in basal nodes or roots of sugar cane produced on any of the three soil series studied. For all three soil series, the mineral concentration was much higher in the root tissue than in the nodal tissue and the range in response to treatment was also greater in the root tissue.

The mean calcium concentration in roots produced on unlimed soils of the Akaka series was 900 p.p.m., and when heavily limed, 4 750 p.p.m. There was marked inverse relation between calcium concentration and aluminium concentration for the roots of sugar cane produced on Akaka soils. Calcium deficiency, associated with reduced calcium uptake mainly because of the presence of aluminium, was probably limiting sugar yields for unlimed soils of the Akaka series. The significant increase in yield of sugar cane in response to combined lime and phosphate treatments on the soils of the Hilo series was not reflected in the mineral constituents found in either the basal node or root tissue of sugar cane produced on these soils.

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The chemical composition of the nodal and root tissue, when considered with the yield of sugar cane produced on these soils, does not fully clarify the role of aluminum and the application of lime. There is a need to study other factors of the soil-plant relationships in these unusual soils.

additional index words: liming, phosphate fertilization, fertilization, latosols, sugar cane, plant analysis

Roy, A. C. 1969. Phosphorus-silicon interactions in soils and plants. Ph.D. Dissertation, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

Interactions between phosphorus and silicon were studied in three steps: first, laboratory equilibration; second, uptake by plants from culture solutions; and third, uptake by plants from soils.

Phosphorus decreased Si sorption and Si decreased P sorption by soils but the effect of P on Si sorption was greatest. The interactions between Si and P on P and Si sorption by soils were related to their solubilities in soils. The solubility of Si in soils varied with soil pH and soil mineralogy. Phosphorus desorption from soils increased in the presence of sorbed Si, while Si desorption decreased in the presence of sorbed P.

Phosphorus requirements of surface soils decreased with increasing amounts of residual phosphate and silicate. Silicate decreased P sorption most effectively at low soil pH. Residual effects of silicate on P sorption were inversely related to the amounts of residual phosphate. Silicate applied to surface soils depressed P sorption by sub-soils. Extractable soil P increased with increasing amounts of residual silicate.

Silicon movement was measureable in all soils studied. Calcium chloride solution was more effective than water in displacing silicon in Kapaa soil. The distribution of Si in soil profiles was a function of the amounts of silicate applied and soil pH. There was an inverse relationship between the rates of applied phosphate and Si content of soil profiles. Considerable Si had moved to 24 inches in the profiles of Kapaa soil during nine months after silicate applications.

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Phosphorus and silicon absorption by plants from culture solutions was a function of plant species. In general, plants which accumulate little Si, absorbed most P in the presence of Si, while in plants which accumulate Si, P absorption was depressed by Si. Silicon absorption was depressed in the presence of P.

Pot experiments were conducted to evaluate placement effects in soils on phosphorus-silicon interactions. Placement effects varied with species. For lettuce, mimosa, corn and sugarcane, P uptake was enhanced by placing P and Si together in the soil. For rice, the presence of Si depressed P uptake. For rice and sugarcane, Si uptake was greatest when P and Si were separated from each other, while for lettuce, mimosa and corn, P and Si together in the soil effected greatest Si uptake. Phosphorus uptake by lettuce and mimosa was greatest from band placements, while mixed placements were superior for corn, rice and sugarcane. Mixed placements were superior for Si uptake.

additional index words: soil mineralogy, soil pH, cation exchange capacity, fertilizer placement, plant nutrient uptake

Saundarajan, S. S. 1971. Sorbed and solution phosphorus and their relationship to crop response. Ph.D. Dissertation, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

Adsorption of phosphorus from aqueous solutions by several Hawaiian and Indian soils was studied in relation to P concentration, equilibration time, ionic environment and temperature. The effect of a prior P application on the sorption of P subsequently applied was studied using samples of a calcareous Superstition sand, previously used in a pot experiment in which P was a variable. The phosphate sorption curves were used for estimating the P requirement of soils for maximum crop growth of pearl millet (Pennisectum typhoides) and desmodium (Desmodium intortum).

To approximate equilibrium it was necessary to allow six and eight days reaction time for acid soils and calcareous montmorillonitic soils respectively. Substitution of K for Ca in the equilibrating solution always resulted in increased P adsorption. Also an increase in the salt concentrations (KCl and $CaCl_2$) increased P retention by soils.

Phosphate sorption isotherms suggested that for non-calcareous soils at low solution P concentrations, P sorption was limited mostly to monolayer adsorption by P reactive sites. At higher concentrations an abrupt increase in P retention occurred. The shape of the isotherms suggested either presence of groups of P reactive sites which are energetically different and/or multilayer adsorption.

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In calcareous soils at low solution P concentrations the mechanism of P retention seems to be adsorption, with precipitate formation, probably $CaHPO_4$, becoming important as P concentration in solution increased. Provided the equilibration time is long, phosphate added to a calcareous soil, even in low amounts, may form nuclei for additional P precipitation.

Almost all of the P adsorption and desorption isotherms followed the Langmuir equation. This enabled the calculation of P adsorption maxima, which were found to be a good means of expressing the P buffering capacity of soils. Thermodynamic studies showed the differential heats of P adsorption to vary after 0.8 fractional saturation of P reactive sites.

Phosphate sorption curves were used as a basis for fertilizing soils on which millet was grown. The equilibrium solution P concentrations at which 95 % maximum yields occurred varied with soils. Still it might be possible to use a general solution concentration value (0.6 ppm) for most of the agricultural soils as their P adsorption maxima are usually $<$ 2600 ppm. The percentage saturation of the P adsorption maximum for 95 % yields of millet was inversely related to the adsorption maximum. Yields of desmodium in comparison with millet showed an interaction existing between crops and adjusted solution P concentrations required for maximum yields in different soils.

additional index words: phosphorus sorption isotherms, plant-soil interactions, fertilizer-soil interaction, millet, desmodium, soil solutions, soil pH

Seng, T. 1970. Effects of calcium and pH status on subsoil root development of legumes in an aluminum rich soil. M.S. Thesis, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

This study was designed to delineate the effects of calcium and pH on the growth and chemical composition of certain tropical and temperate legumes in a tropical subsoil containing high aluminum.

