Int.J.Curr.Microbiol.App.Sci (2019) *8*(5): 975-986

EXCELLENT PUBLISHERS

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 8 Number 05 (2019)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2019.805.114

Can Rice Hybrids Fit Well into Inherently Low Fertile Acidic Soils with Minimal Nitrogen Fertilizer Inputs under Intense Rainfall Receiving Rain Fed Lowlands of Andaman and Nicobar Islands

B. Gangaiah*, A. Sirisha and Sachidananda Swain

Division of Natural Resource Management, ICAR-Central Island Agricultural Research Institute, Port Blair, Andaman & Nicobar Islands

**Corresponding author*

Keywords

Rice, Hybrids, Variety, Nitrogen, Net income, Nitrogen use efficiency

Article Info

Accepted:
10 April 2019
Available Online:
10 May 2019

ABSTRACT

Rain fed lowland traditional variety rice cultivation in Andaman and Nicobar islands in acidic soils with low inherent fertility is done with minimal use of fertilizer and thus have low yields and profits. Use of hybrids and balanced fertilization especially nitrogen (N) may improve the situation. In this context, a field study was made during 2016 rainy season to assess the performance of 8 hybrids (including a variety) in main plots and four N rates (0, 50, 100 and 150 kg/ha) as sub-plot treatments. Experiment was laid out in split plot design with three replications. Results based on grain yield (t/ha) and net income (Rs/ha) revealed that rice hybrid 'KPH-459' (3.32 t/ha and Rs. 14585) and 100 kg/ha N fertilization (3.22 t/ha and Rs.12105) as the best treatments. Cultivar and nitrogen interaction indicated that 'KPH-459' with 50 kg N fertilization is as good as 'PR-14019', 'PR-14112' hybrids and better than 'WGL-14' variety receiving highest N (150 kg) for profits. Cultivation of 'KPH 459' hybrid with 100 kg N gave the significantly higher profits (Rs. 29607) than all other cultivars and N combinations. Nitrogen uptake followed the trend of grain yields, however all N use efficiency indices (Physiological efficiency, Apparent recovery and Utilization efficiency) except agronomic efficiency have highest values high at 50 kg N. N response of rice crop and 6 cultivars was linear (KPH-459' and 'PR-14019' have quadratic response). Replacement of current rice varieties with 'KPH-459' hybrid with high soil N dependence requiring low N dose (50 kg/ha) could be rewarding for Andaman and Nicobar Islands climate having high rain fall and low soil fertility and fertilizer use by farmers.

Introduction

Rice (*Oryza sativa* L.) is only the cereal food crop grown in Andaman and Nicobar Islands (ANI) under rain fed situations by transplanting. During 2016-17, it was cultivated on 4876 ha with a production of 12593 tonnes (t) and productivity of 2.58 t/ha (DOES, 2018). Though these yield was at par with that of country (2.55 t/ha), it was far behind the highest productivity (3.998 t/ha) reported from the state of Punjab (Agricultural Statistics at a Glance, 2017) in the country. This huge yield gap (35.5%) was mainly ascribed to use of traditional varieties that was evident from the fact that 70% of rice acreage is under long duration, photosensitive variety 'C-14-8' (Subramani *et al.,* 2014). Several high yielding varieties (HYV) are bred locally and popularized among stakeholders in the islands (Singh *et al.*, 2014) besides their introductions from main land states with similar ecology. Hybrids development in place of HYV was taken up in the country in 1989 that resulted in release of first hybrid in 1995 and by 2016, 90 hybrids were released in the country (DRD, 2018). These hybrids spread on 3 m ha (Raja, 2016) were estimated to have pushed up yields by 18.13% in Uttar Pradesh (Singh *et al.,* 2009) and India (FAO, 2014). Thus rice hybrids introduction do merits consideration in islands too. For realizing genetic potential of HYV and hybrids, adequate and balanced fertilization is necessary as every tonne of rice grain produced on an average removes 20-3-21.5 kg/ha of N-P-K (Dobermann *et al.*, 1998). Paddy soils of ANI are acidic, saline (acidic-saline, acid-sulphate-saline soils etc.) and are deficit in primary nutrients of NPK (Singh *et al.*, 1988). However, fertilizer use is low and mostly confined to vegetable and fruit crops. During 2016-17, 1682 t of NPK fertilizers were used in the islands (DOES, 2017) at an average rate of 41 kg/ha (19.0-21.4-0.6 kg N-P-K) of cultivated area. This low use of N as against the optimum dose 100 kg (Damodaran *et al.,* 2012) calls for use of suitable alternative management approaches. In this context, hybrids with vigorous root density (Zhang *et al.,* 2009) relying more on soil N (Hunag *et al.*, 2017) than the fertilizer N may come in handy and should be explored in islands. High rain fall received during rice crop season not only constrains top dressing of N but also its efficacy by way of runoff water induced losses. Studies on relative performance of hybrids and their N requirements are yet to be attempted in the islands and in this context a study was made to find out the cultivars and nitrogen interactions for the enhancing the rice production.

