Original Research Article

EFFECT OF GRADED LEVELS OF NITROGEN APPLICATION ON YIELD AND YIELD ATTRIBUTES IN DIFFERENT RICE VARIETIES

ABSTRACT:

As the application of nitrogen fertilizers in agriculture is increasing day by day which is leading to environmental pollution and increasing the cost of cultivation, a field experiment was conducted at IIRR farm, Rajendranagar, Hyderabad during three consecutive seasons (Kharif-2020, Rabi-2021 and Kharif-2021) to study the effect of different nitrogen levels application on yield and yield attributes in rice. The experiment was laid out in split plot design with four nitrogen levels as main plots, fourteen varieties as sub plots and replicated thrice. Among the nitrogen treatments N150 recorded highest number of panicles, more panicle length and higher grain yield which is on par with N100. N0 recorded lowest number of panicles, less panicle length, lowest grain yield and harvest index. Among the varieties highest 1000 grain weight was noticed in Birupa while N-22 in Kharif-2020 and Kharif-2021 and, Nidhi in Rabi-2021 recorded the lowest value. Birupa showed least reduction in grain yield with N50 compared to N100 in all three tested seasons. MTU-1010 recorded highest grain yield whereas lowest grain yield was noticed in N-22. Higher harvest index was observed in MTU-1010 in Kharif-2020 and Rabi-2021 and, IR-64 in Kharif-2021 while lowest value was recorded in N-22 in Kharif-2020 and Rabi-2021 and, Nidhi in Kharif-2021.

Keywords: Rice, Nitrogen, Grain yield and Harvest index

INTRODUCTION:

Global demands for food and fiber will increase up to 70% by 2050 [1]. Globally, rice is cultivated in around 167.2 million ha, with a total production of 769.7 million tons with an average productivity of 4.10 tonnes ha^{-1}. An increase of 2% - 3% year^{-1} in rice production has to be maintained to ensure the self-sufficiency in rice, within limited arable land [2]. Further, the use of chemical fertilizer has been rapidly increasing to meet the continuously growing demands of increased yield from the existing land. Particularly in highly populated developing countries, the increasing rate of fertilizer use is dramatic. However, this increased rate of fertilizer has negative impact on food safety, environment and soil health. It has been reported that, the use of excess N fertilizers increases NO_3-N and NH_4-N in underground water which is a threat for human health. Chemicals like KCl, $NaNO_3$, K_2SO_4 and NH_4Cl added in soil due to application of fertilizers are responsible for demolishing soil structure [3]. Thus, it is important to minimize the use of chemical fertilizers.

Nitrogen (N) is a vital element and the application of N fertilizer could significantly increase yield formation in rice. The increased rice productivity has been associated with a 20 fold increase in the global use of N fertilizer applications during the past five decades and this is expected to increase at least threefold by 2050. The global N fertilizer consumption increased by 800% from 1960 to 2012. Although the rate of cereal grain yield increased by 65% between 1980 and 2010, the consumption of chemical fertilizers increased by 512%. World utilization of nitrogen fertilizer has reached approximately by 120 million tons in 2019 [4]. High input of N fertilizers leads to low nitrogen use efficiency due to the rapid loss of nitrogen through volatilization, denitrification, leaching in the soil-flood water system, surface runoff, and wind erosion. This results in significant environmental problems such as causes soil acidification, water eutrophication, air pollution, algal blooms, hypoxia, and public health issues due to consumption of N contaminated groundwater [5].

Importantly, the efficient use of nitrogen is recognized as a production factor for rice, but it has always been a problem to improve the N utilization rate of the rice plant and to increase efficiency of absorbed nitrogen for grain production. Further, nitrogen fertilizer is costly, thus it is important to minimize the losses of nitrogen fertilizers and maximize the economic utility. Application of the appropriate level of nitrogen fertilizers is a major discussion with regards to economic viability of rice crop production. Hence, this study was conducted with the objective to evaluate the effect of different nitrogen levels on rice yield and yield attributes.

MATERIAL AND METHODS:

A field experiment was conducted at ICAR- Indian Institute of Rice Research, Hyderabad during Kharif-2020, Rabi-2021 and Kharif-2021. The experiment was laid out in a split plot design with three replications. Nitrogen levels were given as N0 (0 Kg N ha^{-1}), N50 (50 Kg N ha^{-1}), N100 (100 Kg N ha^{-1}) and N150 (150 Kg N ha^{-1}) taken as main plots. The seedlings of fourteen rice varieties were selected as sub plots. The varieties were sown separately in raised bed nursery and twenty five day old seedlings were transplanted into main field by adopting a spacing of 20 cm between rows and 10 cm with in a row. Nitrogen applied as per treatment in form of urea in 3 splits at basal, maximum tillering and flowering stage. Phosphorus was applied as single super phosphate at the rate of 60 kg ha^{-1} and Potash as muriate of potash at the rate of 40 kg ha^{-1} as a basal dose at the time of transplanting. Irrigation and weed management was carried as per schedule. Prophylactic measures were taken to prevent crop damage due to pests and diseases.

From each treatment five hills were selected at physiological maturity and the panicles were separated from the plants and were counted and expressed as panicle number m^{-2}. Panicles were kept in oven and dried at 80°C until constant weight is obtained and expressed as panicle weight in g m^{-2}. Panicles from five hills were selected randomly from each plot at physiological maturity and the panicle length was recorded (cm) and the average length was workout. The filled and unfilled grains were separated from the panicle and were counted using seed counter and expressed as number of filled grains $panicle^{-1}$ and number of unfilled grains $panicle^{-1}$.

Spikelet sterility expressed in per cent was calculated by using the formula

$$\text{Spikelet sterility (\%)} = \frac{\text{Number of filled grains}}{\text{Total number of spikelets}} \times 100$$

The grain samples from each treatment were collected and from them weight of thousand grains was recorded and expressed in grams. At physiological maturity, panicles from each treatment were harvested, sun dried, threshed, cleaned and weight of grains was recorded after reducing grain moisture content to 14% and expressed in g m^{-2}.