A gradient of applied calcium at various pH levels showed a significant effect of calcium but not of pH on subroot growth and calcium content. Subroot aluminum levels decreased with increasing calcium regardless of pH. Adjustment of subsoil pH was accomplished with magnesium carbonate in the zero and low calcium treatments, and levels of magnesium were equalized with magnesium sulfate. A depressing effect of the added magnesium on subroot growth was noted, but was overcome by adding calcium.

With the zero calcium treatment at pH 4.8, it was impossible to ascertain both symptomatically and chemically that the low subroot growth was because of aluminum toxicity or calcium deficiency. However at pH 5.5 and 6.3 where exchangeable aluminum levels were decreased, depressed subroot growth was still apparent indicating that calcium was definitely deficient. Application of calcium to the subsoil had no significant effect on subroot phosphorus in the calcium treated series. However the uptake was greater in the plus-Ca than in the zero-Ca treatment.

additional index words: calcium fertilization, phosphorus fertilization, subsoil root development, legumes, calcium deficiency

Shimabukuro, Z. 1962. The relationship of potassium and magnesium for sudangrass production in selected Hawaiian soils. M.S. Thesis, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

Yield of sudangrass was increased by application of K up to 100 pounds per acre on topsoil and 200 pounds per acre on stripsoil in the first cutting. Depression in yield in the first cutting was observed at the level of 200 pounds of K or more on topsoil and at the level of 400 pounds of K or more on stripsoil, but these depressions disappeared in the second cutting on both soils. The depressions in the first cutting occurred when potassium content in the dry tissue exceeded 1.8 to 1.9 percent on both soils. In the second cutting, yield on topsoil increased with increasing magnesium applications at 100 pounds per acre of K but not at higher levels of K. Yield and Mg content in dry tissue were highly correlated. Total yield of sudangrass on topsoil, including the first and second cutting, showed higher values at the levels of 100 pounds of K with 200 pounds of Mg, 400 pounds of K with 200 pounds of Mg, and 800 pounds of K with 100 pounds of Mg. The yield of these three plots were not statistically different. Mg and Ca content were severely depressed with increasing applications of K and with increases in content of K in tissue.

additional index words: soil fertility, soil pH, calcium fertilizer, plant tissue nutrient levels

Silva, J. A., J. G. Darroch, and R. P. Humbert. 1960. Economic evaluation of yield response of sugarcane as a function of soil potassium and of supplemental potash. Soil Sci. 90:178-184.

ABSTRACT

Results of potash experiments on the islands of Hawaii and Kauai which were harvested from 1950 to 1957 were summarized. Polynomial yield equations, which included terms for soil potassium, the square root of applied potash and their product, were developed to describe the yield response surfaces for each of thses islands. These equations explained 63.5 per cent and 61.8 per cent of the variation in yield on Hawaii and Kauai, respectively. Cost data were obtained from a plantation on each island, and an economic evaluation was made of the incremental yield increases from potash applications. This economic evaluation of the yield response surface allows the agronomist to make recommendations for potash applications over a range of soil potassium levels.

additional index words: sugar cane, soil potassium, applied potash, yield response, economic evaluation, Hawaii, Kauai

Silva, J. A. 1968. Fertilization of orchids. Pacific Orchid Society of Hawaii Bull. 26(3):7-11.

ABSTRACT

General discussion of plant nutrients and fertilizer requirements of orchids. Explanation of the "guaranteed analysis" of fertilizer products and its significance when purchasing fertilizer. Data on fertilizer ratios, application rates and pH of solutions of commonly-used orchid fertilizers are also presented. Factors affecting fertilizer application to orchids discussed.

additional index words: orchids, fertilization, plant nutrients, orchid fertilizers

Silva, J. A. 1971. Possible mechanisms for crop response to silicate applications. Proc. Int. Symp. Soil Fert. Evaln., New Delhi, 1:807-814.

ABSTRACT

The effects of Si on plant growth appear to be related to reactions of this element with P in the soil and in the plant. Chemical similarity of the two elements is largely responsible for this. In addition, evidence has been presented which strongly suggests that Si has a role in P metabolism. Crop response to Si applications in Hawaii may also arise from Ca, the major cation associated with the silicate carrier. Soil mechanisms for increased growth which involve Si are increased solubility of sorbed soil P, decreased P fixation, increased cation exchange capacity and decreased Al activity. In addition, Ca contributes to increased pH which decreases P fixation, increases cation exchange capacity, and decreases concentrations of Al, Mn and Fe, as well as to increased Ca supply. Plant mechanisms for increased growth which involve Si are increased P absorption by roots, increased P transport from roots to tops, increased efficiency of P utilization by the plant, and correction of nutrient imbalances. Carrier Ca also contributes to plant growth by increasing Ca levels and correcting nutrient imbalances in the plant.

additional index words: Si, calcium silicate, P availability, crop response, soil effects, plant effects

Stoop, W. 1974. Interaction between phosphate adsorption and cation adsorption by soil and implications for plant nutrition. Ph.D. Dissertation, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

Interactions between phosphate adsorption and cation adsorption were studied in four Hawaiian soils. These belonged to the following soil groups: Hydrandept, Gibbsihumox, Eutrustox and Haplustoll. Relevant ion adsorption mechanisms were investigated by electrochemical techniques and direct adsorption measurements by means of adsorption isotherms. Implications for the availability of P, Ca, Mg and K for plants were investigated in pot experiments.

