Deriving Genetic Coefficients of Popular Rice (*Oryza Sativa* L.) Varieties of Scarce Rainfall Zone of Andhra Pradesh for Yield Estimation

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Abstract

A field experiment was undertaken at Regional Agriculture Research Station, Nandyal, Acharya N.G. Ranga Agricultural University, Andhra Pradesh during 2019-20 on vertisols under irrigated condition to derive genetic coefficients for popular rice varieties of the scarce rainfall zone to increase the yield estimation accuracy. The treatments consisted of seven rice varieties (BPT 5204, NDLR 7, NDLR 8, NLR 3041, NLR 33358, NLR 34449 and BPT 2270) in randomized block design and replicated thrice. Higher Leaf Area Index (LAI) of 2.00 and 6.82 was observed in NDLR 7 at 30 Days After Planting (DAP) and 60 DAP respectively whereas higher LAI of 6.28 and 6.08 was observed in BPT 2270 at 90 DAP and harvest respectively. Among varieties higher root dry weight per square metre was observed in NLR 3041 at 30 DAP, 60 DAP, 90 DAP and harvest (70.4 g, 251.7 g, 413.7 g and 447.4 g respectively). Shoot dry weight per square metre differ among varieties at different stages. Higher shoot dry weight at 30 DAP in NDLR 8 (157.9 g), at 60 DAP in NLR 33358 (778.5 g), at 90 DAP and harvest in BPT 2270 (1326.3 g and 1812.1 g respectively) was recorded. Among the varieties tested NLR 33358 was short duration (106 days) and BPT 2270 was long duration (164 days). Plant height and panicle length was non significant whereas higher productive tillers per square metre (400.4) and harvest index (47.4) was observed in NLR 33358. Higher seeds per panicle (250.7) was observed in NDLR 7. Lower test weight (12.82 g) and grain yield (6320 kg ha^{-1}) was observed in NLR 33358. Higher test weight (16.37 g) and grain yield (7907 kg ha^{-1}) was observed in BPT 2270.

Key words: Rice, Genetic coefficients, Leaf Area Index (LAI), Biomass partitioning, Yield, Harvest index

1. Introduction

Agriculture is facing the challenge of adapting to the consequences of climate change, a phenomenon affecting crop productive stability by reducing water availability for growth. Yield estimation is one of the primary challenges for successful implementation of Pradhan

Mantri Fasal Bhima Yojana (PMFBY) Programme. Conventional methods of crop yield estimation are more time consuming, laborious, expensive and limited to short window of data collection. Using these methods assessing yield losses is quite complicated and challenging. A comprehensive scientific approach which can assess/estimate yield losses of individual farm units is the need of the hour for successful implementation of insurance in agriculture. FengMei Yao *et al.* (2005) derived genetic coefficients of different cultivars used for validating the model by repeatedly adjusting the model until a close match between the simulated and the observed phenology and yield was obtained. Crop simulation models are the better ways to understand the interactions between the different factors of the productive process and allow defining new scenarios to introduce changes in their variables. Sharma and Kumar (2006) parameterized and validated CERES-Rice model using experimental data and derived cultivar-specific genotypic coefficients for four varieties during calibration. Validation based on several independent sets of yield data, including different locations, years, nitrogen and irrigation water treatments showed good agreement (R2 =0.7785) between observed and simulated grain yields. The model was found good to design management practices of four varieties.

Shamim *et al*. (2010) carried out an investigation during *kharif* season of 2007 and 2008 to develop genetic coefficients of four different genotypes of aromatic rice (cv. Pankhali, Narmada, GR-104 and Pusa Basmati-1) on three different dates *viz*., D1 (8th July), D2 (22nd July) and D3 (8th August). The simulated grain yield increased linearly with incremental unit increase in day length, solar radiation, reduction of maximum temperature and vice versa. Simulated grain yields increased up to 27.9 per cent under elevated scenarios of CO_2 from 380 to 410 ppm by the model. The model was found suitable to account for the effects of transplant age of seedlings on simulated grain yield in comparison with the base yield. Crop modeling and system analysis have also been viewed as potential tool to quantify the effects of climate, seasonal weather condition, soil environment, management and genotype as well as their interaction on crop growth, yield, resource-use efficiency and environmental impacts (Shamim *et al*. 2012).

To bridge the gap, RICE-YES programme of IRRI is being implementing in Andhra Pradesh. Genetic coefficients of popular rice cultivars grown in different agro-ecological zones is highly essential to increase the yield estimation accuracy. Hence this experiment is proposed to derive genetic coefficients for popular rice varieties of the scarce rainfall zone for accuracy in yield estimation.

