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Assessment of Agrophysiological Traits in Candidate Advanced Lines of Rice Crop

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Abstract:

The main objective of study was to evaluate the physiological characters which can be a significant tool in the selection or discarding the advanced genotypes of any crop. Field experiment was conducted at National Agricultural Research Center (NARC) during 2012 using RCBD with three replications in order to cram the impact of physiological variation in coarse as well as fine candidate advance lines of rice in National Uniform Yield Trail (NUYT). 27 rice candidate advanced lines including four commercial cultivars i.e (2 for coarse varieties and 2 for fine varieties) and the germplasm (research material) of 23 advanced lines were selected and obtained from different sources (research centers) of Pakistan. Chlorophyll contents

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had significant effect on biological and paddy yield of all coarse and fine NUYT advance rice lines as well as in commercial cultivars. Coarse KS-133 showed maximum chlorophyll contents (relative value was 48.45) with biological and paddy yield (12567; 6420 kg/hac) and harvest index (HI 51%) and Fine advanced line R-456(relative value was 50.14) and had biological and paddy yield (5866; 2466kg/hac) with (HI 41.86%). The highest biological and paddy yield was monitored in advance coarse line NARC-10-6 (1330kg/hac and 7246kg/hac) having harvest index (HI 54%) while in case of fine advance lines maximum biological and paddy yield (6213kg/hac and 2370kg/hac) containing harvest index (HI 38%) was noted in NIAB-201001 form all 27 NUYT candidate cultivars/advance lines. Physiological parameters mainly photosynthetic rate, stomatal conductance, transpiration, rate and sub stomatal CO_2 concentration shown non-significant trend in all coarse and fine NUYT candidate advance lines as well as commercial varieties. Significant variations were monitored between coarse as well as fine advance lines with respect to biological and paddy yield.

Key words: Physiological attributes, rice cultivars, chlorophyll contents, photosynthetic rate, stomatal conductance, Paddy yield

Introduction

Rice is very important crop and plays vital role in uplifting the economy of Pakistan. Rice provides world half population as basic diet and is main source of foreign exchange earning by its exports in Middle East and African countries. Rice account 4.9% value added in agriculture and I% of GDP. It is cultivated an area of 2571 thousand hectares (8.7% more than last year) and its production was estimated about 6160 thousand tons (27.7% more than last year). (GOP, 2012). Rice is grown in wide range of environmental conditions from equatorial plates to sub tropical mid latitudes from low land paddy field to high altitude terraces.

Physiological variation causes great impact on vegetative as well as reproductive growth and development of rice crop. The physiological processes including alleviation of photosynthetic efficiency, oxidative damage, uptake of water and nutrients by crop are severely influence under continuously changing climatic conditions and it also cause yield variability in cereal crops (Wang *et al.*, 2011; Olesen *et al.*, 2011). Photosynthesis is important factor which greatly enhanced plant biomass production which ultimately increase paddy yield (Makino, 2011). Many studies shown that close relationship between photosynthesis, biomass and yield which predicted that enhancing photosynthetic rate increase yield without altering any genetic factor (Long *et al.*,2006). Lack of correlation between photosynthesis and plant yield has been frequently observed when different genotypes of a crop are compared. This is also true because modern cultivars have been bred for various traits besides photosynthesis. Hirasawa *et al* (2011) observed that genetically controlled variation in stomatal conductance for given leaf N content or for rate of photosynthesis in rice cultivars. Leaf nitrogen is closely related to photosynthetic rate and paddy yield. Nitrogen leaf requirement is very important factor which predict the N top dressing prior to panicle initiation and panicle differentiation growth stages of rice crop (Esfahani *et al.*, 2008). The plant attributes which assist for enhancing paddy yield are bigger panicle size, batter plant type having higher photosynthetic rate with more light use efficiency.

The preliminary studies were carried out in order to understand the mechanism of physiological traits The main objective of study was to evaluate the physiological characters which can be of significant tool in the selection or discarding the advanced genotypes of rice.

Materials and Methods:

27 rice candidate advanced lines including four commercial cultivars i.e (2 for coarse varieties and 2 for fine varieties) were

selected and the germplasm (research material) of 23 advanced lines was taken from different sources (research centers) of Pakistan. Nursery was sown on 7th of June, 2012 and was transplanted on 11th of July, 2012 in rice field under standing water conditions in the field area of rice program, National Agricultural Research centre, Islamabad (33° 42' N, 73º 10' E). The experiment was conducted under RCBD design and with three replications. Fertilizer (NPK) was applied for field preparation with the doses of 120:60:60 Kg/ha for both coarse as well as fine rice varieties. All other agronomic operation was same for the trail.

