The Pharma Innovation Journal 2022; 11(1): 231-233

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(1): 231-233

www.thepharmajournal.com
Received: 07-11-2021
Accepted: 09-12-2021

Anubhuti Singh
Research Scholar, Department of Crop Physiology, Acharya Narendra Dev University of Agriculture & Technology, Narendra Nagar, Kumarganj, Ayodhya, Uttar Pradesh, India

AK Singh
H.O.D., Department of Crop Physiology, Acharya Narendra Dev University of Agriculture & Technology, Narendra Nagar, Kumarganj, Ayodhya, Uttar Pradesh, India

Anil Kumar Singh
Junior Breeder, SASRD, Medziphema, Nagaland Agriculture University, Nagaland, India

Ankit Singh
Research Scholar, Department of Crop Physiology, Acharya Narendra Dev University of Agriculture & Technology, Narendra Nagar, Kumarganj, Ayodhya, Uttar Pradesh, India

Corresponding Author:
Anubhuti Singh
Research Scholar, Department of Crop Physiology, Acharya Narendra Dev University of Agriculture & Technology, Narendra Nagar, Kumarganj, Ayodhya, Uttar Pradesh, India

Morphological & physiological basis of submergence tolerance in rice (*Oryza sativa* L.)

Anubhuti Singh, AK Singh, Anil Kumar Singh and Ankit Singh

Abstract
Rice (*Oryza sativa* L,) crop is much damaged by several days of total submergence. The effect can be a serious problem for rice farmers in the rainfed lowlands of Asia, and runs contrary to a widespread belief amongst plant biologists that rice is highly tolerant of submergence. The present study deals with evaluation of promising rice genotypes for submergence on the basis of plant height, dry matter yield and biochemical parameters; carbohydrate & chlorophyll. Submergence stress for duration of 14 days duration given to rice genotypes and the difference in growth attributes i.e. plant height, dry weight & biochemical traits like carbohydrate etc. were quite evident between the susceptible and tolerant genotypes.

Keywords: rice, submergence, carbohydrate, dry matter

Introduction
Among the 42 biotic and abiotic stresses affecting rice production, submergence is considered the third most important constraint for higher productivity in eastern India (Setter *et al*., 1998) [6]. Excessive flooding poses risks to human life and is a major contributor to the poverty and vulnerability of marginalized communities. Complete submergence due to flooding is most prevalent in the low-lying rice growing areas of the world. Crop loss due to excess water and water logging is also considerably high in such regions. A total of 22 million hectares of rice-2 growing area is adversely affected by flash flooding, half of which is in eastern India.
Flooding afflicts some 20 million ha in Asia each year and estimates indicate that submergence stress causes annual losses of $650 million to $1 billion in Asia. In India, about 16.1 million ha rainfed lowland rice are grown each year, of which 4.4 million ha are highly submergence-prone (intermediate rainfed lowlands; Haefele and Hijmans, 2007). In addition, submergence might also occur in shallow rainfed lowlands and irrigated lowlands. Damage to plants caused by submergence could have several causes linked to floodwater conditions, particularly the interference in normal gas exchange and light interception. The adverse effects of flooding on rice vary by genotype, and of particular importance are the carbohydrate status of the plant before and after submergence, the developmental stage at which flooding occurs, duration and depth, and the level of turbidity and turbulence of floodwater (Setter *et al.*, 1995; Jackson and Ram, 2003; Das *et al.*, 2005) [7, 5]. Recent research identified the *sub*-1 gene as the main gene controlling submergence tolerance. The cloning of the gene underlying tolerance (Xu *et al.* 2006) [9] has enabled the development of precise markers targeted transfer of this gene into widely accepted "mega varieties" through a marker-assisted backcrossing (MABC) approach. The effects of *sub*-1 on plant survival under submergence are dramatic, and the gene has no yield penalty under non-submerged conditions. Results at IRRI showed that *sub*-1 varieties give an average of 1–3.8 tonnes higher yield than non-*sub*-1 types under 12–17 days of complete submergence (Singh *et al.*, 2009) [8]. Similar results were obtained in India at farmer's fields in several states like Uttar Pradesh, Bihar, West Bengal and Orissa. In some cases, *sub*-1 varieties gave a near normal yield whereas intolerant varieties were completely destroyed (Singh *et al.*, 2009) [8]. The advantages of *sub*-1 varieties have been verified in three seasons of multilocation tests in India and Bangladesh through the testing of Swarna *sub*-1. In India Swarna *sub*-1 has already been released by the states of Uttar Pradesh and Orissa. Other two varieties IR 64 *sub*-1 and Samba Mahsuri *sub*-1 have also released. They will be available to the farmers of Uttar Pradesh. In Uttar Pradesh almost 1 m ha area is covered by Swarna. This can be easily replaced by its improved version, Swarna *sub*-1, which offers additional advantage of tolerance to flooding.

