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EFFECT OF SUPERPHOSPHATE APPLICATION RATE ON PASTURE ESTABLISHMENT ON QUEENSLAND'S WET TROPICAL COAST

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SUMMARY

There were marked improvements in pasture establishment from the use of superphosphate, with the first 2 cwt of superphosphate per acre generally producing the greatest improvement. Grass and weed responses to superphosphate far exceeded legume responses. There was no evidence of correlation between optimum superphosphate rate and soil or site characteristics.

I. INTRODUCTION

The wet tropical coastal area of Queensland extends in a narrow strip between the Bloomfield River (15½°S.) and Ingham (19°S.) on the east coast. Average annual rainfall at various centres in the region ranges from 80 to 180 in. Throughout the region there is a comparatively dry period of about 3 months in the winter. The trials presented in this paper were carried out in some of the wetter areas of the region.

Native vegetation of the region has never been fully described. Webb (1967) dealt briefly with the habitat types, and concluded that soil fertility and drainage are the major ecological factors determining development of the vegetation.

He suggested that mesophyll vine forests occur on the better drained land and more fertile soils. With poorer drainage these grade through mesophyll palm vine and *Melaleuca* sedge forest to sedge savanna and low-layered *Melaleuca* woodland. Sclerophyll forests occur on better drained soil of lower fertility. Under the influence of fire and poor drainage, these grade through eucalypt grassy woodland to closed shrub woodland (mangroves).

The soils of the region have not been adequately described. They are derived from basalt, schist, granite, mixed alluvium, beach sand and organic material.

Although fertilizers have been used for growing sugar-cane for many years, little interest in fertilizers has been shown by the grazing industry in the region until recently.

Grof (1966) reported large responses to phosphorus in pot-grown grasses and legumes. He also reported superphosphate responses in pasture establishment on a virgin alluvial soil cleared of layered sclerophyll forest. This response was of the nature of a tenfold increase in dry-matter production from application of 2 cwt superphosphate per acre at planting. Previously other workers had obtained evidence (unpublished) over a period of about 20 years, suggesting that pastures could benefit from use of phosphatic fertilizers.

This paper reports on part of the programme investigating superphosphate requirements for pasture establishment on Queensland's wet tropical coast.

II. MATERIALS AND METHODS

Sites.—The trial sites are described in Table 1. Chemical analyses of the soils of the trial sites indicated a pH range of between 4·9 and 5·9 (mean 5·3). Available P (Kerr and von Stieglitz 1938) ranged between 5 and 10 p.p.m. (mean 7 p.p.m.).

Rainfall.—During the first 6 months of 1966, when the trials were carried out, only 49 in. of rain was recorded at the Tropical Agriculture Research Station, South Johnstone, compared with a 28-year mean of 101 in.

Design and layout.—The design used at all sites was a 5 x 5 latin square with five rates of 22% superphosphate, viz. 0, 2, 4, 6 and 8 cwt per acre. Plot size was 20 lk x 25 lk (.005 ac), and plots were laid down contiguously on uniformly cultivated land.

Site preparation.—Most trials were carried out in association with commercial pasture plantings. In all cases the final soil preparation was by discing, following commercial practice. At virgin sites, the timber was pulled and windrowed. The soil was root-raked and the timber burned. The trials were sited between windrows to avoid ash effects.

Fertilizer preparation and application.—A basal dressing of eight nutrients was applied to all plots with the superphosphate treatments, using commercial grade fertilizers. The components of the fertilizer mixtures were:—

Muriate of potash at 115 lb/ac (60 lb K/ac).

Epsom salts at 200 lb/ac (20 lb Mg/ac).

Fritted trace element mixture at 100 lb/ac (Fe, 7; Mn, 2·5; Zn, 3·2; Cu, 3·2; B, 0·6; and Mo, 0·1 lb/ac).

Granulated superphosphate at 2, 4, 6 and 8 cwt/ac (P at 22, 44, 66 and 88 lb/ac). (At site 6, an accidental aerial application of 5 cwt superphosphate per acre occurred before the trial commenced, altering the treatments to 5, 7, 9, 11 and 13 cwt superphosphate per acre).

