

THE EFFECT OF CALCIUM AND NITROGEN ON REDUCING STRAIGHTHEAD AND INCREASING SEED SET RATE OF RICE ON A SILT LOAM SOIL

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Abstract

Four varieties (Cocodrie, PB11, PB13, and PB18) were planted in the greenhouse to test the effect of Ca and N on reducing straighthead on this Silt Loam soil. Cocodrie has been normally used as a straighthead susceptible check in straighthead studies. Straighthead and seed set rate were significantly different among the treatments of Check, Nitrogen and, Calcium-I (164.25g Ca) and Calcium-II (328.50g Ca) for all varieties ($p < 0.0001$). Nitrogen application reduced straighthead symptom by 1-2 scores for the four varieties, and Ca greatly reduced straighthead symptoms by 2-5 scores in this silt loam soil collected from the natural site. Both N and Ca greatly increased the seed set rate for all varieties, but the seed set rate increase by Ca application was greater than that by application of N. In general, the application of additional N can reduce straighthead and increase the seed set rate, while application of Ca greatly reduces straighthead and increase the seed set rate on the Silt Loam soil in the greenhouse conditions.

Introduction

Straighthead disease is a physiological disorder of rice (*Oryza sativa* L.) and is the most damaging non-fungal disease. Even though large efforts have been made to study straighthead disease for improving cultivar resistance since early 1900s in the US, its causal factors are still not exactly known. We conducted this experiment in greenhouse conditions to address the relationship of straighthead with application of Ca and N into a silt loam soil.

Straighthead rating of rice was found to be associated closely with minerals concentration. Xiong et al. (Xiong, Li et al. 1987) found a 10% reduction in rice production when soil As concentration was 25 mg Kg⁻¹. Dunn et al. (Dunn, Batten et al. 2006) reported that high N application rate reduced the incidence of straighthead, same result also reported by Belefant-Miller and Beaty (Belefant-Miller and Beaty 2007). Liu et al. (Chuan-Ping, Chang-An et al. 2010) reported that the mobility of As is reduced significantly with application of high concentration of CaO₂ because of the formation of Ca-As compounds which have the low solubility such as Ca₄(OH)₂(AsO₄)₂·4H₂O and Ca₅(AsO₄)₃(OH) (Bothe and Brown 1999).

Materials and Methods

US cultivar Cocodrie and three breeding lines, PB 11, PB 13, PB 18 were planted in pots in greenhouse. Four treatments were applied, Control (CK), 4.10 g/pot Nitrogen (N), 164.25 g/pot Calcium (Ca-I), 328.50 g/pot Calcium (Ca-II), with 8 replications.

During the growing season, a variation of straighthead symptoms including sterile and deformed grains and panicles were observed among the Ca and N treatments as well as varieties. Straighthead score and seed set rate (%) were analyzed using SAS program version 12.0. 30 days old root system were analyzed by Root Image Processor Win Rhizo 2012b version.