Swarna *sub*-1 can be also cultivated in highly flood-prone areas where Swarna is not cultivated because of its sensitivity to flooding. This approach will enhance the productivity of rice by 1 to 2 tons per ha. Keeping these view in mind state government of UP has already launched a programme on large scale seed production and up scaling of Swarna *Sub* 1.
Recent studies on the plant responses to submergence stress with conventional plant physiological and genetic as well as through biotechnological approaches have began to bear fruits.

Material and Method

The present investigation was conducted in submergence tank (Size: 23x20 m) of Department of Crop Physiology, A.N.D. University of Agriculture & Technology, Kumarganj, Ayodhya (U.P.) during Kharif season of 2019 & 2020. The experiment was conducted with 18 rice genotypes (tolerant & susceptible).

Plant height (cm): Plant height was recorded from base of the plant to the top most leaf of the plant before submergence & after desubmergence. In each plot, five plants were selected and mean height was calculated and expressed in cm.

Dry weight per plant (g)

Five plants were collected randomly form each treatment at various stage of crop growth. After drying them in sum, finally dried in over at 70±1 °c for 24 hrs and dry weight of plant was taken with the help of electronic balance

Determination of carbohydrate content (mg g -1 dry wt.)

Carbohydrate content of seeds was determined before and after stress condition according to the method described by Yemm and Willis (1954) [10].

Determination of chlorophyll content (SPAD value)

Chlorophyll content of leaf was directly measured from intact leaves microprocessor based plant efficiency analyzer model: X55/M-PEA.

Result and Discussion

A major submergence tolerance QTL- submergence-1 (*SUB1*), was cloned and has been incorporate into most popular rice varieties Swarna, Sambha Mahsuri, BR-11 through marker assisted back crossing to enhance their submergence tolerance (Xu *et al.* 2006) [9]. Swarna with *SUB1* can survive in complete submergence for 2 weeks because they do not elongate during submergence, conserving energy for survival and recovery after de-submergence. It resulted chlorophyll degradation under submerged condition. *Sub1* rice varieties showed more than 80% survival when 60 days old plants were subjected for 14 days complete submergence in clear water and stagnant condition.
Reduction in carbohydrate content during submergence is one of the essential biochemical events which affect the survival and growth during submergence. Submergence in the existing study resulted in reduced chlorophyll content in both tolerant and susceptible rice varieties grown in the tank but the percent increase is more in tolerant varieties (Table.1). The loss of chlorophyll could be due to high ethylene content trapped invite the plant during flooding which induced chlorosis of leaves. The adverse effect was more pronounced in total chlorophyll content.

Table 1: Effect of submergence on plant height, dry weight, carbohydrate content and chlorophyll