Materials and Methods

A rain fed lowland transplanted rice experiment was carried out during July-November, 2016 at the Bloomsdale research farm, ICAR- Central Island Agricultural Research Institute, Andaman & Nicobar Islands, India. The experimental clay loam soil collected from 0 -20 cm depth in June, 2016 was analysed as per Singh *et al.,* (2005). The analysis revealed that slightly acidic (6.3 pH), non-saline (ECe: 0.55 dS/m) soil with 6150 kg/ha of organic carbon was rated low for available N-P-:K (254-108-129 kg/ha).The experiment was laid out in split plot design (SPD) with three replications. Main plot treatments consisted of eight rice cultivars i.e.7 hybrids and a high yielding variety (Table 1) while in sub-plot, four nitrogen rates (0, 50, 100 and 150 kg/ha) representing 0, 50, 100 and 150% of recommended dose of rice crop were allocated. Nitrogen fertilizer as prilled urea (46.4% N) was given in three equal splits on 5^{th}, 27^{th} and 47^{th} day after transplanting (DAT) rice. A sub-plot size of 5 m x 3 m was used. A 1 m buffer channel between sub-plots on all sides with a 30 cm height soil levee and 2 m alleys of bunds and a channel between replications have effectively contained the inter-plot movement of N. Irrigation water was also applied to each sub plot separately. The experimental plot uniformly received 60 kg/ha each of P_2O_5 and K_2O as single super phosphate (16% P_2O_5) and potassium chloride (60% K_2O) applied in last puddling. The experimental soil was puddle thrice with power tiller in standing water. Soil was allowed to settle for a day, was manually levelled and experimental lay out was done. Thirty day old nursery grown healthy seedlings were transplanted in main field on 3^{rd} August, 2016 with 1-2 seedlings/

hill at 20 cm x 15 cm spacing. The crop was grown under rain fed conditions with supplemental irrigation and faced no moisture stress during its life cycle. Pre-emergence application of pendimethalin 38.7% CS @ 0.75 kg a.i/ha immediately after transplanting and two manual weeding on 25 and 45 DAT have effectively taken care of weed pressure. Nitrogen top dressing succeeded two manual weedings and field was dewatered prior to N application and re-watered two days later. Plant height (cm) of 10 randomly selected hills from ground to tip of the top most leaf was measured and for the same plants panicles were counted treatment wise prior to harvest. These hills were harvested at 5 cm above the ground level and weight was recorded (g). Grains were separated by hand and counted manually. Grains/panicle was arrived as ratio of total grains / panicle number. Grain and straw was oven dried for bringing down the moisture contents to 14 and 10% and dry weight was recorded. Harvest index was estimated as ratio of weight of 10 hills grain (14% moisture) to weight of straw (10% moisture) + grain. Weight of 1000 grains (14% moisture) was recorded and reported as test weight (g). Crop was harvested and biomass yield (kg/plot) was recorded. Biomass was sun dried for two days and threshed by manually operated pedal thresher to separate grain. Grain yield was recorded plot wise. Grain and straw yields were adjusted to 14 and 10% moisture level and their total weight is taken as biomass yield /plot. From plot yields, per ha yield was estimated. Nitrogen (N) concentration of grain and straw was estimated as per procedures of Singh *et al.*, (2005) and uptake (kg/ha) was calculated as product of grain/ straw yield (kg/ha) x nutrient concentration (%) / 100. Nitrogen use efficiencies were calculated as per Fageria *et al.*, (2011). Nitrogen harvest index was estimated as grain uptake / biomass uptake x 100. Economics were estimated based input prices of market and output price of rice grain as announced by Government of India as minimum support price (Rs. 14,700/t, 2016-17) and assumed straw price of Rs. 2,000/t. Benefit Cost Ratio (BCR) was worked out as ratio of gross income {grain yield (t/ha) x 14700 +straw yield (t/ha) x 2000} to cost of cultivation (Rs/ha). A fertilizer N price of 12.87/ kg was used. The analysis of variance was done in Split Plot Design and significance of treatment differences was compared by critical difference (CD) values at 5% level of significance (P=0.05) and statistical interpretation of treatments was done as per Gomez and Gomez (1984).

Results and Discussion

Weather during study period

Weather data during the experiment period was stressful for water with low rains in August and excess rain in September months (Figure 1). A rain fall of 179.4 cm was received in 59 rainy days. Rain fall of November (16.82 cm in 9 rainy days) was not much useful to the crop, as it coincided with crop maturity period. A mean maximum and minimum temperature of 30.6 and 24.7^{0}C and a mean relative humidity of 75- 90% was recorded at the Indian Meteorological Department (IMD) weather station at Port Blair during crop cycle (August-November). Crop required irrigations during August, October months to maintain 3-5 cm standing water and were provided through running stream water. Biotic pressures (pests & diseases and weeds) were taken care through use of plant protection measures and manual / herbicidal weeding measures. Recommended P and K fertilizers application uniformly to crop has excluded their stress also. Thus any difference in crop performance was solely ascribed to cultivars (hybrid/ variety), nitrogen fertilization and their interaction. The results of study were presented for cultivar & nitrogen followed by their interaction for grain yield and income.

