Central Asian Journal of Plant Science Innovation **1** (2021) 23–31

RESEARCH PAPER

Response of yield and yield components of released rice cultivars from 1990-2010 to nitrogen rates

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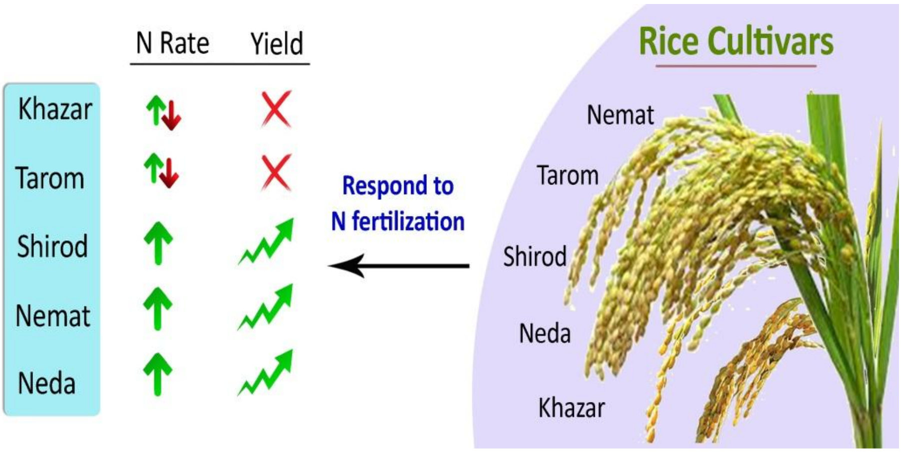
Highlights

- Increasing the amount of soil nitrogen does not always guarantee an increase in rice yield.
- Some rice cultivars do not need to use or increase soil nitrogen to increase grain yield.
- Agromorphological traits in rice are affected by soil nitrogen content.

Graphical Abstract



Article Info

Receive Date: 11 December 2020
Revise Date: 15 March 2021
Accept Date: 26 March 2021
Available online: 29 March 2021

Keywords:
Rice
Nitrogen
Cultivar
Tiller
Panicle

Abstract

This study examined to compare high-yielding cultivars and respond to N fertilization especially yield component and the aim of this development of rice cultivars suitable for low input requirements. An experiment was arranged in a randomized complete block design with a split-plot arrangement of five rice cultivars, three N rates with four replications in 2011 in Iran. N rates including 0, 69, and 138 kg N/ha as (N_0), (N_{69}) and (N_{138}) and rice cultivars including Nemat (C_1), Khazar (C_2), Neda (C_3), Shirodi (C_4), and Tarom (C_5). The results indicated that all traits response to cultivar and N rates were detected for the parameters examined. The lowest applied N rate had a lower yield than the other two N rates. Grain yields were 5552 for 69 kg N/ha and 6124 for 134 kg N/ha averaged over all cultivars. The grain yield of Khazar and Tarom was independent of the N rate, but the grain yield of Nemat, Neda and Shirodi increased when the N rate was increased from 67 to 138 kg/ha. Panicle density responded to an N rate similar to grain yield. Khazar produced more total spikelet number while Neda had a higher Panicle density. Grain yield and yield components of Nemat, Neda, and Shirodi respond to N rates dependently when planted into high nitrogen. Finally, modern rice cultivars were more efficient at recovering N than older cultivars.

