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Research Article

Evaluation of Drought Tolerant Rice Genotypes in Different Moisture Regime on Western Nepal

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Abstract

Field experiments were conducted under irrigated, rainfed and reproductive water stress environment for three successive years (2015-2017) at Regional Agriculture Research Station, Khajura; Regional Agriculture Research Station, Doti and Agriculture Research Station, Surkhet to identify and select high yielding and major diseases and pests' resistant genotypes. Twenty-four genotypes identified from IRRI/STRASA experiment were taken for evaluation in RCB design with 3 replications under low fertilizer dose. Genotypes IR 83376-B-B-7-1, IR 877761-52-1-2-2, IR 95840-33-3-2-1 and IR 82608-B-B-33-2 were found drought resistance, early maturing. So, these genotypes would help to food security in western region of Nepal where average rainfall is low and drought is prevailing during rice growing months.

Keywords: Drought; Rice; Rainfed; Genotypes

Introduction

Rice (*Oryza sativa*) is most susceptible to damage from water deficit [1]. Drought is a world-wide problem that seriously influences amount and stability of grain production. The effect of drought varies with the variety, degree and duration of stress and its coincidence with different growth stages [2]. The full yield potential of rice on any site in any season is probably never realized. Periods of unsuitable weather causes stress hence reduce the yield [3]. Particularly, drought stress at reproductive stage of the crop has large effect on grain yield under rainfed condition [4]. The percentage of drought affected land area in the World more than doubled from the 1970s to the early 2000s [5]. Increasing human population and global climate change make the situation more serious [6]. It is estimated that 50% of world rice production is affected by drought [7]. Water deficit is becoming increasingly frequent in irrigated areas due to falling water tables. The international scarcity of water threatens the sustainability of the irrigated rice ecosystem [8].

In Nepal, rice is grown in about1.5 million ha with total production of 5.60 million tons [9]. Rice area and production in eastern region are higher and decline when move from east to west due to a large variation in rainfall amount, on set of rainfall, varieties grown and differences on socio-economic conditions among the regions. The productivity also shows the same trend from east to west [10]. Rice production and annual rainfall data shows positive response of rice yield with amount of rainfall [11]. Rainy season starts in June15 and end in last of October and during this period, total rainfall ranges from 1200 to 1800 mm with monthly average 200 mm. Moreover, rice is being affected at different spell of drought severities due to uneven distribution of rainfall during the rice growing season. Rice area was reduced by 13% mainly in rainfed districts of Nepal due to severe drought incidence in 2006 [12].

Rice is grown over a wide range of agro-ecological conditions; from the lowlands in the Terai (70 masl) across high mountain valleys and mountain slopes (3050 masl) in Jumla, the highest rice-growing location in the world. Therefore, varieties recommended for one region, may not work for all over the country. Thus, this study was conducted to select of drought tolerant rice genotypes under reproductive water stress condition for mid and far western regions.

Materials and Methods

Location

Field experiments were conducted at Regional Agriculture Research Station (RARS), Khajura, Regional Agriculture Research Station (RARS), Doti and Agriculture Research Station (ARS), Surkhet during rainy seasons of 2015 to 2017. RARS, Khajura, RARS, Doti and ARS, Surkhet lie at the latitudes of 28°06'N, 29°15'N and 28°30'and longitude of 81°37'E, 80°55'Eand 81047'with an altitude of 181m, 610m and580 meters above from sea level, respectively.

Treatment

A total twenty-four genotypes in Advanced Yield Trial 100 to 120 days maturity were tested in RCBD. Irrigated and reproductive water stress trials were conducted at RARS Khajura, and rainfed trails were conducted at ARS, Surkhet and RARS, Doti.