Cultivar and nitrogen

Plant height and yield attributes

Rice cultivars and N dose have resulted in bringing vast differences in plant height and yield attributes (Table 1). Rice hybrid 'KPH-459' has produced significantly taller plants than 'PR-14112', 'DRRH-3' hybrids and WGL-14 and was at par with other hybrids. 'DRRH-3' has the shortest plants. Significantly higher number of panicles/m^2 (268) and grains/panicle (135) were recorded with KPH-459. However, grains/ panicle of KPH-459 were at par with HRI-186. DRRH-3 and WGL-14 that has lowest panicles/m^2 and grains/ panicle stood at the top (23.70 g) and bottom (16.58 g) for test weight, respectively.

Plant height and panicle/m^2 increased significantly with each successive increase of 50 kg N from 0 to 100 kg N/ha. Further increase in N to 150 kg failed to enhance these attributes markedly. However, grains/ panicle increased significantly only up to 50 kg N application over control and test weight remained unaffected by N dose.

Grain, biomass yield and harvest index

Biomass, grain yield and harvest index were markedly improved due to N dose and cultivars too differed greatly for these attributes (Table 2). Rice hybrid 'KPH-459' has significantly higher grain, biomass yield and harvest index values (3.32, 8.43 t/ha and 39.4) than all other cultivars. All hybrids except 'DRRH-3' hybrid have exceeded HYV 'WGL-14' for grain and biomass yield. For lower biomass yields, 'PR-14112' joined 'WGL-14' and 'DRRH-3' group with at par values. DRRH-92 and HRI-186 with at par yield among themselves are the second best grain yielders.

Each successive increase of 50 kg N dose from 0 to 100 kg/ha has significantly increased the grain and biological yield of rice (Table 2). However, harvest index has increased with 100 kg N dose over control only. Nitrogen fertilization on an average has increased grain and biological yields by 70.9 and 40.2% over no N control. This increase (%) in grain yield was 43.0, 58.9 and 0.01% with 50, 100 and 150 kg N dose over its immediate preceding dose. Grain yield exhibited quadratic response as determined by regression equation: $y=1.375 + 0.522x$ (y: yield in t/ha and x: N dose kg/ha) with a R^2 value of 0.900. However, quadratic equation ($y=0.475 + 1.422x - 0.18x^2$) has better explained the yield response with high R^2 values (0.985).

Nitrogen uptake and use efficiency

Nitrogen concentration of grain and straw were markedly altered by N fertilization and cultivars have no influence (Figure 2).

Rice cultivars differed for grain, biomass (grain + straw) N uptake, N use efficiency indices (Table 3) and N dose too have marked impact on above parameters. Rice hybrid 'KPH-459' has significantly higher N uptake, NHI, AE, AR and UE values. However, for PE, 'HRI-186' hybrid stood at the top and excelled 'KPH-459'. Cultivars 'DRRH-3' and 'WGL-14' with at par N uptake and use efficiency values (except PE and AR) stood at the bottom and have statistically lower values than all other 6 hybrids.

Application of 50 and 100 kg N has markedly improved N concentration of grain and stover over no N control. Biomass N uptake (kg/ha) on an average was increased by 71.6% with N application as compared to its control. Nitrogen harvest index increased significantly with 50 N applications over no N control (46.2) and all N fertilised plots have at par NHI values. Except AE, all other N use indices (PE, AR and UE) have significantly higher values at 50 kg N dose over control. AE attained highest values at 100 kg N. Nitrogen response was linear (y=1.375 + 0.522x; R^2: 0.900).

Economics

Economics (Rs/ha) of rice cultivation was significantly altered by cultivars and N fertilization and varied among cultivars (Table 4). The differences in cost of cultivation between a hybrid and variety (Rs. 3600/ha) came from higher seed cost of hybrid as compared to a variety (Rs. 42432). Hybrid seed price (Rs/kg) was 6.67 times that of a variety (Rs. 30/kg) and 20 kg seed was used in both of them.

On income side, the differential grain and straw yields of cultivars translated into net income changes. 'KPH-459' hybrid had significantly higher net income (Rs.14585) than all other cultivars and thus has higher BCR (1.32). At the current study yields, 'DRRH-3' hybrid cultivation was a loss making proposition. 'WGL-14' variety and 'PR-14019' hybrid cultivation may also be uneconomical as their net income is < CD value. 'DRRH-92' and 'HRI-186' hybrids are the second best economically remunerative rice cultivars. Other two hybrids (PR-14111 and PR-14112) too have small profit margins. Benefit cost ratio (BCR) followed the net income trend.

Each 50 kg increase in N rate has increased the cost of cultivation by Rs.944. Nitrogen fertilization on an average has increased the gross and net income by 62.9 and 44.5% as compared to no N control (Rs. 33565). However, on account of low grain and straw yields, no N control has recorded net losses (Rs.-10539). Further, the yields obtained with 50 kg N too have small profits (Rs. 1197) that are < CD values and thus is also not profitable. Application of 100 kg N was essential to realise best profits (Rs. 12105) and BCR (1.26) values.