Harvest index is defined as ratio of economic yield to total biological yield (Donald, 1962) and is expressed in percentage. Harvest index of rice was calculated by using the formula

$$\text{Harvest Index (\%)} = \frac{\text{Economic yield (g plant}^{-1}\text{)}}{\text{Total biological yield (g plant}^{-1}\text{)}} \times 100$$

RESULTS AND DISCUSSION:

Panicle number m^{-2}:

Data presented in table 1 reveals that significant differences were observed between N treatments for panicle number m^{-2}. N0 recorded the lowest mean panicle number m^{-2} (269.9, 280.7 and 260.0) in Kharif-2020, Rabi-2021 and Kharif-2021, respectively. Increasing N application has increased the panicle number m^{-2} and highest mean value was observed with N150 (361.0, 347.9 and 333.9) in Kharif-2020, Rabi-2021 and Kharif-2021, respectively. Metwally *et al*. [6] also reported that nitrogen application of 165 kg N ha^{-1} improved the number of panicles $hill^{-1}$. The role of nitrogen in the stimulation of cell division may have led to more panicle formation during the productive stage in rice. Similar results were also reported by Abd EL-Hamed [7] and Sorour *et al*. [8]. The tested varieties differed significantly for panicle number m^{-2}. Significant interaction was observed between varieties and seasons. IR-64 (428.0) in Kharif-2020, GQ-25 (350.5) and Vasumathi (351.2) in Rabi-2021 and, Heera (373.4) in Kharif-2021 recorded higher mean panicle number m^{-2} whereas Birupa in Kharif-2020 (262.5) and Rabi-2021 (286.5) and, Anjali (263.7) in Kharif-2021 recorded the lowest. There was a significant interaction between N treatments and varieties for panicle number m^{-2}.

Panicle weight (g m^{-2}):

A perusal of data on panicle weight m^{-2} was presented in table 2. There were significant differences between the N treatments for panicle weight m^{-2}. Lowest weight was noticed with N0 (356.3, 368.1 and 374.3) in Kharif-2020, Rabi-2021 and Kharif-2021, respectively and increasing N application has increased the mean panicle weight. Highest mean panicle weight was recorded with N150 (580.2, 586.9 and 559.8) in Kharif-2020, Rabi-2021 and Kharif-2021, respectively. Significant interaction was observed between varieties and seasons. Significant differences were observed among the varieties for panicle weight. MTU-1010 in Kharif-2020 (554.2) and Rabi-2021 (546.4) and, Indira (551.3) and MTU-1010 (550.7) in Kharif-2021 recorded higher mean panicle weight while lowest was observed in N-22 (369.6, 365.5 and 318.3) in Kharif-2020, Rabi-2021 and Kharif-2021, respectively. Significant interaction was observed between N treatments and varieties for panicle weight m^{-2}. Fageria and Santos [9] reported that panicle weight was significantly influenced by N and genotype treatments.

Panicle length (cm):

Panicle length differed significantly between different N treatments (table 3). Lowest mean panicle length was observed with N0 (21.4, 21.3 and 21.4) in Kharif-2020, Rabi-2021 and Kharif-2021, respectively. Increasing N application has increased length of panicle and highest mean panicle length was recorded with N150 (23.1) in all three tested seasons. Similar findings were also obtained by Metwally *et al*. [10] and Yoseftabar [11], who reported the maximum panicle length at highest level of nitrogen application. Significant differences were noticed among the tested varieties for panicle length. Significant interaction was observed between varieties and seasons. Highest mean panicle length was observed in Vasumathi (24.3, 24.1 and 24.4) while lowest was recorded in N-22 (19.9, 19.8 and 19.6) in Kharif-2020, Rabi-2021 and Kharif-2021, respectively. Significant interaction was observed between N treatments and varieties for panicle length.

Filled grains panicle^{-1}:

Data presented in table 4 showed significant differences between N treatments for number of filled grains panicle^{-1}. The lowest mean number of filled grains pan^{-1} was observed with N0 (110.3, 110.5 and 109.9) in Kharif-2020, Rabi-2021 and Kharif-2021, respectively. Increasing N application has significantly increased the number of filled grains panicle^{-1} and highest mean number was recorded with N100 (145.4, 155.1 and 142.6) in Kharif-2020, Rabi-2021 and Kharif-2021, respectively. Similar results have been obtained by Abd EL-Hamed [7] and Sorour *et al*. [8]. The tested varieties differed significantly for number of filled grains panicle^{-1}. Significant interaction was observed between varieties and seasons. Highest mean number of filled grains panicle^{-1} was noticed in Indira (165.1, 161.8 and 154.4) in Kharif-2020, Rabi-2021 and Kharif-2021, respectively while lowest was recorded in IR-64 (91.2) in Kharif-2020 and, N-22 in Rabi-2021 (105.9) and Kharif-2021 (106.1). This might be due to source sink interaction, meaning maximum proportion of N source is used to produce maximum spikelets panicle^{-1} and grain filling [12]. Significant interaction was observed between N treatments and varieties for number of filled grains panicle^{-1}.

Unfilled grains panicle^{-1}:

Data presented in table 5 revealed that there were significant differences between N treatments for number of unfilled grains panicle^{-1}. N0 (25.9, 31.0 and 23.7) recorded the highest mean number of unfilled grains panicle^{-1} whereas lowest was observed with N100 (11.5, 14.3 and 14.5) in Kharif-2020, Rabi-2021 and Kharif-2021, respectively. Increasing N application has decreased number of unfilled grains panicle^{-1} up to N100, but increased with N150. This increase in number of unfilled grains with N150 might be associated with production of more number of panicles hill^{-1} and photo assimilation. Significant differences were noticed among the varieties for number of unfilled grains panicle^{-1}. Interaction between varieties and seasons was found to be significant. N-22 and Nidhi in Kharif-2020 (24.6), Heera (26.5) in Rabi-2021 and Birupa (24.7) in Kharif-2021 recorded higher mean number of unfilled grains panicle^{-1} while lowest was noticed in Vasumathi (12.9) in Kharif-2020, MTU-

1010 (15.1) in Rabi-2021 and IR-64 (12.0) in Kharif-2021. Interaction between N treatments and varieties for number of unfilled grains panicle^{-1} was found to be significant. These results are similar to those obtained by Metwally *et al*. [13]; Ghoneim [14].

Spikelet sterility (%):

Spikelet sterility differed significantly among different N treatments (figure 1). Spikelet sterility has decreased with increasing N application up to N100 and slightly increased with N150. Increase in spikelet sterility with N150 compared to N100 may be attributed to production of more number of panicles hill^{-1} in N150 which affected partitioning and translocation of assimilates to grain. Application of heavy nitrogen increases tillering as well as spikelet number per plant thus reduces the number of engorged pollen grains per anther and leading into increased spikelet sterility [15]. Significant differences were noticed among the tested varieties for spikelet sterility. Interaction for spikelet sterility was found to be significant between varieties and seasons. Highest mean spikelet sterility was observed in N-22 in Kharif-2020 and Rabi-2021 and, in Heera in Kharif-2021. MTU-1010 recorded lowest spikelet sterility in all three tested seasons. Significant interaction was observed between N treatments and varieties for spikelet sterility.

