Neem cake-urea mixed applications increase growth in paddy

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Significant increase in the growth of paddy plant parts was achieved by halving the urea used and pelleting the remaining with neem cake prior to application. Results on a non-averaged dataset showed significant increase in leaf length, number of leaves, number of panicles, number of tillers and greenness of leaves. Averaged data showed similar results barring the number of panicles, which were not significantly different from the control. The results point to a higher availability of nitrogen in the treatment, even though half the amount of urea was applied as opposed to the control. This could be attributed to inhibition of de-nitrifying bacteria by neem as well as a slower continuous release of nitrogen when urea is pelleted with neem than when it is applied directly. The study makes a strong case for cutting down on nitrogen application in paddy using low-cost, readily available materials, without compromising on the yield.

Keywords: Neem cake, nitrogen application, paddy, urea.

VARYING efficiencies of nitrogen absorption and differential rates of uptake of plants based on growth stages of crops have been known for decades[1–3] and have resulted in a number of formulations for slow release of fertilizers and modifications of cultivation methods[4–6]. However, adoption of these practices has been low among farmers who continue to rely on split dosages and urea as the primary source of nitrogen. In the case of paddy, nitrogen use efficiency is estimated to be only 30–40% of the application[7]. The loss of nitrogen through run-off, ammonia emissions, leaching and de-nitrification is a serious environmental issue[8,9]. Environmental impacts of nitrogenous fertilizers include contamination of local groundwater resources and rivers[6,7,10,11] and emission of nitrous oxide which is both a greenhouse gas as well as a major cause of ozone depletion[12–14]. Slow-release nitrogenous fertilizers typically cost more than conventional formulations and have had less acceptance among farmers. Low-cost alternatives to slow-release fertilizers include addition of plant-derived organic substances such as neem cake, neem leaf[15] and *Pongamia* extract[16]. Many of these also inhibit de-nitrifying bacterial activity. Other plant-derived products such as waste from processed medicinal compounds[17,18] and tannins from forest litter[19] also inhibit de-nitrification.

A farmer's field-based experiment-cum-demonstration was conducted in two villages, Thuruvai and Rayapuddupakkam, in Puducherry and Tamil Nadu respectively, in 2002–03. Selected fields had clayey soil and the same variety of paddy (IR20). A random paired-block design was used with each field containing both the test and control blocks. Blocks were sub-divided into four 5×5 m plots. Each test block was separated from the rest of the field by a bund and linked directly to the irrigation source to prevent inflow of water and dissolved nutrient from the rest of the field. A total of 21 test and control block pairs were set up in this manner. Urea was applied in the control block at the rate of 120 kg N/ha in a split dosage with two-thirds at the time of transplanting and the rest 25 days later. The total amount of nitrogen applied was halved for the test block (60 kg N/Ha) and applied in the same proportion after blending with neem seed cake in the proportion of 3 : 1 and drying two days in the shade.

We recorded relative growth of parts of the paddy plant. Fifteen plants were chosen randomly from each of the four plots per block, i.e. 60 samples each from a block-pair. Observations included leaf length, panicle length, leaf colour (using the IRRI colour card), number of leaves, number of panicles, and number of tillers. Box plots show data both as averaged reading (Figure 1) as well as disaggregated (Figure 2) for the listed variables. Yield measurements for these experiments were not possible as they interfered with harvesting operations and farmers were unwilling to allow harvesting of the experimental plots separately.

The data were analysed with the R package[20] using the ESS[21] and R-Commander interfaces[22]. Analysis with and without averaging the values per block of samples was done. As most parameters were not normally distributed, a Bartlett and Levene's test for homogeneity of variance was performed to see if the data were suitable for analysis of variance. Both tests showed that most of the variables could not be compared using parametric tests barring the number of tillers, which had an acceptable P value in Barletts test (Tables 1 and 2).

Pairwise t-test (done for comparison sake though the data were not suitable for parametric tests) and Wilcoxon test were done (Tables 3 and 4). The Wilcoxon test (on paired non-averaged data) showed strong differences on all growth variables other than panicle length. On averaged data neither panicle length nor number of tillers was significantly different, while differences between all the other variables were significant. A Kruskal–Wallis rank sum test showed that all variables were significantly different with non-averaged data, while only average leaf length was strongly significant (Table 5). Average numbers of leaves and panicles were significant, while average numbers of panicle length, leaf colour and number of tillers were not significantly different. A correlation ma-

