NITROGEN SUPPLY, CCC, AND HARVEST TIME EFFECTS ON *PASPALUM PLICATULUM* SEED PRODUCTION

A. G. CAMERON*† AND L. R. HUMPHREYS*

ABSTRACT

CCC at 0, 1 *or* 10 *kg a.i. ha*$^{-1}$ *was applied shortly after floral initiation to a* Paspalum plicatulum *cv. Rodds Bay sward fertilized with* 0, 100 *or* 400 *kg nitrogen ha*$^{-1}$ *at Mt. Cotton, south-east Queensland. Crop lodging on the ground was positively related to nitrogen supply, but CCC did not influence crop height, internode number or length, extent of lodging, or seed yield.*

Seed yield averaged 61, 301 *and* 361 *kg ha*$^{-1}$ *in the* N_0, N_{100} *and* N_{400} *treatments respectively. High nitrogen supply increased tiller density, tiller fertility, and raceme number, and decreased tiller survival, raceme length, total seed density, seed weight, and seed viability.*

Seed viability was maximal at an advanced maturity stage, and maximum yield of pure live seed occurred on May 19, *which was* 56 *days after first head emergence and* 17 *days after the occurrence of maximum seed yield in the fertilized treatments.*

INTRODUCTION

Rodd's Bay plicatulum (*Paspalum plicatulum* cv. Rodd's Bay) has higher seed yields and better synchronization of flowering than many tropical pasture grasses. Nitrogen fertilizer greatly increases seed yield (Chadhokar and Humphreys 1973*a*) but also increases the incidence of crop lodging on the ground. Growth retardants such as CCC (2-Chloroethyl-trimethylammonium chloride) are used to control lodging of cereals in Europe (Linser 1968) by reducing plant height and internode length, and CCC has been shown to decrease the height of the tropical grasses *Digitaria decumbens* and *Chloris gayana* (Stobbs 1973). However, we have not sighted any references where CCC has been tested for its capacity to control the lodging of tropical grass seed crops. This paper reports an experiment investigating the use of CCC on a plicatulum crop fertilized with different rates of Nitram at Mt. Cotton, south-eastern Queensland. A secondary interest was the effect of nitrogen supply on seed quality, on seed yield and on the optimum time of harvest; seed viability of an earlier crop was substantially improved by application of urea fertilizer (Chadhokar and Humphreys 1973*a*).

METHODS

The experiment was conducted at the University of Queensland Mt. Cotton Farm, 40 km, south-east of Brisbane, on a red-yellow podzolic soil (Beckman 1967). Rodd's Bay plicatulum was sown in rows 1 m apart in November 1967. The site was used for a fertilizer nitrogen seed production experiment until May 1970, and was grazed intermittently until November 1974, by which time plicatulum had formed a uniform sward. A basal dressing containing the nutrients Zn, Cu, B and Mo was applied at sowing, and P, K, S and Ca were applied in 1967, 1968, 1969, 1974 and 1975. No nitrogenous fertilizer had been applied since February 1970, and residual nitrogen treatment effects from the previous experiment were not apparent. The area was slashed to 10 cm on January 23, 1975.

* Department of Agriculture, University of Queensland, St. Lucia 4067.
† Present address: Agriculture Branch, Northern Territory Administration, Darwin 5790.

The experimental treatments were:

(a) nitrogen fertilizer: 0, 100 or 400 kg N ha^{-1}, applied as Nitram (34% N) in split applications on January 30 and February 14, 1975.

(b) CCC: 0, 1 or 10 kg of CCC a.i. ha^{-1}, applied with 0.1 per cent non-ionic wetting agent in 1400 l water ha^{-1} on February 20, 1975.

There were eight replications. CCC treatments were arranged as main plots, and nitrogen treatments were split plots, each 3 m × 4 m.

Seed yield was determined on six occasions between May 2 and May 26, heads containing mature seed being harvested from one 0.5 m × 1 m quadrat in each sub-plot from a different quadrat location on each date. Seed was threshed using a rubbing board and sieves, and was cleaned using an "ER" General Seed Blower for 12 min per sample. Seed was dried for 72 h at 40°C. Seed viability was tested using 20/32°C night/day temperature with light and 0.2% potassium nitrate. Tiller density was determined immediately prior to first head emergence in March, and at the final harvest. Inflorescence height and internode number were determined from 15 fertile tillers per sub-plot. Density of harvested inflorescences was noted, and total inflorescence density was also recorded on six occasions from March 26 to May 26. The extent of crop lodging was visually estimated, and dry weight of tops above 2.5 cm was determined from one 0.4 m × 0.4 m quadrat in each sub-plot on May 27, 1975. More detail is available in Cameron (1976).