Cultivar X nitrogen

Grain yield

Grain yield and net income of rice differed greatly due to cultivar and N fertilization interaction (Table 5).

Hybrids grain yields got magnified with N fertilization with best yield response at 100 kg N fertilization. Rice hybrids 'KPH-459', 'PR-14019' showed decline in yields with 150 kg N as compared to 100 kg indicating their response is in between these two doses. In other cultivars, yield is increasing slightly and net income will be the best indicator. At low as well as recommended dose of N (50 and 100 kg), 'KPH-459' hybrid is inevitable choice.

Net income

Yield differences of cultivars when seen from net income point of view entirely a new picture emanated (Table 6). At no N and 50 kg N rate, rice cultivation is loss making proposition irrespective of cultivar (except 3 hybrids at 50 kg N i.e. KPH-459, DRRH-92 and PR-14019). Hybrid 'KPH-459' with 100 kg N dose remained the most remunerative treatment (Rs. 29607).

Increasing N dose beyond 100 kg/ha has reduced the net income of 'KPH-459' and 'PR-14019'. Nitrogen response of cultivars varied greatly. All cultivars except 'KPH-459' and 'PR-14019' have linear response to the N fertilization rate (Table 7). However, the linear responses of 6 cultivars were better explained by quadratic equations than linear one.

Table.1 Plant height and yield attributes of rice as affected by cultivars and nitrogen rate

Rice hybrid / variety* (C)	Panicles/ m^2	Grains /panicle	Test weight (g)	Plant height (cm)
DRRH-92	251^{c}	106^{ab}	19.98^{bc}	106.0^{abc}
HRI-186	237^{b}	130^{c}	21.31^{d}	107.1^{bc}
KPH-459	268^{d}	135^{c}	19.28^{bc}	110.2^{c}
PR-14019	242^{bc}	103^{ab}	18.97^{b}	105.9^{abc}
PR-14111	241^{bc}	108^{b}	19.02^{bc}	105.4^{abc}
PR-14112	232^{b}	109^{b}	20.13^{c}	104.8^{ab}
DRRH-3	216^{a}	98^{a}	23.70^{e}	100.4^{a}
WGL-14*	218^{a}	107^{ab}	16.58^{a}	102.0^{ab}
CD (P=0.05)	13.3	9.6	1.14.	5.08
Nitrogen rate (kg/ha): N				
0	167^{a}	99.7^{a}	19.72^{a}	89.9^{a}
50	235^{b}	108.3^{b}	19.85^{a}	103.4^{b}
100	274^{c}	113.2^{b}	19.92^{a}	113.2^{c}
150	275^{c}	114.8^{b}	19.97^{a}	116.4^{c}
CD (P=0.05)	10.0	7.22	NS	3.82
Interaction (C x N)	NS	NS	NS	NS

*Same alphabet in superscript denotes at par values

Table.2 Grain and biomass yield and harvest index of rice as affected by cultivars and nitrogen rate

Rice hybrid / variety* (C)	Yield (t/ha)		Harvest index
	Grain	Biomass	
DRRH-92	2.90^{d}	7.96^{d}	36.4^{bcd}
HRI-186	2.93^{d}	8.02^{d}	36.5^{bcd}
KPH-459	3.32^{e}	8.43^{e}	39.4^{d}
PR-14019	2.56^{c}	7.52^{c}	34.0^{abc}
PR-14111	2.66^{c}	7.42^{bc}	35.8^{bcd}
PR-14112	2.62^{c}	7.16^{ab}	36.6^{bcd}
DRRH-3	2.10^{a}	6.88^{a}	30.5^{a}
WGL-14*	2.34^{b}	6.89^{a}	34.0^{ab}
CD (P=0.05)	0.128	0.293	4.70
Nitrogen rate (kg/ha)			
0	1.75^{a}	6.05^{a}	28.9^{a}
50	2.50^{b}	7.73^{b}	32.3^{b}
100	3.22^{c}	8.72^{c}	33.9^{b}
150	3.25^{c}	8.99^{d}	33.2^{b}
CD (P=0.05)	0.096	0.220	3.51
Interaction (Cultivar x N)	0.225	0.512	NS

*Same alphabet in superscript denotes at par values

Table.3 Nitrogen uptake and use efficiency of rice as influenced by cultivars and N rate

