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Research Note

Revealing genetic variation in local upland rice germplasm collection of Odisha

Swapan K. Tripathy*, Sasmita Dash, Arjun K. Prusti, Digbijaya Swain, Asit P. Dash, Dayanidhi Mishra and Kartik Ch. Pradhan
Department of Agricultural Biotechnology, College of Agriculture, OUAT, Bhubaneswar-751003 (INDIA)
E.mail: **swapankumartripathy@gmail.com**
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Abstract
Wide array of genetic variation was observed for agro-economic traits among a set of 96 land races. Bhogi revealed short plant stature and it took just 78 days to mature. Khursudi and Asumakunda revealed high yield potential, while Salampikit, Kalakeri, Browngora, CR Dhan 40 and N22 were identified to have high degree of drought tolerance. Considering both leaf area and chlorophyll index; Kinari and Setka-1 had significantly higher value indicating efficient photosynthesis under water stress. Salampikit and N 22 were identified to be nearly free from BLB (0.8-1.0 score) whereas, almost all other genotypes showed moderate to high susceptibility. High tillering capacity (Harisankar, CR Dhan 143-2-2, Kinari, Hiran, Badi and Kutiarasi), longer panicle (Kantadumer, Rasakadali , Damaraphuli, Padarabank, Somo , Asumakunda and Anjali), heavy panicle (Sarian, Dhobasaria, and Anjali), and more number of grains per panicle (Padarabank, Pustak and Pankopoat) were recorded in few landraces. Dhanisaria, Kanding and Dhubasaria recorded significantly higher percentage of grain fertility. Chinger-2 had very bold grains and popular upland varieties e.g., Khandagiri, Vanaprabha and Mandakini revealed higher grain and kernel length.

Key words
Genetic variation, morpho-economic traits, drought tolerance, landraces.

With the alarming shrinking of natural resources (land and water) and adverse affects of climate change on agriculture, it becomes extremely difficult task to produce food for seven billion people of the world. Recurrent erratic rainfall and high temperature have drastically reduced the productivity. To meet the food demands of 2050, at least 70% more food will have to be produced at an annual rate of increase of 44 million tons. In this context, India needs to produce 120 mt by 2030 to feed its one and a half billion plus population (Adhya, 2011). Therefore, rice breeders have to reorient the breeding strategies and develop high yielding short duration rice varieties to combat the recurrent occurrence of drought in coming years. The cultivation of drought tolerant rice varieties can reduce the demand for irrigation water by 50–70%. Genetic makeup of the varieties and the relevant production technologies are the major crucial factors to augment productivity in rice. The existing genotypes particularly the short duration rice varieties (Khandagiri, Parijat, Udaygiri, Naveen and Nilagiri) so far developed are rarely adaptable to pre-monsoon drought situation. However, the available land races still serves as huge reservoir of valuable genes for biotic and abiotic stresses which may be harnessed in upland breeding programme in rice. The success rate will improve with the increase of genetic variability. Therefore, the present pursuit was attempted to assess extent of genetic variability and sort out genetically desirable genotypes from a set of available short duration land races and improved upland varieties of rice based on important agro-economic traits.

A set of 96 short duration local land races collected from different corners of Odisha along with already identified drought tolerant donors from gene bank at National Rice Research Institute (NRRI), Cuttack and a few high yielding rice varieties were assessed for genetic variation in terms of 23 agro-economic traits including seed yield and ancillary traits; drought tolerance parameters (leaf rolling, drought recovery, leaf drying), physiological traits (leaf area and chlorophyll index), tolerance to nutritional stress (zinc tolerance) and bacterial leaf blight.

The field experiment comprising above 96 germplasm lines were laid out in augmented design with four blocks and 23 varieties plus four promising standard check varieties (N22, Vandana, Khandagiri and Mandakini) in each block under upland situation. Each genotype was sown in three rows of 3m length with a spacing of 20cm between rows and 10cm between plants. Normal plant protection measures were taken to check development of diseases and population of insect pests. Other management practices were followed as per recommended package of practices. Similar field experiment comprising the same set of test genotypes was necessitated for proper assessment of drought tolerance (0-9 scale) during Summer season.

Observations were recorded on five randomly selected plants from middle row of each plot for all biometric traits except days to maturity and grain yield which were recorded on plot basis, and 100-

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grain weight, which was taken from random sample of seeds of each plot. The data on agro-economic traits were subjected to analysis of variance (Panse and Sukhatme, 1985) and analysis of genetic variability (Singh and Choudhury, 1985).