Culture practices

Twenty-five days old seedling was transplanted with two to three seedlings per hill with 20 cm spacing between hills and between rows. Irrigation was applied at transplanting to until milking for irrigated condition. Drought stress during reproductive stage is created by delaying seed sowing and transplanting by four weeks. The water from experiments was drained off 4 weeks (28 days) after transplanting to induce Reproductive Stress. Fertilizer applied @ 60:30:20 kg/ha of N: P_2O_5: K_2O. Nitrogen was applied as urea (46% N) on two occasions (1/2 each at transplanting as a basal and at 30 days after transplanting), while the P_2O_5 and K_2O were applied once as a basal application in form of Di- ammonium phosphate (DAP) (46% P and 18% N) and of Murate of Potash (60% K_2O), respectively. Other agronomic practices were conducted according to recommended for rice cultivation in Nepal.

Data collection and analysis

Observations were recorded on days to 50% flowering, days to 80% maturity, plant height (cm), panicle length (cm) grain yield (kg/ha) and straw yield (kg/ha). For statistical analysis, analysis of variance among traits were done by using STAR package at 0.05 level of significance. Likewise, Daily maximum temperature, minimum temperature and rainfall were recorded during rice growing season (Figure 1).

Figure 1: Meteorological situation of experimental areas.

Result and Discussion

Days to flowering

The pooled analysis of data revealed that the genotypes were highly significant for days to 50% flowering in all location (Table 1). Days to 50% flowering ranged from 83 days after sowing (IR 83376-B-B-71-1) to 93 DAS (IR 95840-33-3-2-1) in stress in reproductive stage where as in normal irrigated condition (control) days to flowering was ranged from 80 days (IR 87754-42-1-3-3) to 88 days IR 87761-39-1-1-4 and IR 95840-33-3-2-1) at RARS, Khajura. The genotype IR 83376-B-B-71-1 and IR 80461-B-79-3 flowered same day in both irrigated and reproductive stress condition. So, we concluded that these varieties were tolerance of drought. Likewise, genotype IR 80461-B-79-3 flowered early i.e.91 days in reproductive stress condition and 88 days in control and genotype IR 79615-9-3-1-3 flowered early i.e. 100 days in reproductive stress condition and 97 days in control at ARS, Surkhet. Similarly, Days to 50% flowering ranged from after sowing 84 days (IR 80461-B-79-3) to 97 DAS (IR 79615-9-3-1-3) at RARS, Doti. In drought condition, days to flowering delayed due to decrease of water potential in plant tissues generate high moisture tension in plant which inhibits flower primordia development [13].