After the plots were seeded and raked, the fertilizers were spread by hand and left on the surface to be washed into the cultivated soil by rain.

Seed preparation and planting.—The grasses used as test species were common guinea and Hamil (both cultivars of *Panicum maximum*). The legumes were centro (*Centrosema pubescens*) and stylo (*Stylosanthes gracilis*). The grass and legume were selected for each site according to commercially recommended practice (Table 1). Planting rates were higher than normal to ensure an even stand and reduce the effect of weed competition. All legume seed was inoculated with the appropriate *Rhizobium* strain. After the seed was broadcast by hand prior to fertilizer application, the plots were raked very lightly to give the seed a light cover.

TABLE 1

TRIAL SITE DESCRIPTIONS

Site No.	Parent Material	Northcote P.P.F.	Field Texture	Drainage	History	Pasture Species Used
1	Schist . .	Um 2·2	Loam—fine sandy	Satisfactory	Virgin	Common guinea grass; stylo
2	Schist . .	Um 4·4	Loam—fine sandy	Good . .	Virgin	Common guinea grass; centro
3	Alluvial	Gn 2·81	Sandy loam	Satisfactory	20-year-old intermittently grazed clearing	Common guinea grass; stylo
4	Alluvial	Gn 3·11	Coarse sandy loam	Satisfactory	30-year-old intermittently grazed clearing	Hamil grass; stylo*
5	Schist . .	Um 5·5	Loam . .	Good . .	Virgin	Common guinea grass; centro
6	Granite	Gn 2·84	Organic loam	Poor; high water table	Virgin	Common guinea grass; stylo*

* Legume and grass seed drilled in alternate rows 22 in. apart.

Sampling.—Trials were sampled once only, approximately 3 months after planting. Quadrats were cut 4 in. above ground level with an Allen Oxford reciprocating mower. Quadrats measured 0·0005 ac (10% of the plot) and were obtained from the centre of each plot, parallel to the 25 lk side. At sites 4 and 6, where seed was drilled in, this was at right-angles to the direction of the rows. Centro vines from within the quadrat were hand-cut with shears at ground level and included in the sample.

As each site was sampled, roots of one legume plant per plot were examined visually for evidence of nodulation.

III. RESULTS

Treatment yields from the various trials are illustrated in Figure 1. There was wide variation between treatment replicates for all components at all sites.

