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STUDIES ON THE EFFECT OF THE GROWTH HORMONE CERONE 720 ON THE YIELD OF RICE (var. Rustic) IN GUYANA

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ABSTRACT. A series of trials was carried out with the growth hormone CERONE 720 (active ingredient ethephon) on rice (var. Rustic) in Guyana during the Autumn cycle of 1995 and Spring cycle of 1996. In 1995, there was three experiments while in 1996 there was a larger scale on-farm experiment. The result were as follows: Experiment 1 - in which twelve CERONE 720 application rates ranging from 0 to 51.20 g a.i./L of water were administered to seed under 10 cm simulated flooded condition. The 0.16-0.32g a.i./L range of treatments increased ($P \leq 0.001$) seedling emergence above the flood water level 42% to 80%. The CERONE 720, therefore, increased the rate of elongation of the rice seedling leaves under flood. Experiment 2 - in which CERONE 720 was found to increase rice yield in a farmer's field by approximately 6% when applied as a seed treatment at the rate of 1.44g a.i./L of water. This trial also indicated that a seedling rate of 100 kg ha^{-1} could leap to a significantly ($P \leq 0.05$) higher yield than the normal rate of 150 kg ha^{-1} if CERONE 720 was applied to seed at the lower seedling rate; this gave a saving of 50 kg ha^{-1} of seed while at the same time providing an additional 0.24 t ha^{-1} of grain. Experiment 3 - in which CERONE 720 was applied to experiment station plots as a foliar spray just prior to panicle initiation at the rate of 300 g a.i. ha^{-1}. Grain yield was increased by approximately 13% while grain quality was improved. Experiment 4 - in 1996 six large scale plots were selected in four commercial farmer's field along the coastal belt of Guyana and CERONE 720 was applied at the recommended rate of 300 g a.i. ha^{-1} as a foliar spray just prior to panicle initiation to one-half of each plot; the other half was untreated. The treatment led to an average increase in grain yield of 620 kg ha^{-1} or 12.5% of the variety Rustic which occupied about 70% of the total area under rice production in Guyana. This yield increase translated to a net profit increase of approximately US$88 ha^{-1} (Guy $12496 ha^{-1}) and confirmed on a large scale what was achieved on experiment station plots in the previous crop cycle.

INTRODUCTION

CERONE 720 which contains 720 g of the active ingredient 2-chloroethyl phosphoric acid, called ethephon, per litre, is an organic

phosphorus compound used on a number of crops as a growth regulator. Depending upon plant species, chemical concentration, and timing of application to one or more of the customary growth sites (roots, leaves, stems, flowers or fruit) the ethylene released to these tissues produces numerous physiological effects and can be utilized to regulate various phases of plant metabolism, growth, and development (Thomson, 1981).

In rice, CERONE 720 has been found to increase tillering, induce earlier and more uniform flowering, hasten maturity and harvest, increase the number and weight of grains per panicle and improve grain quality. Overall, yield was found to increase by approximately 15 to 20% in Ecuador and Brazil (Rhone-Poulenc, 1994). Several other researchers have reported yield increases from the application of ethephon to rice (Kundu and Biswas, 1985; Fang *et al.*, 1983; Rao and Fritz, 1989; Wescott *et al.*, 1985; and, Barros, 1991).

In Brazil, CERONE 720 is applied to rice just prior to the initiation of the reproductive phase when the growing point is just about to differentiate into a floral bud. The success of CERONE 720 depends on the appropriate timing of its application and the recommended dose. A dose of 300 g a.i. ha^{-1} has been recommended for rice (Rhone-Poulenc, 1994).

The present study evaluated CERONE 720 on grain yields of the variety Rustic, the major variety (70% of total area) cultivated in Guyana's 350,000 ha of rice cultivation per year. The investigation was done in collaboration with the Guyana Rice Development Board (GRDB) and private farmers during the period 1995 to 1996. In 1995 the study (Experiments 1 to 3) concentrated on laboratory and on-station trials as a preliminary stage of the investigations. One on farm trial was also conducted. The results then led to large scale studies (Experiment 4) located in farmers' fields along Guyana's coastal rice belt. The plots were selected after the farmers had sown and the treatment was superimposed on the farmer's practices.

