International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(3): 1569-1572

Received: 04-03-2018
Accepted: 06-04-2018

**Devidas Thomabare**
Department of Plant Molecular Biology and Biotechnology, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

**Archana Prasad**
Department of Plant Molecular Biology and Biotechnology, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

**Satish Verulaker**
Department of Plant Molecular Biology and Biotechnology, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

**Correspondence**
**Devidas Thomabare**
Department of Plant Molecular Biology and Biotechnology, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

# Screening and identification of diverse rice germplasm for drought stress and irrigated condition

**Devidas Thomabare, Archana Prasad and Satish Verulaker**

**Abstract**
Rice (*Oryza sativa* L.) is an important food crop and large amount of water required in its life cycle as compared to other crops. Drought is the major problem in most of the rice growing areas. In present study, yield and yield related traits like days to 50% flowering, plant height, panicle length, total number of tillers, number of effective tillers, etc. were observed in drought stress and irrigated condition. Among the traits observed, days to 50% flowering was quite earlier (83 days) in CHENGRI-2 during drought and KALOKUCHI-223 (79 days) in irrigated condition. Similarly, plant height in drought stress was 112.3 cm (IR7728-75-B-B) and irrigated 117.4 cm (DJOGLON-DJOGLO) which was lowest among all the genotypes. The panicle length in drought stress was 23.07 cm (BHATAJHOOLI) and control condition panicle length was observed in 23.42 cm (BHATAPHOOL). Highest number of tiller was observed in wild rice-99 (10.46 cm) and wild rice-41 (8.88 cm) under stress condition and irrigated conditions respectively. Number of effective tillers was highest in drought condition as compared to irrigated condition. The maximum number of panicle per plant was observed in SLO-16 (9.18) under stress condition and wild rice-41 (9.22) under irrigated condition. The seed index for PRATAO germplasm line was 2.17 gm and 2.35 gm during drought and irrigated conditions respectively. The highest grain yield in drought stress was in SAFRI17 (535 gm/m$^2$) and RAMJIYAVAN (622 gm/m$^2$) in irrigated condition. The highest performing genotype under drought stress also showed 35 percent yield reduction as compared to normal condition. It shows that the effect of drought can be minimized up to certain extent. In this study we focused on various morphological and seed parameters for selection of high yielding variety in drought and irrigated condition.

**Keywords:** Rice, grain, yield, drought, stress and irrigated condition

## Introduction
Rice (*Oryza sativa* L.) is the staple food of half of the world population (Singh *et al.*, 2012) [8]. Rice belongs to graminae family having 24 species in the genus *Oryza* (Vaughan *et al.* 2003). It provides dietary energy and protein source in the developing countries. It is cultivated in at least 114 developing countries and is the primary source of income to more than 100 million peoples in Asia (Singh *et al.*, 2015) [9]. Rice has three subspecies *indica*, *japonica* and *javanica* which are growing in tropical and sub-tropical region of the world.

In Asia 23 million hectares of total rice cultivation area is drought prone and drought is becoming problem even in traditionally irrigated area (Pandey *et al.*, 2005) [7]. Biotic and abiotic stresses are major problems in rice yield potential and drought causes the major stress affect on overall rice production. One of the major drought prone rice producing region in the world is eastern Indo-Gangetic Plain (Huke and Huke, 1997) [2]. In these plain losses due to reproductive stage drought are most severe in the key rice producing states of eastern India, like Chhattisgarh, Orissa, Jharkhand, Bihar, and eastern Uttar Pradesh. In several drought years, total losses of rice production in Chhattisgarh, Orissa and Jharkhand have been reported as much as 40%, valued at US$ 650 million (Pandey *et al.*, 2005) [7]. However, new methods have been developed for screening of drought stress (O'Toole, 2004) [5] and they are facilitating progress in our understanding of drought resistance traits. Many morphological and external factors responsible for drought resistance is a complex trait and would help stabilized rice production. Drought tolerance is exact mechanisms and inheritance of traits for lack of modern molecular techniques for genetic improvement of rice breeding program for water limiting environments has been slow (Khush 2001) [3]. Therefore, major limiting factor in irrigated rice production areas: Osmotic adjustment, stomatal conductance and dehydration tolerance enables the plant to tolerate drought due to the ability of rice roots to penetrate into compacted soils (Babu *et al.* 2001) [1]. Development of drought resistant rice varieties through molecular marker techniques and breeding is of considerable economic value, as it can increase crop production in areas with inadequate irrigation systems (Subbarao *et al.* 2005) [11]