Interactions between phosphate adsorption and cation adsorption were important in highly weathered soils containing mainly variable charge clay minerals such as Fe and Al hydrous oxides. These soils could be characterized by their zero point of charge (ZPC). The ZPC will increase with increasing contents of oxidic colloids. Consequently the adsorption of anions, particularly phosphate, will increase. For the soils in this study ZPC and P adsorption decreased in the following order: Hydrandept > Gibbsihumox > Eutrustox > Haplustoll

Calcium was adsorbed specifically by the hydrous oxides present in the highly weathered soils, especially the Hydrandept and Gibbsihumox. The ZPC value of oxidic soils therefore should be determined in $CaCl_2$ solutions to prevent the interference from adsorbed Ca in soil samples. This interference did affect ZPC measurements with NaCl or Na_2SO_4 as supporting electrolytes since the non-specifically adsorbed Na ion does not compete with Ca adsorbed in the Stern layer. Consequently no ZPC was determined but an isoelectric point (IEP) which refers to the charge at a distance of several Å units away from the colloid surface.

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A similar problem applied to the extraction of exchangeable Ca by NH_4OAc. Non-specifically adsorbed NH_4^+ ions did not compete effectively with specifically adsorbed Ca, causing incomplete Ca extraction from these soils.

With decreasing ZPC values, cation adsorption became relatively more important than anion adsorption. Consequently, adsorbed phosphate, which lowered the ZPC, was associated also with increased cation adsorption. The adsorption of 700 ppm P by the Gibbsihumox lowered the ZPC of that soil from 4.10 to 3.85 and increased the cation adsorption by 1.35 me/100g soil at pH 5.5. This amounts to 0.6 me/mmol P adsorbed/100g soil. The increase in cation adsorption was more pronounced for specifically adsorbed divalent cations than for non-specifically adsorbed monovalent cations.

Because of specific Ca adsorption, applications of NH_4 phosphates had greater effects on the adsorption of other cations (Na, K, NH_4, Mg, Ca) than had Ca phosphates. Hence if all P in these highly weathered soils was applied as Na (or NH_4) phosphates, deficiencies of Mg, Ca and certain trace elements could be induced. In addition dispersion of inorganic and organic fractions occurred in the Gibbsihumox.

Phosphate solubility in the oxidic soils depended mostly on salt concentration and cation valency. It was decreased by the accompanying cation according to a lyotropic series: $K < Mg < Ca$. This cation effect on P solubility decreased with increasing contents of layer silicate clay minerals and/or increasing base saturation of the soil. Consequently it was almost absent in the Haplustoll, which contains montmorillonite and kaolinite.

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The cation effect on P solubility has direct practical implications for oxidic soils because it affects P availability to plants at low P application rates, as was demonstrated by pot experiments with the Eutrustox. Increasing Ca concentrations were significantly related to lower P solubility and as a result lower P uptake and lower yields of sudangrass. Consequently the Ca : P molar ratio in applied fertilizers has implications for P and also cation availability. It was demonstrated that by manipulating the Ca : P ratio one could increase nutrient (P, K and Mg) uptake and yields of sudangrass and decrease the leaching losses of cations (Na, K, NH_4, Mg, Ca). As a result the efficiency of applied fertilizers can be improved considerably.

additional index words: fertilizer use efficiency, fertilizer carriers, zero point of charge, hydrandept, gibbsihumox, eutrustox, haplustoll, oxidic soils, cation exchange capacity

Suehisa, R. H., O. R. Younge, and G. D. Sherman. 1963. Effects of silicates on phosphorus availability to Sudan grass grown on Hawaiian soils. Hawaii Agr. Exp. Sta. Tech. Bull. 51.

ABSTRACT

Soils representing three main latosolic groups in the Hawaiian Islands were used in studying phosphorus-silicon interactions. Low-Humic Latosol, Humic Latosol, and Aluminous Ferruginous Latosol soils, each possessing distinct differences in morphology and mineral composition, were found to pose interactions upon silicate additions that were beneficial in some cases and harmful in others. Both the high silicon representative of the Low Humic Latosol (Poamoho soil) and the low silicon representative, Aluminous Ferruginous Latosol (Kapaa soil), showed no beneficial response when various soluble silicates were applied together with phosphates, but significant changes in yield and phosphorus uptake were obtained in the siliceous (15 to 25% SiO_2) Humic Latosol (Helemano soil).

The dry matter yield of sudan grass grown on Helemano soil was three times greater when soluble silicon was applied with phosphorus than when phosphorus was applied alone. Soluble silicate treatments alone also showed better yield performance than the controls. The form of the water-soluble phosphate fertilizer utilized determined the magnitude of the silicon benefit on yields; i.e., the less soluble phosphates produced greater yield increases than did the more soluble phosphates when applied together with silicon. Dicalcium phosphate and rock phosphate improved yield only in the first and second cuttings, but ammonium phosphate improved yield only in the first cutting. When sodium metasilicate was applied alone at 1000 lbs per acre, 76% more phosphorus was assimilated by the test crop than by the control. Dicalcium phosphate was intermediate in supplying phosphorus in the presence of sodium metasilicate. Apparently, the phosphorus-fixing capacity of the soil remained unsatisfied with respect to phosphorus

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at the deficient level of application. Perhaps silicon enhanced availability of the phosphorus by reducing the fixing capacity or by substituting for phosphorus in the soil system. This could explain the higher percentage of performance of the less soluble phosphorus carriers over highly soluble phosphorus in the presence of soluble silicates.