Genotypes	RARS Khajura								ARS, Surkhet				RARS, Doti			
	Irrigated				Reproductive stress											
	2015	2016	2017	Mean	2015	2016	2017	Mean	2015	2016	2017	Mean	2015	2016	2017	Mean
IR 83376-B-B-91-3	87	86	83	85	83	93	88	88	88	94	90	91	87	99	90	92
IR 82608-B-B-33-2	82	86	81	83	81	89	88	86	90	95	91	92	88	99	91	93
IR 74371-70-1-1	83	86	82	84	83	91	88	87	90	98	96	95	89	99	96	95
IR 87754-42-2-2-4	83	88	81	84	83	92	91	89	89	92	92	91	91	93	92	92
IR 87759-12-2-1-1	83	88	85	85	84	93	89	89	88	95	91	91	89	99	91	93
IR 87753-11-2-1-1	84	87	82	84	86	90	90	89	87	94	93	91	86	95	93	91
IR 87761-51-1-1-4	83	87	80	83	84	87	88	86	89	93	92	91	86	95	92	91
IR 83383-B-B-141-1	83	85	81	83	83	89	89	87	88	93	92	91	86	95	92	91
IR 84859-B-86-3-1	84	85	79	83	79	89	89	86	91	93	89	91	86	97	89	91
IR 87761-52-1-2-2	82	88	80	83	80	92	88	87	92	92	90	91	87	95	90	91
IR 87761-39-1-1-4	90	88	86	88	93	93	90	92	91	98	98	96	87	98	98	94
IR 87751-20-4-4-2	84	88	82	85	83	92	89	88	89	93	91	91	88	96	91	92
IR 87754-42-1-3-3	74	87	80	80	84	91	88	88	85	95	90	90	85	100	90	92
IR 87749-10-1-1-4	87	88	82	86	84	92	88	88	87	94	92	91	88	96	92	92
Sarju-52	84	89	86	86	85	87	92	88	96	97	90	94	99	103	90	97
IR 83376-B-B-71-1	82	84	83	83	79	84	87	83	85	95	92	91	86	98	92	92
IR 80461-B-79-3	81	90	83	85	77	94	84	85	85	91	88	88	84	94	88	89
IR 95781-15-1-1-4	83	86	87	85	82	88	87	86	87	92	89	89	86	95	89	90
IR 78875-207-B-3-B	87	84	83	85	88	88	92	89	89	95	93	92	88	97	93	93
IR 95840-33-3-2-1	89	89	87	88	90	93	94	92	92	97	92	94	95	101	92	96
IR 89889-18-1-2-1	84	87	84	85	83	91	94	89	92	97	93	94	92	101	93	95
IR 93809-2-1-3-2	83	85	81	83	84	87	87	86	92	93	91	92	90	95	91	92
IR 95814-29-1-1-3	88	86	88	87	91	88	94	91	98	100	97	98	97	103	97	99
Sukhkha Dhan-2	83	84	82	83	79	88	86	84	85	93	89	89	86	96	89	90
F-test	*	**	**	**	**	**	**	**	**	**	**	**	**	**	**	*
LSD	7.43	2.88	2.30	4.20	2.73	2.88	4.10	3.24	4.10	2.20	2.60	3.20	3.80	1.3	2.60	2.57
CV	5.36	2.02	2.00	4.01	1.99	1.95	2.7	6.64	2.80	9.20	1.40	8.20	2.10	3.80	1.40	7.30

