http://www.pjbs.org

PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 4 (12): 1495-1497, 2001

Seedling Establishment of an Anoxia-tolerant Rice Genotype as Affected by Soil Source and Days after Submergence

Jiban Krishna Biswas, [1]Ho Ando, Rumena Yasmeen,
Sheikh Tanveer Hossain, Muhammad Ali Siddiquee and Abdul Jalil Mridha
Bangladesh Rice Research Institute, Gazipur-1701, Bangladesh
[1]Yamagata University, Tsuruoka-997-8555, Japan

Abstract: Haenuki, quite tolerant to anoxia, was considered for observing its sensitivity in terms of seedling establishment to different soils of Yamagata prefecture and days after soil submergence (DAS). DAS did not affect seedling establishment in the soils except lowland soils of Yamagata University at 21 DAS. However, the genotype performed quite better in upland and lowland soils from Shonai and Shinjo Agricultural Experiment Station and upland soil from Yamagata University. It appears that upland soil turning to lowland condition might improve the seedling establishment.

Key words: Days after submergence, lowland conditions, seedling establishment, soil, rice

Introduction

The genotypes that are anoxia-tolerant could be used for anaerobic seeding to have uniform seedling establishment (Yamauchi *et al.*, 1993). Pre-germinated seeds, in this method, are sown underneath a reasonable soil depth with a few centimeters of water. As a result, the seeds are protected from birds, competition from weeds and washing away caused by rain or seeds drying during the period of no rainfall. More so, better anchorage in this situation can provide more resistance to lodging. But unstable seedling establishment is still observed in this method (Yamauchi and Biswas, 1996; Yamauchi *et al.*, 2000). Soil type and depth (Munemura and Kunitake, 1964), speed of redox potential decrease (Seki *et al.*, 1986), incorporated organic matter (Otsuka *et al.*, 1988), and anaerobic decomposition product (Takijima, 1963) etc. might affect the seedling establishment.

Based on the anaerobic seeding concept, considerable work has been done in the tropics (Yamauchi *et al.*, 1995, Tun Winn *et al.*, 1997, Chau and Yamauchi, 1994; Yamauchi *et al.*, 2000). Main theme of this concept is based more on anoxia-tolerant genotype less on cultural management. But a true type anoxia-tolerant genotype with wide adaptability is yet to be developed. An anoxia tolerant genotype with wide adaptability to different soils is needed to make the technology appropriate. Haenuki, a popular genotype in Shonai area of Yamagata prefecture, Northeast Japan is found quite better in terms of seedling establishment. Despite its tolerance to low oxygen environment the genotype might not adjust to varying conditions of different soils. It is important to verify the performance in different soils with respect to different days after soil submergence (DAS) so that the genotype and few relevant cultural practice could be recommended for anaerobic seeding till true type anoxia-tolerant genotype come into existence through an appropriate breeding program. That is why this study was considered to observe the seedling establishment of anoxia-tolerant Haenuki as affected by different soils from Yamagata prefecture and days after soil submergence.

Materials and Methods

The experiment was conducted at phytotron, Yamagata University, Japan in 2000. Haenuki, an anoxia-tolerant genotype was grown in the soils from Shonai Agricultural Experiment Station (Shonai), Yamagata University farm (University) and Shinjo Agricultural Experiment Station (Volcanic) from Yamagata prefecture, North East Japan. The soils were collected from both lowland and upland sources. Shonai and University soils belong to Entisols and Volcanic soils to Andisols type. Shonai lowland soil had the lowest organic carbon (1.7%). Volcanic upland and lowland soil had 9.8 and 7.6% organic carbon, respectively. The pH levels of these soils ranged from 5.4 to 6.7. Plastic pots (90 X 85-mm) were used as experimental unit. It was a 3-replicated factorial complete randomized designed experiment. The factors were, soils (Shonai, University and Volcanic) soil source (upland and lowland) and days after submergence (DAS) (0, 7, 14 and 21-DAS). Each pot contained 200 gm of soils (passed through 2mm sieve) well mixed with 0.25% rice straw. First batch of pots was submerged at 21 days before seeding, so as the second batch at 14 days, third batch at 7 days and fourth batch at 0 days to coincide the seeding date. 0-day seeding means the pot was submerged a few hours before seeding. Sprouted seeds (sprouted at 30 °C) were seeded with the help of forceps at 10mm seeding depth. Water above the soil surface was maintained 25mm. Addition of water was done carefully, so that no water could drain out from the pot. The seedlings were allowed to grow for 10 days in a phytotron at 30 °C day and night temperature.

Seedling establishment (%), coleoptile (1^{st} and 2^{nd} experiment), 1^{st} leaf length, plant height and root length were observed. Redox potential (Eh) was measured every day up to 3^{rd} day of submergence, then every 2 days up to 21 DAS by a portable TOA, ORP meter (model RM-12P). pH was measured by pocket pH meter (model pH boy KS501) weekly. Extra pots were arranged and readings were taken by inserting the probe into the seeding depth. All these observations were taken from three replicated trials.