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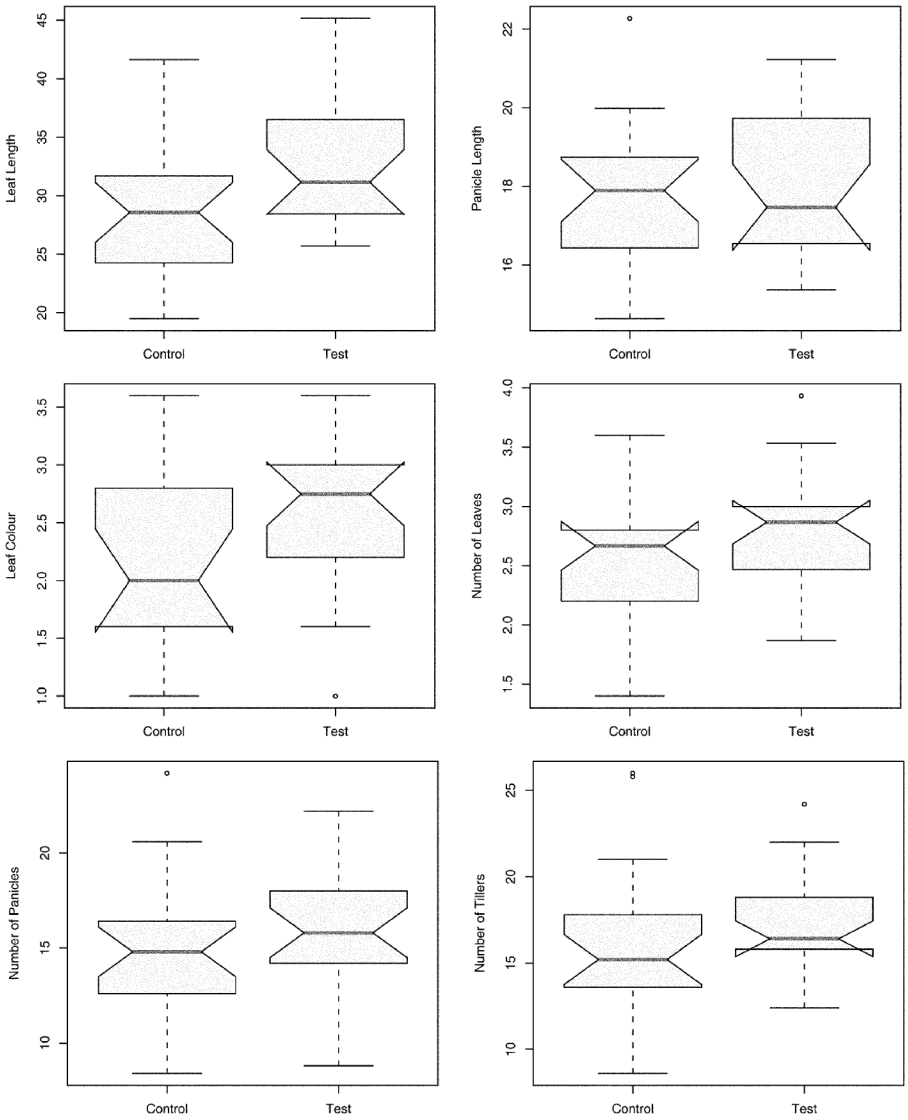

Figure 1. Box plots of data averaged per block.

Table 1. Tests for homogeneity of variance on non-averaged data

Variable	Bartlett's *K*-squared	*P* value
Bartlett test of homogeneity of variance (non-averaged data)		
Leaf length	2.11530	0.14580
Panicle length	1.49220	0.22190
Leaf colour	0.52370	0.46930
Number of leaves	0.27560	0.59960
Number of panicles	1.56880	0.21040
Number of tillers	4.02330	0.04488
Variable	*F* value	*Pr* (>*F*)
Levene's test for homogeneity of variance (non-averaged data)		
Leaf length	1.76840	0.18380
Panicle length	2.71120	0.09975
Leaf colour	2.17970	0.14150
Number of leaves	0.15760	0.69150
Number of panicles	1.70780	0.19270
Number of tillers	1.85490	0.17470

Table 2. Tests for homogeneity of variance on averaged data

Variable	Bartlett's *K*-squared	*P* value
Bartlett test of homogeneity of variance (averaged data)		
Average leaf length	0.00810	0.92810
Average panicle length	0.50720	0.47640
Average leaf colour	0.52370	0.46930
Average number of leaves	2.62090	0.10550
Average number of panicles	1.56880	0.21040
Average number of tillers	4.02330	0.04488
Variable	*F* value	*Pr* (>*F*)
Levene's test for homogeneity of variance (averaged data)		
Average leaf length	0.00280	0.95780
Average panicle length	1.83660	0.17680
Average leaf colour	2.17970	0.14150
Average number of leaves	1.69780	0.19400
Average number of panicles	1.70780	0.19270
Average number of tillers	1.85490	0.17470