The genetic diversity for some traits needed for high yielding performance and less stress tolerance limited in local cultivated rice germplasm. This is due to the repeated use of the indigenous germplasm in rice breeding programs (Moncada *et al*., 2001) [4]. Introgression of new desirable genes from other rice species can provide genetic improvement for increasing rice potential through various desirable morphological traits and modern molecular marker through different breeding methods. Plant breeding to develop drought resistant rice suffers from the lack of a specific method for screening the large numbers of genotypes (Zeigler and Puckridge 1995) [13].

In this study we focused on evaluation of genetic diversity of rice germplasm lines on the basis of various yield and yield related traits to identify the genotypes having high yield potential under drought and irrigated condition. We identified some genotypes having high yield potential under drought as well as irrigated condition.

## Materials and Methods

### Plants materials

The experimental material consist of 147 elite germplasm lines/accessions which include wild rice, collection from undivided Madhya Pradesh and Chhattisgarh, popular rice varieties, advanced breeding lines and land races.

**Table 1.1:** Details of 147 accessions used for phenotypic screening of rice germplasm

| L. N. | Rice Genotypes | L. N. | Rice Genotypes | L. N. | Rice Genotypes |
|---|---|---|---|---|---|
| 1 | Annada | 24 | Ir64 | 47 | IR84984-17-83-48-1-B |
| 2 | Arb 8 | 25 | Ir55419-04 | 48 | IR84984-83-15-862-B |
| 3 | Abhya | 26 | Kranti | 49 | IR90019-17-159-B |
| 4 | Azucina | 27 | Lalmati | 50 | IR90019-22-28-2B |
| 5 | Arb6 | 28 | Laloo-14 | 51 | B-6 |
| 6 | Bamleshwari | 29 | Mahamaya | 52 | IR84887-B-15 |
| 7 | Buddha | 30 | Mtu1010 | 53 | RRF78 |
| 8 | Bakal | 31 | Ramjiyavan | 54 | Shabhagi Dhan |
| 9 | Bas-370 | 32 | Samleshewari | 55 | Mtu1010 |
| 10 | Bhataphool | 33 | Swarna | 56 | Punjab-Bas 3 |
| 11 | Batroo | 34 | Safri-17 | 57 | Ryt-3275 |
| 12 | Bhatajhooli | 35 | Shennong89366 | 58 | Aganni |
| 13 | Badsha-Bhog | 36 | Swarna-Sub1 | 59 | Karma Masuri |
| 14 | Ct9993 | 37 | Vandana | 60 | Safri-17 |
| 15 | Cross116 | 38 | Ibd-1 | 61 | Rp-Bio-226 |
| 16 | Chaptigurmutiya | 39 | Danteshwari | 62 | Dubraj |
| 17 | Deshi-Lal-Dhan | 40 | Poornima | 63 | Bpt-5204 |
| 18 | Deshi-No17 | 41 | Ir86931-B-400 | 64 | Jitpiti |
| 19 | Dagaddeshi | 42 | Ir86918-B-305 | 65 | Pr-122 |
| 20 | Ir62266 | 43 | Ir87728-75-B-B | 66 | Ir64 |
| 21 | Ic267982 | 44 | Ir87728-367-B-B | 67 | Slo16 |
| 22 | Ir36 | 45 | Swarna-Sub1 | 68 | Kalokuchi223 |