Results and Discussion

Seedling establishment was not affected by DAS in soils except University lowland soil at 21 DAS. The lowland soil significantly reduced seedling establishment at 7 and 21 DAS in University soil and at 14 DAS in Shonai soil. The upland soils from any place did not affect the growth of first leaf length, plant height and root length across DAS. In contrast, the lowland soil from Shonai and University affected the growth of first leaf length and plant height significantly. The Shonai lowland soil exhibited the lowest leaf length at 0

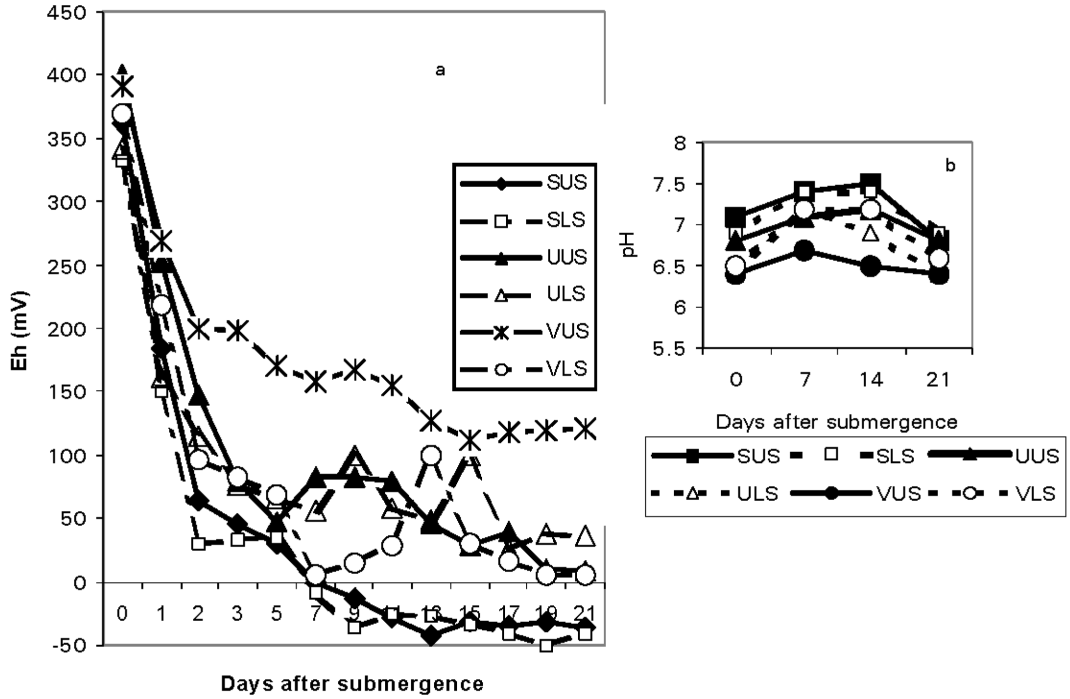

Fig. 1: Kinetics of Eh (a) and pH (b) of different soils under submerged conditions

Table 1: Seedling attributes of Haenuki as affected by different soils and days after submergence

DAS	Seedling establishment[a] (%)		Diff	1st leaf length (mm)		Plant height (mm)		Root length (mm)	
	U	L		U	L	U	L	U	L
Shonai									
0	66.7a	66.7a	ns	14.3	11.6	109.1	87.5	45.4	38.1
7	76.7a	70.0a	ns	15.5	16.1	127.9	102.7	51.9	46.0
14	86.7a	63.3a	*	16.6	13.1	138.0	121.2	56.2	48.7
21	63.3a	83.3a	ns	11.6	18.9	1032.7	144.9	47.9	58.9
University									
0	80.0a	60.0ab	ns	17.5	11.8	142.0	77.6	62.4	25.7
7	93.3a	63.3ab	**	19.4	11.7	191.7	111.1	66.2	41.4
14	80.0a	70.0a	ns	16.1	12.6	154.2	130.2	81.3	49.4
21	86.7a	33.3b	**	17.5	6.0	175.6	50.1	89.4	16.8
Volcanic									
0	66.7a	73.3a	ns	13.7	14.3	112.1	126.6	53.0	42.8
7	76.7a	80.0a	ns	16.0	17.0	117.0	158.7	51.1	59.1
14	73.3a	66.7a	ns	15.2	13.2	125.7	131.9	62.1	46.9
21	73.3a	53.3a	ns	16.2	11.2	144.6	112.1	69.6	38.8
$LSD_{0.05}$				6.0		60.5		31.3	

[a] arcsine transformation ** = significant at 1% level by LSD, * = significant at 5% by LSD, ns = not significant by LSD at 5% level.
In a column, means followed by a common letters under each soil category is not significantly different at 5% level by DMRT (for seedling establishment). U = upland soil source, L = lowland soil source