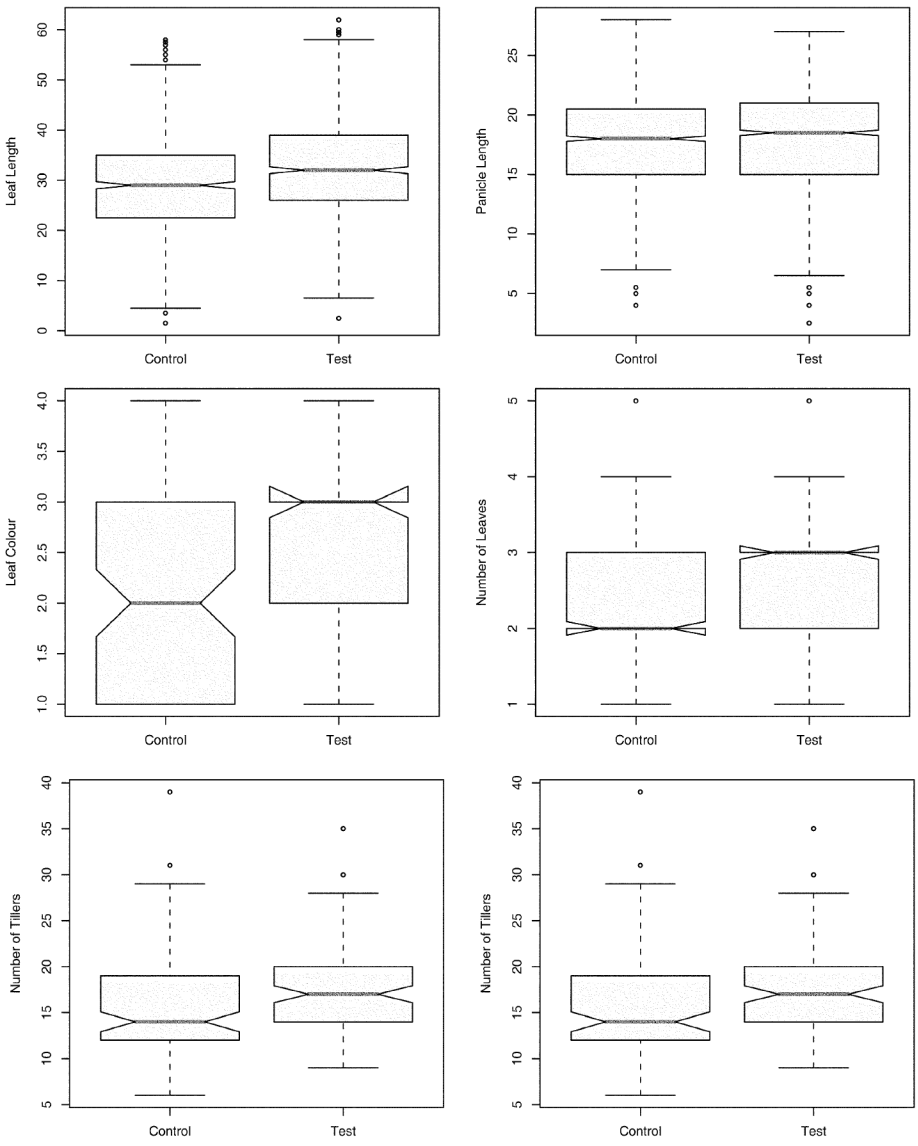

Figure 2. Box plots of disaggregated data.

Table 3. Wilcoxon pairwise comparison on non-averaged data

	Wilcoxon test		
Variable	*W* value	*P* value	Evidence against null hypothesis
Leaf length	373716	< 2.2e-16	Very strong
Panicle length	94037	0.3663	Little or none
Leaf colour	11798.5	8.265e-16	Very strong
Number of leaves	5113.5	1.153e-07	Very strong
Number of panicles	54076	2.159e-14	Very strong
Number of tillers	54610	6.013e-14	Very strong

trix within the growth factors between control and test plots was run (Table 6). A significant correlation between leaf length (a proxy for leaf area, i.e. photosynthetic area) and other growth variables was expected. However, this was true only for leaf length and panicle length. A strong correlation between the number of tillers and number of panicles was also found.