10.22034/CAJPSI.2021.01.03

E-ISSN: 2783-1310

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1. Introduction

Rice (*Oryza sativa* L.) is one of the most important crops in the world and is the foremost staple food in Asia, providing 35-60% of the dietary calories consumed by nearly three billion people (Fageria, 2003). By the year 2025, it will be necessary to produce about 60% more rice than is currently being produced to meet the food needs of a growing world population (Fageria, 2007). The fact that today farmers were faced with the introduction of cultivars of crops particularly rice by the breeder that the selection of suitable cultivars for traditional farmers who have previously had a limited selection is difficult. Perhaps the main purposes of breeder have only produced cultivars with high production potential or resistance to one or more of the disease or lodging. But considering developments, there still is not seen all the features of positive in a certain cultivar and why every day is introduced more new cultivars. But farmers are cultivated still as old and traditional cultivars. The main reason was its good quality, good marketability and its price high. On the one hand increased production costs due to increased price and application of inputs, especially fertilizers and pesticides led to an important choice is the type of rice by farmers. On the other hand, the new cultivars are requiring high application of chemical fertilizers, especially nitrogen, that is not economically affordable spend and without application is produced severe decrease. But the important point in the breeding discussion of cultivars, especially for rice in Mazandaran that is grown with irrigated-flooding conditions review fertilizer-efficiency of cultivars and response is rice cultivars to nitrogen.

Nitrogen is one of the most yield-limiting nutrients in lowland rice production, and proper N management is essential for optimizing rice grain yields (Fageria et al., 2010). However, the energetic cost of synthesizing N fertilizers is very high and N fertilization often represents the most expensive energy input in cereal-based cropping systems (Crews and Peoples, 2004). Also, N fertilizer is one of the most expensive inputs for rice production and N deficiencies are widely reported in lowland rice soils (Fageria and Baligar, 1995). N fertilization has been an essential tool for increasing crop yield and quality, especially for cereals, and for ensuring maximum economic yield (Hirel et al, 2001).

Furthermore, the N fertilizer rate that produced maximum grain yield also produced the highest head rice yield (Bond and Bollich, 2007). Nitrogen rates for optimum grain yield vary based on cultivar and soil texture (Walker, 2006). Furthermore, rice cultivars commonly grown in Iran require and respond to large amounts of N. With regard to management practices, the choice of plant variety is particularly important (Giambalvo et al., 2010); in fact, several studies have shown that many crop species have genetic variability for NUE (Fageria et al., 2008) and that the use of the best-adapted genotype can contribute to improved efficiency in how cereal crops acquire and use soil N or fertilizer N (Giambalvo et al., 2010). In the other study, found that modern wheat varieties were less efficient at recovering soil N than older varieties, which suggests that old varieties may be the best choice for low input and organic growing systems (Foulkes et al., 1998). In contrast, other researchers (Le Gouis et al., 2000) have found that NUpE and NUtE have increased with the introduction of improved varieties, and those modern varieties give the best results even under limited N availability.

Also, was showed that wheat breeding has greatly increased grain yield and that this improvement has been associated with an increase in optimum N rate; the increase in N fertilizer use has counter-acted the improvement in grain yield, resulting in a static NUE at optimum N levels (Sylvester-Bradley and Kindred, 2009). The varieties suited for low input or organic systems should combine high N use efficiency with superior competitive ability against weeds (Giambalvo et al., 2010). An extensive study has been conducted in the north of Iran's rice-growing region examining the response of rice to N rates. However, this study examined to compared semi-dwarf cultivar (Neda), conventional-height cultivars (Tarom), high-yielding cultivars (Shirodi, Nemat and Khazar). Therefore, the aim of this study development of rice cultivars suitable for low input requires knowledge about how different varieties respond to N fertilization especially the yield component.