DAS and the highest at 21 DAS. In case of the University lowland soil, the lowest leaf length and plant height was observed at 21 DAS (Table 1). Within 2 DAS, Eh exhibited a sharp fall with distinct variation among some of the soil types (Fig. 1a). The volcanic upland soil had the similar pattern but maintained a distinct higher level than the other soils. The lowest Eh values were observed in Shonai upland and lowland soils. The other soils were appeared to be better in terms of oxidation potential (Fig. 1a). Haenuki is an anoxia tolerant genotype (Biswas *et al.*, 2001b). The genotype showed some tolerance to volatile fatty acids also (Biswas *et al.*, 2001a). pH of the soils were in the range of 6-7 (Fig. 1b). No apparent abnormality was observed in the soils under consideration. So the significant reduction in seedling establishment in University lowland soils at 21 DAS can not be attributed to accumulated volatile fatty acids. More so, the soil was low in organic matter (Biswas *et al.*, 2001b) and having better oxidation potential could not be blamed for the accumulation of hydrogen sulfide. So the seedling establishment affected by the university lowland soil at 21 DAS should be attributed to the factors other than volatile fatty acids and hydrogen sulfide. From above results and discussions, it could be concluded that despite the tolerance to volatile fatty acids, the seedling establishment of an anoxia-tolerant genotype vary with the soil type and sources. The cause of this variation needs further study. It appears that upland soil turning to lowland condition might have better seedling establishment. In other words crop rotation like lowland crop followed by upland crop is expected to improve the seedling establishment under direct seeded lowland rice culture.

Acknowledgment

The senior author is indebted to the Japanese Society for the Promotion of Science (JSPS) for providing him the post-doctoral fellowship to perform this work.

References

Biswas, J. K., H. Ando and K. Kakuda, 2001a. Effect of volatile fatty acids on seedling growth of anoxia-tolerant rice (*Oryza sativa* L.) genotypes. Soil Sci. Pl. Nut., 47: 87-100.

Biswas, J. K., H. Ando and K. Kakuda, 2001b. Effect of calcium peroxide coating, soil source and genotype on the rice (*Oryza sativa* L.) seedling establishment in hypoxia. Soil Sci. Pl. Nut., 47 (In press).

Chau, N.M. and M. Yamauchi, 1994. Performance of anaerobically direct seeded rice plants in the Mekong Delta, Vietnam. Int. Rice Res. Notes., 19: 6-7.

Munemura, K. and M. Kunitake, 1964. J. On the influence of buried seed on the emergence and the stand of rice plant in the direct sowing in submerged fields. J. Nigata Agril. Exp. Stn. 14: 10-14

Otsuka, K., M. Tamura and K. Suzuki, 1988. Study on rice direct seeding in flooded soil after wheat cultivation in northern limit of rice-wheat double cropping region. Jpn J. Crop Sci., 57: (Extra issue 1), 283-284

Seki, M. Y. Kato, H. Iwata, H. Kato, T. Shiota, Y. Hasegawa, and T. Kengyo, 1986. Effect of soil conditions on emergence and establishment of rice plant in direct sowing in flooded paddy field. Res. Bull. Aichi Agril. Res. Ctr., 18: 34-41

Takijima, Y., 1963. Studies on behaviour of the growth inhibiting substances in paddy soils with special reference to the occurrence of root damage in the peaty paddy field. Bull. National Agril. Sci. Series. B 13: 117-252

Tun Winn, M. Yamauchi, Than Soe, Sein Ni, San Thien, and A.G. Garcia, 1997: Rice (*Oryza sativa* L.) cultivars suitable for direct seeding in Myanmar. Jpn. J. Topic. Agric., 41: 66-73

Yamauchi, M., Aguilar, A.M., Vaughan and D.V. Seshu, 1993. Rice (*Oryza sativa* L.) germplasm suitable for direct sowing under flooding soil surface, Euphytica., 67: 177-184.

Yamauchi, M., 1995. Anaerobic direct seeding in the tropics. JIRCAS J., 2: 65-78

Yamauchi, M., P.V. Choung and N.M. Chau, 1995. Echophysiology of rice crop establishment in wet direct seeding in Vietnam with emphasis on anaerobic seeding growth. Vietnam and IRRI: a partnership in rice research. IRRI, P.O. Box No. 933, Manila, p: 89-95.

Yamauchi, M. and J. K. Biswas, 1996. Direct seeding in Asia and the process of seedling establishment in anaerobic soil. In Proc. Int. Symp. Maxm. Sustainable rice yield through improved soil and environment. Thailand, p: 661-671.

Yamauchi, M., R.C. Aragones, S.C. Pablo. S.C. Pompe, C.A. Asis. Jr, and R.T. Cruze, 2000. Seedling establishment and grain yield of tropical rice in puddled soil. Agron J., 92: 275-282.