Spikelets panicle^{-1}:

It clearly evident from figure 2 that significant differences were observed between N treatments for number of spikelets panicle^{-1}. The lowest mean number of spikelets panicle^{-1} was observed with N0 (136.3, 141.5 and 133.7). Increasing N application has significantly increased the number of spikelets panicle^{-1} and higher mean number of spikelets panicle^{-1} was recorded with N100 (156.8, 169.3 and 157.1) and N150 (157.6, 168.4 and 157.6) in Kharif-2020, Rabi-2021 and Kharif-2021, respectively. The tested varieties differed significantly for number of spikelets panicle^{-1}. Significant interaction was observed between varieties and seasons. Highest mean number of spikelets panicle^{-1} was noticed in Indira (181.9, 182.9 and 174.4) in in Kharif-2020, Rabi-2021 and Kharif-2021, respectively whereas lowest was observed in IR-64 (108.1) in Kharif-2020 and, Tella Hamsa (119.9) in Rabi-2021 and N-22 (120.0) in Kharif-2021. Significant interaction was observed between N treatments and varieties for number of spikelets panicle^{-1}. Ding *et al*. [16] found that nitrogen fertilizer increases spikelet number per panicle by enhancing cytokinin synthesis in rice.

1000 grain weight (g):

Significant differences were noticed among N treatments for mean 1000 grain weight. Increasing N application has increased 1000 grain weight. N150 (22.5, 21.7 and 23.1) has recorded highest mean 1000 grain weight while lowest was observed with N0 (20.8, 20.8 and 21.0) in Kharif-2020, Rabi-2021 and Kharif-2021, respectively. The results are in accordance with Metwally *et al*. [13], Ghanbari-Malidareh [17] and Sorour *et al*. [8] who reported promoting effects of nitrogen on 1000-grain weight. The tested varieties differed significantly for 1000 grain weight. Interaction between varieties and seasons for 1000 grain weight was found to be significant. Birupa (25.5, 24.6 and 25.5) recorded highest mean 1000 grain weight in Kharif-2020, Rabi-2021 and Kharif-2021, respectively while lowest was observed in N-22 in Kharif-2020 (18.3) and Kharif-2021 (17.9) and, Nidhi (17.9) in Rabi-2021. Least reduction of 1000 grain weight with N50 compared to N100 was observed in Anjali (0.72%) in Kharif-2020, Tella Hamsa (0.83%) in Rabi-2021 and Daya (1.13%) in Kharif-2021. Significant interaction was observed between N treatments and varieties for 1000 grain weight.

Grain yield (g m^{-2}):

Grain yield represented in figure 3 indicates that there were significant differences between N treatments for grain yield. With increase in nitrogen application there was significant increase in the mean grain yield. Results showed that highest mean grain yield was recorded with N150. Lowest mean grain yield was observed with N0 in all three tested seasons. The studies by Koutroubas and Ntanos [18] and Gharib *et al*. [19] also reported that increasing nitrogen level up to 150 kg N ha^{-1} enhanced grain yield. Significant differences were noticed among the varieties also for grain yield. Interaction for grain yield was found to be significant between varieties and seasons. Among the varieties MTU-1010 recorded highest mean grain yield whereas lowest mean grain yield was noticed in N-22 in all three seasons. Least reduction in grain yield with N50 compared to N100 was observed in Birupa (15.94%, 16.03% and 13.73%) in Kharif-2020, Rabi-2021 and Kharif-2021, respectively. Significant interaction was observed between N treatments and varieties for grain yield. The increased grain yield could be attributed to the role of nitrogen in enhancing grain yield components i.e., number of panicles m^{-2}, panicle length, quantity of filled grains per panicle and panicle weight.

Harvest index (%):

It is revealed from figure 4 that there were significant differences between N treatments for harvest index. Lowest mean harvest index was observed with N0. Increasing N application has increased mean harvest index and highest value was recorded with N100 which is on par with N150. The tested varieties differed significantly for harvest index. Significant interaction was observed between varieties and seasons. MTU-1010 in Kharif-2020 and Rabi-2021 and, IR-64 in Kharif-2021 showed highest mean harvest index while lowest value was recorded in N-22 in Kharif-2020 and Rabi-2021 and, Nidhi in Kharif-2021. Birupa in Kharif-2020 (6.16%) and Kharif-2021 (9.95%) and, Heera (4.01%) in Rabi-2021 showed least reduction in harvest index with N50 compared to N100. Significant interaction was observed between N treatments and varieties for harvest index. Wajid *et al*. [20] also found the increase in harvest index with increasing fertilizer dose up to 250 kg N ha^{-1}.

CONCLUSION:

Application of appropriate levels of N fertilizers is one of important factor to increase grain yield in rice. The results of this study indicated that the nitrogen application of 150 kg N ha^{-1} significantly enhanced the grain yield and yield components which is on par with 100 kg N ha^{-1}. Rice varieties responded well to increasing levels of nitrogen application. Treatment of 150 Kg N ha^{-1} has shown higher panicle number and more panicle length. Among the rice genotypes MTU-1010 has recorded highest mean grain yield and lowest mean grain yield was recorded in N-22. Birupa showed least percent reduction in grain yield with 50 kg N ha^{-1} compared to 100 kg N ha^{-1}, among the tested varieties.