27 rice candidate lines including four commercial cultivars i.e (2 for coarse varieties and 2 for fine varieties) were measured. Data on parameters like photosynthetic rate, stomatal conductance, and transpiration rate were measured with the help of Infra Red Gas Analyzer (IRGA) which is non-destructive method to collect data from the mother shoot plant at panicle initiation developmental stage of rice advanced lines. Chlorophyll content was measured with the help of Spade chlorophyll meter from uppermost fully expended leaves of rice advanced lines as well as from four commercial cultivars. Harvesting was done at crop maturity and data of Biological yield and paddy yield were taken after harvesting. The data collected for various traits was put for analysis of variance (ANOVA) at 5% probability level by using Statistix Software and measured as described by Steel and Torrie, 1997.

Results and Discussion

Climatic Conditions during the Crop Period (2012)

The weather conditions for the period under research are summarized in Figures. Seasonal rainfall was 679 mm (Fig. 2). The maximum rainfall was recorded in the month of August (248 mm). The air temperature during the season was normal. Mean air temperature of , April, May, June, July, August, September, October and November were 29.9, 36.2, 40.9, 36.9, 34.5, 32, 22 & 16° C (Fig. 1). The maximum average temperature was recorded in the month of June (40.9° C). The minimum average temperature was observed in the month of October (15° C).

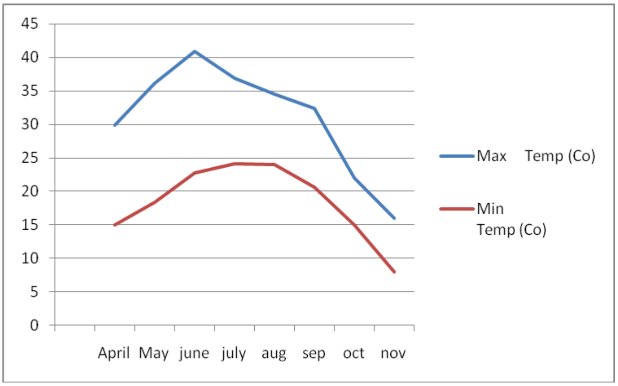

Fig 1. Maximum and Minimum Temperature during 2012

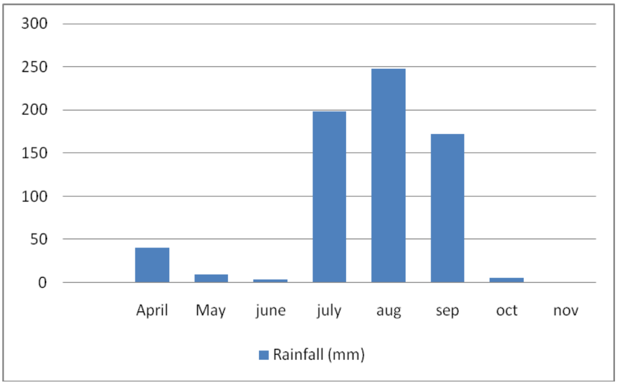

Fig. 2. Rainfall pattern during crop season of 2012

Chlorophyll contents

It is evident from the data presented in Table-1 and Table-2 that chlorophyll contents were significantly different in all coarse and fine NUYT advance rice lines as well as commercial cultivars. Chlorophyll contents in rice leaves at early vegetative stage was maximum in coarse cultivar KS-133 (relative value is 48.45) having biological and paddy yield (12567; 6420 kg/hac) and harvest index (HI 51%) whereas, minimum chlorophyll contents was noted in advanced line KSK-456 (relative value is 40.64) containing biological and paddy yield (9767; 4933 kg/hac) and harvest index (HI 50%). Fine advanced line R-456 showed highest chlorophyll contents (relative value is 50.14) and had biological and paddy yield(5866; 2466kg/hac) with (HI 41.86%), while less contents was in NUYT advanced line PK-8677-18-1-7-17 (relative value is 40.46) which had obtained 4100 and 1740 Kg/ha) biological and paddy yield respectively (HI 43%). The results indicated that chlorophyll contents played a vital role for enhancing biological and paddy yield in all coarse as well as fine NUYT advance lines as well as in commercial cultivars. These lines have different genetic makeup which also causes influences on their performances. Leaves play crucial role to improve crop physiological functions and status of crops. Phytochrome stabilize leaves chlorophyll contents (Okada and Katoh, 1998). Yamazaki *et al*. (1999) observed positive correlation between the Chlorophyll contents and the photosynthesis and light quality may play vital role in regulating the photosynthetic characteristics. It has been also observed that fertilizer application at proper time and dose and better climatic conditions especially temperature improved vegetative growth and development and also enhanced yield of rice crop (Yashida *et al.,* 1981). Close relationship exist between nitrogen and chlorophyll contents in many crops as indicated by Okawa and others 2004. Nitrogen increases chlorophyll content and protein levels which ultimately enhanced the potential yield of crops (Ding and others 2005; Walker and others 2006; Good and others 2007). Leaf nitrogen is closely related to photosynthesis rate and grain yield in rice (Peng *et al.* 1995).