2. Materials and Methods

An experiment was conducted to evaluate the response of five cultivars of rice to different nitrogen rates. The experiment was conducted at a farm of Sari research, Mazandaran Province, Iran (36 38 N, 52 29 E, 14.7 m altitude) during May-August of 2011. The total precipitation during the grain-filling period was 10 mm in 2011. The soil was clay with 4.61 % organic matter, 0.12 % N, 2 mg/kg Olsen-P, and 23 mg/kg exchangeable K. Specific detail of soil and weather presented in Table 1 and 2. Treatments were applied using a randomized complete block design with a split-plot arrangement with four replications. N rates including 0, 69, and 138 kg N/ha as (N_0), (N_{69}) and (N_{138}) and rice cultivars including Nemat (C_1), Khazar (C_2), Neda (C_3), Shirodi (C_4), and Tarom (C_5). A long-height and conventional cultivar were Tarom. Cultivars were semi-dwarf and new breaded Neda, Nemat, and Shirodi and conventional and old breaded were Khazar. The seed of each cultivar was seeded at 60 kg/ha. Seedlings were raised in the field with a sowing date on 1 and 2 May and transplanted on 28 and 29 May at a hill spacing of 0.20 by 0.20 m with two seedlings per hill. Plots were transplanting in late May. The experiment was transplanted using seedling with 20 cm between each row. Individual plots consisted of 10 rows measuring 5 m in length.

Table 1. The weather condition in experiment site in rice growth stages at Sari in 2011.

Variable	April	May	June	July	August	September
Minimum tem.	11.54	16.06	22.00	23.96	25.86	21.19
Maximum tem.	17.03	21.09	27.80	30.83	32.74	35.87
Evaporation (mm)	55.5	93.7	166.6	136.3	199.7	150.2
Precipitation (mm)	0.07	0.27	0.05	1.66	1.15	4.67

Table 2. Selected soil properties for composite samples at experimental site at i in 2011.

Soil texture	K (ppm)	P (ppm)	N (%)	OM (%)	OC (%)	pH	EC (µmohs/cm)	Depth (cm)
C	23	2	0.12	4.61	2.68	7.7	1.48	0-30

Rice was grown in an irrigated condition (flooding) until the maturity growth stage at which N rates were broadcasted onto the soil. Thus, rates of 0, 69, and 138 kg N/ha were applied. Nitrogen {as urea [(NH2)2CO]}, P (150 kg/ha as superphosphate triple) and K (150 kg/ha as KSo_4) were applied and incorporated before transplanting. Nitrogen was also applied at mid tillering (33%) and at panicle initiation (33%). The heading date for cultivars (50% of plants) was in early July, and plants were harvested from 1 to 15 August. Standard agronomic and pest management practices were used during the growing season according to local recommendations. After plots were harvested to determine rough rice yield all yield component subsamples had been collected. Yield components, that is, the total number of spikelets, percentage of filled spikelet and stem and panicle height were determined from 20 plants sampled randomly from each plot. The percentage of filled spikelets was defined as the filled grains (specific gravity ≥ 1.06 g/cm^3) as a percentage of the total number of spikelets. The percentage of filled spikelets was defined as the filled grains (specific gravity ≥ 1.06 g/cm^3) as a percentage of the total number of spikelets. Twenty rice panicles were then randomly selected from each sample, threshed, and the number of filled and blank spikelets was counted to determine components yield the average for each treatment. The total number of panicles in each sample was counted to determine panicle number m^2 (panicle density). At maturity, plots were drained approximately 2 wk before harvest when rice grain reached approximately 200 g/kg moisture content for each cultivar and treatment, a randomly selected area of 3 m^2 from each plot was harvested with a small-plot combine to determine rice yield using a 0 to 5 cm cutting height. Rough rice yield was adjusted to 120 g/kg moisture content. Aboveground biomass and grain yield were determined from all plants from a 3 m^2 (1×3 m) in each plot. All data were subjected to analysis of variance using SAS (version 6.12, SAS Institute, Cary, NC) with cultivar and N rate. The statistical model used included sources of variation due to replication, nitrogen, cultivar, and interactions of nitrogen × cultivar. Data from each sampling date were analyzed separately. Means were tested by DMRT at P = 0.05 [DMRT (0.05)].