Table 1: Day to 50% flowering of drought tolerant rice genotypes over the location in different moisture condition during 2015to 2017.

Plant height

Plant height was highly affected by moisture stress. In Normal irrigated condition at Khajura condition, all genotypes grow well and had taller plant. Likewise, shorter plant was found in reproductive stress condition. In 2017, rainfall was well distributed in Khajura, so taller plant was found in both irrigated and reproductive stress condition. In rainfed condition, plant did not suffer on early stage and suffer in later stage so, plant height affected less than drought condition. Plant height reduce under water stress condition because of plant development is reduced as a consequence of poor root development by impaired mitosis; cell elongation and expansion; reduced leaf-surface traits (form, shape, composition of cuticular and epicuticular wax, leaf pubescence and leaf color), which affect the radiation load on the leaf canopy and inhibition of stem reserves [14,15]. From these, we concluded plant height was more responsive in early moisture stress than later stage. Detail result is presented in table 2.

Genotypes	RARS Khajura								ARS, Surkhet				RARS, Doti			
	Irrigated				Reproductive stress											
	2015	2016	2017	Mean	2015	2016	2017	Mean	2015	2016	2017	Mean	2015	2016	2017	Mean
IR 83376-B-B-91-3	94	101	106	100	79	66	88	88	97	80	88	88	81	99	95	92
IR 82608-B-B-33-2	102	106	108	105	81	72	92	86	108	97	102	102	75	99	93	89
IR 74371-70-1-1	99	103	112	105	68	75	87	87	105	84	95	95	79	99	105	94
IR 87754-42-2-2-4	99	102	103	101	83	72	83	89	86	78	82	82	74	93	97	88
IR 87759-12-2-1-1	102	105	97	101	80	71	88	89	92	82	87	87	73	99	98	90
IR 87753-11-2-1-1	98	103	105	102	75	73	88	89	78	78	78	78	71	95	100	89
IR 87761-51-1-1-4	96	101	106	101	76	75	93	86	85	79	82	82	76	95	100	90
IR 83383-B-B-141-1	98	102	104	101	76	71	94	87	86	91	88	88	76	95	92	88
IR 84859-B-86-3-1	92	94	102	96	77	78	84	86	85	81	83	83	72	97	95	88
IR 87761-52-1-2-2	98	104	104	102	79	77	90	87	87	78	82	82	71	95	101	89
IR 87761-39-1-1-4	99	102	105	102	73	68	79	92	86	73	79	79	76	98	90	88
IR 87751-20-4-4-2	96	103	100	100	78	63	91	88	91	81	86	86	74	96	98	89
IR 87754-42-1-3-3	93	104	102	100	72	78	90	88	88	79	83	83	75	100	94	90
IR 87749-10-1-1-4	94	104	103	100	73	78	90	88	95	80	88	88	79	96	96	90
Sarju-52	99	94	100	98	75	69	90	88	83	73	78	78	65	103	85	84
IR 83376-B-B-71-1	98	109	98	102	78	73	90	83	76	80	78	78	70	98	92	87
IR 80461-B-79-3	98	105	105	103	90	68	92	85	99	92	95	95	76	94	97	89
IR 95781-15-1-1-4	103	110	112	108	73	77	101	86	107	97	102	102	87	95	96	93
IR 78875-207-B-3-B	99	103	103	102	77	74	94	89	90	88	89	89	80	97	98	92
IR 95840-33-3-2-1	113	82	112	102	87	62	104	92	120	117	118	118	89	101	110	100
IR 89889-18-1-2-1	95	90	105	97	79	67	92	89	98	86	92	92	81	101	93	92
IR 93809-2-1-3-2	100	89	103	97	81	64	91	86	98	83	91	91	80	95	92	89
IR 95814-29-1-1-3	106	87	110	101	82	65	94	91	88	88	88	88	72	103	94	90
Sukhkha Dhan-2	105	105	98	103	86	77	91	84	92	94	93	93	75	96	100	90
F-test	*	**	**	**	*	*	*	**	**	**	**	**	**	**	NS	*
LSD	9.08	9.5	3.71	7.44	12.7	9.9	9.20	10.6	8.5	9.1	14.	3.2	6.69	1.3		4.0
CV	5.59	5.7	9.20	4.01	9.89	8.4	12.3	12.1	5.6	5.2	9.1	8.2	5.36	3.8	7.34	9.6

Table 2: Plant height (cm) of drought tolerant rice genotypes over the location in different moisture condition during 2015to 2017.

Panicle length

Long panicles were found in Surkhet than other places. Likewise, in normal irrigated condition all genotypes bared long panicle and (table 3). In drought condition all genotypes bared short panicle than normal irrigated and rainfed condition. In water shortage condition, decrease in translocation of assimilates towards reproductive organs which ultimately decreased flower organ formation [16]. Likewise, genotypes IR 87754-42-1-3-3, IR 89889-18-1-2-1 and IR 80461-B-79-3 had less affected by water stress in term of panicle length than other genotypes. Detailed result is presented in table 3.