Biological and Paddy yield

It is obvious from data in Table-1 and 2 that significant variation was observed on biological and paddy yield of candidate advance lines and commercial cultivars in coarse as well as fine rice varieties. The highest biological and paddy yield was monitor in advance coarse line NARC-10-6 (1330kg/hac and 7246kg/hac) having harvest index (HI 54%) and lowest was in NUYT candidate line NIA-102 (8900kg/hac and 4766kg/hac) and harvest index (Hi 53%) respectively, while in case of fine advance lines maximum biological and paddy yield (6213kg/hac and 2370kg/hac) containing harvest index (HI 38%) was noted in NIAB-201001 and the minimum was recorded in PK-8667-8-5-1 advance line (3750kg/hac and 1516kg/hac) and harvest index (HI 40%). The increase in biological and paddy yield in coarse NARC-10-6 and fine NIAB-201001 advance lines may be due to their genetic makeup and their ability to give better performance as compared to other advance NUYT lines and commercial cultivars under changing climatic conditions. Harvest Index (HI) cause great impact on yield of rice crop. HI of coarse advance lines as well as commercial varieties is more than fine which indicates efficient translocation of assimilates for rice productivity. These results are inline with the finding of Alam *et al.*, (2009) who reported that increase in HI enhanced economic yield of rice efficiently. HI of coarse is higher than fine might be due to semi dwarf genetic trait of coarse cultivars/advance lines. It was observed that certain crop genotypes have ability to perform better by modifying physiological processes and ultimately improved productivity (Rahman *et al.*, 2009). This requires more detailed understanding of physiological processes of photosynthesis and crop productivity under moisture stresses. Physiologically best performed candidate advance line and rice cultivar were evaluate and role of photosynthetic assimilates correlated with final paddy yield.

Impact of physiological attributes in rice advance lines and commercial cultivars

The observations on different growth and development parameters were recorded along with the grain yield. Photosynthetic rate, sub stomatal CO_2 concentration, transpiration rate and stomatal conductance of three leaves form mother shoot from each treatment per plot were measured at flag leaf stage under field conditions after calibrating and adjusting LC Pro, portable photosynthesis system which is principally based on the concept of non destructive method of measuring plant's inside mechanisms. The device consisted of an enclosed reservoir; the reservoir contained a volume of CO_2 enriched air, which was monitored by an infrared gas analyzer (IRGA). When the internal CO_2 concentration within the reservoir was elevated, diffusion rates through the porous medium were measured by recording changes in CO_2 concentration within the reservoir. All gas exchange measurements were made between the hours of 1000 and 1400. The LC Pro was "environmentally controlled" with an adjustable light source and a Peltier-cooling unit built into the Parkinson Leaf Chamber (PLC). Physiological parameters mainly photosynthetic rate, stomatal conductance, transpiration, rate and sub stomatal CO_2 concentration causes non-significant impact on biological and paddy yield in all coarse and fine NUYT candidate advance lines as well as commercial varieties. Physiological attributes played a vital role for translocation of assimilates and as a result of that better growth and development of crop. Photosynthesis is the primary metabolism of plant and important source of dry matter production. Photosynthetic efficiency of crop cause synergistic effect on its photo assimilates which enhanced it yield potential (Makino; 2011). Athar & Ashraf (2005) indicated that plant/crop adaptation to altering weather conditions with reference to photosynthesis is essential to improve crop growth and productivity. The positive correlation between potential leaf photosynthesis and maximal crop growth rate was monitor in many crops. Evapotranspiration and crop coefficients (Kc) have relationship with crop development and productivity (Asim *et al.*, 2006).

Conclusion

Crop breeding and management strategies including selection of resistance advance lines, planting nursery and transplanting, seedlings timeliness are need of time in order to achieve sustainable yield of paddy crop under continuous changing climatic scenario. However, Physiological attributes chlorophyll contents, photosynthetic rate, transpiration rate, stomatal conductance, sub stomatal CO_2 concentration may be measured and be included in assessing and releasing of new advance lines.