Rice hybrid / variety* (C)	N uptake (kg/ha		NHI	Nitrogen use efficiency*			
				AE	PE	AR	UE
	Grain	Grain					
DRRH-92	33.8	64.5	52.0	26.4	96.2	34.64	33.31
HRI-186	34.5	67.4	50.6	31.7	108.8	36.96	40.17
KPH-459	39.4	76.2	51.2	37.6	102.9	48.51	50.30
PR-14019	29.9	60.0	49.5	20.3	87.8	28.64	25.45
PR-14111	30.8	60.6	50.2	23.5	88.4	25.87	22.86
PR-14112	31.7	61.2	51.1	24.5	75.0	27.39	20.57
DRRH-3	25.0	53.0	46.8	14.9	87.3	19.59	17.12
WGL-14*	27.8	55.2	49.8	18.4	72.9	23.11	16.87
CD (P=0.05)	2.41	6.63	NS	2.10	4.02	2.673	3.658
Nitrogen rate (kg/ha): N							
0	18.7	40.5	46.2	*α*	*α*	*α*	*α*
50	29.2	57.8	50.4	14.8	92.6	34.47	32.67
100	38.7	72.9	53.0	29.3	88.7	32.30	29.71
150	39.9	78.0	51.0	29.9	88.4	24.96	22.62
CD (P=0.05)	1.81	4.99	3.5	1.58	3.02	2.01	2.75
Interaction (C x N)	NS	NS	NS	NS	NS	NS	NS

*NHI: Nitrogen harvest index; AE: Agronomic efficiency (kg grain/ kg N applied): PE: Physiological efficiency (kg biomass/ kg N uptake): AR: Apparent recovery (%); UE: Utilization Efficiency (kg/kg)

Table.4 Economics of rice cultivation as influenced by cultivars and nitrogen rate

Rice hybrid / variety* (C)	Economics (Rs/ha)			Benefit Cost Ratio
	Gross returns	Cost of cultivation	Net returns	
DRRH-92	52771^{d}	46032^{b}	6739^{d}	1.15^{bc}
HRI-186	53813^{d}	46032^{b}	7781^{d}	1.17^{c}
KPH-459	60617^{e}	46032^{b}	14585^{e}	1.32^{d}
PR-14019	47474^{c}	46032^{b}	1442^{b}	1.03^{b}
PR-14111	49014^{c}	46032^{b}	2982^{c}	1.06^{b}
PR-14112	47910^{c}	46032^{b}	1878^{bc}	1.04^{b}
DRRH-3	39740^{a}	46032^{b}	-6292^{a}	0.86^{a}
WGL-14*	43643^{b}	42432^{a}	1211^{b}	1.03^{b}
CD (P=0.05)	2541	-	1600.0	0.106
Nitrogen rate (kg/ha) : N				
0	33565^{a}	44166^{a}	-10539^{a}	0.76^{a}
50	46390^{b}	45110^{b}	1197^{b}	1.03^{b}
100	58194^{c}	46053^{c}	12105^{c}	1.26^{c}
150	59415^{c}	46997^{d}	12402^{c}	1.26^{c}
CD (P=0.05)	1910.5	-	1203.0	0.080
Interaction (C x N)			2812.5	

*Same alphabet in superscript denotes at par values

Table.5 Grain yield (t/ha) of rice as influenced by cultivar X nitrogen rate

Rice hybrid / variety*	Nitrogen rate (kg/ha)			
	0	50	100	150
DRRH-92	1.91[c]	2.70[d]	3.43[d]	3.56[d]
HRI-186	1.74[bc]	2.45[bc]	3.75[e]	3.78[d]
KPH-459	1.91[c]	3.02[e]	4.25[f]	4.10[e]
PR-14019	1.80[bc]	2.65[cd]	2.95[c]	2.84[b]
PR-14111	1.78[bc]	2.40[b]	3.14[c]	3.32[c]
PR-14112	1.70[abc]	2.53[c]	3.09[c]	3.16[c]
DRRH-3	1.54[a]	1.93[a]	2.44[a]	2.49[a]
WGL-14*	1.65[ab]	2.28[b]	2.69[b]	2.74[b]
	V at same N		V at different N	
CD (p=0.05)	0.225		0.246	

*Same alphabet in superscript denotes at par values for V at same N

Table.6 Net income (Rs.) of rice as influenced by cultivar X nitrogen rate

Rice hybrid / variety*	Nitrogen rate (kg/ha)			
	0	50	100	150
DRRH-92	-9124	3814[b]	15206[c]	17060[a]
HRI-186	-11908	-201	21558[d]	21676[e]
KPH-459	-8783	10611[c]	29607[e]	26906[f]
PR-14019	-10143	3281[ab]	7305[b]	5327[a]
PR-14111	-10104	-700	9935[b]	12797[c]
PR-14112	-11302	751[a]	8380[ab]	9685[b]
DRRH-3	-14510	-8795	-1155	-704
WGL-14*	-8441	816[a]	6000[a]	6471[a]
	V at same N		V at different N	
CD (p=0.05)	2812.5		3075.0	