2. Material and Methods

A field experiment was undertaken at Regional Agriculture Research Station, Acharya N.G. Ranga Agricultural University, Nandyal, Andhra Pradesh during 2019-20 on vertisols under irrigated condition to derive genetic coefficients for popular rice varieties of the scarce rainfall zone to increase the yield estimation accuracy. The treatments consisted of seven rice varieties (BPT 5204, NDLR 7, NDLR 8, NLR 3041, NLR 34449 and BPT 2270) in randomized block design and replicated thrice. The Nursery was sown on 17.08.2019 and transplanted on 10.9.2019. Recommended dose of fertilizers of 240 N, 80 P_2O_5 + 80 K_2O kg ha^{-1} was applied with nitrogen in three splits, phosphorus as basal and potassium in two splits. Data on days to reach different phenophases, biomass partitioning and leaf area index at monthly intervals upto harvest, plant height, productive tillers per square metre, panicle length, seeds per panicle, test weight, grain yield and harvest index at harvest was recorded. The data gathered in each observation were statistically evaluated using analysis of variance (ANOVA) technique (Panse and Sukhatme 1985). The critical difference (CD) was computed to assess the significance of treatment means at 5% level of probability.

3. Results and Discussion

3.1 Weather during crop growth period

An amount of 716.2 mm rainfall received during 31.0 rainy days during the crop growing period (Table 1). Maximum temperature ranges from 30.1^{0}C to 33.3^{0}C, Minimum temperature ranges from 19.6^{0}C to 24.9^{0}C, Relative humidity ranges from 84.7% to 90.% at 8.30 hrs and 50.5% to 71.3% at 17.30 hrs. Evaporation ranges from 2.0 to 3.6 mm/day. Bright sunshine hours ranges from 2.9 to 8.3 per day.

3.2 Leaf Area Index and Biomass Partitioning

Higher Leaf Area Index (LAI) of 2.00 and 6.82 was observed in NDLR 7 at 30 DAP and 60 DAP respectively whereas higher LAI of 6.28 and 6.08 was observed in BPT 2270 at 90 DAP and harvest respectively (Table 2). Lower LAI in NLR 33358 (1.46 and 3.31) at 30 DAP and 60 DAP, NDLR 7 (3.86) at 90 DAP and NLR 34449 (3.42) at harvest was recorded. Among varieties higher root dry weight per square metre was observed in NLR 3041 at 30 DAP, 60 DAP, 90 DAP and harvest (70.4 g, 251.7 g, 413.7 g and 447.4 g respectively). Significantly lower root dry weight per square metre was observed in BPT 2270 (46.9 g) at 30 DAP, BPT 5204 (142.9 g) at 60 DAP, NDLR 7 (171.7 g and 238.3 g) at 90 DAP at harvest respectively. Shoot dry weight per square metre differ among varieties at different stages. Higher shoot dry weight at 30 DAP, NDLR 8 (157.9 g), NLR 33358 (778.5 g), BPT 2270 (1326.3 g and 1812.1 g) was recorded. Significantly lower shoot dry weight per square metre was observed in NLR 34449 (127.1 g) at 30 DAP, BPT 2270 (505.8 g) at 60 DAP, BPT 5204 (1024.3 g) at 90 DAP and NLR 33358 (1375.6 g) at harvest respectively.

3.3 Growth and Yield parameters

Among the varieties tested NLR 33358 was short duration (106 days) and BPT 2270 was long duration (164 days) (Table3). Some varieties flower earlier than the others. Those that flowered earlier matured early while those that flowered late had a delay in their maturity. Early flowering indicates short life cycle and is considered a positive character for rice improvement. Early maturing varieties are advantageous in areas with short rainfall duration because they grow faster during the vegetative phase and are thus more competitive with weeds. They reduce weed control costs and utilize less water (Khush, 1995). It is a known fact that drought frequently impedes production of rain-fed lowland rice (Haefele and Bouman, 2009).

Plant height and panicle length was non significant whereas higher productive tillers per square metre (400.4) and harvest index (47.4) was observed in NLR 33358. The differences in growth characters due to genotypes may be attributed to their inherent characteristics. Yield attributing characters viz. number of panicle/m2, panicle length, grains/panicle,weight of panicle and number of filled grains/panicle varied significantly due to varieties. Higher seeds per panicle (250.7) was observed in NDLR 7. Lower seeds per panicle (196.9) was observed in BPT 5204. The result of the present study showed that 100 grain weight varied significantly among the tested varieties. Higher test weight (16.37 g) and grain yield (7907 kg ha-1) was observed in BPT 2270. This could also be due to their differences in origin and genetic makeup. Similar reports have been published by a BRRI scientist (BRRI, 1997) as well as Ashrafuzzaman et al., (2009). Lower test weight (12.82 g) and grain yield (6320 kg ha-1) was observed in NLR 33358. Lower harvest index (41.8) was observed in NDLR 7. All the genotypes showed variations for vegetative traits and yield and its components. Also, there was positive relationship between the quantitative traits and the final yield (Yusuff et al., 2014). The findings corroborate with those of Sumreen *et al.,* (2011), Thomas and Lal (2012), Singh and Kumar (2014), Gohain (2014) and Tiwari *et al.,* (2015) and Kuldeep et al., (2017).