2.0 EXPERIMENTATION

2.1 Experiment 1: To study the effect of CERONE 720 as a seed treatment on rice seedling emergence under flooded conditions.

MATERIALS AND METHODS

The first investigation consisted of 12 rates of CERONE 720 (0, 0.04, 0.08, 0.16, 0.32, 0.48, 0.64, 0.96, 1.28, 2.56, 5.12, and 51.20g a.i./L of water) replicated twice and laid down in a completely randomized design. The variety was Rustic. Imbibition was accomplished by soaking

300 seeds for 24 hours in the respective concentrations. The seeds were then pre-germinated for two additional days on paper towels that were kept damp. Germination was considered as the emergence of the coleptile and counts were taken 48 and 72 hours after soaking.

The experiment continued into a second investigation of seedling emergence under food. There were two treatments (CERONE 720 treated and untreated seeds sown in water 10 cm deep) by using the 12 CERONE 720 rates that were replicated twice in a randomized complete block factorial design, making a total of 48 plots. The flooded treatment consisted of a plastic cup filled to 10 cm of water into which the germinated seedlings were placed. Each of the 48 cups (plots) were sown with fifty seedlings (3-days old). Seedling emergence was evaluated 12 days after sowing. Seedling emergence percentage was measured.

RESULTS AND DISCUSSION

It was observed that pre-germination of the CERONE 720 treated seeds, at all levels between 0.04 to 0.96 g a.i./L occurred with 24 hours after being removed from the soaking phase compared to the control treatment. Above 0.96 g a.i./L there was no sign of germination at day 3.

Significant differences were observed for the main effect of CERONE 720 seed treatment ($P \leq 0.001$) on seedling emergence and are presented to Table 1. The CERONE 720 treatments are divided into four ranges that were statistically similar, namely, 0.00 or the control plot, 0.04 to 0.08, 0.16 to 0.32 and $\geq$0.48 g a.i./L of water.

Table 1. The effect of CERONE 720 concentration on seedling emergence under a 10 cm flood. Emergence above the flood water level was measured 12 days after flooding.

CERONE 720 concentration g a.i./L of water (treatment ranges)	% emergence
0.00	42
0.04 - 0.08	70
0.16 - 0.32	80
$\geq$ 0.48	70
Mean (12 treatments)	62

S.E.M. = $\pm$ 5.6 for the 12 treatment means

Conclusion: Without CERONE 720 there was poor emergence above the water surface under flooding. The CERONE 720 rate of 0.16 to 0.32 g a.i./L of water applied as a seed treatment increased seedling emergence above the flood water level from 42% to 80% after a period of 12 days.

This indicated that CERONE 720 increased the rate of elongation of the rice seedling leaves under flood.

2.2 Experiment 2: To evaluate the effect of CERONE 720 as a seed treatment on rice yield in plots in a farmer's field.

MATERIALS AND METHODS

There were 3 treatments laid down in a 3 x 3 latin square design, namely:

(i) 100 kg/ha seeding rate + 1.44 g a.i. CERONE 720 per litre
(ii) 150 kg/ha seeding rate with no seed treatment
(iii) 150 kg/ha seeding + rate 1.44 g a.i. CERONE 720 per litre

The treatments were replicated 3 times and carried out at Blackbush Polder for the rice season of Spring 1995.

The rice seeds for all treatments were allowed to imbibe water for 24 h and then pre-germinated for 2 days in the cool before sowing in the field. Plots were sown on 16 December 1994 and harvested on 19 April 1995.

RESULTS AND DISCUSSION

Table 2. The effect of seeding rate and CERONE 720 seed treatment on yield components of direct seeded rice at Blackbush Polder, Guyana, Spring 1995.