A change in the pH of the soil occurred upon application of sodium metasilicate, calcium silicate, or silica gel. Soluble silicates caused increases in pH whereas colloidal silica produced the opposite effect. The liming effect of sodium metasilicate was attributed to the hydrolysis of the material into sodium hydroxide and silicic acid. As was expected, the slightly less soluble calcium silicate was less effective than sodium metasilicate in changing the pH of the soil. The colloidal silica perhaps decreased the pH by releasing silicic acid to the soil. A greater change in pH occurred in the least buffered of the soil systems, such as the Poamoho soil. The detrimental effect caused by the increased concentration of sodium ions at high rates resulted in depressed yields because of soil depletion and water-logging and to loss of seedlings on germination.

An inverse relationship between sodium metasilicate application and extractable aluminum was found to exist in the Helemano soil. The magnitude of the effect was greatest when the soluble silicate was applied alone. Although the tests also illustrated that dicalcium phosphate at 1000 pounds per acre of P applied with different levels of silicon caused a significant decrease in the aluminum concentration, the effectiveness of the silicate was less than when it was applied alone. The beneficial response in yield, which follows silicon application, can be attributed in part to the reduction in aluminum if the aluminum is in fact present in toxic amounts, but this will not completely explain the greater availability of phosphorus associated with such applications.

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The soil representatives of the Low Humic Latosol (Poamoho) and the Aluminous Ferruginous Latosol (Kapaa) showed nonbeneficial effects from silicon applications. Because only Humic soils were found readily responsive, indications are that the area of use of silicon in increasing phosphorus efficiency may be limited. Furthermore, the benefits from added silicon may be controlled by other cations in the soil system.

additional index words: silicate, phosphorus fertilization, latosols, sudangrass, phosphorus fixation

Tamimi, Y. N., C. W. Garcia and J. C. Nolan. 1967. The effect of major and minor elements upon the yield of kikuyugrass. Proc. 3rd Annual Beef Cattle Field Day. Univ. of Hawaii, Coop.Ext. Serv.,Misc. Pub. 45. p. 23-26.

ABSTRACT

In a field-plot trial on a latosolic brown forest soil, the effect of twelve different fertilizer and soil amendments including macro and micro elements on yield of kikuyugrass were evaluated. Significant increases in yield were obtained with applications of nitrogen, phosphorus, lime plus magnesium, calcium silicate, boron and copper.

additional index words: kikuyugrass, forages, forage fertilization, liming, micronutrients

Tamimi, Y. N., and R. L. Voss. 1970. Mineral accumulation in corn-grain as affected by rates of P and $CaSiO_3$ fertilization. Agron. Abstr. p. 129.

ABSTRACT

Corn grain was collected from plants grown on 5 x 5 experiment of P x $CaSiO_3$, and analyzed for N, P, K, Ca, Mg and Si. P rates range from 0 to 672 kg/ha, while $CaSiO_3$ rates ranged from 0 to 53.8 tons (metric)/ha. Increasing P rate caused a decrease in grain total nitrogen, and Si, while it increased the accumulation of P, K and Mg. Phosphorus rates did not seem to have significant effect on Ca content of the grain. As $CaSiO_3$, rate was increased, grain P, Si, K and Ca were found to increase significantly. Grain nitrogen and Mg were not influenced by $CaSiO_3$ rates. There was a significant interaction between P and $CaSiO_3$ rates upon grain P, K and Ca. The positive correlation between grain phosphorus and K and Mg were significant, and between K and Mg were also very highly significant. There was a negative correlation between grain P and Si content. The high correlations between P and K, and P and Mg points very strongly to the relationship of K and Mg in the process of phosphorylation in the grain.

additional index words: corn fertilization, phosphorus fertilizers, silicate fertilizers

Tamimi, Y. N. 1971. Responses of kikuyu and pangola grasses to nitrogen, phosphorus and potassium. I. Effect of low rates. Proc. 7th Annual Beef Cattle Field Day. Univ. of Hawaii, Coop. Ext. Serv., Misc. Pub. 81. p. 76-84.

ABSTRACT

Kikuyu and pangola grasses were subjected to fertilizer experiments for a period of five years. Nitrogen, phosphorus and potassium rates ranged from 0, 50, 100, 150 and 200 lbs. of the element per acre per year. It was found that yield of kikuyu and pangola increased with increasing rate of nitrogen. Application of 200 lbs. nitrogen per acre per year increased kikuyugrass yield close to 3 times that of the zero nitrogen, while for pangola the increase in yield was about 2 times that of the control. Level of grass protein increased only at 200 lbs. N/A rate. Response to phosphorus at these rates was not great but yield did increase with applying phosphorus. Application of potassium on this site caused a decrease in kikuyu yield while it slightly increased yield of pangola. At these low levels of fertilization at the Mealani Experiment Station, yield of pangola throughout the 5 year period was consistently higher than that of kikuyu.

additional index words: forages, grasses, forage nutrition, pasture fertilization

Tamimi, Y. N. 1971. Response of kikuyu and pangola grasses to rates of nitrogen, phosphorus and potassium. II. Effect of high rates. Proc. 7th Annual Beef Cattle Field Day. Univ. of Hawaii, Coop. Ext. Serv., Misc. Pub. 81. p. 85-92.

ABSTRACT

Effect of high rates of nitrogen, phosphorus and potassium on yield and on forage quality of kikuyu and pangola were investigated. Levels of these elements were 0, 250, 500, 750 and 1000 lbs/acre. The study was conducted for three years. Yield results showed kikuyu responding greatly to nitrogen at levels reaching 750 lbs N/A/year. Response to nitrogen by pangola was greater than kikuyu at rates below 500 lbs N. Crude protein was found to increase from 12.5% and 10% to 8% and 18.3% for kikuyu and pangola respectively when 1000 lbs N/A/year were applied. Increase in yield due to increasing phosphorus rate was similar in both grasses. Control averaged 6700 lbs of dry matter, while the 1000 lbs P/acre was over 18,000 lbs/A. Generally speaking response to potassium by the two species was not great. On the average, it was found that kikuyu has a higher potential for yield at high fertility levels than pangola.

additional index words: forage nutrition, forages, grasses, pasture fertilization

Tamimi, Y. N., and H. Y. Mishima. 1971. Effect of fertilization on the early growth of ten windbreak species. Proc. 7th Annual Beef Cattle Field Day. Univ. of Hawaii, Coop. Ext. Serv., Misc. Pub. 81. p. 93-96.