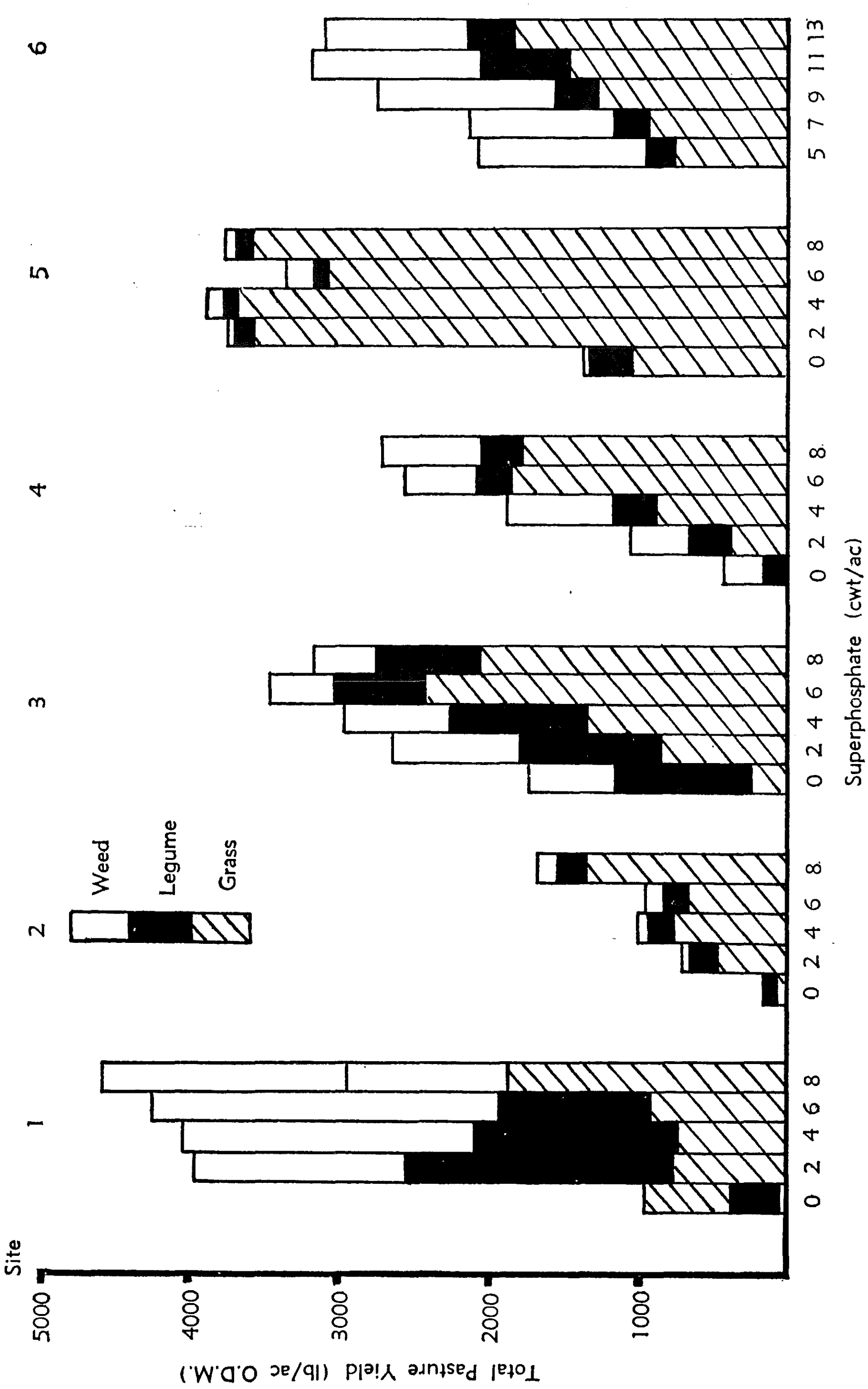

Fig. 1.—Yields of grass, legume and weed from various superphosphate treatments.

Responses of grass, legume, weed and total pasture to superphosphate are summarized below.

Grass.—Maximum grass production was achieved from application of 2 cwt superphosphate per acre at site 5.

Grass production increased steadily as the superphosphate rate was increased to 6 cwt at sites 3 and 4, 8 cwt at sites 1 and 2, and 13 cwt at site 6.

Legumes.—Visual examination of legume roots when the trials were sampled suggested that nodulation had been effective at all sites under all treatments.

Legume production did not respond significantly to superphosphate at sites 2, 3 or 5. An application of 2 cwt superphosphate per acre produced maximum response in legume production at sites 1 and 4. Legume yields improved slightly as the superphosphate rate increased to 11 cwt at site 6.

Weeds.—Weed growth did not respond to superphosphate above the accidental basal 5 cwt per acre at site 9. A steady increase in weed growth with increasing superphosphate rate levelled out at 4 cwt at site 4, and at the 6 cwt level at sites 1 and 2. Yield of weeds declined above the 6 cwt level at sites 1 and 5. Weed growth tended to decline steadily as superphosphate application increased above 2 cwt at site 3.

Total pasture.—Total pasture yields were at a maximum where a dressing of 2 cwt superphosphate per acre was applied at sites 1 and 5. Total pasture production improved steadily as superphosphate application rate increased to 6 cwt at sites 3 and 4, 8 cwt at site 2, and 11 cwt at site 6.

IV. DISCUSSION

Use of superphosphate had a beneficial effect on pasture establishment at all sites. Generally grasses responded well to superphosphate, while weeds response was less marked. Positive legume responses were recorded at only three sites.

Obviously the soils on which the trials were carried out were deficient in one or more of the plant foods contained in superphosphate. Response of the various pasture components to applied superphosphate would depend on several other factors:

(*a*) Species reaction to superphosphate.

(*b*) Competition between components at the various superphosphate levels.