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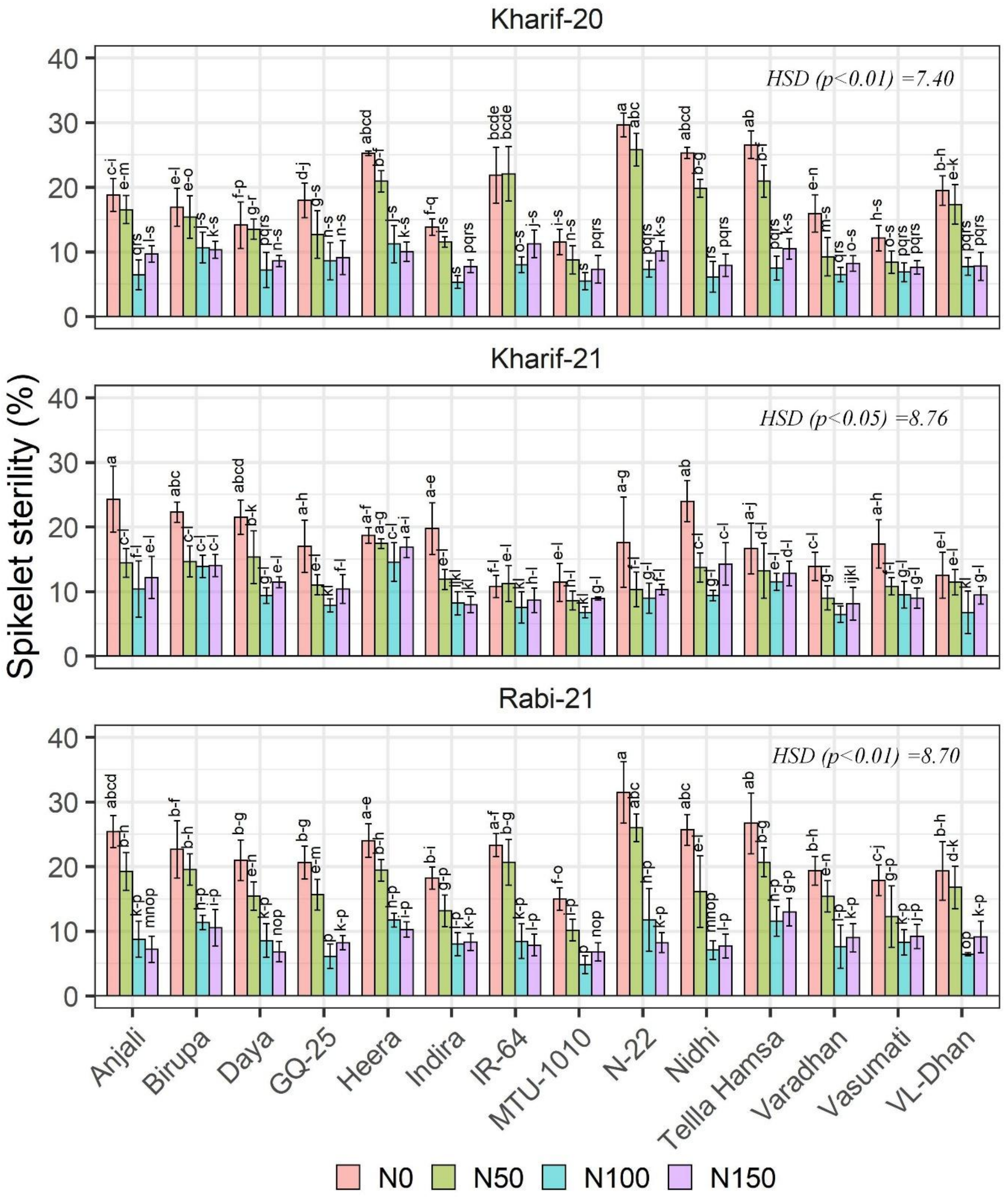
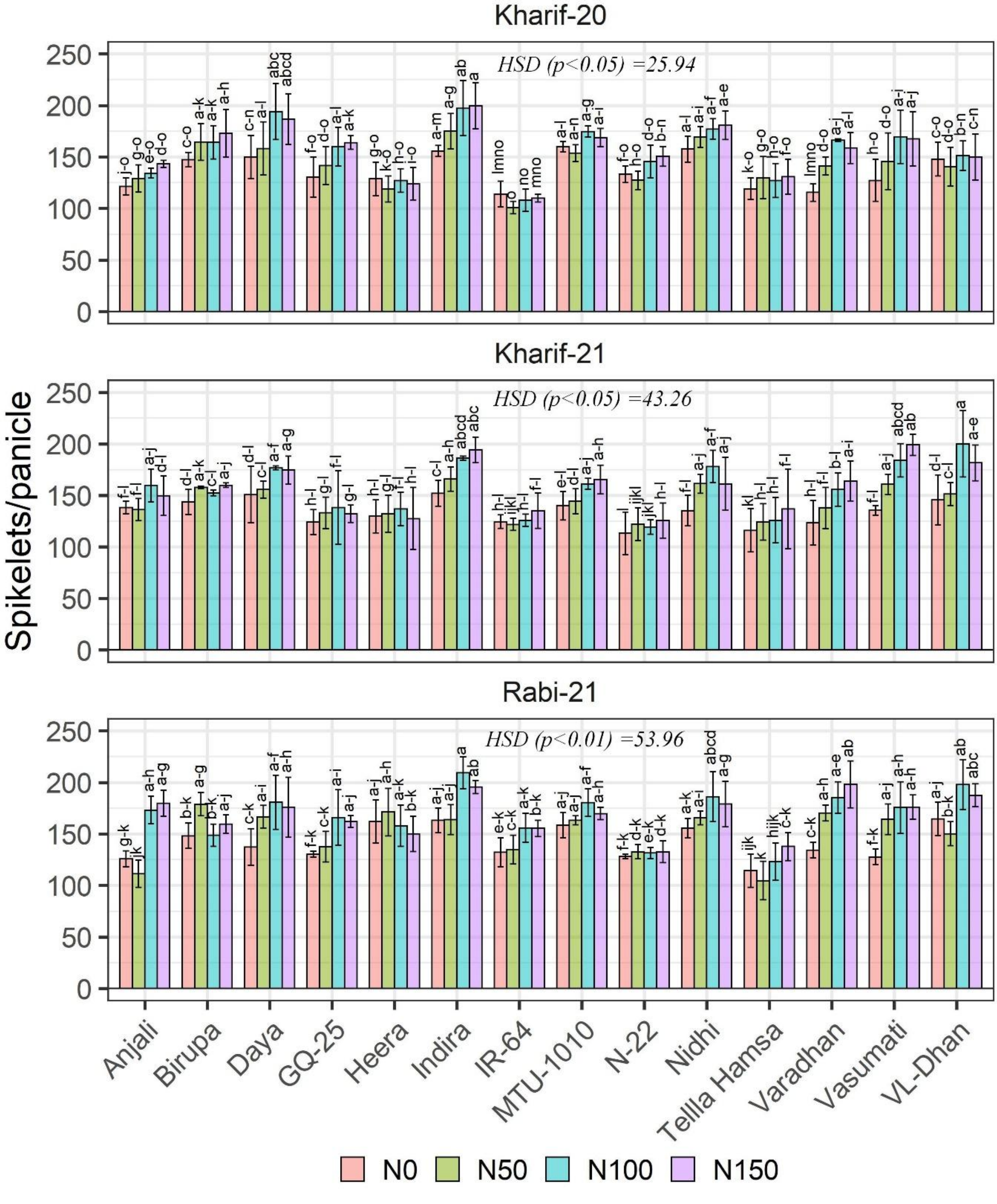
Figure 1: Influence of Nitrogen levels on spikelet sterility (%) in different rice cultivars. Each bar represents the mean of 3 replications.