Genotypes	RARS Khajura								ARS, Surkhet				RARS, Doti			
	Irrigated				Reproductive stress											
	2015	2016	2017	Mean	2015	2016	2017	Mean	2015	2016	2017	Mean	2015	2016	2017	Mean
IR 83376-B-B-91-3	23	28	26	26	19	18	20	19	26	29	27	27	25	22	24	23
IR 82608-B-B-33-2	24	25	25	25	20	18	21	20	28	29	28	28	23	22	26	24
IR 74371-70-1-1	25	28	26	26	18	22	21	20	29	27	28	28	25	25	24	25
IR 87754-42-2-2-4	29	26	26	27	22	21	22	22	29	26	27	27	25	26	25	25
IR 87759-12-2-1-1	29	25	25	26	23	19	20	21	27	29	28	28	25	26	27	26
IR 87753-11-2-1-1	26	27	26	26	23	21	22	22	28	27	29	28	25	26	27	26
IR 87761-51-1-1-4	26	24	26	25	22	20	21	21	29	27	29	28	26	26	28	27
IR 83383-B-B-141-1	24	26	27	26	20	22	20	21	28	27	28	28	22	25	25	24
IR 84859-B-86-3-1	27	25	23	25	19	22	20	20	28	26	27	27	20	24	26	23
IR 87761-52-1-2-2	28	30	25	27	22	23	24	23	29	28	29	29	24	25	27	25
IR 87761-39-1-1-4	28	29	24	27	21	21	21	21	24	26	25	25	20	21	23	21
IR 87751-20-4-4-2	24	29	26	26	21	18	23	21	26	27	27	27	25	24	27	25
IR 87754-42-1-3-3	22	26	27	25	20	21	24	22	27	28	28	28	24	26	26	25
IR 87749-10-1-1-4	21	27	27	25	21	23	23	22	27	30	29	28	24	23	28	25
Sarju-52	26	22	26	25	21	19	21	20	26	29	28	28	24	24	26	24
IR 83376-B-B-71-1	25	25	21	24	19	21	19	20	25	26	25	25	23	19	23	22
IR 80461-B-79-3	25	22	26	24	23	19	23	22	26	28	27	27	24	22	27	24
IR 95781-15-1-1-4	27	23	24	25	19	23	20	21	26	27	27	26	21	23	26	23
IR 78875-207-B-3-B	25	26	23	25	22	23	20	21	23	25	24	24	23	22	24	23
IR 95840-33-3-2-1	24	19	22	22	19	17	21	19	24	27	26	25	19	22	23	21
IR 89889-18-1-2-1	26	22	25	24	22	22	23	22	27	27	27	27	23	21	24	23
IR 93809-2-1-3-2	24	23	26	24	19	17	20	19	28	26	28	27	22	23	25	23
IR 95814-29-1-1-3	26	26	26	26	23	17	24	21	30	26	28	28	20	24	26	23
Sukhkha Dhan-2	26	23	22	24	20	20	19	20	23	26	25	25	21	21	23	22
F-test	NS	**	**	NS	NS	*	NS	NS	**	NS	**	NS	**	NS	NS	NS
LSD		3.4	2.53			5.4			2.2		1.9		2.99			
CV	14.6	8.3	13.6	14.0	13.3	9.6	12.3	12.1	7.5	5.8	8.6	8.2	7.90	6.1	7.50	9.7

Table 3: Panicle Length (cm) of drought tolerant rice genotypes over the location in different moisture condition during 2015to 2017.

Grain yield

Highest grain yield was obtained in irrigated trial than rainfed and reproductive drought trial. In 2016, trials suffered from more water stress than other two years in drought and rainfed trial which decreased grain yield (table 4). Among the location, higher grain yield found in Surkhet than Doti in rainfed condition. In 2015, higher and well distribute rainfall in Surkhet and rice received sufficient water and produced higher grain yield than irrigated. In irrigated trail during 2015, heavy rainfall just after transplanting, killed seedling and gap filling done after 15 days reduced tillering and produced lower grain yield. Likewise, in 2017, rainfall is well distributed and optimum amount during vegetative stage which increase grain yield in all location. In water stress condition reduced of water content, diminished leaf water potential, turgor pressure, stomatal activity and decreased in cell enlargement and growth which affect various physiological and biochemical processes, such as photosynthesis, respiration, translocation, ion uptake, carbohydrates, nutrient metabolism and growth promoters and decrease net assimilation [17]. Detail is presented in table 4.