Odisha is the genetic paradise of rice (Ramiah, 1953) and there is a dare need to access the wealth of genes which exist now in local genetic backgrounds. Rice can effectively survive and grow in a wide range of agro-climatic conditions (Kim *et al.*, 2012). Varieties with maturity duration within 90-100 days are in vogue preferred for suitability in upland condition. In the present investigation, days to 50% flowering and days to maturity (physiological maturity) ranged from 48.9 to 106.9 days and 78.3 to 135.3 days respectively (Table 1). Among the local land races, Setka-1, Danisaria, Podasankara, Dangaradhan, Bhogi, Dasaharadhan, Paradhan, Nandigiri, Dhalashree-B, Saria-B and Zhu 11-26 recorded significantly early flowering at around 60days and attained maturity even within 90 days. Among these, Bhogi took just 78days to mature and it can be a valuable material for breeding of rice varieties for upland situation. African rice are highly weed-competitive and drought-tolerant. Such characteristics may be harnessed through interspecific crosses of African rice with Asian rice for increase of rice productivity in upland situation (Craufurd *et al.*, 2000). Laxuman *et al.* (2011) studied backcross inbred line population developed from an inter-specific cross between *Oryza sativa* cv. Indica and NERICA-L-20 (New Rice for Africa) and assessed genetic variability for yield and its component traits. They observed that phenotypic coefficients of variance and genotypic coefficients of variance for most of the traits were either high or moderate except for productivity traits like days to heading, days to 50% flowering, panicle length and plant height at maturity.

Farmers used to cultivate early rice varieties in the upland situation which are sown at onset of monsoon and harvested latest before 15th October. Cultivation of these varieties entirely depends upon seasonal rainfall during Kharif. Therefore, genotypes chosen for upland situation need to have drought tolerance to combat frequent drought spell during kharif season. In recent years, vagaries of monsoon warrant selection of rice varieties for suitability of cultivation with minimum water availability. Therefore, in the present pursuit, an attempt was taken to screen the available local land races and popular upland rice varieties for rigorous screening for drought tolerance. Drought tolerance was assessed based on extent of leaf rolling, drought recovery (% of plants recovered due to irrigation just after a period of drought stress) and leaf drying which were scored on 0-9 scale as recommended by IRRI. Saria-B and CR Dhan 40 were identified to have high degree of drought tolerance compared to the best check variety Vandana based on leaf rolling score (LRS). Whereas, Biramani, Dhanisaria, Padarabank, Saria B, CR Dhan 40, Kalakeri and Browngora were found highly tolerant to drought stress based on drought recovery score (DRS) and Kharkoili, Chinger-1, Dengabari, Khursudi, Kinari, Dular, Kusuma, Damaraphuli,Chinger-2, Saria-B, Kalakeri, Browngora and Salampikit sustained drought tolerance based on leaf drying score (LDS)(Table 1). Considering above three parameters for assessment of drought tolerance, Saria-B, Kalakeri, Browngora, CR Dhan 40 and N22 were worth to have high degree of drought tolerance. Varieties screened were noted to be different depending upon the parameter used for selection of genotypes for drought tolerance. The differential response of rice varieties might be due to different mechanisms they harbour to combat the limited water stress condition. For instance, rice varieties which scored tolerant based on leaf rolling score, might have a strong mechanism to restrict transpiration loss of water plausibly by equipped functioning of guard cells. Similarly, varieties responded well for drought recovery might have efficient root characteristics while, those scored tolerant for leaf drying might have efficient mechanism for stability for synthesis of chlorophyll in the green foliage.

Physiological parameters pertaining to drought stress e.g., leaf area and chlorophyll index (measured by chlorophyll meter) were assessed in present set of materials. Very high leaf area ($\geq$60cm^2) was recorded in case of Sanarasi, followed by Pugakal, Karanga, Ambajhuka, Haladigundi and Padarabank while, chlorophyll index was shown to be significantly high in case of Kantadumer, Bastul, Litipiti, Dal, Jhulipuagi and Setka-1. It is worth to note that the genotypes recorded high in leaf area did not have high chlorophyll index. Considering both leaf area and chlorophyll index, Kinari and Setka-1 had significantly higher value which is required for efficient synthesis of photosynthates under water stress.