3. Results and Discussion

Based on the results in Table 3 analysis of variance was significant for grain yield and harvest index in nitrogen rates, rice cultivars and rice cultivars ×nitrogen interaction at 1% probability. The nitrogen application 138 kg N with 6124.2 kg and control with 4132.0 kg was the highest and lowest of grain yield, respectively. In contrast, control and 138 kg N with 54.68 and 51.23 % had the highest and lowest harvest index. There was a negative correlation between harvest index with stem length (-0.56**) (Table 5). So overall, with increasing N fertilizer had increased grain yield and harvest index had decreased. There was a positive correlation between grain yield with the number of panicles, the number of total tiller per hill and tiller produce percentage (0.84**, 0.84**, 0.63**, respectively) (Table 5). Stem length and panicle length was significant by nitrogen rates and rice cultivars at 1% probability level (Table 3). So that the stem length and panicle length with the application of 138 kg N and controlwith98. 63 and 27.40 cm were the maximum and 78.42 and 24.64 cm were the lowest, respectively. So the overall length of the stem and panicle will increase with increasing nitrogen (Table 4). There was a positive correlation between panicle length with the number of total spikelets (0.55**) and a negative correlation with spikelet fertility percentage (-0.71**) (Table 5).

In rice cultivars, the grain yield of Neda with 6095.3 kg was the maximum and Khazar with 4046.7 kg/ha was the lowest. The highest and the lowest of harvest indexes were obtained by Neda and Tarom with 58.37 and 47.13%, respectively. Shiroudi cultivar with 29.06 cm had the maximum panicle length and Tarom with 120.07 cm stem length had the highest. Panicle length and stem length of Neda cultivar with 23.45 and 71.14 cm were the shortest, respectively (Table4). Interaction of rice cultivars ×nitrogen rates was obtained the highest and lowest in grain yield by $N_{138}C_3$ and N_0C_2 with 7407.50 and 3190.00 kg/ha and in harvest index by $N_{138}C_3$ and $N_{138}C_5$ with 60.52 and 36.91 %, respectively.

The number of panicles per square meter was significant by nitrogen rates, rice cultivars and rice cultivar × nitrogen interaction at 1% probability level. That application of 138 kg N was with 342.95 and 242.21 panicles were the highest and lowest, respectively. Neda and Khazar cultivars with 351.27 and 195.08 panicles were obtained the highest and lowest number of panicles per square meter, respectively. There was a positive correlation between the number of panicles with the number of the total tiller and tiller produce percentage (0.97** and 0.64**, respectively) (Table 5). Generally, increasing N fertilizer will increase the number of panicles per square meter. Interaction of rice cultivars × nitrogen rates was obtained the highest and lowest in the number of panicles per square meter by $N_{138}C_3$ and N_0C_2 with 395.75 and 166.02 panicles, respectively. The total number of spike lets per panicle and spikelet fertility percentage was significant by nitrogen rates and rice cultivars at the 1 %probability level. Application 138 kg N and control with 117.39 and 94.43 spikelets were the highest and lowest, respectively. In contrast spikelet, fertility percentage with 78.56 and 82.45% were the lowest and highest, respectively. In Tarom and Khazar cultivars was the lowest and highest total numbers of spikelet per panicle with90.17 and 130.16, respectively. The spikelet fertility percentage of Nemat and Tarom cultivars were the highest and lowest with 95.46 and 70.83%, respectively. There was a negative correlation between spikelet fertility percentage with tiller produce percentage (-0.52**) (Table 5).

The number of total tiller per hill and tiller produce percentage was significant by nitrogen rates and rice cultivars at the 1 % probability level. So that application of 138 kg N with 11.25 tiller and 81.70% the most and 7.79 tillers and 78.99% the lowest were produced number of total tiller per hill and tiller produce percentage, respectively. Khazar had produced with 5.82 tillers and 73.75%, the lowest number of total tiller per hill and tiller produce a percentage. While Neda and Nemat cultivars with12.15 tiller and 86.29% had the highest number of total tiller and tiller produce a percentage. Overall the total tiller and tiller produce percentage had increased with increasing N fertilizer. Tiller produce percentage was significant in rice cultivar × nitrogen interaction at the 1% probability level. The lowest and highest were obtained tiller produce percentage by $N_{138}C_5$ and $N_{69}C_1$ with 88.79 and 69.20%, respectively. There was a positive correlation between the number of the total tiller with tiller produce percentage (0.80**) (Table 5 and 6).