| 23 | IR42253 | 46 | IR84984-83-15-110-B | 69 | KALIYA |
| 70 | Pratao | 96 | E2526 | 122 | DT13/7 |
| 71 | Chuvadau130 | 97 | M-114 | 123 | DT13/11 |
| 72 | Chengri-2 | 98 | M-184 | 124 | DT13/12 |
| 73 | Cr5272 | 99 | M-1051 | 125 | DT13/13 |
| 74 | Epagri-2 | 100 | M-1433 | 126 | DT13/14 |
| 75 | Pinkaeo | 101 | M-2260 | 127 | DT13/17 |
| 76 | Djoglon- Joglo | 102 | M-2298 | 128 | DT13/23 |
| 77 | WR1 | 103 | M-2463 | 129 | DT13/37 |
| 78 | WR2 | 104 | MAHESHWARI | 130 | DT13/38 |
| 79 | WR3 | 105 | AVT-1-IME3 | 131 | DT13/44 |
| 80 | WR32 | 106 | R1570 | 132 | SUVT3/7 |
| 81 | WR36 | 107 | AVT-2-ASG-5 | 133 | DT13/71 |
| 82 | WR 41 | 108 | AVT-L-5 | 134 | DT13/72 |
| 83 | WR73 | 109 | AVT-2-ASG-6 | 135 | DT13/70 |
| 84 | WR99 | 110 | DURGESHWARI | 136 | DT13/67 |
| 85 | WR116 | 111 | SHAMLA | 137 | DT13/68 |
| 86 | WR132 | 112 | AVT2IME 10 | 138 | DT-9 |
| 87 | E1701 | 113 | RAJESHWARI | 139 | DT-10 |
| 88 | E1702 | 114 | CHADRAHASINI | 140 | DT-11 |
| 89 | E1703 | 115 | JALDUBI | 141 | DT-29 |
| 90 | E1827 | 116 | AVT2-A-6 | 142 | DT-31 |
| 91 | E2010 | 117 | AVT2-IMAE-12 | 143 | DT-32 |
| 92 | E2312 | 118 | INDRA-SUG-DHAN1 | 144 | DT-36 |
| 93 | E2367 | 119 | AVT2E-TP-6 | 145 | DT-47 |
| 94 | M4628 | 120 | AVT-1-ASG | 146 | DT-48 |
| 95 | E1857 | 121 | AVT2E-TP-5 | 147 | DT-79 |

**Field experiment**

The experiment was carried out at Department of Plant Molecular Biology and Biotechnology, Indira Gandhi Krishi Vishwa Vidyalaya, Raipur, India, during *kharif* season 2017. The field experiment was conducted at reproductive stage of drought stress condition and irrigated condition. The experiment was carried out in irrigated (non-stress) and drought condition with two replications. Rice seedlings of 25 days were transplanted to the main field of stress and irrigated condition from nursery.

**Evaluation of agronomic traits**

The observations for yield and its contributing traits were recorded at specific stage such as maximum tillering stage, vegetative, maturation and at post-harvest by following Standard Evaluation System (SES), IRRI 2002. The fixed five plants were selected from each line and the observations were recorded for yield related traits. The following traits are measured: Days to 50% flowering, number of tillers/plant, effective number of tiller, plant height (cm), panicle length (cm), panicle number, biological yield ($g/m^2$), grain yield ($g/m^2$), harvest index (%) and 100 seeds weight (gm).

**Data analysis**

Data analysis was done using software package MS-EXCEL and OPSTAT software for Windows. In this study, data taken for 10 yield related traits of 147 germplasm lines was analyzed.