ABSTRACT

Response of ten windbreak species to levels of nitrogen, phosphorus and potassium were investigated. Rates of nitrogen and potassium were 0, 100 and 200 lbs/acre per year. Phosphorus rates were 0, 200, 400 and 600 lbs/acre applied only at time of planting. The ten species were: Mexican cypress, Paperbark, Ironwood, Redwood, Eucalyptus globulus var. compacta, Norfolk island pine, Monterey cypress, Wild olive, Eucalyptus paniculata and Eucalyptus sideroxylon. Growth of these trees after four years showed response to fertilization by Mexican cypress, Ironwood, Monterey cypress, Wild olive, Redwood, E. sideroxylon and E. paniculata.

additional index words: windbreaks, forestry nutrition

Tamimi, Y. N., and D. T. Matsuyama. 1972. The effect of calcium silicate and calcium carbonate on growth of sorghum. Agr. Digest 25:37-44.

ABSTRACT

Application of calcium silicate to a Hydric Dystrandept soil increased dry matter yield of sorghum. Calcium carbonate caused a great decrease in yield. When calcium silicate was applied with calcium carbonate it had a tendency to reduce the "harmful" effect of calcium carbonate on growth of sorghum. Tissue percent nitrogen was generally increased with increasing rate of calcium carbonate and decreased with increasing rate of calcium silicate. Calcium carbonate significantly increased tissue phosphorus, while calcium silicate did not have any significant effect. Plant tissue K decreased with increasing calcium silicate, while calcium carbonate had no significant effect. An increase in tissue Ca was associated with increasing rates of calcium silicate as well as calcium carbonate. Reduction in tissue Mg was very considerable with increasing rate of calcium carbonate but not with calcium silicate. It seems that calcium silicate may have a "stabilizing" effect on Mg uptake. Tissue percent Si consistently increased with increasing calcium silicate applications while calcium carbonate at intermediate levels reduced tissue percent Si. Increasing rates of calcium silicate enhanced Mg retention by the soil, while with increasing rates of calcium carbonate soil exchangeable Mg was significantly reduced. The reduction in sorghum yield due to applications of calcium carbonate may be due to low levels of soil Mg that were associated with calcium carbonate treatments.

additional index words: sorghum, calcium silicate, calcium carbonate, forage fertilization

Tamimi, Y. N., and J. R. Thompson. 1972. The effect of fertilization on establishment and productivity of legumes. I. Effect of phosphorus and lime rates on growth of ladino clover. Proc. 8th Annual Beef Cattle Field Day. Univ. of Hawaii Coop. Ext. Serv., Misc. Pub. 97. p. 65-70.

ABSTRACT

In a pot experiment using an Hydric Dystrandept soil the effects of phosphorus and calcium carbonate in 4 x 4 factorial experiment were studied. Phosphorus rates were 0, 50, 150 and 450 lbs/acre and 0, 2, 4, and 8 tons per acre were the rates of calcium carbonate. Increasing rate of phosphorus increased the number of stolons per plant as well as the length of stolons. Yield and crude protein content of ladino clover increased with increasing phosphorus rate. Calcium carbonate had significant effect on stolon formation and elongation.

additional index words: forages, pasture fertilization, phosphorus fertilizers, lime

Tamimi, Y. N., and D. T. Matsuyama. 1972. The effect of fertilization on establishment and productivity of legumes. II. Effect of nitrogen, phosphorus and potassium on yield of kikuyugrass and pangolagrass in combination with big trefoil. Proc. 8th Annual Beef Cattle Field Day. Univ. of Hawaii, Coop. Ext. Serv., Misc. Pub. 97. p. 71-78.

ABSTRACT

Big trefoil was established in kikuyugrass and pangolagrass plots which were previously subject to five years of N x P x K fertilizer experiment. Better establishment of big trefoil was accomplished on plots that previously received higher levels of phosphorus and of potassium. Yield of grasses and legume were found to increase with increasing levels of phosphorus and potassium. Previous nitrogen fertilizer did not show any residual effect on growth of these grasses or the legume. Big trefoil, which benefited the grasses by supplying nitrogen, increased the total yield of forage. This increase in yield may also be accompanied by an improvement in forage quality due to the presence of legume.

additional index words: pastures, pasture fertilization, forages, legumes, grasses

Teranishi, D. Y. 1968. The effects of silicon, phosphorus, and soil pH and their interactions on yield and nutrient uptake of sugarcane. M.S. Thesis, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

Sugarcane variety H53-263 was grown for nine months on a Typic Gibbsihumox soil in a field experiment which had a complete factorial arrangement of three levels each of Si, (0, 830 and 1660 kg/ha, supplied as TVA slag), P (112, 280 and 1120 kg/ha, supplied as treble superphosphate), and pH (5.5, 5.8, and 6.2, obtained with varying amounts of calcium carbonate, TVA slag, and sulfur). Sugarcane yields increased with increasing rates of applied Si, P and pH. Yields with 112 and 280 kg P/ha with Si applications were equal to or higher than yields from 1120 kg P/ha applied without added Si. Reponse to Si applications was greater at pH 6.2 than at pH 5.5 due to lower solubility of Si at higher pH. Soil P availability and plant P uptake increased with Si applications, but the high rate of Si at low pH (5.5) resulted in reduced P uptake suggesting competition between Si and P. Soil P availability was also increased by reduction of KCl-extractable Al due to increased pH as well as to increased levels of applied Si at constant pH. Applied Si appeared to increase the efficiency of P utilization in the plant and thus contribute to increased yields. Soluble plant Si and water extractable soil Si values were closely correlated (r=0.91). Both increased as soil pH decreased indicating enhanced Si availability at low pH. Phosphorus applications increased water extractable soil Si and Si applications increased modified Truog-extractable soil P.