Table 3. Mean square of analysis variance of nitrogen rates on yield and yield components of rice cultivars at Sari in 2011.

ANOVA	DF	Grain yield (Kg/ha)	HI (%)	SL (cm)	PL (cm)	PN (m²)	TSNPP	SFPP (%)	TTNPH	TP (%)
Replication	3	1472406.45 **	19.37 ns	31.39 ns	2.14 *	11864.47 **	95.15 ns	37.78 *	22.19 **	98.69 **
Nitrogen	2	21044871.36 **	59.88 ns	2136.68 **	39.36 **	56344.46 **	2731.74 **	75.66 **	72.47 **	91.89 **
Error (a)	6	820540.02	8.66	32.54	0.29	1850.86	53.33	11.06	2.68	9.92
Cultivar	4	7910566.67 **	198.88 **	4108.24 **	79.6 **	48203.26 **	3766.36 **	1170.10 **	82.33 **	429.41 **
C*N	8	525640.46 **	81.61 **	73.14 ns	1.08 ns	2550.02 **	27.68 ns	16.41 ns	2.05 ns	56.71 **
Error	36	137761.71	21.31	36.67	0.59	754.09	71.06	12.34	1.28	7.27
C.V. (%)		7.04	8.70	6.74	2.96	9.8	7.86	4.36	11.37	3.31

** and * significant in 1 and 5% levels, respectively. ns, non-significant. HI: Harvest Index, SL: Stem Length, PL: Panicle Length, PN: Panicle Number, TSNPP: Total Spikelet Number Per Panicle, SFPP: Spikelet Fertility Per Panicle, TTNPH: Total Tiller Number Per Hill, TP: Tiller Production

Table 4. Mean comparison of nitrogen rates on yield and yield components of rice cultivars at Sari in 2011.

Treatments	Grain yield (Kg/ha)	HI (%)	PL (cm)	SL (cm)	PN (m²)	TSNPP	SFPP (%)	TTNPH	TP (%)
N_0	4132.0 ^{c}	54.68 ^{a}	24.64 ^{c}	78.42 ^{c}	242.21 ^{c}	94.43 ^{c}	82.45 ^{a}	7.79 ^{b}	78.99 ^{b}
N_{69}	5552.6 ^{b}	53.22 ^{ab}	26.31 ^{b}	92.29 ^{b}	321.57 ^{b}	109.72 ^{b}	80.43 ^{ab}	10.89 ^{a}	83.22 ^{a}
N_{138}	6124.2 ^{a}	51.23 ^{b}	27.43 ^{a}	98.63 ^{a}	342.95 ^{a}	117.39 ^{a}	78.56 ^{b}	11.25 ^{a}	81.70 ^{a}
C_1	5692.8 ^{b}	53.33 ^{b}	28.53 ^{a}	83.52 ^{c}	348.08 ^{a}	101.08 ^{c}	70.83 ^{c}	12.11 ^{a}	86.29 ^{a}
C_2	4046.7 ^{d}	52.01 ^{b}	25.61 ^{b}	91.13 ^{b}	195.08 ^{c}	130.61 ^{a}	80.82 ^{b}	5.82 ^{d}	73.75 ^{b}
C_3	6095.3 ^{a}	58.37 ^{a}	23.45 ^{c}	71.14 ^{d}	351.27 ^{a}	93.25 ^{d}	82.96 ^{b}	12.15 ^{a}	86.06 ^{a}
C_4	5630.8 ^{b}	54.37 ^{b}	29.06 ^{a}	82.02 ^{c}	309.77 ^{b}	120.80 ^{b}	72.33 ^{c}	10.54 ^{d}	84.46 ^{a}
C_5	4882.3 ^{c}	47.13 ^{c}	23.99 ^{c}	120.07 ^{a}	307.02 ^{b}	90.17 ^{d}	95.46 ^{a}	9.25 ^{c}	75.96 ^{b}