Genotypes	RARS Khajura								ARS, Surkhet				RARS, Doti			
	Irrigated				Reproductive stress											
	2015	2016	2017	Mean	2015	2016	2017	Mean	2015	2016	2017	Mean	2015	2016	2017	Mean
IR 83376-B-B-91-3	3417	4757	4748	4307	2183	602	2908	1898	4191	3710	3960	3954	3553	2819	3883	3419
IR 82608-B-B-33-2	3286	5161	4397	4281	1700	1854	2626	2060	4222	4299	4135	4219	2309	3056	3050	2805
IR 74371-70-1-1	3699	4268	5165	4377	1221	568	2454	1414	4594	3372	3912	3959	4198	2653	4967	3939
IR 87754-42-2-2-4	3807	4362	4691	4287	1630	609	3348	1862	3957	4296	4569	4274	4399	4444	3933	4259
IR 87759-12-2-1-1	3592	5009	4431	4344	1841	873	2574	1763	4785	3643	4156	4194	3496	4236	4217	3983
IR 87753-11-2-1-1	3225	4598	4395	4073	750	801	2485	1345	3545	4244	4155	3981	4439	3549	3533	3840
IR 87761-51-1-1-4	4197	5512	4690	4800	2187	727	2578	1831	4694	4354	4557	4535	3634	3889	4050	3858
IR 83383-B-B-141-1	3316	4880	4885	4360	1697	1223	2565	1828	3872	3832	3907	3870	1765	3528	2967	2753
IR 84859-B-86-3-1	3984	4975	4043	4334	1897	639	1924	1487	4448	3453	3904	3935	3447	3840	5033	4107
IR 87761-52-1-2-2	4192	4925	4176	4431	2603	2381	1968	2317	4469	3846	4154	4156	3279	4146	4617	4014
IR 87761-39-1-1-4	4172	4274	6204	4883	2381	549	2505	1812	4469	3731	4083	4094	2024	3354	4883	3420
IR 87751-20-4-4-2	3889	4488	4731	4369	1632	675	2439	1582	4080	3778	3957	3938	3835	3368	2633	3279
IR 87754-42-1-3-3	3799	5262	5114	4725	1499	825	2980	1768	4642	3602	4074	4106	2479	3715	4417	3537
IR 87749-10-1-1-4	3407	4231	4738	4125	1694	656	2540	1630	3917	3814	4245	3992	2749	3681	4283	3571
Sarju-52	3481	4808	5038	4442	1494	1487	2125	1702	3785	4090	4431	4102	2706	2167	4467	3113
IR 83376-B-B-71-1	3354	5228	4609	4397	3056	3516	3196	3256	3924	3792	3903	3873	3378	3194	3767	3446
IR 80461-B-79-3	3202	6034	4459	4565	2462	706	2735	1968	3920	3216	3547	3561	3405	2403	4167	3325
IR 95781-15-1-1-4	3636	5623	4716	4658	1095	608	2380	1361	4747	3880	4286	4304	3850	1875	3983	3236
IR 78875-207-B-3-B	3828	5253	4706	4596	1094	959	2842	1632	4479	3893	4188	4187	4259	3521	4233	4004
IR 95840-33-3-2-1	3793	4414	5028	4412	1290	3368	2051	2236	4406	3927	4179	4171	2305	1625	3483	2471
IR 89889-18-1-2-1	3654	4755	4616	4342	1564	493	2590	1549	4073	4394	4333	4267	4119	1771	3967	3285
IR 93809-2-1-3-2	3389	4742	3615	3915	1773	1136	1980	1630	4038	3643	3857	3846	3047	2569	3433	3016
IR 95814-29-1-1-3	3292	4524	5039	4285	1089	763	1418	1090	3906	3785	3892	3861	1301	1576	3667	2181
Sukhkha Dhan-2	3935	4925	4998	4619	1362	775	2967	1701	3986	3981	4044	4004	2689	2139	4083	2970
Mean	3648	4875	4718	4414	1716	1116	2507	1780	4215	3857	4101	4058	3194	3047	3988	3410
F-test	NS	**	*	**	*	**	*	**	*	NS	NS	**	**	**	**	*
LSD		858	1837	1348	1488	563	892	981	571			1271	1736	1353	1900	1663
CV	18.52	10.7	18.7	19.01	22.75	20.7	21.7	22.10	10.26	11.5	18.9	18.20	12.66	16.7	10.66	19.7

Table 4: Grain yield (kg/ha) of drought tolerant rice genotypes over the location in different moisture condition during 2015 to 2017.