**Results and Discussion**

**High yield performance under drought and irrigated condition**

The results related to performance of rice genotypes under drought stress and irrigated condition has been presented in Table 2. Rice genotypes grown under drought condition produced low yield grain other than irrigated condition. Therefore, a yield decrease was observed in almost all genotypes grown under drought stress condition. The minimum yield performance was observed in DT13/17 (0.272 gm) for drought condition and irrigated condition (0.2885gm). Whereas maximum yield performance was observed in KARMA MASURI (0.428gm) in stress condition as compared to irrigated condition (0.655gm). Similar result of yield reduction was observed under drought stress condition was reported by Ouk *et al*., (2006). They reported 12 to 46% reduction in grain yield under stress condition as compared to control condition.

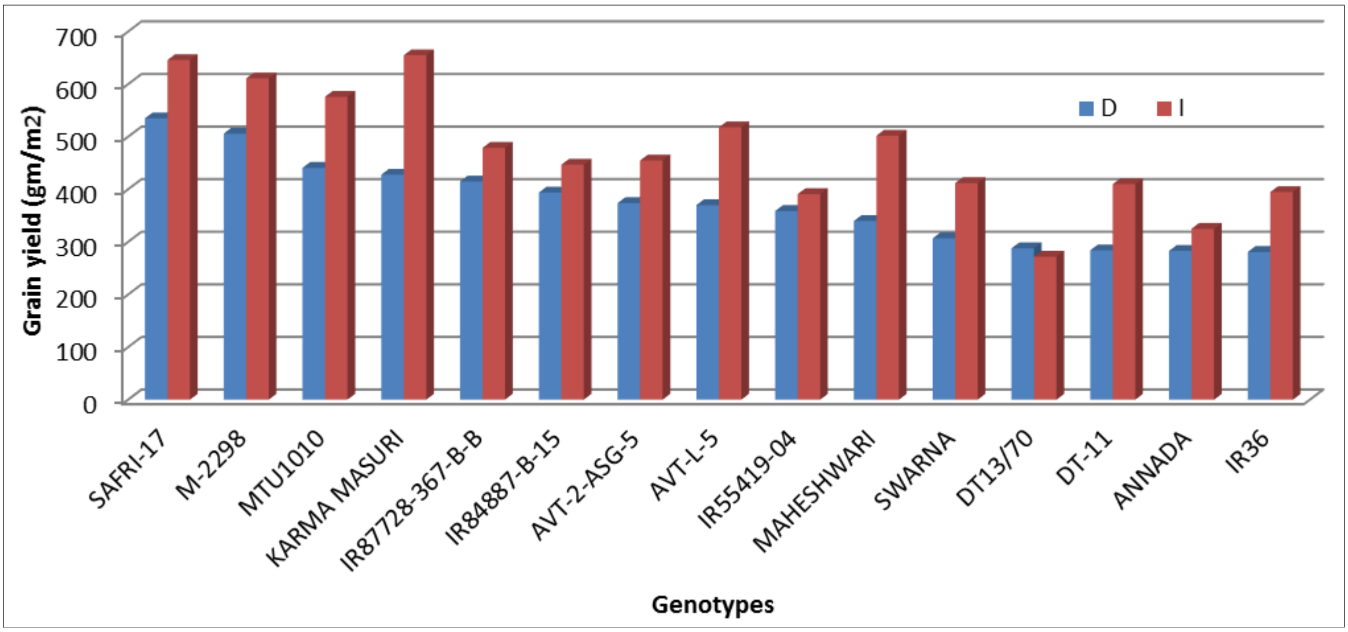


**Fig 1:** High yield performance of rice genotypes under reproductive stage drought compared to control.
Yield contributing traits under drought and irrigated condition.

The rice seed grown in stress condition had low yield as compare to irrigated condition. The entire rice germplasm panel showed significant differences among all the traits. Therefore, significant genetic diversity among the rice germplasm was observed. The observations were recorded in drought stress and irrigated condition with two replications. In stress condition earliest 50% flowering was observed in CHENGRI-2 (83 days) and KALOKUCHI-223 (79 days) during irrigated condition. The mean value for this trait was 88 days under drought stress condition and 96 days during irrigated condition. Similar result was observed under drought stress condition by Ouk *et al.,* 2006. The average plant height during stress condition was 112.3 cm and 117.4 cm in irrigated condition. The significant decrease in plant height was observed in rice genotypes grown under drought stress condition. Similar results were also reported by Singh (2000) [10]. The longest panicle length under drought condition was in BHATAJHOOLI (28 cm) with overall mean of 23.07 cm and during irrigated condition panicle length was longest in BHATAPHOOL (42 cm). General mean for panicle length during irrigated condition was 23.42 cm.