Yield Component	Seedling rate			
	100 kg ha^{-1}	150 kg ha^{-1}	150 kg ha^{-1}	
	+CERONE 720 seed treatment	no seed treatment	+CERONE 720 seed treatment	S.E.M ±
Grains/panicle	61	51	69	2.6
Panicles/m^2	683	779	726	34
Yield, t ha^{-1}	5.45	5.21	5.51	0.27

The results are shown in Table 2. CERONE 720 was found to increase the number of grains per panicle and total grain yield at the normal seeding rate of 150 kg ha^{-1}. CERONE 720 treated seed at a lower seeding rate of 100 kg ha^{-1} increased grains/panicle and total grain yield above ($P \leq 0.05$) the untreated normal seeding rate of 150 kg ha^{-1}. This

meant that farmers could sow 50 kg less seed per hectare and also obtain 0.24 t ha^{-1} more grain if they treated the seeds with CERONE 720.

Conclusions:

1. CERONE 720 increased rice yield by approximately 6% when applied as a seed treatment.
2. A seeding rate of 100 kg ha^{-1} can lead to a significantly ($P \leq 0.05$) higher yield than a rate of 150 kg ha^{-1} if CERONE 720 is applied to the lower seeding rate.
3. CERONE 720 did not increase the number of panicles in this experiment.

2.3 Experiment 3: The effect of different rates of CERONE 720 applied just prior to panicle initiation on rice yield under experiment station conditions.

MATERIALS AND METHODS

There were 3 rates of CERONE 720, namely, 0, 240 and 300 g a.i. ha^{-1}. The test was laid down in a randomized block design with four replicates. The plot size was 1000 m^2.

The variety Rustic was used and the trial was planted on 17 June 1995 at the Burma Experiment Station in Guyana. A seeding rate of 140 kg ha^{-1} was applied as a foliar spray just prior to panicle initiation.

RESULTS AND DISCUSSION

Results are presented in Table 3. CERONE 720 applied at the rate of 300 g a.i. ha^{-1} just prior to panicle initiation increased ($P \leq 0.05$) grain yield by approximately 13%. However, an application rate of 240 g a.i. ha^{-1} showed no effect and this could not be explained.

There was strong evidence to show that harvested grains from CERONE 720 treated plots had a higher ($P \leq 0.01$) percentage of cleaned grains than paddy from untreated plots.

Conclusion: CERONE 720 applied at the rate of 300 g a.i. ha^{-1} just prior to panicle initiation increased ($P \leq 0.05$) grain yield by approximately 13% under experiment station conditions.

Table 3. The effect of different rates of CERONE 720 applied just prior to panicle initiation on rice (var. Rustic) yields at Burma Experiment Station, Guyana 1995.

Treatment (g a.i. ha^{-1})	*Yield (t ha^{-1})	% cleaned grains
0	5.22	77.8
240	5.21	93.8
300	5.89	85.3
S.E.M ±	0.16	3.8

*At 14% moisture content

2.4 Experiment 4: The effect of CERONE 720 on rice grain yield in farmers' fields on the coastal belt of Guyana.

MATERIALS AND METHODS

Four farms were selected along the coastal belt of Guyana during the 1996 Spring Cycle. The farms were located at East Bank Essequibo (Farmer Samand), West Demerara (Farmer Baker), Mahaicony (Farmer Bhajan) and Corentyne (Farmer Rambridge) and planted by the farmers with the variety Rustic. On each farm an area of 2000 m^2 was isolated and CERONE 720 was applied at the rate of 300 g a.i. ha^{-1} as a foliar spray just prior to panicle initiation to one half of the isolated area. The other half was left untreated for comparison. At both the West Denerara and Corentyne farms, a second 2000 m^2 area was included. This gave a total of six plots left untreated (Fig. 1). Panicle initiation was determined by visual examination of the cross section of the main culm of 10 plants chosen at random in the field. Harvesting was carried out in April 1996. The statistical analysis was carried out for a randomized block experiment.

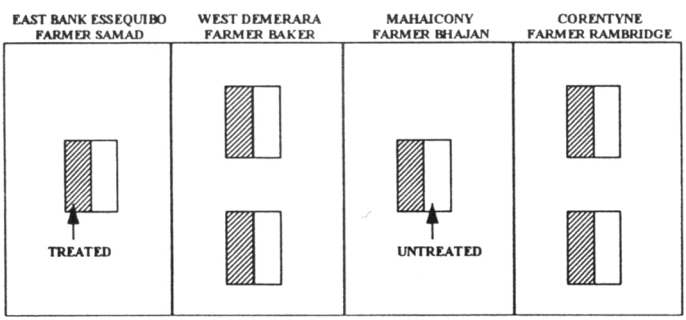

Figure 1. Schematic view of experimental layout of treated and untreated plots on the farmer's fields.