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ASSESSMENT OF PHYSIOLOGICAL VARIATION IN CANDIDATE (NUYT) VARIETIES FOR PADDY YIELD

Entries	Line	Chlorophyll contents	Photosynthetic rate (micromol/m2/s)	Transpiration rate (millimol/m2/s)	Stomatal conductance (millimol/m2/s)	Sub Stomatal CO_2 Conc (vpm)	Biological Yield (Kg/hac)	Paddy Yield (Kg/hac)	Harvest Index (%)
NIBGE Rice-II	101	45.100 AB	9.4350 N.S	2.9067 N.S	0.1050 N.S	152.83 N.S	10367.00 AB	5646.70 ABC	54.72 N.S
NIA-625	102	44.033 AB	8.6217	2.9100	0.1150	148.17	9233.00 AB	4920.00 C	53.38
KSK-449	103	41.677 AB	7.6983	3.2133	0.1150	195.00	9367.00 AB	5080.00 BC	54.73
KSK-456	104	40.640 B	7.6283	3.3900	0.1150	190.33	9767.00 AB	4933.30 C	50.82
PK-8785-1-1	105	46.143 AB	9.5017	3.3700	0.1200	143.67	10067.00 AB	5380.00 BC	53.48
NARC-10-6	108	45.160 AB	8.9533	3.1500	0.1250	125.67	13300.00 A	7246.70 A	54.48
PK-8480-8-1-1-1	109	44.487 AB	7.6050	3.2267	0.1333	162.50	9433.00 AB	4826.70 C	51.17
KSK-457	111	39.907 B	7.5050	3.3300	0.1650	193.50	9900.00 AB	5180.00 BC	52.74
NIBGE Rice-I	114	44.053 AB	8.3367	2.7833	0.0833	154.50	9167.00 AB	4713.30 C	51.59
DK-2	115	41.983 AB	8.6183	3.1967	0.1250	189.33	9800.00 AB	5026.70 BC	51.67
NIA-102	116	44.820 AB	7.4767	2.7767	0.1150	152.17	8900.00 B	4766.70 C	53.55
NARC-10-1	119	42.763 AB	7.5950	2.4200	0.0950	144.33	9433.00 AB	5106.70 BC	54.24
NARC-10-2	122	43.550 AB	8.8350	3.0567	0.0933	145.83	11633.00 AB	6060.00 ABC	52.15
NARC-10-8	125	43.990 AB	8.1583	2.7067	0.1217	122.50	13033.00 AB	6760.00 AB	51.69
DK-3	129	41.950 AB	7.5950	3.0433	0.1050	189.83	10900.00 AB	5483.30 BC	51.02
KSK-133 (Check)	132	48.457 A	9.5400	3.2033	0.1217	122.50	12567.00 AB	6420.00 ABC	51.09
Rustam Dhan	135	41.577 AB	8.6883	3.0633	0.1083	186.17	10233.00 AB	5233.30 BC	51.41
IR-6 (Check)	138	45.390 AB	9.7333	3.1133	0.0917	157.67	12033.00 AB	6150.00 ABC	51.17
LSD at 5 (%)		7.5332	N.S	N.S	N.S	N.S	4133.30	1739.70	N.S

Table-1: Agrophysiological attributes in coarse advance lines

Table-2: AgroPhysiological attributes in fine advance lines

Entries	Line	Chlorophyll contents	Photosynthetic rate (micromol/m_2/s)	Transpiration rate (millimol/m_2/s)	Stomatal conductance (millimol/m_2/s)	Sub Stomatal CO_2 Conc (vpm)	Biological Yield (Kg/hac)	Paddy Yield (Kg/hac)	Harvest Index (%)
PK-8892-4-1-3-1	152	44.790 AB	7.0000 N.S	2.6217 N.S	0.1133 N.S	171.33 N.S	4516.70 BC	1993.30 ABC	44.38 N.S
EF-1-30-39-04	153	42.323 AB	7.1117	3.0550	0.0933	142.83	4250.00 C	1716.70 BC	40.40
PK-8677-18-1-7-17	154	40.467 B	6.5467	2.9867	0.0917	163.33	4100.00 C	1740.00 BC	42.39
PK-8667-8-5-1	157	41.063 B	7.4717	2.7900	0.0950	164.17	3750.00 C	1516.70 C	40.47
PK-8647-11-1-1	159	41.513 B	7.2467	3.0883	0.0950	155.33	5463.30 AB	2133.30 AB	38.98
R-456	160	50.143 A	9.4667	3.3233	0.1267	124.00	5866.70 A	2466.70 A	41.86
NIAB-201001	163	41.313 B	9.5600	2.6600	0.0867	131.83	6213.30 A	2370.70 A	37.93
Super Basmati (Check)	166	42.957 AB	7.0333	3.0317	0.0800	156.33	3700.00 C	1593.30 BC	43.23
Basmati-515 (Check)	169	45.510 AB	7.2450	2.7300	0.0950	151.00	4266.70 C	1743.30 BC	40.02
LSD at 5 (%)		8.2647	N.S	N.S	N.S	N.S	966.28	568.96	N.S