4. Conclusion

Studies on different parameters of popular rice varieties of scarce rainfall zone showed differential response to various growth and yield parameters. Long duration rice varieties with higher grain yield would not fit in the climatic situation where supply of irrigation water is for shorter period. The short duration varieties with optimum grain yield would be better choice for scarce rainfall zone and data collected was utilized for yield estimation accuracy.

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Table 1. Rainfall and weather parameters at RARS, Nandyal during 2019-20

Month	Actual		Deviation from normal (%)	Remarks	Temp (^{0}C)		Relative humidity (%)		Average wind speed (km/hr)	Evaporation (mm/day)	Bright sunshine hours /day
	R.F (mm)	Rainy days			Max	Min	08.30	17.30			
August	209.4	10.0	21.9	Excess	33.3	24.9	84.7	61.2	7.0	2.9	2.9
September	407.8	10.0	166.7	Excess	32.1	24.5	87.8	67.9	2.5	2.1	3.9
October	81.4	8.0	11.4	Normal	32.4	24.1	87.3	71.3	10	2.0	5.8
November	11.6	2.0	-59.0	Deficit	32.0	22.3	86.4	63.0	1.3	3.0	7.2
December	6.0	1.0	140.0	Excess	30.1	19.6	90.0	62.1	0.6	2.2	6.1
January	0.0	0.0	-100.0	Scanty	32.1	19.7	90.0	50.5	0.1	3.6	8.3
Total	716.2	31.0									

Table 2. Leaf Area Index and Biomass partitioning of different varieties

Varieties	Leaf Area Index (LAI)				Biomass partitioning							
					Root dry weight / sqm (gm)				Shoot dry weight/sqm (gm)			
	30 DAP	60 DAP	90 DAP	Harvest	30 DAP	60 DAP	90 DAP	Harvest	30 DAP	60 DAP	90 DAP	Harvest
BPT 5204	1.50	4.54	4.12	3.98	57.6	142.9	222.4	250.0	147.0	513.7	1024.3	1552.7
NDLR 7	2.00	6.82	3.86	3.44	53.3	157.3	171.7	238.3	143.4	645.8	1211.1	1598.9
NDLR 8	1.94	5.53	4.20	4.11	58.7	205.7	213.3	257.3	157.9	665.0	1135.5	1510.5
NLR 3041	1.76	5.45	4.14	3.94	70.4	251.7	413.7	447.4	127.7	528.2	1135.5	1538.7
NLR 34449	1.60	5.34	4.32	3.42	55.5	177.3	349.4	427.3	127.1	651.5	1276.9	1516.7
NLR 33358	1.46	3.31	4.02	3.45	66.3	174.3	214.9	270.6	134.6	778.5	1183.1	1375.6
BPT 2270	1.67	5.53	6.28	6.08	46.9	174.7	309.1	347.3	137.4	505.8	1326.3	1812.1
S.Em±	0.09	0.34	0.36	0.33	3.7	11.0	16.9	18.1	6.2	28.8	56.7	74.2
CD @ 5%	0.26	1.04	1.12	1.00	11.3	33.9	52.2	55.9	19.0	88.7	174.6	228.7
CV %	8.70	11.25	14.26	13.90	10.9	10.4	10.8	9.8	7.7	8.1	8.6	8.3

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Table 3. Days to reach different growth stages, growth, yield parameters and yield of different varieties

Varieties	Days to reach different growth stages			Plant height (cm)	Productive tillers/sqm	Panicle length (cm)	Seeds/ panicle	Test weight (gm)	Grain yield (kg/ha)	Harvest Index (%)
	Panicle initiation	50% flowering	Harvest							
BPT 5204	103.3	111.7	147.7	90.1	413.6	22.0	196.9	13.79	6857	44.3
NDLR 7	94.3	102.0	135.3	95.0	338.8	21.1	250.7	14.13	6589	41.8
NDLR 8	92.3	98.0	126.0	102.9	301.4	24.9	239.3	13.60	6672	44.8
NLR 3041	98.0	102.7	135.7	97.5	349.8	22.0	238.0	14.76	6722	46.2
NLR 34449	92.3	100.3	120.3	98.1	343.2	25.3	207.0	15.05	6364	45.5
NLR 33358	74.0	86.3	105.7	95.2	400.4	23.7	201.5	12.82	6320	47.4
BPT 2270	120.0	128.0	163.7	106.7	385.0	21.7	203.1	16.37	7907	42.2
S.Em±	4.32	4.73	5.18	4.06	17.02	0.99	12.5	0.64	293	2.53
CD @ 5%	13.31	14.57	15.95	NS	52.46	NS	38.4	1.96	904	NS
CV %	7.77	7.86	6.75	7.18	8.15	7.50	9.8	7.67	7.50	9.83