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Low Mn/Si ratios in the plant were associated with decreased leaf "freckling" and higher cane yields, however, these effects may be related to increased plant Si concentration alone. Multiple regression analysis on cane yield and the Si, P, and pH treatments, their squares and interactions, and soil and plant analyses resulted in an equation which explained 55% of the yield variation.

additional index words: Si, P, pH, sugarcane, nutrient uptake, calcium, silicate, yield equations, plant analysis, soil analysis

Thiagalingam, K. 1971. Effects of calcium silicate on yield and nutrient uptake and mechanism of silicon transport in plants. Ph.D. Dissertation, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

The effect of calcium silicate on yield and nutrient uptake by plants and the mechanism of Si uptake were studied in a series of three experiments. First, response to Si was measured on 22 plant species grown on two soils (Humoxic Trophumult and Typic Gibbsihumox) with four levels of calcium silicate in a greenhouse. Response to calcium silicate differed with species and the same species grown on different soils had variable amounts of Si and P depending on the Si contents of the soils. In general the 2.2 T Si/ha application produced maximum yields in both soils. Silicon concentrations in different plant groups were in the following order: grains ≥ grasses ≥ vegetables and fruits ≥ legumes except for those of the two Desmodium species in which concentrations were similar to those of grasses. Tissue Si values to indicate Si status of the 22 species are proposed. Plant Ca concentrations generally increased whereas Mg, Mn, Al, and Fe concentrations generally decreased when calcium silicate was applied. Silicon concentration was greatest in papaya and pineapple leaves and in sugarcane sheaths and was lowest in stems.

Hawaiian Cement Corporation (HCC) and Tennessee Valley Authority (TVA) calcium silicates generally produced higher yields than Technical grade (TG) calcium silicate, especially at low rates. Plant Si concentrations in both HCC and TG calcium silicate were generally higher than in the TVA material indicating greater Si availability in these two materials.

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Second, corn was grown in the field to determine the response to residual Si with variable P and pH levels. Ear corn yields were significantly increased by P applications, but were not significantly affected by residual Si or pH. Highest stover yields were obtained at pH 5.5 suggesting increased Si solubility at this pH may have increased stover yields by increasing mechanical strength and P availability. The application of 280 kg P/ha with Si produced yields nearly equal (98%) to those of 1120 kg P/ha without Si suggesting that comparable yields at lower cost may be obtained with the combination of high Si and low P, than with high P alone. Corn leaf Si values of 0.5 to 0.6% at silking appeared adequate. Plant Si is more closely related to soil Si extracted with water than with sulphuric acid. Multiple regression analysis with yield and leaf nutrients indicated that Si, P, and Fe are especially important for stover production while P, Ca, K, Al and Fe are important for ear production.

Third, five plant species were grown in culture solutions at varying transpiration rates to study the mechanism of Si transport. A statistically significant increase in the amount of water transpired per gram of dry weight with decreasing relative humidity was found in all species except D. intortum, but no significant increase in Si transport was obtained with increasing transpiration in any species. This suggests that Si transport in plants is not related to transpiration. In continuous dark, plants accumulated Si in the roots and only sugarcane translocated large amounts of Si to the tops suggesting that metabolic energy is required for Si transport. Additional evidence of active Si transport was provided by the transpiration stream concentration factor (TSCF) values which were above or below one. Silicon concentrations in xylem exudates of D. intortum, corn and sugarcane were greater than those of external solutions suggesting Si movement by active transport rather than by mass flow.

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In tomato and alfalfa Si concentrations were lower in exudates than in external solutions suggesting a selectivity mechanism in the root. These experiments demonstrated that both Si and P transport require metabolic energy.

additional index words: calcium silicate, Si, P, pH, residual effects, yield response, plant nutrients, soil nutrients, critical Si levels, grasses, vegetable crops, fruit crops, grains, legumes, Si distribution, Si transport, P transport, transpiration

Vinyaratana, S. 1961. The influence of liming of a humic latosol soil on the growth of sorghum. M.S. Thesis, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

Application of lime at a rate of 2 tons per acre to highly leached soils resulted in a large increase in yield of different varieties of grain sorghum. A 4 ton per acre rate did not result in a significantly greater increase. No difference among varieties of sorghum was seen. Lime increased the level of exchangeable calcium in the soil which appear to be deficient in calcium. Soil pH attained by the applications of lime suggested that even heavier applications may be desirable.

additional index words: soil pH, calcium fertilizers, tropical soil, soil fertility

Warner, R. M., and R. L. Fox. 1967. Effect of fertilizers on fruit set and yield of Keauhou Macadamia at Waimanalo. Proc. 7th Annual Hawaii Macadamia Producers Assn. Univ. of Hawaii, Coop. Ext. Serv., Misc. Pub. 36. p. 24-27.

ABSTRACT

Yields of macadamia growing in field plots were depressed when zinc fertilizers were withheld, but no deficiency symptoms were observed.

additional index words: zinc, macadamia

Warner, R. M., and R. L. Fox. 1972. Concentration and distribution of S, Mg, and five micronutrients in macadamia in relation to yields. Proc. 12th Annual Hawaii Macadamia Producers Assn. Univ. of Hawaii, Coop. Ext. Serv., Misc. Pub. 109. p. 26-37.