RESULTS

Crop development and lodging

The 1975 growing season at Mt. Cotton had below normal rainfall; 119, 134, 82 and 66 mm were recorded in January, February, March and April respectively. Supplementary irrigation totalling 228 mm was applied in February and April. In the first week of May 16 mm rain fell, and the balance of the month was sunny and dry, providing excellent conditions for crop maturation. Crop growth in the fertilized treatments was good, and yield of tops on May 27 was 3700, 9400 and 12700 kg ha^{-1} in the N_0, N_{100} and N_{400} treatments respectively.

TABLE 1

Effects of nitrogen rate on tiller characteristics of P. plicatulum.

Character	Nitrogen level (kg ha^{-1})		
	0	100	400
Tiller density 24.iii.75 (no. m^{-2})	477a†	850b	905b
Tiller density 27.v.75 (no. m^{-2})	394a	589b	482ab
Tiller survival (%)	83c	69b	53a
Inflorescence density 26.v.75	55a	239b	268c
Tiller fertility (%)	17a	43b	57c
Inflorescence height (cm)	91a	109b	107b
Internode no. per flowering shoot	10·1c	8·6b	8·2c
Internode length (cm)	9·0a	12·7b	13·0b
Lodging rating* 4.iv.75	0a	170b	380c

†Values followed by the same letter do not differ at P = 0·01.
*Based on per cent area of plot lodged × degree of lodging, where 1 = no lodging and 5 = crop plot on ground.

Dissections showed that 50 per cent of tillers reached floral initiation stage by February 11, nine days before CCC was applied. Leaf tip burning was noted on February 27 in the plots receiving 10 kg CCC ha^{-1}, but was no longer evident by the end of March. First head emergence occurred on March 24. Nitram increased tiller density at this time (Table 1) but decreased per cent tiller survival to maturity.

However, the fertility of tillers was markedly increased by Nitram, and inflorescence density was 55, 239 and 268 in N_0, N_{100} and N_{400} treatments respectively. Nitram slightly increased inflorescence height and internode length, and decreased the number of internodes on flowering shoots. The Nitram treatments produced a range of crop lodging, which became severe after irrigation on April 5 and was further accentuated by a heavy thunderstorm on April 14.

CCC application had no effect at any Nitram treatment level on any of the crop characteristics listed in Table 1.

TABLE 2

Effects of nitrogen rate on seed yield and its components.†

Character	Nitrogen level (ka ha^{-1})		
	0	100	400
Inflorescences harvested (no. m^{-2})	56a*	196b	201b
Raceme no. per inflorescence	4·3a	6·0b	8·2c
Raceme length (cm)	4·0b	4·3c	3·6a
Density of seeds harvested (no. cm^{-1} raceme)	8·0	8·6	8·8
Seed weight (mg)	0·79b	0·69a	0·69a
Seed yield (kg ha^{-1})	61a	301b	361c
Seed purity (%)	97·8a	95·0a	95·5a
Seed germination (%)	20·7b	14·1a	13·3a
Pure live seed yield (kg ha^{-1})	13a	38b	47c

†Mean of six harvest occasions.
*Values followed by the same letter do not differ at $P = 0{\cdot}01$.

Seed yield and its components

Mean seed yield over six harvests (Table 2) was 61, 301 and 361 kg ha^{-1} in the N_0, N_{100} and N_{400} treatments respectively. These increases were due both to more inflorescences and to more seed harvested per inflorescence in the fertilized treatments. Nitram increased the amount of branching (raceme number) of the inflorescence, but decreased the weight of the individual seeds and, in the N_{400} treatment, the length of the individual racemes. Seed purity was very high, but mean germination was low, and reduced by Nitram application. This decreased the response to Nitram when considered as pure live seed.

CCC at 10 kg ha^{-1} significantly reduced raceme length in the N_{400} treatment from 8.3 to 7.7 cm, but there were no other effects of CCC on any of the characters listed in Table 2.