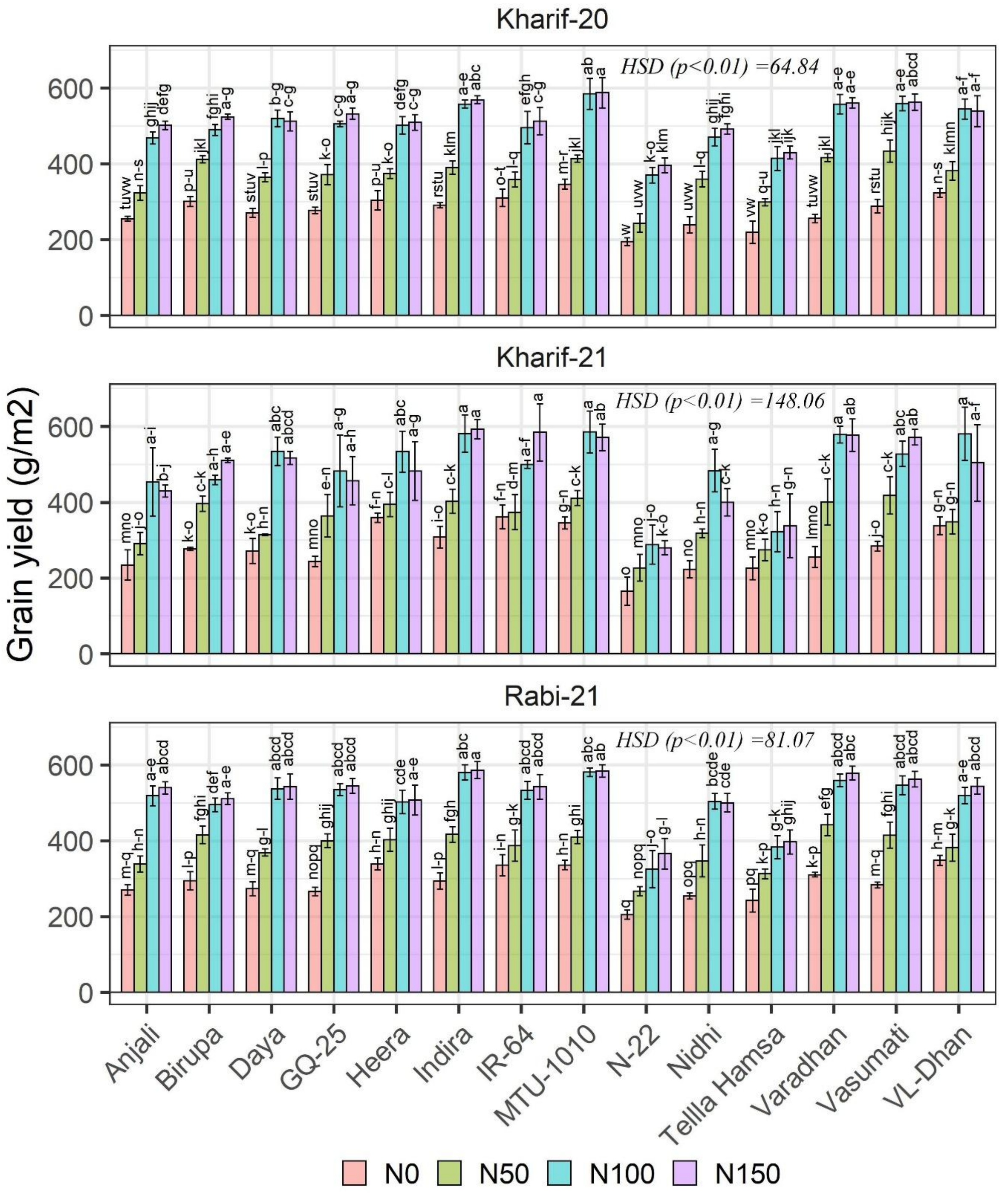
*Treatments with same letters are not significantly different.

Figure 2: Influence of Nitrogen levels on spikelets panicle^{-1} in different rice cultivars. Each bar represents the mean of 3 replications.



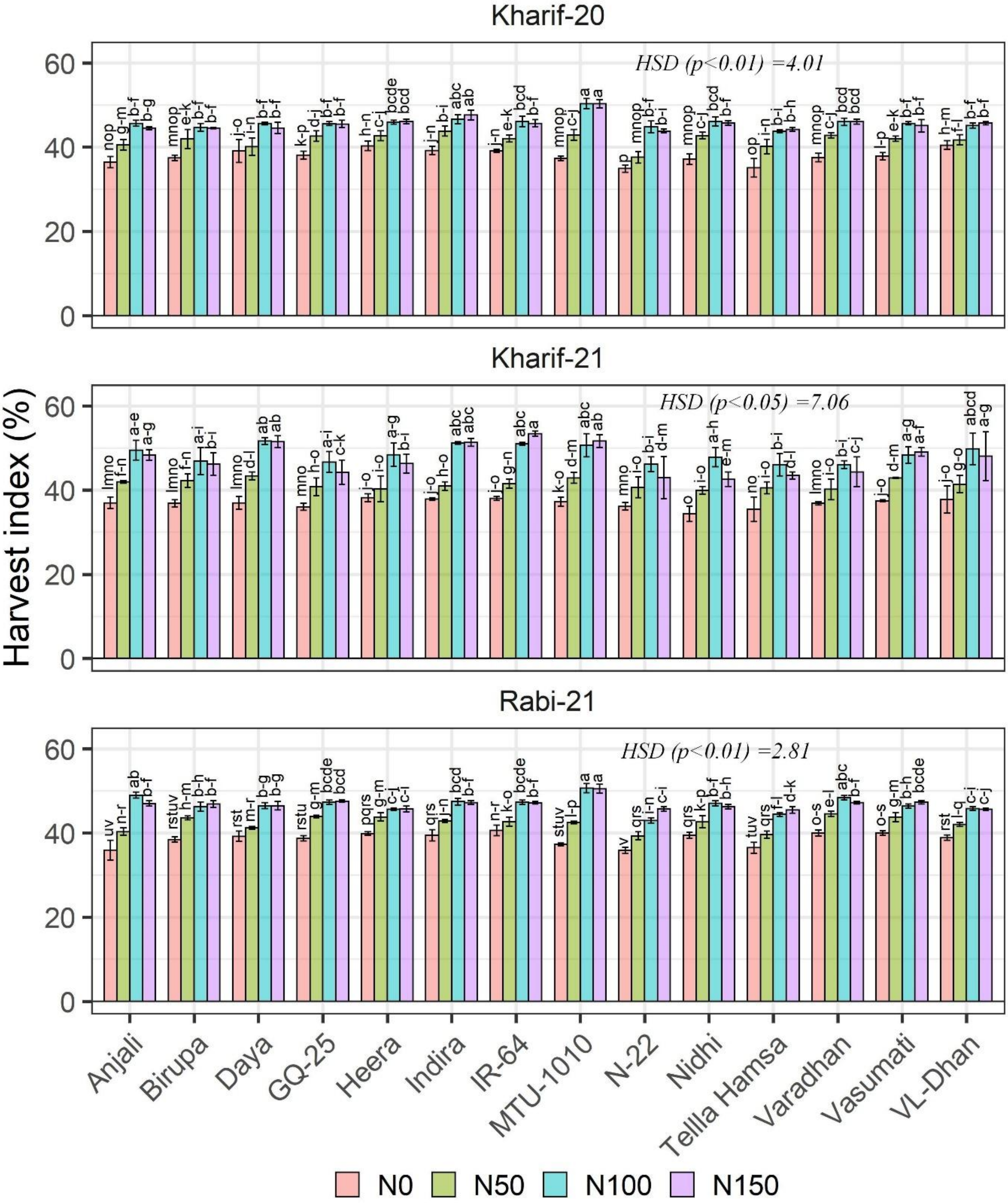
*Treatments with same letters are not significantly different.