Among the nutritional stresses, zinc deficiency many often become a serious problem. Zinc deficiency was scored on 0-9 scale at early seedling stage (within 10-12 days). Vandana-the best check variety was tolerant to zinc stress but susceptible to BLB. Among the test genotypes, Kutiarasi, Kusuma, Pora, Karanga, Kenduphula, Ambajhuka, Kunor, Padarabank Jhitipiti, Raas, Sanarasi and Dasaharadhan had shown significantly high degree of tolerance to zinc deficiency even compared to Vandana. Among the diseases, bacterial leaf blight (BLB) is a serious problem in upland rice cultivation. Most of the test genotypes succumb to BLB infestation. Among the check varieties, N22 scored tolerant to BLB while Vandana was highly sensitive. In the present investigation, Salampikit and N 22 were identified to be nearly free from BLB (0.8-1.0 score) whereas, almost all other genotypes showed moderate to high susceptibility.

Varieties with plant height around 100-110cm is usually suitable for drought stress upland condition. Three popular check varieties included under study e.g., N22, Vandana and Mandakini had moderate plant height (around 115 cm.) whereas, Khandagiri, was significantly shorter in height (86.2 cm.) as compared to the best standard check variety Vandana. Among the test genotypes, Bastul, Setka-2, Dhubasaria, Malkadna, Jhulipuagi and Bhogi had shown plant height around 90-95 cm. In contrast, Ninibudhi, Badi, Harishankar, Pandeydhan, Khursudi, Kinari, Jhirkabanji, Merlo, Barei, Pora, Ambajhuka, Padarabank, Kanding, Asumakunda and Hiran exhibited tall stature (>130 cm.) which may not be suitable for upland situation. Rest of the test genotypes had recorded moderate plant height.

Harisankar, Kutiarasi, Badi, Hiran, Kinari and CR Dhan 143-2-2 revealed significantly high tillering ability (around $500/m^2$) among the test entries as compared to Vandana. Besides, Harishankar, Kahnei, Merlo, Jhulipuagi and Barei had shown high tillering ability. Gomathinayagam *et al.* (1990) studied the genetic variability in 40 upland rice genotypes. The coefficient of variation was high for number of effective tillers per plant and grain yield per plant.

Panicle features including length, weight, compactness and grains per panicle seem to be important factors for high productivity. Kantadumer, Rasakadali , Damaraphuli, Padarabank, Somo , Asumakunda and Anjali excelled in panicle length (≥26.5 cm.) among the test genotypes under study. Sarian, Dhobasaria, Anjali, Padarabank, Asumakunda, Pustak and CR Dhan 40 had shown significantly higher panicle weight (≥ 3.0 g). In this context, some of the land races e.g., Pankapota, Padarabank and Pustak had significantly very high number of grains per panicle.

Plant types with early heading, low tillering and heavy panicle are reported to be suitable for upland condition (Fukuta *et al.,* 2012). Flowering to grain filling seems to be a critical stage for upland rice for recovery of high grain yield under drought stress. Therefore, genotypes with heavy panicle with high grain fertility status under drought stress are an important criterion for screening of genotypes for drought tolerance. Among the test genotypes, Khursudi, Dular, N22, Asumakunda, Pustak, Kandasuri, kanding, Dhanisaria, Nandigiri, Dhubasaria, Dhalashree-B and CR 143-2-2 had recorded significantly high grain fertility percentage even more than 90% and each of them excelled over the best standard check variety Vandana. While, Sarian, Dhobasaria, and Anjali were shown to have heavy panicle. Grain dimension determines the test weight of a genotype. A few of the test genotypes e.g., Kantadumer, Dhubasaria, Saria and Kandasuri in the present pursuit had bold grains and therefore, recorded significantly high 1000-grain weight(28-29 g) among the test genotypes. Sharma *et al.* (1990) recorded a range of 8.4-25.5 g for 1000-grain weight in a set of 43 traditional upland rice.

Grain yield of a genotype is an artifact which resulted from a combination of yield contributing ancillary traits and it depends upon the interaction with ecological/environmental condition under which the genotype is grown. Genotypes with combination of desirable ancillary traits along with drought tolerance would certainly excel in productivity under drought stress. In the present investigation, the overall mean grain yield/ha revealed a spectacular wide array of variation ranging from 14.7 to 36.6q/ha among the test genotypes. In the present pursuit, Asumakunda and Khursudi performed well with significantly high grain yield (>36.0 q/ha) than the best standard check variety Vandana. Rao (2000) observed highest genetic variation in grain yield followed by percentage of filled spikelets in a set of very early rice genotypes under upland condition. Yadav *et al.* (2001) revealed significant genetic variability for number of tillers per plant, panicle length, number of grains per panicle, 100-seed weight and grain yield per plant in a set of 124 rain fed landraces of rice.