Time of harvesting

Harvested seed yield showed little change over time in the N_0 treatment (Figure 1) and differences were not significant. The fertilized treatments showed declining yields from May 2 (39 days after first head emergence) to May 26, except for the N_{400} treatment on May 19. This occurred despite increasing inflorescence density in the fertilized treatments, and was due to decreased seed yield per inflorescence, associated with slightly shorter racemes (data not presented) in the later emerging inflorescences, and with decreased seed density, as the seeds shattered. However, the seeds harvested in all treatments increased in size from May 2 to May 19 (Figure 2) and were substantially heavier in the N_0 treatment. Seed germination was positively related to seed size, and increased to a mean maximum of 32, 28 and 25 per cent for the N_0, N_{100} and N_{400} treatments respectively; these individual differences did not reach significance but the main effects of nitrogen treatment (Table 2) over all harvests were significantly different. This altered the shape of the pure live seed yield relationship with time (Figure 2), which showed a sharp peak at May 19, which was 56 days after first head emergence.

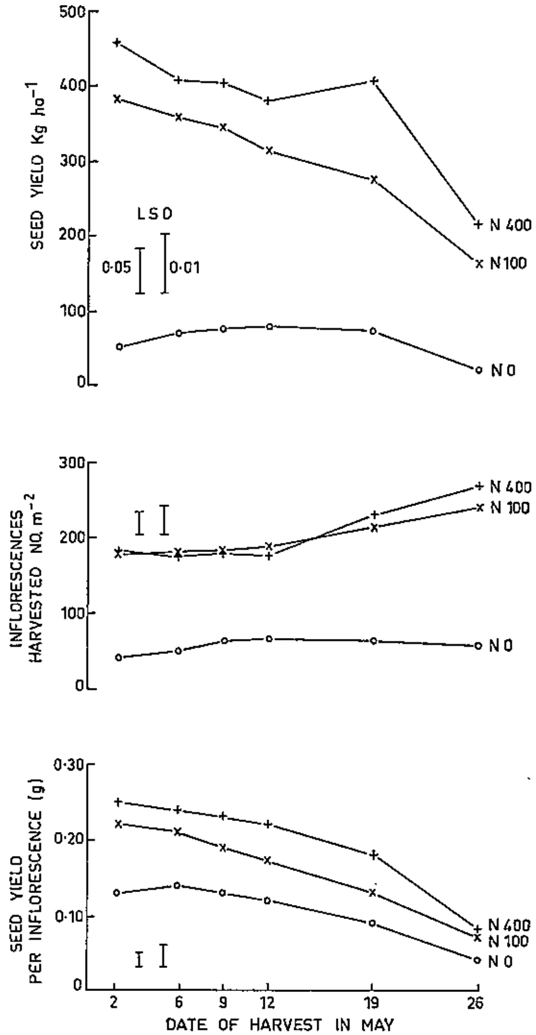

FIGURE 1

Effects of nitrogen rate on seed yield, number of inflorescences harvested and seed yield per inflorescence on various harvest dates.

An estimate of harvest efficiency can be obtained by comparing the number of seeds harvested with the total number of seed abscission calluses on the inflorescences. This suggested that maximum yield of viable seed was harvested at an advanced shattering stage, when on May 19 harvest efficiency was 42, 40 and 53 per cent in the N_0, N_{100} and N_{400} treatments respectively. On the other hand, harvest efficiency was 66, 79 and 79 per cent in the same treatments on May 2 when maximum seed yield was recorded.

DISCUSSION

Although CCC caused foliar damage to plicatulum, it did not shorten plants or reduce crop lodging. This agrees with the results of some pot experiments (Cameron 1976) in which CCC was applied without result to *P. plicatulum* cv. Rodd's Bay, *Cenchrus ciliaris* cv. Biloela, *Chloris gayana* cvs. Pioneer and Callide, *Panicum maximum* var. *trichoglume, P. maximum* (common) and *Setaria anceps* cvs. Kazungula and Narok. It contrasts with responses with *C. gayana* and *D. decumbens* obtained by Stobbs (1973) to 2.9 and 4.9 kg CCC ha^{-1}. Genotypic differences in response to growth retardants are common and the reliability of response often depends upon the occurrence of favourable climatic conditions.