Variety	PH Before	PH After	Dry wt.	Carbohydrate Before	Carbohydrate After	Chl. Before	Chl. after
Swarna sub-1	84.70	91.12	31.34	155.00	187.67	7.76	11.58
IR 64 sub-1	77.67	89.47	30.67	153.87	188.67	8.53	12.12
Sarju 52	63.34	78.51	18.74	145.00	157.67	3.76	6.84
Sahbhagi	78.67	87.43	25.75	166.33	187.67	6.53	10.60
Sourabh	70.75	77.86	19.45	139.00	160.33	7.07	10.96
Sukha dhan-6	65.67	73.45	18.30	143.67	169.33	5.11	8.81
HUR 1304	64.67	74.98	24.24	146.00	173.33	7.23	11.14
Bio seed bheem	78.00	87.34	26.97	162.00	199.00	9.08	12.35
38 B	66.33	75.85	20.45	155.33	182.67	8.62	11.67
NDR-9501	76.67	90.24	21.54	162.33	190.67	7.86	9.59
IR 64	64.67	75.95	26.69	149.00	160.33	8.43	11.32
DRR-44	72.33	80.23	31.76	162.33	180.33	7.07	9.91
IPR-763	70.54	79.48	35.35	154.00	184.33	6.37	8.37
DRR-42	73.58	83.78	31.48	161.00	182.67	8.66	10.48
Malbhog	60.63	70.39	29.45	165.67	184.33	6.62	9.86
Bina-11	81.43	88.50	28.91	160.00	183.00	8.70	12.64
GS-I	68.25	77.17	31.43	164.00	186.33	6.58	9.11
Sukha dhan-5	66.65	76.52	19.44	146.76	172.67	6.34	8.32
S.Em±	1.22	1.45	7.75	5.95	6.34	3.75	1.25
C.D. at 5%	5.8	8.2	8.43	9.10	9.89	4.63	1.87

Acknowledgment

The author is really grateful to Dr. Ashok Kr. Singh (H.O.D., Department of Crop Physiology), Acharya Narendra Dev University of Agriculture & Technology, Narendra Nagar, Faizabad (U.P.) and Dr. Anil Kumar Singh, Junior breeder, SASRD, Medziphema, Nagaland Agriculture University, Nagaland, India for encouraging to do this research work.

Conclusion

Submergence is the major abiotic stress in flood prone ecosystem because it can substantially reduces crop stand and leading to severe yield loss. However, with tolerant varieties and management option, it is possible to minimize yield losses caused by submergence. Nutrient management during pre and post flood to minimize or avoid submergence or all

found to be beneficial (Ella and Ismail, 2006). After 14 days of complete submergence reduction in plant height, dry weight, carbohydrate and chlorophyll content was observed more in susceptible genotypes than the tolerant ones like Swarna Sub-1, IR-64 *Sub-1*.

Reference

1. Das DK, Maiti, Debtanu, Pathak H. Site specific nutrient management in rice in Eastern India using a modeling approach. Nutrcycl Agroecosyst. 2009;83:85-94.
2. Das KK, Sarkar RK, Ismail AM. Along with ability and nonstructural carbohydrate levels in relation to submergence tolerance in rice. Plant Sci. 2005;168:131-136.
3. Ella ES, Ismail AM. Seedling nutrient status before submergence affects survival after submergence in rice. Crop Sci. 2006;46:1673-1681.
4. Haefele SM, Hijmans RJ. Soil quality in rice-based rainfed lowlands of Asia: Characterization and distribution. In: Agarwal, P.K., Ladha, J.K.; Singh, R.K.; Devakumar, D.; Hardy, B. (ads.). Science technology and trade for peace and prosperity proceedings of the 26th International Rice Research comference, 2006, 9-12,
5. Jackson MB, Ram PC. Physiological and molecular basis of susceptibility and tolerance of rice plants to complete submergence. Ann. Bot. 2003;91:227-241.
6. Setter TL, Ramakrishanayya G, Ram PC, Singh BB. Mallik S, Roy JK, *et al*. Physiology of rice: prospects for increasing tolerance to submergence. In: Proceedings of the International symposium on Rainfed Rice for sustainable food security. Central Rice Research Institute, Cuttack, India, 1998, 349-369.
7. Setter TL, Tuong TP, Ingram KT. Environmental characterization requirements for strategic research in rice grown under adverse condition of drought flooding of salinity. In rainfed lowland rice: Agricultural Research for high-risk environments (Ed.K.T. Ingram). International Rice Research Institute, Manila. Philippines, 1995, 3-18.
8. Singh S, Mackill DJ, Ismail AM. Responses of Sub1 rice introgression lines to submergence in the field: Yield and grain quality. Field Crops Res. 2009;113:12-23.
9. Xu K, Xia X, Fukao T, Canlas P, Maghirangrodriguez R, Heuer SIsmail AM, *et al*. Sub1 A is an ethylene response factor like gene that confers submergence tolerance to rice. Nature. 2006;442:705-708.
10. Yemm EW, Willis AJ. The estimation of carbohydrates in plant extracts by anthrone. Biochemistry Journal. 1954;57:508-514.