Figure 3: Influence of Nitrogen levels on grain yield (g m^{-2}) in different rice cultivars. Each bar represents the mean of 3 replications.



*Treatments with same letters are not significantly different.

Figure 4: Influence of Nitrogen levels on harvest index (%) in different rice cultivars. Each bar represents the mean of 3 replications.



*Treatments with same letters are not significantly different.

Table 1: Influence of Nitrogen levels on number of panicles m^{-2} in different rice cultivars. Each value represents the mean of 3 replications.

	Number of panicles m^{-2}														
Varieties	Kharif-2020					Rabi-2021					Kharif-2021				
	N0	N50	N100	N150	Mean	N0	N50	N100	N150	Mean	N0	N50	N100	N150	Mean
Anjali	250.0	287.7	355.0	364.3	314.3	286.3	368.7	318.0	311.7	321.2	225.0	256.7	281.7	291.3	263.7
Birupa	221.7	258.3	281.7	288.4	262.5	236.3	259.0	334.3	316.3	286.5	229.0	276.1	291.3	308.3	276.2
Daya	249.0	293.3	307.0	314.6	291.0	301.7	298.7	369.3	374.7	336.1	269.0	278.4	355.0	357.0	314.9
GQ-25	263.3	297.7	328.0	334.9	306.0	280.0	371.0	367.0	384.0	350.5	251.0	335.0	380.0	375.7	335.4
Heera	315.3	380.7	415.7	425.0	384.2	272.7	280.0	336.7	349.0	309.6	337.0	368.3	394.3	394.0	373.4
Indira	231.0	259.0	301.7	308.3	275.0	254.3	338.3	339.0	363.0	323.7	277.0	309.7	350.0	343.0	319.9
IR-64	347.7	434.0	455.7	474.5	428.0	322.3	347.7	355.3	358.3	345.9	301.0	332.0	366.7	390.7	347.6
MTU-1010	240.0	280.0	324.3	342.7	296.8	243.7	269.3	315.7	340.7	292.3	269.0	304.7	345.7	341.3	315.2
N-22	261.7	316.0	323.3	341.1	310.5	282.0	323.0	325.0	348.3	319.6	217.0	283.7	310.0	315.7	281.6
Nidhi	254.0	312.3	322.3	329.0	304.4	280.0	308.0	355.3	365.7	327.3	259.0	286.8	343.3	329.3	304.6
Tellla Hamsa	287.0	329.0	381.3	390.0	346.8	289.3	371.0	341.3	318.7	330.1	237.0	279.8	280.7	285.0	270.6
Varadhan	287.3	338.0	355.3	378.0	339.7	287.3	301.0	315.7	309.0	303.3	229.0	305.6	340.0	335.0	302.4
Vasumati	274.0	339.3	360.0	368.4	335.4	308.3	324.3	381.0	391.0	351.2	265.0	321.3	320.3	319.0	306.4
VL-Dhan	297.0	345.3	395.0	393.9	357.8	286.0	329.0	301.7	339.7	314.1	275.0	277.3	303.7	288.7	286.2
Mean	269.9	319.3	350.5	361.0	325.2	280.7	320.6	339.7	347.9	322.2	260.0	301.1	333.0	333.9	307.0
LSD Treatment (T)	8.77**														
LSD Variety (V)	13.52*														
LSD Season (S)	NS														
LSD (T x V)	27.05*														
LSD (T x S)	NS														
LSD (V x S)	30.86**														
LSD (T x V x S)	NS														
CV (%)	9.17														

p<0.05, **p<0.001

Table 2: Influence of Nitrogen levels on panicle weight m^{-2} in different rice cultivars. Each value represents the mean of 3 replications.

	Panicle weight m^{-2}														
Varieties	Kharif-2020					Rabi-2021					Kharif-2021				
	N0	N50	N100	N150	Mean	N0	N50	N100	N150	Mean	N0	N50	N100	N150	Mean
Anjali	340.3	387.7	528.7	569.7	456.6	359.3	417.7	534.0	604.7	478.9	332.0	376.7	500.3	487.0	424.0
Birupa	371.7	488.7	555.0	592.3	501.9	369.7	481.3	561.0	573.7	496.4	422.7	478.7	583.0	543.7	507.0
Daya	320.7	442.3	576.7	582.0	480.4	347.0	451.3	598.0	611.3	501.9	389.7	389.7	588.0	611.3	494.7
GQ-25	359.0	430.3	565.7	601.0	489.0	349.7	460.3	596.5	603.0	502.4	323.0	438.7	525.0	551.3	459.5
Heera	404.0	434.3	579.0	567.7	496.3	425.7	459.0	572.3	576.0	508.3	453.3	484.0	555.0	611.7	526.0
Indira	388.0	442.7	627.7	629.0	521.8	377.0	481.3	639.7	645.7	535.9	396.0	495.3	669.7	644.0	551.3
IR-64	392.7	417.3	551.3	580.0	485.3	415.3	455.3	598.0	605.0	518.4	463.0	446.3	660.0	573.3	535.7
MTU-1010	413.0	492.3	652.7	658.7	554.2	404.7	486.0	644.4	650.7	546.4	426.3	484.0	639.7	652.7	550.7
N-22	272.7	316.7	424.7	464.3	369.6	293.4	339.3	400.7	428.7	365.5	254.3	304.3	358.3	356.3	318.3
Nidhi	328.0	416.0	525.7	554.0	455.9	320.7	406.3	562.3	566.3	463.9	303.7	387.7	477.7	558.7	431.9
Tellla Hamsa	304.7	374.0	478.3	490.7	411.9	321.0	383.0	451.3	462.7	404.5	321.7	344.0	414.3	388.3	367.1
Varadhan	329.3	479.3	613.7	623.0	511.3	381.3	498.7	607.0	640.7	531.9	334.3	485.3	646.3	644.7	527.7
Vasumati	363.0	500.7	614.3	627.3	526.3	350.0	474.0	614.3	629.7	517.0	388.3	498.3	643.0	590.3	530.0
VL-Dhan	400.7	443.3	604.7	583.4	508.0	438.7	446.0	591.0	618.1	523.5	432.3	428.7	576.3	641.3	519.7
Mean	356.3	433.3	564.1	580.2	483.5	368.1	445.7	569.3	586.9	492.5	374.3	431.5	559.8	561.0	481.7
LSD Treatment (T)	12.33**														
LSD Variety (V)	21.44**														
LSD Season (S)	NS														
LSD (T x V)	42.89**														
LSD (T x S)	NS														
LSD (V x S)	37.14**														
LSD (T x V x S)	NS														
CV (%)	7.22														

p<0.05, **p<0.001

Table 3: Influence of Nitrogen levels on panicle length (cm) in different rice cultivars. Each value represents the mean of 3 replications.