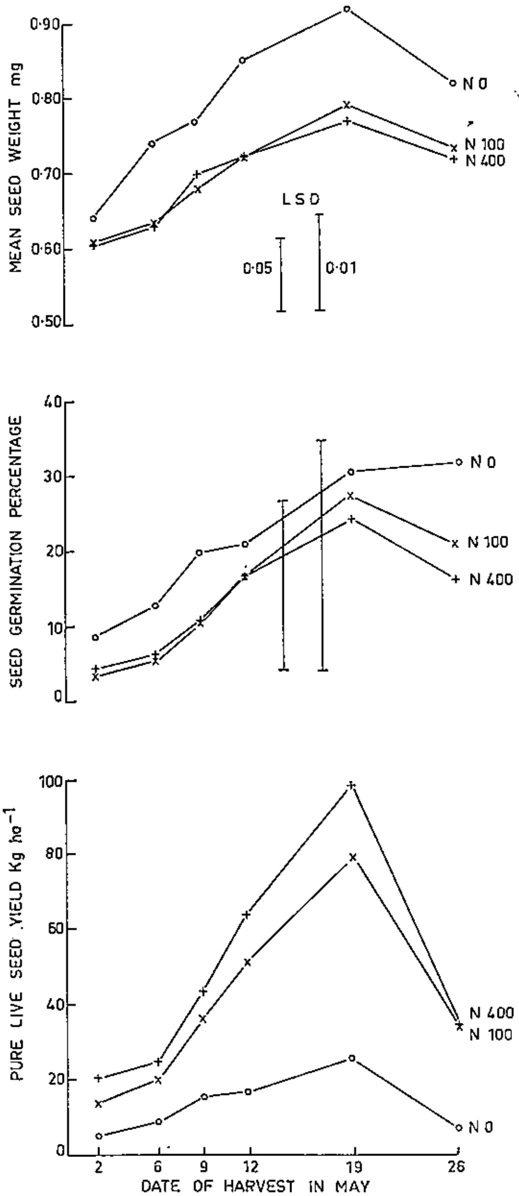

FIGURE 2

Effects of nitrogen rate on seed weight, germination and pure live seed yield on various harvest dates.

Severe crop lodging in a previous experiment (Chadhokar and Humphreys 1973*a*) caused decreased harvest efficiency. This did not apply in the present study, where little rain fell on the lodged crop. Districts with a reliably dry finish to the season are less likely to encounter losses of this type.

Seed yield in this experiment was very responsive to nitrogen supply up to 100 kg N ha^{-1} but the pathways of yield increase differed from some earlier studies. Inflorescence density was a more predominant yield determinant than seed yield per inflorescence in this older sward. Previously (Chadhokar and Humphreys 1973*a*, *b*) in row or seedling crops tiller density was positively associated with nitrogen supply, but tiller fertility was unaffected; in this study both tiller density and tiller fertility were higher with good nitrogen nutrition, which agrees with Henzell and Oxenham (1964). Compensatory reductions in some components of seed yield per inflorescence were also noted in high nitrogen treatments. In the present experiment raceme length was reduced, and total seed density (determined from abscission calluses) on May 27 averaged 17.4, 16.4 and 15.3 seeds cm^{-1} of raceme in the N_0, N_{100} and N_{400} treatments respectively. Previously seed weight was either independent of or positively associated with nitrogen supply, in contrast to this study in which seed size was negatively related to nitrogen supply. This suggests that variation in the extent of competition between and within inflorescences and variation in environmental influences determine the direction of nitrogen response. In the 1970 crop, increased seed size in the high nitrogen treatments was associated with poor seed retention on the inflorescence, whereas better seed retention occurred in the dry, sunny autumn of 1975.

Seed germination was related to seed size, and the varying effect of nitrogen nutrition on the seed quality of the 1970 and 1975 crops is understandable in these terms. Seed viability was below good commercial standards, and further grading would have been necessary to remove small, immature seeds. This underlines the advantage of delaying seed harvest to an advanced maturity stage.

The main conclusions for seed growers are:

(i) CCC does not offer promise for controlling lodging.

(ii) Nitrogen fertilizer will decrease seed viability in some years and increase it in others, depending on the weather.

(iii) Better seed quality and higher yields of viable seed result from delaying seed harvest until early formed seed has shed.

(iv) Economic responses to levels above 100 kg N per ha are unlikely to occur with plicatulum crops.

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