Two processes probably contributed to the increased nitrogen availability – inhibition of de-nitrifying bacteria by neem and the slow release of nitrogen caused by the binding of urea to the surface of neem cake[6]. As the experiments were conducted on farmer's fields, farming practices between different plots could not be standardized. It should be noted however that comparisons were paired and within the same block, therefore, inter-field variations did not affect the analysis. Thus inter-field differences in soil nitrogen and irrigation water would not have influenced the results. Nitrogen provided by the neem

Table 4. Pairwise comparison on averaged data

Variable	*t* value	*P* value	Evidence against null hypothesis
T-test			
Average leaf length	4.19600	0.0004448	Very strong
Average panicle length	1.04970	0.30640	Little or none
Average leaf colour	2.31140	0.03361	Fairly strong
Average number of leaves	3.56980	0.001918	Very strong
Average number of panicles	2.00540	0.05864	Suggestive
Average number of tillers	1.52730	0.14230	Little or none
Variable	***W* value**	***P* value**	**Evidence against null hypothesis**
Willcoxon test			
Average leaf length	20.00000	0.0003538	Very strong
Average panicle length	91.00000	0.41200	Little or none
Average leaf colour	13.00000	0.04529	Fairly strong
Average number of leaves	28.50000	0.002631	Very strong
Average number of panicles	55.00000	0.03701	Fairly strong
Average number of tillers	65.50000	0.14510	Little or none

Table 5. Kruskal–Wallis test on non-averaged and averaged data

Variable	*K–W* chi-squared	*P* value	Evidence against null hypothesis
Kruskal–Wallis rank sum test with $df = 1$ (test/control) and non-averaged data			
Leaf length	55.657	8.629e-14	Very strong
Panicle length	6.4831	0.010890	Very strong
Leaf colour	8.5643	0.003428	Very strong
Number of leaves	15.9192	6.61e-05	Very strong
Number of panicles	7.0263	0.008032	Very strong
Number of tillers	6.9874	0.008209	Very strong
Kruskal–Wallis rank sum test with $df = 1$ (test/control) and averaged data			
Average leaf length	3.7034	0.0543	Fairly strong
Average panicle length	0.0837	0.7724	Little or none
Average leaf colour	2.5061	0.1134	Little or none
Average number of leaves	2.7666	0.09625	Suggestive
Average number of panicles	3.017	0.0824	Suggestive
Average number of tillers	2.0232	0.1549	Little or none

Table 6. Correlation matrix

	Average leaf length	Average panicle length	Leaf colour	Number of panicles	Number of tillers	Number of leaves
Control plots						
Average leaf length	1	0.51	0.2	–0.13	–0.2	0.13
Average panicle length	0.509	1	0.04	–0.41	–0.44	–0.11
Leaf colour	0.199	0.04	1	0.08	0.21	0.24
Number of panicles	–0.13	–0.41	0.08	1	0.86	0.06
Number of tillers	–0.2	–0.44	0.21	0.86	1	0.19
Number of leaves	0.13	–0.11	0.24	0.06	0.19	1
Treatment plots						
Average leaf length	1	0.62	0.22	0.03	0.05	–0.01
Average panicle length	0.62	1	0.12	–0.15	–0.07	0.09
Leaf colour	0.22	0.12	1	0.07	0.13	0.16
Number of panicles	0.03	–0.15	0.07	1	0.9	–0.16
Number of tillers	0.05	–0.07	0.13	0.9	1	–0.11
Number of leaves	–0.01	0.09	0.16	–0.16	–0.11	1

cake itself would be insignificant given that the weight of neem cake used was a third of the urea and the nitrogen percentage in neem cake is very small (2–5%)[23] compared to urea (46)[24]. Efforts by individual farmers may

have differential impact on yield. However, it is not possible to study this effect under standardized conditions and therefore, further analysis along this line was not pursued.

Our study showed that addition of neem cake was an economical and acceptable way of reducing fertilizer application. However, it also showed higher growth of vegetative than reproductive tissue, although both were higher than the control. Better controlled conditions would allow determination of the impact of such treatments on paddy yield. Also, an additional control where only neem cake is applied, would have allowed us to further clarify its role.

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Antidiabetic activity of *Aloe vera* and histology of organs in streptozotocin-induced diabetic rats

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An attempt was made to study the beneficial effects of *Aloe vera* (L.) Burm. fil. in streptozotocin-induced diabetic rats. In diabetic induced rats fed with *A. vera* (300 mg/kg body wt), the fasting plasma glucose levels were reduced to normal and body weight was found to be increased. In the pancreatic sections of diabetic rats fed with *A. vera*, the islets were comparable to normal rats. In liver, the changes caused after induction of diabetes are granular cytoplasm, dilated sinusoids, shrunken nuclei and inflammation, which was re-

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