Root Image Processor Win Rhizo 2012b version

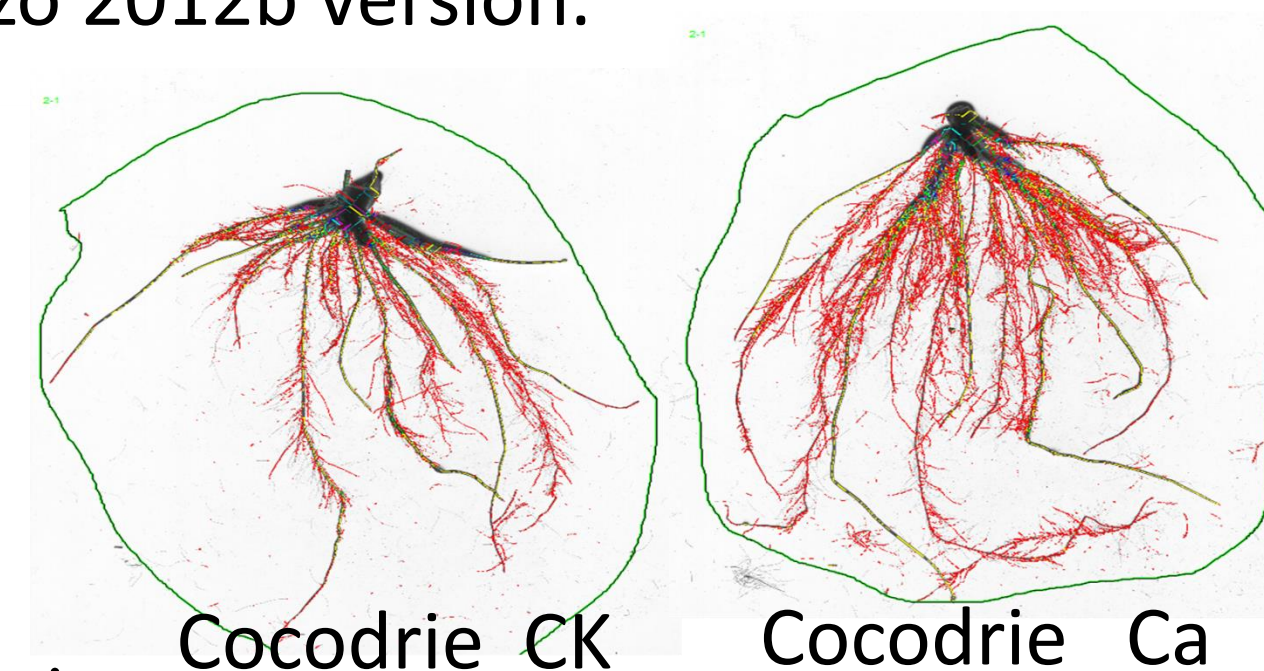


Table 1. Straighthead Rate Score of PB 11, Cocodrie, PB 13 and PB 18 under N and Ca Treatment

Variety	CK	N	Ca-I	Ca-II
Cocodrie	8	7	4	4
PB 11	8	6	7	6
PB13	8	6	5	5
PB18	8	6	3	3

Table 2. Seed Set Rate of PB 11, Cocodrie, PB 13 and PB 18 under N and Ca Treatment

Variety	CK	N	Ca-I	Ca-II
Cocodrie	0.65%	9.47%	13.93%	Missing
PB 11	1.30%	22.06%	Missing	12.77%
PB 13	0.00%	40.42%	48.00%	44.70%
PB 18	16.22%	33.70%	73.16%	77.32%

Table 3. Total root length of PB 11, Cocodrie, PB 13 and PB 18 under N and Ca Treatment analyzed by root image processor.

Variety	CK	N	Ca-I	Ca-II	P Value
	mm				
PB 11	372.71 a	121.34 b	354.48 a	326.37 a	P<0.05
Cocodrie	204.35 c	275.67 bc	521.37 a	475.10 ab	P<0.05
PB 13	265.3 b	267.6 b	612.5 a	574.1 a	P<0.05
PB 18	139.44 c	343.63 b	663.08 a	591.26 a	P<0.05

The means with the same letter are not significantly different in each row.

References

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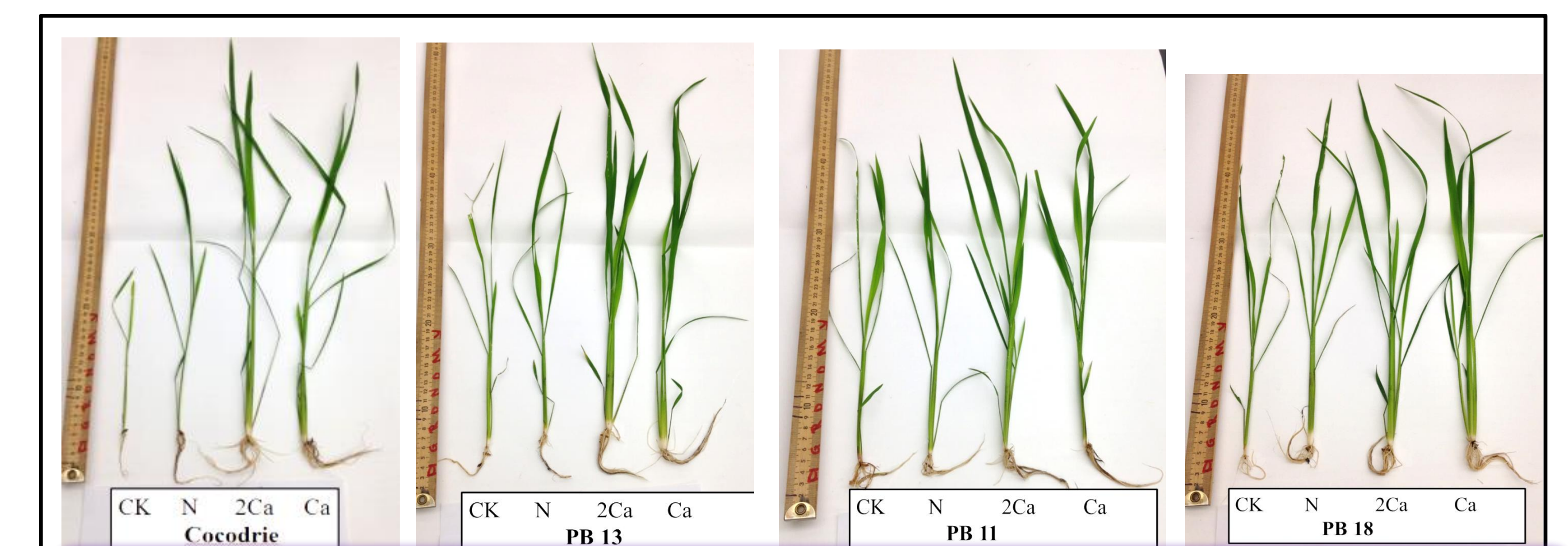