**Table 2:** Observations recorded for yield and contributing traits during drought stress and irrigated condition

| Sr. No. | Character | Condition | Mean | Range | Sed | CD | CV |
|---|---|---|---|---|---|---|---|
| 1 | DTF (Days) | Drought | 87.91 | 83 − 103 | 4.15 | 8.2 | 4.72 |
| | | Irrigated | 95.97 | 79 − 121.5 | 6.92 | 13.69 | 7.21 |
| 2 | PH (cm) | Drought | 112.3 | 67.5 − 156.3 | 8.15 | 16.1 | 7.25 |
| | | Irrigated | 117.4 | 75.4 − 209.8 | 13.49 | 26.66 | 11.48 |
| 3 | PL (cm) | Drought | 23.07 | 18 − 28 | 1.47 | 2.92 | 6.41 |
| | | Irrigated | 23.42 | 15.6 − 42 | 2.75 | 5.43 | 11.74 |
| 4 | TNT | Drought | 10.46 | 6.7 − 23.3 | 2.06 | 4.08 | 19.74 |
| | | Irrigated | 9.58 | 5 − 20.2 | 1.53 | 3.03 | 16.00 |
| 5 | NET | Drought | 9.39 | 5.7 − 17.2 | 1.83 | 3.63 | 19.61 |
| | | Irrigated | 8.88 | 4.4 − 18.4 | 1.54 | 3.05 | 17.38 |
| 6 | PN | Drought | 9.18 | 4.5 − 15.5 | 1.83 | 3.63 | 19.61 |
| | | Irrigated | 9.22 | 4.2 − 2.5 | 2.70 | 5.34 | 29.31 |
| 7 | SI | Drought | 2.17 | 0.87 − 3.43 | 0.34 | 0.67 | 15.81 |
| | | Irrigated | 2.35 | 0.76 − 3.41 | 0.23 | 0.45 | 9.86 |
| 8 | BY ($gm/m^2$) | Drought | 690 | 250 − 1295 | 0.83 | 0.36 | 26.62 |
| | | Irrigated | 900 | 382 − 3780 | 0.41 | 0.81 | 45.5 |
| 9 | GY ($gm/m^2$) | Drought | 270 | 80 − 535 | 0.22 | 0.44 | 81.3 |
| | | Irrigated | 430 | 141 − 622 | 0.23 | 0.45 | 52.3 |

DTF- Days to 50% flowering, PH- plant height, PL-panicle length, TNT-Total number of tiller, NET- number of effective tiller, SI- Seed index, BY- Biological yield, GY- Grain yield.

The maximum numbers of tillers were observed in wild rice-99 (23.3) during stress condition and wild rice-41 (20.2) during irrigated condition. The mean value for total number of tillers was 10.46 and 8.88 during drought and irrigated condition respectively. Therefore drought condition resulted in production of more number of tillers as compared to irrigated condition. The maximum number of panicles per plant was observed in SLO-16 (15.5) with overall mean of 9.18 in stress condition and wild rice-41 (18.4) in irrigated condition with mean of 9.22. The seed index under drought condition was highest in PRATAO (3.43 gm). The mean value of seed index during drought condition was less (2.17 gm) as compared to irrigated condition (2.35 gm).