	Panicle length (cm)														
Varieties	Kharif-2020					Rabi-2021					Kharif-2021				
	N0	N50	N100	N150	Mean	N0	N50	N100	N150	Mean	N0	N50	N100	N150	Mean
Anjali	22.8	23.2	24.2	24.0	23.6	22.0	23.3	24.2	24.1	23.4	23.2	23.5	24.3	24.1	23.8
Birupa	20.2	20.3	21.8	21.6	21.0	20.0	20.3	22.0	21.7	21.0	20.5	20.7	21.7	21.5	21.1
Daya	21.6	21.0	23.0	22.3	22.0	21.3	21.0	23.0	22.3	21.9	21.7	21.0	22.5	22.2	21.8
GQ-25	22.8	23.4	22.7	23.6	23.1	22.2	23.5	22.3	24.2	23.0	23.0	23.3	22.3	23.3	23.0
Heera	21.9	21.7	21.8	22.6	22.0	22.2	21.7	21.5	23.2	22.1	21.5	21.9	22.0	22.3	21.9
Indira	19.3	20.6	21.7	22.2	20.9	19.5	20.3	21.8	22.3	21.0	19.2	20.5	21.5	21.8	20.8
IR-64	21.0	22.1	22.3	24.3	22.4	20.8	22.2	22.3	23.8	22.3	20.8	22.0	22.0	24.7	22.4
MTU-1010	23.4	24.0	24.4	24.3	24.0	23.2	23.4	24.1	24.3	23.8	23.1	23.4	24.1	24.5	23.8
N-22	18.2	20.1	20.2	20.9	19.9	17.8	20.1	20.5	20.8	19.8	18.5	19.8	19.8	20.3	19.6
Nidhi	21.9	22.3	22.9	24.0	22.8	22.3	22.2	22.7	24.3	22.9	21.5	22.3	23.2	23.7	22.7
Tellla Hamsa	20.4	21.1	22.6	21.6	21.4	20.7	21.3	22.7	21.0	21.4	20.5	21.0	22.3	21.5	21.3
Varadhan	21.8	23.1	24.0	23.3	23.1	22.0	22.8	23.8	23.5	23.0	21.5	23.5	24.3	23.3	23.2
Vasumati	22.4	23.7	25.3	25.7	24.3	22.3	23.3	25.5	25.2	24.1	22.5	23.8	25.0	26.2	24.4
VL-Dhan	22.2	23.0	24.0	23.4	23.2	22.3	23.0	23.8	23.2	23.1	22.3	22.8	24.0	23.3	23.1
Mean	21.4	22.1	22.9	23.1	22.4	21.3	22.0	22.9	23.1	22.3	21.4	22.1	22.8	23.1	22.3
LSD Treatment (T)	0.528**														
LSD Variety (V)	0.667**														
LSD Season (S)	NS														
LSD (T x V)	1.335**														
LSD (T x S)	NS														
LSD (V x S)	0.87*														
LSD (T x V x S)	NS														
CV (%)	4.88														

p<0.05, **p<0.001

Table 4: Influence of Nitrogen levels on filled grains panicle^{-1} in different rice cultivars. Each value represents the mean of 3 replications.

	Filled grains panicle^{-1}														
Varieties	Kharif-2020					Rabi-2021					Kharif-2021				
	N0	N50	N100	N150	Mean	N0	N50	N100	N150	Mean	N0	N50	N100	N150	Mean
Anjali	98.4	107.8	125.6	129.4	115.3	93.8	90.1	157.6	166.8	127.1	104.7	116.6	143.6	131.1	124.0
Birupa	122.5	138.9	146.8	155.1	140.8	114.2	143.9	131.7	142.6	133.1	111.4	134.6	131.1	137.4	128.6
Daya	128.8	136.6	180.2	170.6	154.1	108.9	140.9	165.4	163.5	144.7	117.9	131.6	160.2	154.5	141.0
GQ-25	107.4	124.1	146.5	148.9	131.7	103.4	115.9	155.3	148.8	130.8	102.7	118.2	127.2	118.3	116.6
Heera	96.2	93.9	112.8	111.8	103.7	123.2	137.9	139.3	134.4	133.7	105.3	109.2	116.6	106.3	109.4
Indira	134.4	154.8	186.9	184.1	165.1	133.2	142.4	192.4	179.1	161.8	122.4	146.1	170.6	178.6	154.4
IR-64	89.0	78.7	99.3	97.7	91.2	101.2	107.2	142.5	143.0	123.5	111.1	108.0	116.5	123.6	114.8
MTU-1010	141.4	140.0	165.0	156.5	150.7	134.7	146.5	171.6	158.2	152.7	123.7	131.8	150.3	150.8	139.1
N-22	93.7	94.5	134.8	135.2	114.6	87.9	98.0	116.2	121.7	105.9	93.8	109.3	108.6	112.6	106.1
Nidhi	117.7	135.6	166.2	166.3	146.5	115.6	139.0	173.1	165.1	148.2	103.1	139.2	161.3	138.7	135.6
Tellla Hamsa	87.6	102.9	117.6	116.9	106.3	84.1	82.7	108.8	119.7	98.8	96.9	107.2	111.3	119.8	108.8
Varadhan	97.0	128.4	155.5	145.5	131.6	108.4	143.9	170.8	180.4	150.9	106.2	125.2	145.8	150.8	132.0
Vasumati	111.6	133.9	158.1	154.9	139.6	104.9	144.2	161.1	159.7	142.5	112.0	143.4	166.7	181.2	150.8
VL-Dhan	118.7	115.8	139.5	138.1	128.0	133.2	125.1	185.0	170.2	153.4	127.7	134.0	187.1	164.6	153.4
Mean	110.3	120.4	145.4	143.6	129.9	110.5	125.5	155.1	153.8	136.2	109.9	125.3	142.6	140.6	129.6
LSD Treatment (T)	5.38**														
LSD Variety (V)	8.98**														
LSD Season (S)	NS														
LSD (T x V)	17.97**														
LSD (T x S)	NS														
LSD (V x S)	15.56**														
LSD (T x V x S)	NS														
CV (%)	11.15														

p<0.05, **p<0.001

Table 5: Influence of Nitrogen levels on unfilled grains panicle^{-1} in different rice cultivars. Each value represents the mean of 3 replications.