Values within a column followed by same letter are not significantly different at Duncan ($P \leq 0.05$). N rates of 0, 69, and 138 kg N/ha as (N_0), (N_{69}) and (N_{138}), and rice cultivars including Nemat (C_1), Khazar(C_2), Neda (C_3), Shirodi (C4), and Tarom (C_5).

Table 5. Correlation traits of nitrogen rates on yield and yield components of rice cultivars at Sari in 2011.

Traits	1	2	3	4	5	6	7	8	9
1. Grain yield	1								
2. Harvest index	0.09	1							
3. Panicle length	0.38 **	-0.03	1						
4. Stem length	0.02	-0.56 **	0.00	1					
5. Panicle number	0.84 *	-0.09	0.27 *	0.11	1				
6. Total spikelet number per panicle	0.11	0.00	0.55 **	0.08	-0.16	1			
7. Spikelet fertility per panicle	-0.31	-0.26 *	-0.71 **	0.48 **	-0.22	-0.44 **	1		
8. Total tiller number per hill	0.84 **	0.06	0.31 *	-0.02	0.97 **	-0.15	-0.35 **	1	
9. Tiller production per hill	0.63 **	0.42 **	0.36 **	-0.34 *	0.64 **	-0.08	-0.52 **	0.80 **	1

Table 6. Mean comparison of interaction effects of nitrogen rates on yield and yield components of rice cultivars at Sari in 2010.

Interactions	Grain yield (Kg/ha)	HI (%)	PL (cm)	SL (cm)	PN (m^2)	TSNPP	SFPP (%)	TTNPH	TP (%)
N_0C_1	4666.66 ^{f}	53.79 ^{abc}	27.39 ^{c}	72.48 ^{fg}	289.50 ^{de}	90.98 f	72.95 ^{ef}	9.68 ^{efg}	82.94 ^{bc}
N_0C_2	3190.00 ^{g}	50.67 ^{bc}	22.66 ^{g}	81.45 ^{ef}	166.06 ^{h}	118.33 ^{bc}	81.04 ^{bcd}	4.69 ^{j}	70.30 ^{f}
N_0C_3	4508.33 ^{f}	57.28 ^{ab}	21.92 ^{g}	63.07 ^{h}	283.56 ^{e}	78.36 ^{g}	84.98 ^{b}	9.49 ^{i}	83.33 ^{bc}
N_0C_4	4686.66 ^{f}	56.05 ^{abc}	28.03 ^{bc}	73.88 ^{fg}	259.31 ^{ef}	105.76 ^{cde}	77.33 ^{de}	8.49 ^{gh}	81.15 ^{cde}
N_0C_5	3608.33 ^{g}	55.41 ^{abc}	22.21 ^{g}	101.23 ^{bc}	212.62 ^{g}	78.73 ^{g}	95.96 ^{a}	6.58 ^{i}	77.23 ^{e}
$N_{69}C_1$	5620.00 ^{de}	52.37 ^{bc}	28.29 ^{bc}	85.57 ^{de}	377.62 ^{ab}	100.93 ^{def}	71.76 ^{f}	13.47 ^{ab}	88.79 ^{e}
$N_{69}C_2$	4494.99 ^{f}	53.21 ^{abc}	25.54 ^{de}	91.43 ^{d}	189.68 ^{gh}	130.47 ^{b}	83.13 ^{bc}	5.58 ^{ij}	72.80 ^{f}
$N_{69}C_3$	6370.00 ^{bc}	57.32 ^{ab}	23.95 ^{f}	71.65 ^{gh}	374.50 ^{ab}	97.35 ^{ef}	82.01 ^{bcd}	12.98 ^{abc}	86.48 ^{ab}
$N_{69}C_4$	5936.66 ^{cd}	54.13 ^{abc}	29.00 ^{b}	84.62 ^{de}	341.06 ^{bc}	126.11 ^{b}	70.22 ^{f}	11.83 ^{bcd}	86.49 ^{ab}
$N_{69}C_5$	5341.16 ^{e}	49.06 ^{c}	24.79 ^{def}	128.20 ^{a}	325.00 ^{cd}	93.75 ^{ef}	95.02 ^{a}	10.58 ^{def}	81.52 ^{cd}
$N_{138}C_1$	6791.66 ^{b}	53.64 ^{abc}	25.90 ^{d}	92.59 ^{cd}	377.12 ^{ab}	111.32 ^{cd}	67.80 ^{f}	13.19 ^{ab}	87.14 ^{ab}
$N_{138}C_2$	4455.00 ^{f}	52.15 ^{bc}	27.64 ^{c}	103.51 ^{b}	229.50 ^{fg}	143.03 ^{a}	78.29 ^{cd}	7.18 ^{hi}	78.15 ^{de}
$N_{138}C_3$	7407.50 ^{a}	60.52 ^{a}	24.47 ^{ef}	78.72 ^{efg}	395.75 ^{a}	104.03 ^{def}	81.88 ^{bcd}	13.98 ^{a}	88.37 ^{a}
$N_{138}C_4$	6269.16 ^{bc}	52.93 ^{abc}	30.15 ^{a}	87.57 ^{de}	328.93 ^{cd}	130.55 ^{b}	69.45 ^{f}	11.31 ^{cde}	85.74 ^{ab}
$N_{138}C_5$	5697.50 ^{de}	36.91 ^{d}	24.99 ^{def}	103.78 ^{b}	383.43 ^{ab}	98.02 ^{def}	95.40 ^{a}	10.59 ^{def}	69.12 ^{f}