Higher grain yield reduction was found in reproductive stage drought (58.9%) than normal irrigated condition. Likewise, grain yield reduction 7.9% at Surkhet and 22.7 at Doti in rainfed condition. Similarly, genotypes IR 74371-70-1-1, IR 87753-11-2-1-1 and IR 84859-B-86-3-1 were highly susceptible to water stress and reduced more than 65% grain yield in reproductive drought than normal irrigated condition. Likewise, genotypes IR 95814-29-1-1-3, IR 95840-33-3-2-1, IR 80461-B-79-3, Sukhkha Dhan-2, IR 83383-B-B-141-1 and IR 87761-39-1-1-4 had found higher grain yield reduction in rainfed condition than normal irrigated condition. Yield reduction in water stress is due to reduction of cell water content, diminished leaf water potential, turgor pressure, stomatal activity and decrease in cell enlargement and growth. Severe water stress may result in the arrest of photosynthesis, disturbance in metabolism [18] (Table 5).

EN	Genotypes	Grain yield reduction %		
		Reproductive Stress	Rainfed Surkhet	Rainfed Doti
1	IR 83376-B-B-91-3	55.9	8.2	20.6
2	IR 82608-B-B-33-2	51.9	1.5	34.5
3	IR 74371-70-1-1	67.7	9.5	10.0
4	IR 87754-42-2-2-4	56.6	0.3	0.6
5	IR 87759-12-2-1-1	59.4	3.4	8.3
6	IR 87753-11-2-1-1	67.0	2.2	5.7
7	IR 87761-51-1-1-4	61.9	5.5	19.6
8	IR 83383-B-B-141-1	58.1	11.2	36.9
9	IR 84859-B-86-3-1	65.7	9.2	5.2
10	IR 87761-52-1-2-2	47.7	6.2	9.4
11	IR 87761-39-1-1-4	62.9	16.2	30.0
12	IR 87751-20-4-4-2	63.8	9.9	25.0
13	IR 87754-42-1-3-3	62.6	13.1	25.1
14	IR 87749-10-1-1-4	60.5	3.2	13.4
15	Sarju-52	61.7	7.7	29.9
16	IR 83376-B-B-71-1	26.0	11.9	21.6
17	IR 80461-B-79-3	56.9	22.0	27.2
18	IR 95781-15-1-1-4	70.8	7.6	30.5
19	IR 78875-207-B-3-B	64.5	8.9	12.9
20	IR 95840-33-3-2-1	49.3	5.5	44.0
21	IR 89889-18-1-2-1	64.3	1.7	24.3
22	IR 93809-2-1-3-2	58.4	1.8	23.0
23	IR 95814-29-1-1-3	74.6	9.9	49.1
24	Sukhkha Dhan-2	63.2	13.3	35.7
	Mean	59.8	7.9	22.7

Table 5: Mean Grain yield reduction percentage in drought and rainfed with respect to normal irrigated.

Straw yield

Straw yield was higher in normal irrigated than reproductive drought and rainfed condition due to higher plant height and less tiller motility in irrigated condition. In drought condition, plant suffered from water stress from tillering stage, so plant growth stunt and reduced tillering. Likewise, in rainfed condition, early growth is better and higher tiller but later stage when water become limited then young tiller found dead. Water is a major constituent of plant tissue as reagent for chemical reactions and solvent for translocation of metabolites and minerals as well as an essential component for cell enlargement through increasing turgor pressure. When water stress arises then plant check to translocation of metabolites to young parts than young plant parts died [19]. Among the genotypes IR 95840-33-3-2-1, IR 95814-29-1-1-3 and IR 87753-11-2-1-1 had produced higher straw yield (Table 6).