ABSTRACT

There are few published data on the levels of S, Mg and micronutrient composition of macadamia leaves which can be related to adequate macadamia nutrition as indicated by deficiency symptoms, growth, and production. The limited data which is available is reviewed and, together with field results from an experiment on Oahu, some tentative categories for deficiency-sufficiency-excess are suggested. The following levels are suggested as being deficient. S, 0.18%; Mg, 0.6%; Fe, 20 ppm; Mn, 10 ppm; Zn, 10 ppm. Boron, Mn and Mg at 100 ppm, 1500 ppm and 0.16% respectively was deemed to be excessive.

additional index words: sulfur, magnesium, micronutrient, macadamia

Whitney, A. S. 1970. Effects of harvesting interval, height of cut, and nitrogen fertilization on the performance of Desmodium intortum mixtures in Hawaii. Proc. 9th Int. Grassland Congr., Sao Paulo. 1:632-636.

ABSTRACT

Desmodium intortum mixtures with pangola and kikuyu grasses were compared with the grasses alone under different intensities of cutting, with and without added nitrogen. Ten-week cutting intervals resulted in higher yields than 5-week intervals, but rendered grass-alone treatments unpalatable to cattle. The 13 cm cutting height was consistently better than 5 cm for D. intortum, but the differences were nonsignificant. Nitrogen fertilization reduced the legume component to less than 10% in the 10-week treatments, and less than 1% in the 5-week treatments. Under optimum management without nitrogen fertilization, D. intortum fixed over 300 kg of N/ha/yr in mixtures with either pangola or kikuyu.

additional index words: pangolagrass, kikuyugrass, nitrogen fixation, nitrogen transfer, animal acceptability, fertilization, harvesting interval, pasture management

Yaptenco, C.C. 1963. The phosphorus nutrition of seedlings in relation to phosphate fixation by two Hawaiian soils. M.S. Thesis, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

The effect of phosphate fixation by Kapaa and Lualualei soils on the P nutrition of seedlings was studied. Direct seeding and root-pad-soil contact techniques were used for alfalfa, soybean, corn, and sudan grass seedlings employing tagged phosphate.

The influence of time of growth, method of fertilizer P application (mixed or banded) and rate of P fertilizer (5 or 500 ppm P) on the efficiency of P uptake was studied.

Immobilization of P in the roots of alfalfa and sudan grass is associated with the Al and Fe status of the rooting medium and causes a P loss from the tops, affecting the growth adversely.

For maximum growth corn seedlings need approximately 9000, 7000 and 4000 ppm P in the dry matter after respectively 1, 2, and 3 weeks of growth. The band application of phosphate was effective in the Kapaa soil, which has a very high P fixing capacity. In the Lualualei soil (low P fixing capacity) mixing soil and P fertilizer was more effective.

additional index words: P nutrition, P fixation, seedling nutrition

Younge, O. R., and J. C. Ripperton. 1960. Nitrogen fertilization of pasture and forage grasses in Hawaii. Hawaii Agr. Exp. Sta. Bull. 124. 47 p.

ABSTRACT

The response of six grasses and two legume-grass mixtures to various rates of nitrogen is reported for 9 dryland field experiments. Napier and panicum produced the highest yields and gave satisfactory yield responses at up to 300 lbs of nitrogen per acre per year. Napier was outstanding in maintaining grazing capacity and yields at about 90% of normal during drought years with the May-to-September period averaging less and 1 inch of rain per month. The check produced 162 cow-day units of grazing, 9,050 lbs grazeable dry matter, and 610 lbs protein per acre. Nitrogen at 280 lbs produced 437 cow-days, 18,000 lbs dry matter, and 1,660 lbs protein per acre per year.

Applying nitrogen to alternate ratoons of paspalum, as compared to nitrogen at each ratoon, gave yield increases in drought and normal years ranging from 25 to 40% for the alternate method. In wet years there was no gain. Kikuyu, paspalum, rhodes, and molasses grasses were inferior in production to napier and panicum and gave lower returns for nitrogen fertilization.

additional index words: tropical pastures, ratoons, daylength, temperature, crop production, reclamation, pasture grasses, nitrogen fertilization, fertilization

Younge, O. R. 1961. Pangolagrass requires high potassium fertilization. Hawaii Farm Sci. 10(2):3-5.

ABSTRACT

In soil fertility experiments on aluminous soils on Kauai, it was observed that the pangolagrass component of yield from a mixture of pangolagrass and Desmodium intortum was declining. The decline in grass component went from a peak of over 90% of the yield to less than 25%. The deficiency was found to be potassium supply to the grass. After K fertilizers were applied, the grass component in the yield raised dramatically. At low K levels, Desmodium became dominant over the grass.

additional index words: fertilizer balance, latosols, aluminous soils, forage mixtures, grasses, pangolagrass

Younge, O. R., and D. L. Plucknett. 1963. Zinc deficiency reduces Hawaii crop yields. Hawaii Farm Sci. 12(1):4-6.

ABSTRACT

Severe zinc deficiency appeared in corn on soils in which heavy coral applications had been made in World War II. Corn yields were reduced markedly, in some cases no grain yields were obtained, while in normal growth areas yields reached 115 bushels per acre. Also, irrigated alfalfa on coral sands responded markedly to zinc applications; maximum yield increases of 38 percent were obtained at about 17 lbs of zinc per acre. This yield increase amounted to 0.75 ton per acre over a 100 day period.

additional index words: alfalfa, corn, coral limestone, coral sand soils, crop deficiency symptoms

Younge, O. R., and D. L. Plucknett. 1964. Heavy fertilization of high value crops in Hawaii. Agrichem. West 7(11):15-16.

ABSTRACT

Hawaiian soils may fix large amounts of phosphorus and potassium. High value crops have been heavily fertilized to reproduce high yields as well as to compensate for fixation problems. Fixation can be partially quenched by heavy fertilization, thereby substantially raising the productive potential of the high fixation soils. Deficiencies of other nutrients in Hawaiian soils are also discussed.

additional index words: phosphorus fixation, potassium, marginal lands, fertilization, crop production

Younge, O. R., and D. L. Plucknett. 1965. Beef production with heavy phosphorus fertilization in infertile wetlands of Hawaii. Proc. 9th Int. Grassland Congr., Sao Paulo. 2:959-963.