RESULTS AND DISCUSSION

The results are shown in Table 4.

Table 4. The effect of CERONE 720 (300 g a.i. ha^{-1}) on grain yield (t ha^{-1}) of rice variety Rustic on four farms, Spring 1996. (Names of farmers in parentheses)

Location of farms	Expt. area	WITH CERONE 720	WITHOUT CERONE 720	Yield increase due to CERONE 720 (kg ha^{-1})	% increase due to CERONE 720
East Bank Essequibo (Samad)	1	5.73	5.05	680	13.5
West Demerara (Baker)	1	5.59	5.42	170	3.1
	2	5.3	5.49	440	9.6
Mahaicony (Bhajan)	1	6.06	4.92	1140	23.2
	1	6.55	5.44	1110	20.4
Corentyne (Rambridge)	2	4.82	4.64	180	4.9
Mean		5.63	5.01	620	12.5

S.E.M.= $\pm$0.16 for % increase due to CERONE 720 treatment.

The ANOVA showed that CERONE 720 consistently improved ($P \leq 0.10$) yields on all farms with an average increase of 620 kg ha^{-1} (12.5%) which was similar to a 13% increase obtained from the previous season's field trials (Experiment 3 above). The increase amounted to approximately 9.8 bags of paddy per hectare. These results support findings from India (Anon, 1988) for CERONE 720 applied as a foliar spray at the rate of 300 g a.i. ha^{-1} just prior to panicle initiation.

The percentage yield increase due to CERONE 720 varied from 3.1% at one of the sites at West Demerara to 23.2% at Mahaicony. But the yield differences among sites were not significant because there were large differences due to the treatment even on the same farm (3.1 and 9.6% at the two sites on the Baker farm and 4.9 and 20.4% at the two sites on the Rambridge farm as shown in Table 4). Also, experimental error could have been reduced drastically if there were at least three sites on each farm. A repetition of the experiment during another crop cycle would definitely increase accuracy of the measurements.

The cost of application (materials and labour) of CERONE 720 at the rate of 300 g a.i.
ha^{-1} was US$28.47 per hectare. Since this application led to an average yield increase of 9.8 bags of paddy per hectare (that is, US$116.50 ha^{-1}) the net return per hectare was US$88.03.

Conclusions:

1. CERONE 720 applied as a foliar spray at the rate of 300 g a.i. ha^{-1} just prior to panicle initiation in farmers' fields increased grain yield of the variety Rustic by an average of 620 kg ha^{-1} or 12.5% across four farms along Guyana's coastal belt.
2. The increase in rice yield due to CERONE 720 gave a net return of approximately US$88 per hectare.

3.0 FUTURE WORK

The foregoing studies have demonstrated that CERONE 720 has increased grain yield in rice when used as a foliar spray just prior to panicle initiation at the rate of 300 g a.i. ha^{-1}. It would have been useful to include at least three repetitions of the treatment on each farm. This would have provided a greater number of degrees of freedom for the CERONE 720 treatment and also for the farm x CERONE 720 interaction, leading to greater accuracy in the results. It would also have been useful to investigate the effects of other rates such as 200, 250, 350 and 400 g a.i. ha^{-1} farmers' fields.

It was suggested that perhaps CERONE 720 could reduce lodging and blast and have varying effects depending on variety. If the hormone increases the quality of the grain, then, perhaps it also has a carry-over effect on seed quality and viability. These hypotheses are certainly worth investigating.

If farmers decide to use CERONE 720 in their rice cultivation, a monitoring and feedback arrangement should be put in place so that the effects of the product could be evaluated over wider space and time dimension. This would yield valuable information on how CERONE 720 affects the returns to be obtained by farmers using various levels of resource inputs and management practices.

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