Genotypes	RARS Khajura								ARS, Surkhet			
	Irrigated				Reproductive stress							
	2015	2016	2017	Mean	2015	2016	2017	Mean	2015	2016	2017	Mean
IR 83376-B-B-91-3	6761	5283	4950	5664	3303	1598	2900	2600	4988	3589	4555	4377
IR 82608-B-B-33-2	5087	4703	4750	4847	4133	2570	2867	3190	4599	5044	5268	4970
IR 74371-70-1-1	4674	7587	4750	5670	3640	2431	2733	2935	4708	3914	4624	4415
IR 87754-42-2-2-4	5218	4438	4500	4719	3301	2431	3133	2955	5395	4449	5276	5040
IR 87759-12-2-1-1	5744	5659	4650	5351	3853	2223	3067	3048	5368	3541	4705	4538
IR 87753-11-2-1-1	4664	7071	4200	5312	4319	2917	2400	3212	5027	4713	5266	5002
IR 87761-51-1-1-4	5446	3933	4750	4710	3994	2152	2133	2760	5173	4157	4993	4774
IR 83383-B-B-141-1	5378	4470	4950	4933	4484	2014	2667	3055	4633	4550	4981	4721
IR 84859-B-86-3-1	5501	6042	4000	5181	3381	2709	2667	2919	4189	3514	4134	3945
IR 87761-52-1-2-2	5398	4904	4750	5017	2883	3473	2767	3041	4622	4049	4666	4446
IR 87761-39-1-1-4	5153	5693	5000	5282	1508	1806	2200	1838	4791	4367	4942	4700
IR 87751-20-4-4-2	5312	6220	4250	5261	3576	1736	2333	2548	4990	4211	4940	4714
IR 87754-42-1-3-3	5276	5562	5000	5279	2876	1806	4000	2894	5194	4015	4915	4708
IR 87749-10-1-1-4	4018	6084	4900	5001	3862	1806	3900	3189	5159	4455	5570	5061
Sarju-52	6816	3823	5500	5380	3437	2153	4500	3363	4913	4110	5241	4755
IR 83376-B-B-71-1	5922	5119	4750	5264	2083	4167	3750	3333	4895	3914	5112	4640
IR 80461-B-79-3	5359	3726	4500	4528	4052	1527	3500	3026	4797	3880	4645	4441
IR 95781-15-1-1-4	4825	6200	4750	5258	4322	1528	3750	3200	5163	4144	5380	4896
IR 78875-207-B-3-B	4421	6750	5000	5390	3767	2500	4000	3422	4400	4415	4787	4534
IR 95840-33-3-2-1	4760	5338	5400	5166	5516	3835	4400	4584	5256	4645	6531	5477
IR 89889-18-1-2-1	5333	6111	4700	5381	3297	1944	3700	2980	4892	4482	5460	4945
IR 93809-2-1-3-2	5375	4942	4750	5022	3574	1944	3750	3089	5254	4279	5506	5013
IR 95814-29-1-1-3	4302	5245	5500	5016	5092	2223	4500	3938	4820	4239	5277	4779
Sukhkha Dhan-2	3455	5022	4250	4242	3707	2777	3250	3245	5444	3954	5395	4931
Mean	5175	5414	4771	5120	3665	2345	3286	3099	4945	4193	5090	4743
F-test	NS	NS	NS	**	**	**	NS	NS	NS	*	NS	NS
LSD				865.32	1229	1347				1754		
CV	19.41	17.6	15.4	21.3	14.12	24.97	15.21	12.10	13	14.5	15.6	19.20

Table 6: Straw yield (kg/ha) of drought tolerant rice genotypes over the location in different moisture condition during 2015 to 2017.

Conclusion

Higher grain yield reduction was found in reproductive stage drought (58.9%) than normal irrigated condition. Likewise, grain yield reduction 7.9% at Surkhet and 22.7 at Doti in rainfed condition. Genotypes IR 95814-29-1-1-3, IR 95840-33-3-2-1, IR 80461-B-79-3, Sukhkha Dhan-2, IR 83383-B-B-141-1 and IR 87761-39-1-1-4 had found higher grain yield reduction in rainfed condition than normal irrigated condition. However, genotypes IR 83376-B-B-7-1, IR 877761-52-1-2-2, IR 95840-33-3-2-1 and IR 82608-B-B-33-2 were found drought resistance, early maturing. These genotypes were found early maturing, high yielding and drought tolerant. So, these genotypes would help to food security in mid and far western region of Nepal.

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Volume 3 Issue 11 November 2019