*Same alphabet in superscript denotes at par values for V at same N

Table.7 Yield response functions of rice cultivars to nitrogen

Rice hybrid / variety*	Nitrogen response	Response equations (R^2 values)		Best response function (based on R^2)
		Linear	Quadratic	
DRRH-92	Linear	$Y= 0.568x + 1.48$ (0.928)	$Y= -0.165x^2 + 1.393x + 0.655$ (0.991)	Quadratic
HRI-186	Linear	$Y= 0.742x + 1.075$ (0.905)	$Y= -0.17x^2 + 1.592x + 0.225$ (0.943)	Quadratic
KPH-459	Quadratic	-	$Y= -0.315x^2 + 2.355x + 0.205$ (0.968)	Quadratic
PR-14019	Quadratic	-	$Y= -0.315x^2 + 1.542x + 0.505$ (0.998)	Quadratic
PR-14111	Linear	$Y= 0.952x + 1.32$ (0.952)	$Y= -0.11x^2 + 1.086x + 0.77$ (0.984)	Quadratic
PR-14112	Linear	$Y= 0.494x + 1.385$ (0.892)	$Y= -0.19x^2 + 1.444x + 0.435$ (0.998)	Quadratic
DRRH-3	Linear	$Y= 0.336x + 1.26$ (0.925)	$Y= -0.085x^2 + 0.761x + 0.835$ (0.972)	Quadratic
WGL-14*	Linear	$Y= 0.368x + 1.42$ (0.888)	$Y= -0.145x^2 + 1.093x + 0.695$ (0.998)	Quadratic

y: yield in t/ha and x: N dose kg/ha

Fig.1 Weather data at study site (rainfall, rainy days on y1 and temperature on y2 axis)

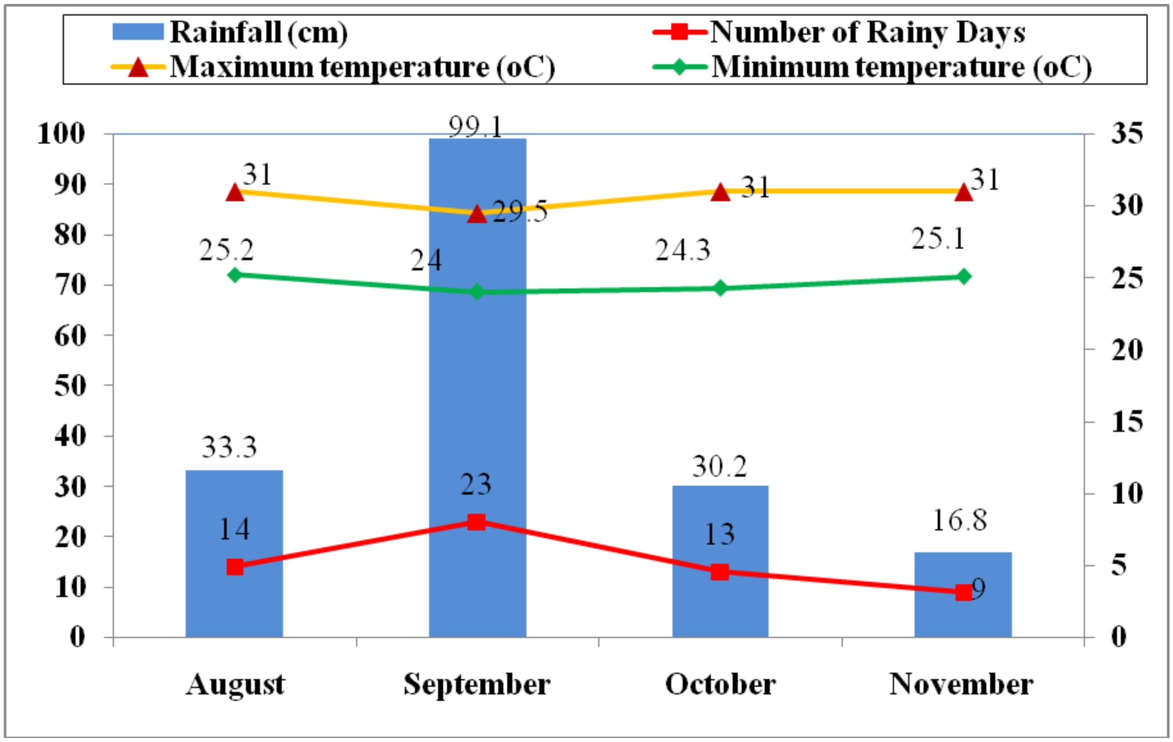
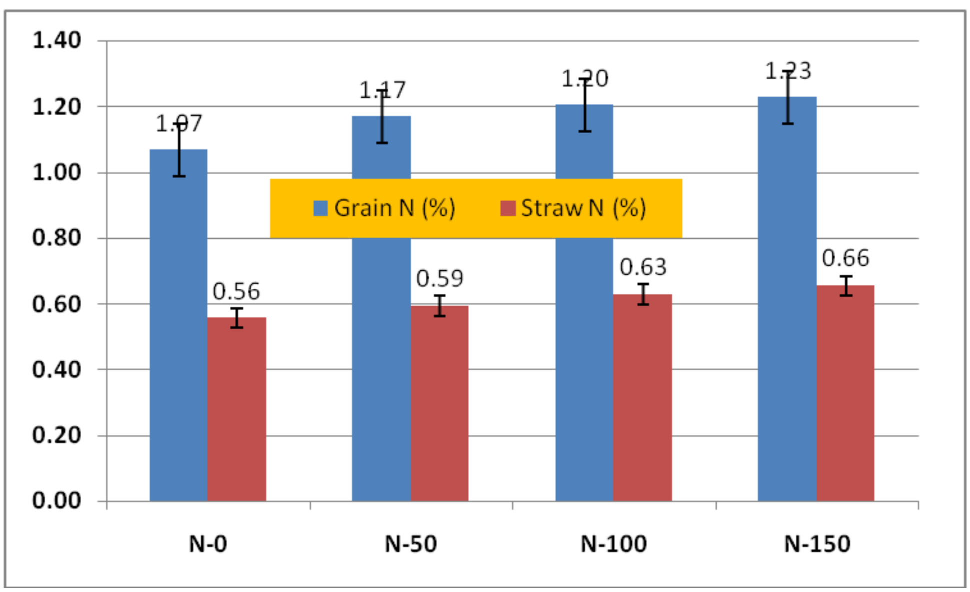