Besides, test weight; the grain dimension seems to be important criteria for determining physical quality traits. In the present investigation, grain and kernel dimension with regard to length, breadth and length/breadth ratio have been studied to sort out a few test genotypes for acceptable quality traits. Kernel dimension is important for consumer's preference. Genotype with kernel length greater than 7.0 and L/B ratios greater than 3.5 usually attracts consumer's preference and fetch market value. Lalubadikaberi, Kahnei, Jhulipuagi, Karanga, Dasaharadhan, IR 87707-445-B-B, Vanaprabha and Khandagiri recorded high grain and kernel length. Grain length/grain breadth and kernel length/kernel breadth give an idea of relative slenderness of grain and kernel of a genotype. In this context, Hiran, Rangahazari, Setka-1 and Damaraphuli had shown higher value for GL/GB as well as KL/KB. Sharma *et al.* (1990) recorded grain length ranged from 5.7 to 9.9 mm, breadth from 1.8-3.0 mm and L/B ratio from 2.4 to 4.3 in a set of 43 traditional upland rice.

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References

Adhya, T.K., 2011. “Vision 2030”, Central Rice Research Institute, *Indian Council of Agricultural Research (ICAR), Cuttack (Orissa), India*, p. 1-12.

Craufurd, P., Dorward, P., Opoku-Apau, A., Dartey, K., Bimpong, I. and Marfo, K. 2000. Testing drought-tolerant plant types of upland rice in Ghana using participatory methods-a plant sciences research programme project. *Department of International Development (DFID), West African Rice Development Association (WARDA)*, p. 1-5

Fukuta, Y., Konisho, K., Senoo-Namai, S., Yanagihara, S., Tsunematsu, H., Fukuo, A. and Kumashiro, T. 2012. Genetic characterization of rain fed upland New Rice for Africa (NERICA) varieties. *Breed Sci*., **62**(1): 27–37.

Gomathinayagam, P., Papiah, C.M., and Sundar Pradhan, G. 1990. Path coefficient analysis in upland varieties of rice. *Madras Agric . J.*, **75**(11-12); 449-450.

Kim, Y., Ha, A.L., Khan, Z.K., Shinwari, D.H., Kim, M., Waqas, M., Kamran and Lee, I.J. 2012. A silicon treatment to rice (*Oryza sativa* L. cv ‘Gopumbyeo’) plants during different growth periods and its effects on rice growth and grain yield. *Pak. J. Bot*., **44**: 891-897.

growth periods and its effects on rice growth and grain yield. *Pak. J. Bot*., **44**: 891-897.

Laxuman, P.M., Salimath, Sashidhar, H.E., Mohankumar, H.D., Patil, S.S., Vamadevaiah, H.M., and Janagoudar, B.S. 2011. Character association and path coefficient analysis among the backcross inbred lines derived from Indica x Nerica cross for productivity traits in rice (*Oryza sativa* L.) *Karnataka J. Agric. Sci*.,**24** (5):626-628.

Panse, V.G., and Sukhatme, P.V. 1985. *Statistical methods for agricultural workers, IARI, New Delhi.* p. 15-67.

Ramiah, K. 1953. Rice Breeding and Genetics Scientific Monograph No. 19, *Indian Council of Agricultural Research, New Delhi.* p. 20-25.

Rao, S.S. 2000. Estimation of grain yield and inter-relationship with yield components in upland rice. *Mysore J. Agric. Sci.*, **34**:142-146.

Sharma, M.K., Richharia, A.K. and Agarwal, R.K. 1990. Variability, heritability, genetic advance and genetic divergence in upland rice. *International Rice Research Notes*, **21**(1):25-26.

Singh R.K. and Choudhury B.C. (1985). Biometrical Techniques in Genetics and Plant Breeding. *International Bioscience Publisher, India*. p 63-68.

Yadav, R. K., Suresh, B. G., Pandey, P. and Binod K. (2001). Assesment of genetic variability, correlation and path association in rice (*Oryza sativa* L.). *J. Bio.Sci.*, **18**:1-8.

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Table 1. Promising upland land races of rice in relation to specific stable morphological traits.