Values within a column followed by the same letter are not significantly different at Duncan ($P \leq 0.05$). N rates of 0, 69, and 138 kg N ha^{-1}as (N_0), (N_{69}), and (N_{138}) and rice cultivars including Nemat (C_1), Khazar(C_2), Neda (C_3), Shirodi (C4), and Tarom (C_5).

Although it is clear that nitrogen increases the yield and yield components in rice and the results of research on rice and other crops have been reported. But the response of different cultivars of rice, including traditional and old cultivars with new and breeding cultivars with the aim the changing trend in yield components of cultivars in the breeding as the comparison is reported to be less. Generally, spikelet fertility percentage and harvest index were the only two traits that with increasing N fertilizer had decreased and other traits were increased. Also, in rice cultivars some traits at one cultivar were minimum and in some others were maximum for other cultivars. So that Nemat cultivar is the new and breeding cultivar so spikelet fertility percentage and tiller produce percentage was the highest. Khazar is an old and breeding cultivar had the highest total number of spikelet per panicle however grain yield, panicle number per square meter and the number of tiller and tiller production percentage were the lowest. Neda cultivar that is a new and breeding improved cultivars grain yield, harvest index, number of panicle per square meter and tiller number were highest and were lowest in the stem and panicle length. Shiroudi cultivar only had the highest panicle length. Tarom is an old and traditional cultivar that has a lower harvest index and the total number of spikelets per panicle and was highest spikelet fertility percentage per panicle and stem length.