Fig.2 Nitrogen concentration (%) of rice grain and straw under varying nitrogen rates



This was because the yield increases with 150 kg over 100 kg N was marginal but N dose increased constantly by 50 kg. However, optimum dose can't be worked out for these 6 cultivars due to linear response (Table 7).

Rice cultivars produced plants with a mean height of 105.7 cm that have 238.0 panicles/ m^2, each panicle had 112 grains and grains have a test weight of 19.87 g. 'KPH-459' hybrid with 30 and 23 more number of panicles/m^2 and grains/ panicle than the mean values has resulted in 23.9 and 18.2% higher grain and straw yield than mean yield of 2.68 and 5.00 t/ha. The higher yields together have resulted in 2.85 times higher net income than the mean (RS. 3791). Similar differences in performance of hybrid over variety reported by Siva Prasad *et al.,* (2017) and Banerjee *et al.,* (2019) corroborate the current research findings.

Current experimental soil was low in available N (258 kg/ha) and was subjected to heavy rains in September month (99.2 cm) that have made the third split dose of N less useful. In the above scenario, rice crop N response was captured. Nitrogen nutrition has contributed to formation of more number of tillers and their transformation into panicles /m^2 and panicles have greater number of grains. Application of 100 kg N has improved the panicles/m^2 and grains / panicle by 12.7 and 6.3% over their mean (mean of 4 N levels) values of 238 and 112. On account of above increases in yield attributes along with meagre increases (0.05 g) of test weight over mean (19.87 g) together have resulted in 20.15% higher grain yield than the mean (2.68 t/ha). The increase in straw yield over mean yield (5 t/ha) was 8.6%. The above grain and straw yield increases have got translated into 2.19 times more net income (Rs. 12105) than the mean of Rs. 3791. Nitrogen dose response of rice crop up to 100 kg N of this study are quite lower than that reported (184.9 kg/ha) by Yadav *et al.,* (2016), but the trend is similar. Nitrogen concentration of both grain and straw was altered by N fertilization on account of low soil N status that along with higher grain and straw yields has increased N uptake substantially due to N application and cultivars. A mean NHI of 50.15 was recorded in this study. A NHI of 53 is required for best performance and these values are obtained with 100 kg N application at the experimental location. The NHI of current study is quiet lower than the reported values of 64% by Fageria and Baligar (2001) for lowland rice. All nitrogen use efficiency indices are best with 50 kg N application; however, AE increased up to 150 kg. Decrease in PE was ascribed lesser increases in N uptake by biomass than the increase in N dose. Decrease in AR was ascribed to inability of rice roots to capture more N supplies when high doses of N was given Apparent Recovery of nitrogen was highest with 50 kg (34.47%) and decreased with increased N rate to the lowest of 24.96 with 150 kg N. UE a product of AR and PE followed their trend.

Interaction effect of cultivar and N indicates that KPH-459 followed by DRRH-92 hybrids are the first and second best performers at low N fertilization (50 kg).

'KPH-459' hybrid with 100 kg N is the best combination for yield and incomes. At 100 kg N dose, the place of 'DRRH-92' was taken by 'HRI-186' hybrid. 'WGL-14' variety was a poor performer and even with highest N dose (150 kg) its performance can't match with 'KPH-459', 'DRRRH-92' and 'PR-14019' receiving 50 kg N. Hybrids superiority at low N of the current study may be ascribed to their larger, deeper, and more vigorous root system (Zhang *et al.,* 2009) of hybrid that might have enabled it to draws more soil N (Hunag *et al.,* 2017) while fertilizer N contributions remained similar for a hybrid and high yielding variety.

From the above study it is concluded that 'KPH-459' rice hybrid and N fertilization of 100 kg/ha are best for grain yield and economics. Cultivar and nitrogen interaction indicated that scope lies for improving rice productivity with low (50 kg) N fertilization by choosing 'KPH 459' hybrid as compared to others. Such interactions need to be explored in islands for overcoming the low N input farming of Andaman and Nicobar Islands subjected to heavy rains that derails N response.