ABSTRACT

The acidic ferruginous and aluminous latosols of Hawaii are infertile and unproductive unless heavily fertilized. These soils rapidly inactivate large amounts of added phosphorus. Pangolagrass-intortum (Digitaria decumbens-Desmodium intortum) pastures treated with 4 rates of phosphorus and grazed with yearling steers produced as high as 1164 PAY (lb/acre/year) liveweight beef gains. Unimproved pastures in Hawaii produce about 30 PAY liveweight gains. Heavy initial costs of treatment are amortized over several years. Satisfactory beef yields demonstrate the feasibility of improving extensive submarginal jungle lands in high rainfall areas heretofore considered beyond economic development.

additional index words: tropical soils, beef production, pangolagrass, phosphorus fertilization, latosols, marginal lands, pasture grasses

Younge, O. R., and D. L. Plucknett. 1966. Quenching the high phosphorus fixation of Hawaiian latosols. Soil Sci. Soc. Amer. Proc. 30:653-655.

ABSTRACT

Hawaiian aluminous-ferruginous latosols are severely deficient in total and available phosphorus and have very high phosphorus fixation capacities. This severely limits crop production. Results of a 6-year field experiment indicate that the problem of phosphorus fixation and low yields can be overcome by a heavy initial phosphorus treatment which quenches the fixation complex, and thus diverts the extra phosphorus to maximum yield production. Additional phosphorus must be added every few years to replace depletion by crop removal, erosion, and slow residual fixation. Long-term yields indicate the costs of reclamation may be readily amortized over a 10- to 20-year period. This experiment was the first in the Tropics to show the long-term residual benefits of massive phosphorus applications in heavy phosphorus-fixing soils.

additional index words: phosphorus, pangolagrass, Desmodium intortum, residual fertilizers, latosols, marginal lands, land reclamation

(6) Fertilizer Use and Technology

Beaton, J. D., and R. L. Fox. 1971. Production, marketing, and use of sulfur products. Soil Sci. Soc. Amer. Fertilizer Tech. and Use, 2nd ed. Chapt. 11.

ABSTRACT

A review with main sections as follows:

I Introduction
II Production, agronomic effectiveness and use
III Benefits from and needs for sulfur products
IV Factors influencing the effectiveness of sulfur products

additional index words: sulfur, fertilizer

DeDatta, S. K. 1963. Availability of phosphorus and utilization of phosphate fertilizers in some Great Soil Groups of Hawaii. Ph.D. Dissertation, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

Superphosphate increased the yield of sugar cane more than the more soluble ammonium phosphate. Phosphate applied as foliar sprays greatly increased the phosphorus content of plants. Higher phosphate status due to foliar sprays did not change the dry matter yields significantly. The influence of lime on fertilizer phosphorus uptake by sudan grass was much greater (about 15 times) when the roots were in contact with the soil for 21 days as compared with 4-day contact. Applications of lime to acid soils to produce a pH of 5.5 effectively precipitated much of the active aluminum and evidently increased the solubility of phosphorus. From the standpoint of phosphorus solubility, liming acid soils to a pH of about 5.5 was adequate.

additional index words: phosphorus, foliar application, sugar cane

Kanehiro, Y. 1966. Nitrogen carriers and their behavior. Proc. 1st Annual Turfgrass Management Conf., Univ. of Hawaii, Coop. Ext. Serv., Misc. Pub. 29. p. 11.1-11.3.

ABSTRACT

The different important nitrogen fertilizers are presented. They are divided into two groups: solid nitrogen materials, and nitrogen solutions. Availability and leachability of some nitrogen fertilizers are discussed. Nitrification, effect on soil acidity, volatilization and other losses of fertilizer nitrogen are other items that are discussed.

additional index words: nitrogen fertilizers, solid nitrogen fertilizers, liquid nitrogen fertilizers

Silva, J. A. 1966. Liquid vs. solid fertilizers. Weeds, Trees and Turf. 5(3):8-10, 16.

ABSTRACT

A comparison of liquid and solid fertilizer materials for agronomic crops and turf. Both forms of fertilizer when properly applied, have been equally effective in producing crop response when compared on a per-pound-of-plant-food basis. In the use of each form, there are certain advantages and disadvantages, and these must be considered. Under certain conditions, the increased ease of handling liquids by pumps or gravity and application in irrigation water or by other means may make liquid fertilizers most economical. Hence, cost to handle and apply the two forms must be considered as well as the cost per unit of plant food in the two forms of fertilizer.

additional index words: liquid fertilizers, solid fertilizers, turf

Silva, J. A. 1968. Pot and field techniques for determining fertilizer needs. Proc. 2nd Annual Hawaii Fertilizer Conf. Univ. of Hawaii, Coop. Ext. Serv., Misc. Pub. 51. p. 7-12.

ABSTRACT

A discussion of the use of plant and soil analysis for assessing fertility status of the crop or field and the role of pot and field experiments in calibrating soil and plant analyses techniques. Factors affecting the conduct of pot and field experiments are discussed. In pot tests the plant is used to assess the nutrient status of the soil by the growth made and the nutrients taken up under controlled conditions. Various indicator crops are used in pot studies and certain assumptions are made regarding the nutrient level in the plant and the nutrient level in the soil. Field experiments are the most direct method of assessing the fertility status of soil in a particular area or field. Since the crop is grown under normal field conditions it is able to reflect the nutrient status of the soil in its yield and nutrient uptake. Various aspects of setting up a field experiment are discussed, including selection of treatments, number of replicates and experimental design.

additional index words: pot tests, field tests, fertilizer needs, experimental design, sampling

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