The range of biological yield was high during irrigated condition as compared to drought stress condition. The mean values for biological yield was 690 $gm/m^2$ and 900 $gm/m^2$ during drought and irrigated condition respectively. The grain yield was highest in RAMJIYAVAN (622 $gm/m^2$) and SAFRI17 (535 $gm/m^2$) during irrigated and drought stress condition respectively. The mean for grain yield was 270 $gm/m^2$ during drought condition and 430 $gm/m^2$ in irrigated condition. Similar result with yield loss in drought condition as compared to irrigated condition was also reported by Basnayake *et al*., (2004).

## Conclusion

Though variation for yield and yield contributing traits was observed during drought and irrigated condition, there are some genotypes with stable performance in drought as well as irrigated condition. Performance of different morphological traits shows best response to drought stress and irrigated condition. Drought stress at reproductive stage caused significant reduction in days to flowering, plant height, panicle length, tillering effect and grain yield as compare to irrigated condition. The genotypes namely SAFRI17, SWARNA SUB-1 and DT13/37 showed better performance during drought condition.

## References


1. Babu RC, Shashidhar HE, Lilley JM, Thanh ND, Ray JD, Sadasivam S *et al*. Variation in root penetration ability, osmotic adjustment and dehydration tolerance among accessions of rice adapted to rainfed lowland and upland ecosystems. Plant Breed. 2001; 120(3):233-238.
2. Huke RE, Huke EH. Rice Area by Type of Culture: South, Southeast, and East Asia. International Rice Research Institute, Los Banos, Philippines, 1997.
3. Khush GS. Green revolution: the way forward. Nature Rev. 2001; 2(2):815-822.
4. Moncada P, Martinez CP, Borrero J, Chatel M, Gauch HJr, Guimaraes E *et al*. Quantitative trait loci for yield and yield components in an *Oryza sativa* × *Oryza rufipogon* BC2F2 population evaluated in an upland environment. Theor Appl Genet. 2001; 102(2):41-52.
5. O'Toole JC. Rice and water: the final frontier. In: Vanavichit A (Ed.) Proceedings of the 1st International Conference on Rice for the Future; Aug 31 to Sep 2; Kasetsert University, Bangkok, Thailand. Bangkok: National Center for Genetic Engineering and Biotechnology and Rice Research Institute, Ministry of Agriculture and Cooperatives. 2004, 12-29.
6. Ouk M, Basnayake J, Tsubo M, Fukai S, Fischer KS, Cooper M *et al.* Use of drought response index for identification of drought tolerant genotypes in rainfed lowland rice. Field Crop Research. 2006; 99:48-58.
7. Pandey S, Bhandari H, Sharan R, Naik D, Taunk SK, Sastri ASRAS. Economic Costs of Drought and Rainfed Rice Farmers' Coping Mechanisms in Eastern India. Final Project Report. International Rice Research Institute, Los Banos, Philippines, 2005.
8. Singh AK, Chandra N, Bharti RC. Effects of Genotype and Planting Time on Phenology and Performance of Rice (*Oryza sativa* L.). *Vegetos*, 2012; 25(1):151-156.
9. Singh D, Singh AK, Singh A, Patel AK, Baghel MS. Impact assessment of short duration paddy variety Birsa Vikas Dhan-109 in Sidhi district of Madhya Pradesh. Journal of Agri. Search. 2015; 2(1):53-56
10. Singh S, Singh TN. Morphological, chemical and environmental factor affecting leaf rolling in rice during water stress. Indian J Plant Physiol. 2000; 5:136-141.
11. Subbarao GV, Ito O, Serraj R, Crouch JJ, Tobita S, Okada K *et al.* Physiological perspectives on improving crop adaptation to drought-justification for a systematic component based approach. In: Pessarkli M, editor. Handbook of photosynthesis. 2nd edu. New York: Marcel and Dekker, 2005, 577-594.
12. Vaughan DA, Morishima H, Kadowaki K. Diversity in the genus *Oryza*. Current Opin Pl Biol. 2003; 6(2):139-146.
13. Zeigler RS, Puckridge DW. Improving sustainable productivity in rice-based rainfed lowland systems of South and Southeast Asia. Geo. Journal. 1995; 35(3):307-324.