References

Agricultural Statistics at a Glance 2017. Ministry of Agriculture and Farmer Welfare, Department of Agriculture, Cooperation & Farmers Welfare, Directorate of Economics and Statistics, pp 544.

FAO (Food and Agricultural Organization). 2014. A regional strategy for sustainable hybrid rice development in Asia. Food and Agricultural Organization of the United States, Regional office for Asia and the Pacific, Bangkok (www.fao.org/3/a-i4215e.pdf), Accessed 25.04.2019.

DRD (Directorate of Rice Development). 2018. Hybrid Varieties of Rice in India. Directorate of Rice Development, Patna. drdpat.bih.nic.in/Hybrid-Rice-Varieties.htm.

Banerjee, H., Sarkar, S., Pal, S., Bandopadhyay, P., Rana, L. and Samanta, S. 2019. Differential growth and yield response of hybrid rice (*Oryza sativa* L.) to seasonal variability *Indian Journal of Agricultural Research*. 53(1): 62-66.

Damodaran, V., Saren, B. K., Ravisankar, N., Bommayasamy, N. 2012. Influence of time of planting, spacing, seedling number and nitrogen management practices on productivity, profitability and energetics of rice (*Oryza sativa*) in island ecosystem. *Madras Agricultural Journal*. 99(7/9): 538-544.

Dobermann, A., Cassman, K. G., Mamm, Aril C. P. and Sheely, J. E. 1998. Management of phosphorus, potassium and sulphur in intensive irrigated lowland rice. *Field Crops Research*, 56: 38-113.

DOES (Directorate of Economics and Statistics). 2018. Agriculture: Major Crops in A&N Islands. DOES, Andaman and Nicobar Administration, Port Blair.

Fageria, N. K. and Baligar, V. C. 2001. Lowland rice response to nitrogen fertilization. *Communications in Soil Science and Plant Analysis*. 32(9): 1405-1429.

Fageria, N. K., Baligar, V. C. and Jones, C. A. 2011. Growth and mineral nutrition of field crops. 3rd Edition, CRC Press, Boca Raton.

Gomez, K. A. and Gomez, A. A. 1984. Statistical Procedures for Agricultural Research. John Wiley and Sons, Inc. London, UK, (2nd Ed).

Huang, M., Peng Jiang, ShuanglüShan, Wei Gao, Guohui Ma, Yingbin Zou, Norman Uphoff and Longping Yuan. 2017. Higher yields of hybrid rice do not depend on nitrogen fertilization under moderate to high soil fertility conditions. *Rice* (N Y): 10: 43.

Raja, Vadlamani. 2016. Hybrid Rice In India-2016-Status. https://www.linkedin.com/pulse/hybrid-rice-india-2016-status-raja-vadlamani/

Singh, D., Chhinkar P. K. and Dwivedi, B. S. 2005. Manual on soil, plant and water analysis. Westville Publishing House, New Delhi.

Singh, A. K., Birendra Kumar, Baghel, R. S. and Singh, R. B. 2009 Sustainability of hybrid rice technology vis a vis inbred rice in Uttar Pradesh. *Indian Res. J Ext. Edu.* 9(2): 22-25.

Singh, N. T., Mongia, A. D. and Ganeshmurthy, A. N. 1988. Soils of Andaman and Nicobar Islands. *CARI Technical Bulletin1*. 1-64 pp. Central Agricultural Research Institute, Port Blair, Andaman & Nicobar Islands.

Singh, P. K., Gautam, R. K., Zamir Ahmed, S. K., Singh, K. Awnindra, Sakthivel,

K. and Dam Roy, S., 2014. Farmers' participatory seed production and adoption of rice varieties in Andaman and Nicobar Islands: a success story, Bulletin, CIARI, Port Blair, pp.1-32.

Siva Prasad, R., Suresh Babu, G., Jalandhar Ram, B. and Rai, P. K. 2017. Evaluation of early mature elite rice (*Oryza sativa* L.) hybrids for yield and quality traits. *Journal of Pharmacognosy and Phytochemistry* 6(4): 18-21.

Subramani, T., Raje, R., Ambast, S. K., Ravishankar, N., Zamir Ahmed, S. K., Damodaran, V. and Bommayasamy, N. 2014. Evaluation of long duration rice varieties for enhancing productivity and profitability under Island ecosystem. *Journal of the Andaman Science Association.* 19(1): 14-18.

Zhang, H., Xue, Y., Wang, Z., Yang, J. and Zhang, J. 2009. Morphological and physiological traits of roots and their relationships with shoot growth in "super" rice. *Field Crops Res.* 13: 31-40.

How to cite this article:

Gangaiah, B., A. Sirisha and Sachidananda Swain. 2019. Can Rice Hybrids Fit Well into Inherently Low Fertile Acidic Soils with Minimal Nitrogen Fertilizer Inputs under Intense Rainfall Receiving Rain Fed Lowlands of Andaman and Nicobar Islands. *Int.J.Curr.Microbiol.App.Sci.* 8(05): 975-986. doi: https://doi.org/10.20546/ijcmas.2019.805.114