	Unfilled grains panicle^{-1}														
Varieties	Kharif-2020					Rabi-2021					Kharif-2021				
	N0	N50	N100	N150	Mean	N0	N50	N100	N150	Mean	N0	N50	N100	N150	Mean
Anjali	22.9	21.4	8.6	13.9	16.7	31.9	21.2	15.4	12.8	20.3	33.6	19.7	16.1	18.5	22.0
Birupa	24.8	25.6	17.3	17.8	21.4	33.8	34.9	16.8	16.9	25.6	32.0	23.1	21.1	22.4	24.7
Daya	21.1	21.6	13.6	16.1	18.1	28.4	25.7	15.3	12.2	20.4	32.8	23.9	16.5	19.9	23.3
GQ-25	23.1	17.5	13.5	15.0	17.3	26.9	21.6	10.5	13.3	18.1	21.3	14.8	11.1	13.8	15.2
Heera	32.4	25.0	14.2	12.3	21.0	38.9	33.3	18.5	15.5	26.5	24.3	22.9	20.1	21.2	22.1
Indira	21.5	20.1	10.4	15.6	16.9	29.8	21.4	16.9	16.2	21.1	29.7	19.7	15.2	15.4	20.0
IR-64	25.0	22.0	8.6	12.3	17.0	30.8	27.5	13.3	12.3	21.0	13.4	13.8	9.4	11.5	12.0
MTU-1010	18.4	13.6	9.6	12.2	13.4	23.8	16.5	8.8	11.5	15.1	16.2	12.5	10.9	14.7	13.6
N-22	39.5	32.7	10.8	15.3	24.6	40.3	34.5	15.4	10.9	25.3	19.4	12.7	10.6	13.0	13.9
Nidhi	39.8	33.6	10.8	14.3	24.6	39.9	26.5	12.9	13.7	23.3	32.1	22.1	16.7	22.4	23.4
Tellla Hamsa	31.5	27.0	9.5	13.8	20.5	30.3	21.9	14.3	18.0	21.1	19.2	16.9	14.6	17.0	16.9
Varadhan	18.4	12.9	10.8	13.1	13.8	25.9	26.2	14.4	17.7	21.1	17.1	12.5	10.1	13.1	13.2
Vasumati	15.7	11.9	11.5	12.5	12.9	22.7	20.0	14.3	16.2	18.3	23.4	17.3	17.3	17.8	18.9
VL-Dhan	29.0	24.7	11.7	11.8	19.3	31.3	25.0	12.8	17.2	21.6	17.8	17.3	12.8	17.0	16.2
Mean	25.9	22.1	11.5	14.0	18.4	31.0	25.4	14.3	14.6	21.3	23.7	17.8	14.5	17.0	18.2
LSD Treatment (T)	1.77**														
LSD Variety (V)	2.47**														
LSD Season (S)	NS														
LSD (T x V)	4.94**														
LSD (T x S)	NS														
LSD (V x S)	4.28**														
LSD (T x V x S)	NS														
CV (%)	20.94														

p<0.05, **p<0.001

Table 6: Influence of Nitrogen levels on 1000 grain weight (g) in different rice cultivars. Each value represents the mean of 3 replications.

	1000 grain weight (g)														
Varieties	Kharif-2020					Rabi-2021					Kharif-2021				
	N0	N50	N100	N150	Mean	N0	N50	N100	N150	Mean	N0	N50	N100	N150	Mean
Anjali	22.8	23.0	23.1	23.4	23.1	22.2	22.6	22.8	22.9	22.6	21.8	23.6	24.3	25.0	23.7
Birupa	24.4	25.3	26.2	26.0	25.5	23.9	24.6	24.8	25.0	24.6	23.9	25.2	26.1	26.5	25.5
Daya	18.8	20.2	20.9	21.2	20.3	18.6	19.3	19.6	19.7	19.3	18.3	20.2	20.4	20.7	19.9
GQ-25	21.8	22.4	23.3	23.6	22.8	20.2	20.5	20.8	21.0	20.7	20.6	21.5	21.9	22.5	21.7
Heera	22.1	23.2	23.6	23.8	23.2	22.4	23.1	23.7	23.8	23.2	21.8	23.1	25.3	25.7	24.0
Indira	20.7	21.5	22.0	22.2	21.6	19.1	19.1	19.6	19.8	19.4	19.3	20.5	21.1	21.3	20.6
IR-64	22.1	23.2	24.1	24.3	23.5	22.7	22.9	23.2	23.3	23.0	23.4	24.8	25.5	26.7	25.1
MTU-1010	22.5	23.2	24.0	24.1	23.5	22.5	22.9	23.6	23.9	23.2	22.4	24.0	24.5	24.5	23.9
N-22	17.4	17.9	18.7	18.9	18.3	18.2	18.6	18.9	18.9	18.6	17.9	17.6	18.5	17.5	17.9
Nidhi	17.6	18.7	19.4	19.8	18.9	17.3	17.8	18.2	18.4	17.9	18.1	18.5	19.1	19.6	18.8
Tellla Hamsa	19.2	19.7	20.5	20.9	20.1	22.0	22.6	22.8	22.9	22.6	21.9	22.4	22.8	22.3	22.4
Varadhan	20.2	21.2	22.2	22.5	21.5	22.0	22.5	22.9	23.0	22.6	23.4	24.7	25.5	25.3	24.7
Vasumati	20.9	21.4	21.9	22.0	21.6	19.3	19.6	19.9	19.8	19.7	20.6	20.8	21.5	21.8	21.2
VL-Dhan	20.2	21.0	21.8	22.0	21.3	20.4	20.4	20.7	20.7	20.5	20.8	22.1	22.4	23.2	22.1
Mean	20.8	21.6	22.3	22.5	21.8	20.8	21.2	21.5	21.7	21.3	21.0	22.1	22.8	23.1	22.2
LSD Treatment (T)	0.173**														
LSD Variety (V)	0.334**														
LSD Season (S)	NS														
LSD (T x V)	0.508*														
LSD (T x S)	NS														
LSD (V x S)	0.580**														
LSD (T x V x S)	NS														
CV (%)	2.51														

p<0.05, **p<0.001