(*c*) Reaction of the various species to uncontrolled factors in the environment, e.g. soil, physical conditions and weather.

Superphosphate effect.—This series of trials has been included in a programme studying the correlation between soil phosphorus levels and pasture establishment responses to applied phosphorus on the wet tropical coast of North Queensland. Until this programme is completed, the critical range for soil phosphorus will not be known. However, soil chemical analyses suggested that all sites should respond to added phosphorus. It is therefore logical to assume that at least part of the measured superphosphate effects was due to phosphorus. Calcium and sulphur effects cannot be ruled out, and will require further field investigation. These trials were designed to investigate immediate commercial problems in pasture establishment, and at the time superphosphate was the major available phosphoric fertilizer. Preliminary pot tests showed that phosphorus provides at least the major nutritional response, and that general calcium and sulphur deficiencies are unlikely.

In the field trials, the greatest dry-matter response resulted from application of the first 2 cwt of superphosphate per acre, though yields generally improved with heavier dresssings. There appears to be no correlation between the level of superphosphate response and the Northcote classification, history, drainage or texture of the soils. However, the optimum superphosphate rate was generally less than 8 cwt/ac.

At site 6, where the treatments were superimposed on an accidental blanket dressing of 5 cwt superphosphate per acre, responses were recorded at the 13 cwt level. As this site was poorly drained, it is probable that nitrogen was limiting. High levels of superphosphate may have improved the ability of the plant root systems to take up nitrogen.

Responses to other nutrients.—Another series of trials was carried out in conjunction with the superphosphate rates trials discussed in this paper. These investigated the effect on pasture establishment of other major (excluding nitrogen) and minor nutrients, using commercial grade fertilizers and basal dressings of superphosphate. Occasional small responses were recorded, but none nearly as decisive or general as the superphosphate effects.

Grass dominance.—There are strong indications at all sites that, as the grass component responded to additional superphosphate, it increasingly dominated the other species.

Trumble and Shapter (1937) and many other authors have reported that, when mixed temperate pasture species are planted with phosphorus fertilizer in a soil low in nitrogen, early legume dominance results. Trumble and Shapter also pointed out that such a pasture planted under high nitrogen conditions tends to be grass dominant, with grass production responding markedly to applied phosphorus.

In this series of trials the observed grass dominance and marked grass response to superphosphate suggest that the plantings were made under conditions of high nitrogen. In the warm humid climate in which these trials were carried out it is probable that there was a substantial release of nitrogen from organic matter breakdown after the soils were cultivated prior to planting. It may be that Trumble and Shapter's observations on the behaviour of temperate grass species sown by seed in the presence of high nitrogen and phosphorus apply also to tropical grass species. The behaviour of grass in these trials may have been a species effect, and work is required to explain the observation.

Legumes apparently failed to realize their full potential to respond to superphosphate. This may have been due to grass dominance or ineffective nodulation. The recommended inoculum was used with the legume seed and visual examination showed that satisfactory nodulation had occurred; thus the poor response of legumes to superphosphate was probably due to grass dominance.

As a result of accelerated grass establishment from superphosphate application, it is possible to graze pastures 2-3 months after planting; similar pastures planted without superphosphate require about a year to establish before grazing. It is possible that legume response to superphosphate would be improved by techniques such as early grazing, drilling grass and legume seed in separate rows, and increasing the legume seeding rate.

Weed infestation.—Weed infestation was heavy at most sites, and it is clear that in commercial plantings using superphosphate special effort would be necessary to minimize the weed problem. Generally, however, grass responded better to superphosphate application than did the weeds.

Sites 2 and 5 were least affected by weeds since they were located on virgin land, comparatively free of weed. Location of the trials in proximity to or on old weedy areas was probably responsible for the weed problems at sites 1, 3 and 4. Hurried and poor seedbed preparation probably aggravated the weed problem at site 1.

Although distribution of sown seed and fertilizer was carefully controlled, distribution of weed species was at random. Thus the weed component offered variable competition, reducing the sensitivity of the trials and possibly affecting response correlations between optimum superphosphate rates and site characteristics.

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