Figure 1. Pictures of 30 Days Samples after Germinate

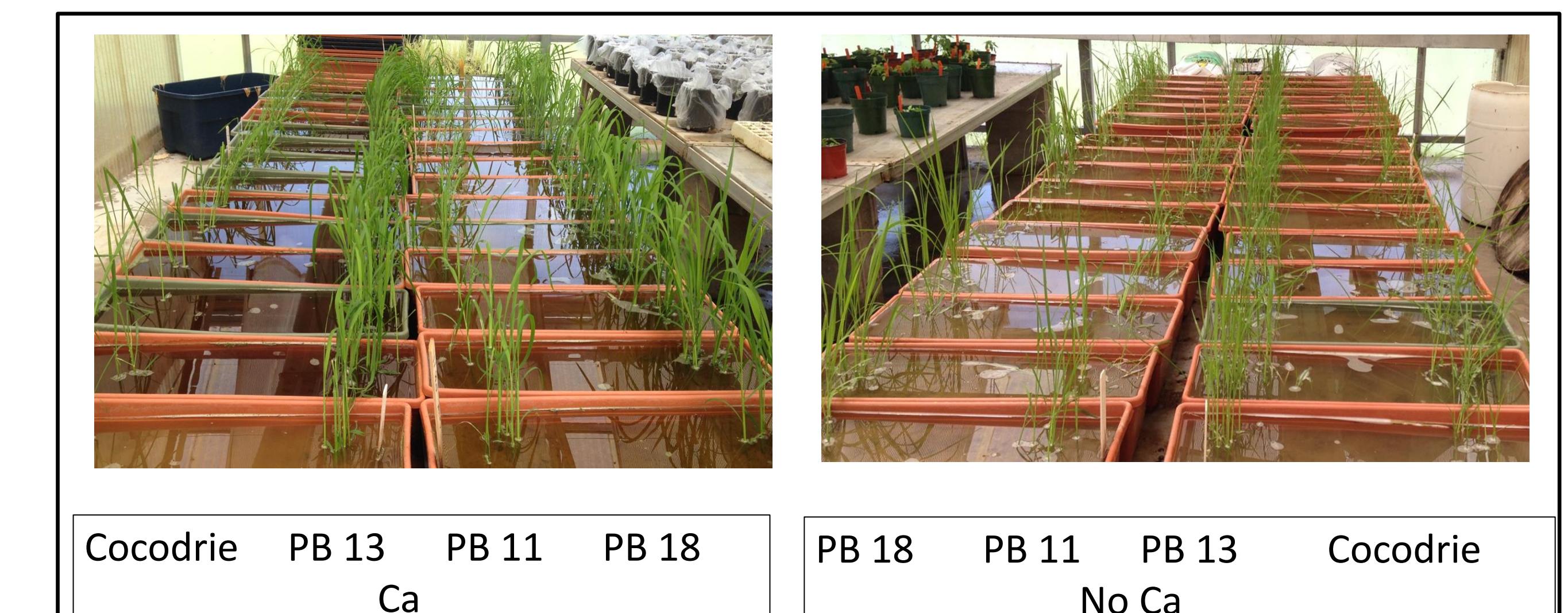


Figure 2. Picture of 24 Days Samples

Results and Discussions

Table 1 shows the Results of Straighthead scores for the four varieties under the four treatments. The straighthead scores had been rated to 8 for US cultivar Cocodrie and three breeding lines, PB 11, PB 13 and PB 18 under the CK treatment. The straighthead scores had been reduced to 6 for the three varieties (PB 11, PB 13 and PB 18), and reduced to 7 for Cocodrie under the N-treatment. While Calcium treatments tended to reduce straighthead further: The Straighthead scores of Cocodrie had been reduced to 4, the scores of PB 13 had been reduced to 5 and the scores of PB 18 had been reduced to 3 under the Ca-treatments. While the score of PB 11 did not show further reduction under the Calcium treatments.

Table 2 showed the results of seed set rate for the four varieties. The seed set rate of Cocodrie increased from 0.65% under CK treatment to 9.47% and 13.93% under the treatments of N and Ca, respectively; The seed set rate of PB11 increased from 1.30% under CK treatment to 22.06% and 12.77% under the treatments of N and Ca-II, respectively; The seed set rate of PB13 had increased from 0% under CK treatment to 40.42%, 48.0%, and 44.7% under the treatments of N, Ca-I and Ca-II, respectively; The seed set rate of PB18 had increase from 16.22% under CK to 33.7%, 73.16%, and 77.32% under the treatments of N, Ca-I, and Ca-II, respectively.

The fig 1 is the pictures of 30 days old seedlings for each variety under four treatments. The seedlings under the treatments of N and Ca-I & II were taller and more health than the seedlings under CK for all four varieties. Table 3 shows the total root length of 30 days old seedlings. Ca increased total root length for the varieties of Cocodrie, PB13 and PB18, and did not show the increasing for Variety PB11. Fig. 2 is the pictures of rice growth in the greenhouse under CK and Ca treatments 24 days after germination. All the seedlings under the Ca treatment were more health than under the treatment of CK.