So, Tarom, because has the high stem length, produced more straw and this has reduced the harvest index because it was low the total number of spikelet per panicle. In fact, it had a lower photosynthetic sink and considering high straw it was high photosynthetic organs and this has increased the spikelet fertility percentage. For Tarom, the low harvest index is the most important problem in the reduction of grain yield and at the same time panicle length, the number of tillers and the total number of spike lets per panicle a factor reduction has been operating in grain yield. Neda was the most suitable cultivar of this study was due to the high grain yield with harvest index and the number of panicles per square meter was high despite the plant height was low. So the Neda in the transfer of the dry matter to grain has been successful. Khazar was an old, traditional and modified cultivar due to lack of tiller production and thus reduce the number of panicle per square meter was produced the lowest grain yield that the main weakness is that this cultivar despite being the destination of photosynthetic the total number of spikelet per panicle was high. Nemat and Shiroudi cultivar terms of grain yield were at one level in the panicle length, stem length, spikelet fertility percentage were similar. But, Nemat in the number of panicles per square meter was close to Neda cultivar and the total number of spikelets per panicle and spikelet fertility percentage was weak. While Shiroudi was lower in the number of panicle per square meter than Tarom but, although the total number of spikelet per panicle was high and spikelet fertility percentage it was low. In general, in rice breeding is the appropriate cultivar is high the number of panicle per square meter and harvest index.

According to the results of interaction grain yield and harvest index were observed that in nitrogen rates had the highest grain yield of Shiroudi and Nemat cultivars which can be found that require less fertilizer than other cultivars and efficiency of its production was high in control. But in Shiroudi with the increased nitrogen fertilizer, although it increased grain yield harvest index was reduced the process trend. It can be received from the application of more nitrogen fertilizer may reduce grain yield and this cultivar has the potential to receive more nitrogen fertilizer. But contrary Nemat was a trend of increase in the grain yield and the harvest index was fixed. This indicates that this cultivar can be fixed into photosynthetic material produced to grain yield and for this cultivar can be increased nitrogen fertilizer. But to Neda cultivar at 69 and 138 kg nitrogen, grain yield was increased. The best cultivar was efficiency-fertilizer because the harvest index was also increased and increased application of nitrogen will increase grain yield. Grain yield in Khazar and Tarom cultivars was low in control and grain yield was increased with application 69 kg N. But grain yield application of 138 kg nitrogen did not differ with the application of 69 kg nitrogen. Despite in Khazar cultivar was fixed harvest index, application of nitrogen fertilizer had increased but the grain yield did not respond to increased nitrogen application and Khazar cultivar had little efficiency-fertilizer. Tarom did not respond like the Khazar to increase nitrogen application but a different trend in this cultivar a severity reduction was in harvest index indicate that is not efficiency-fertilizer by Tarom.

4. Conclusion

Overall, the results of this study can be found that cultivars of the rice with increasing nitrogen fertilizer had increase grain yield, cultivars are desirable when a cultivar can be more desirable that harvest index increased with increasing fertilizer nitrogen or fixed. If it is proved that the harvest index is low efficiency-fertilizer and increase the harvest index was high efficiency-fertilizer. Thus, among the cultivars in terms of efficiency-fertilizer, Neda was the best cultivar and then Shiroudi and Nemat cultivars and finally are Tarom and Khazar. The most important component of yield was the number of tiller per hill in the process of improving and breeding rice and finally the number of panicles per square meter. Application of nitrogen fertilizer and increasing also has the most influence on yield of this component. But the second change increased harvest index by reducing plant height has also been cultivated in the process of improving and breeding rice cultivars. In Khazar and Tarom cultivars increase nitrogen fertilizer application led to increasing panicle length, stem length, number of spike lets per panicle was taken while the increase the number of panicles per hill was low. But contrary to three cultivars Neda, Nemat and Shiroudi was low panicle length, stem length and number of spike lets per panicle variation and the most effect of the nitrogen fertilizer in order to increase the number of tiller per hill and ultimately the number of panicles per square meter. Therefore, in the breeding trend in 1990-2010 modern rice cultivars were more efficient at recovering N than older cultivars based on results.

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How to cite this paper:

Hghshenas, H., Ghanbari Malidarreh, A., 2021. Response of yield and yield components of released rice cultivars from 1990 to 2010 to nitrogen rates. *Cent. Asian J. Plant Sci. Innov.*, **1**, 23-31.