Characters	Range	Promising upland rice Genotypes
Days to 50% flowering	48.9-106.9	Early flowering : Setka-1, Danisaria, Podasankara, Dangaradhan, Bhogi, Dasaharadhan, Paradhan, Nandigiri, Dhobasaria , Dhalashree –B, Saria-B, Kapaanthi, Zhu 11-26
Days to maturity	78.3-135.3	Early maturity :Setka-1, Danisaria, Podasankara, Dangaradhan, Bhogi, Dasaharadhan, Paradhan, Nandigiri, Dhalashree –B, Saria-B, Zhu 11-26
Leaf rolling	0.5-9.3(0-9 scale)	Saria-B, CR Dhan 40
Drought Recovery	0.6-9.4(0-9 scale)	Biramani, Saria-B , Browngora ,CR Dhan 40, Kalakeri
Leaf drying	0.8-8.6(0-9scale)	Kharkoili, Chinger-1, Dengabari, Khursudi, Kinari, Dular, Kusuma, Damaraphuli, Chinger-2, Ambajhuka, Saria-B, Kalakeri, Browngora, Salampikit
Leaf area (cm^2)	18.0-75.0	Sanarasi, Pugakal, Karanga, Ambajhuka, Haladigundi Padarabank
ChIorophyll Index	1.3-15.7	Kantadumer, Bastul, Litipiti, Dal, Jhulipuagi Setka-1
Zinc tolerance	0.6-8.6(0-9 scale)	Kusuma , Sanarasi , Dasaharadhan , Kutiarasi, Karanga, Kenduphula, Ambajhuka , Kunor, Padarabank, Jhitipiti, Ras, Pora
BLB tolerance	0.8-9.3(0-9 scale)	Salampikit N 22
Plant height	88.1-138.1	Dwarf plant types: Khandagiri, Setka-2, Dhubasaria, Malkadna, Bhogi, Jhulipuagi Tall plant types: Ninibudhi, Badi,Harisankar, Pandeydhan, Khursudi, Kinari, Jhirkabanji, Merlo, Barei, Pora, Ambajhuka, Padarabank, kandig, Asumakanda Hiran Intermediate plant types : Rest of the genotypes
Ear bearing tillers	180.4-461.9	Khandagiri , Harisankar , Kahnei , Kinari , Merlo , Jhulipuagi , Barei , Kutiarasi , Hiran , CR 143-2-2 , Ninibudhi , Badi , Rangahazari
Panicle length (cm)	15.0-28.0	Kantadumer, Rasakadali , Damaraphuli, Padarabank, Somo , Asumakunda Anjali
Panicle weight (g)	0.5-3.7	Salampikit , Lalubadikaberi , Dular , Pankapota , Sarian , Padarabank , Somo , Asumakunda , Nandigiri , Dhobasaria , Kapaanthi , Pustak , CR Dhan 40 , Anjali , Kantadumer
Grains/Panicle	31.6-149.3	Dhobasaria , Anjali, Dular , Pankapota , Sarian , Padarabank , Nandigiri , Asumakunda , Pustak , CR DHAN 40 , Lalubadikaberi
1000-Grain Wt. (g)	11.5-29.4	Kantadumer , Karanga, Kandasuri , Dhobasaria , Kapaanthi , Saria , Kalakeri
Grain length (cm)	5.9-9.5	Lalubadikaberi, Kahnei, Jhulipuagi, Karanga, Dasaharadhan, IR 87707-445-B-B
Grain breadth (cm)	1.3-2.9	Chinger-2 , Safri -17 , Pustak , Kantadumer
Grain L/B	2.5-5.9	Setka-1 , Hiran , Rangahazari , Damaraphuli , Sanarasi, Sadabahar , Khandagiri , Sahbhagidhan
Kernel length (cm)	4.1-7.4	Kahnei , Kantadumer , Mandakini , Lalubadikaberi , Karanga , Padarabank , Jhitipiti , Dasaharadhan , IR 87707-445-B-B , Vanaprava , Khandagiri
Kernel breadth (cm)	1.0-2.1	Dhalashree -B, Koliha, Kantadumer
Kernel L/B	2.2-5.2	Setka-1 , Mandakini , Ninibudhi , Badi , Rangahazari , Damaraphuli, Khandagiri , Hiran
Fertility (%)	20.3-95.9	Khursudi, Dular, N22, Asumakunda, Pustak, Kandasuri, kanding, Dhanisaria, Nandigiri, Dhubasaria, Dhalashree-B and CR 143-2-2 , Sahbhagidhan
Seed yield (qtl/ha)	14.7-36.6	Khursudi , Asumakunda