Indian Journal of Agricultural Sciences **92** (4): 521–5, April 2022/Article
https://doi.org/ 10.56093/ijas.v92i4.124010

Organic amendments and nitrogen levels influences grain quality of Rice (*Oryza sativa*) – Wheat (*Triticum aestivum*) cropping system

PRABHJIT KAUR[1]*, K S SAINI[1], KAMALJIT KAUR[1] and KIRANDEEP KAUR[2]

Punjab Agricultural University, Ludhiana, Punjab 141 004, India

Received: 27 September 2021; Accepted: 09 November 2021

ABSTRACT

A field experiment was conducted at Ludhiana and Amritsar during *kharif* and *rabi* 2018–19 and 2019–20 to see the effect of different organic amendments and nitrogen levels on grain quality parameters of rice and wheat. The results revealed that at both locations milling quality such as brown, milled as well as head rice recovery and L:B of rice grain were found significantly higher with treatment in which poultry manure (PM) was applied to rice followed by green manure (GM) and farmyard manure (FYM). N_{100} recorded better milling quality and L:B which was at par with N_{75}. Residual effects of green manure and organic amendments on physical grain characteristics, viz. grain appearance score, hectolitre weight, grain hardness and chemical grain characteristics, viz. sedimentation value, protein content, gluten content of succeeding wheat crop were recorded higher in PM which was significantly superior than GM and FYM at both locations. Whereas, N_{100} and N_{75} found to be superior as compared to N_{50} and control. The improvement in grain quality may be attributed to the increased availability of nutrients coupled with increased absorption and assimilation by plants on long term basis.

Keywords: Gluten, Milling quality, Quality parameters, Rice-wheat

Rice (*Oryza sativa* L.) – Wheat (*Triticum aestivum* L.) cropping system (RWCS) is immensely dominant and profitable system for the food security and livelihoods in South Asia. Globally, rice (*Oryza sativa* L.) is the second most important staple food after maize as it fulfills the dietary requirement of over half of the human population and considered as the major food crop of economic significance in Asia (Ahmed *et al.* 2021). However, recent years have witnessed a significant slowdown in the yield growth rate of RWCS and the sustainability of this important cropping system is at risk due to second-generation technology problems and mounting pressure on natural resources. The continuous and steady application of inorganic fertilizers leads plant tissues to frequently absorb and accumulate heavy metals, which consequently decreases the nutritional and grain quality of crops (Maqbool *et al.* 2020). Application of organic fertilizers such as poultry manure, green manure, and farmyard manure or the combination of organic and inorganic fertilizers, with different levels of nitrogen can be an alternative option to reduce the utilization of inorganic fertilizers (Kakar *et al.* 2019).

The physicochemical properties of the rice and wheat grain, which consist of physical traits as well as chemical grain characteristics have an immense influence on production, consumption and consumer preference. Therefore, rice and wheat grain quality improvement is increasingly demanded by consumers (Zhou *et al.* 2020). Thus, poor nutrient management due to lack of proper and balanced use of chemical fertilizers including micronutrients is one of the factors responsible for low yields and poor grain quality of rice. The present investigation was undertaken to study the effect of application of different levels of fertilizer (N) along with farmyard manure (FYM), poultry manure (PM) and green manure (GM) on the grain quality parameters of rice and wheat.

MATERIALS AND METHODS

The present study was carried out at Students' Research Farm, Department of Agronomy, Punjab Agricultural University, Ludhiana and at Research station, Dyal Bharang, Amritsar during *kharif* and *rabi* 2018–19 and 2019–20. The experimental site is situated at 30° 54' N 75° 48' E and 247 m amsl. The climate of the experimental site is sub-tropical, semi-arid. In summer, maximum air temperature during May and June often exceeds 39°C; in winter (December and January), minimum air temperature falls below 4°C with frosty spells. Average annual rainfall is 650 mm; more than 75% of which is received during monsoon (July to September).

Treatments and experimental details: The experiment was laid in split plot design with four replications. The

[1]Punjab Agricultural University, Ludhiana, Punjab; [2]PAU-Research station, Dyal Bharang, Amritsar, Punjab.*Corresponding author email: Prabhjit.brar@yahoo.in

main plot treatments were green manuring (GM) and organic amendments i.e. farmyard manure (FYM), poultry manure (PM) and control (NA) whereas subplot treatments were different nitrogen levels i.e. control (N_0), 50 kg N/ha (N_{50}), 75 kg N/ha (N_{75}) and 100 kg N/ha (N_{100}). The plot size was 7 m × 3.30 m=23.1m^2. The entire quantity of P_2O_5 and K_2O (30 kg P_2O_5 and 30 kg K_2O per ha) was applied to rice before last puddling. Nitrogen was applied in three equal splits. Well decomposed FYM (N=0.75%, P=0.30% and K=0.70%), Poultry manure (N=3.40%, P=2.73% and K=1.92%) available at Agricultural Research Farm was used. Whereas, in wheat recommended dose of fertilizers was applied @125 kg N and 62.5 kg P_2O_5 per hectare. Various quality parameters were analyzed in lab by following methods:

Milling quality (Rice)

Milled rice percentage: Percentage of milled rice (including broken) obtained from a sample of paddy.

$$\text{Milled rice recovery (\%)} = \frac{\text{Milled rice obtained (g)}}{\text{Total paddy taken (g)}} \times 100$$

Brown rice percentage: The clean paddy samples (100 g) were shelled in laboratory sheller. Shelled (brown) rice was weighed and expressed as percentage.

$$\text{Brown rice recovery (\%)} = \frac{\text{Brown rice obtained (g)}}{\text{Total paddy taken (g)}} \times 100$$

Head rice percentage: Rice grading device was used to separate broken kernel from milled rice after milling. The kernel with more than two-third length was considered as head rice and expressed as percentage.

$$\text{Head rice recovery (\%)} = \frac{\text{Head rice obtained (g)}}{\text{Total paddy taken (g)}} \times 100$$

Grain length (mm), Grain breadth (mm) and Grain length: breadth ratio: For measurement of grain length and breadth ten kernels of rice were arranged in straight line and cumulative length was measured in mm. Average of length and breadth was taken in mm and grain length: breadth ratio was calculated.

Percent broken: Using the grain grader, broken grains were separated from the whole grains. Percentage of the brokens was calculated as:

$$\text{Brokens (\%)} = \frac{\text{Weight of broken grains}}{\text{Weight of paddy samples}} \times 100$$

Quality characters (Wheat)

Sedimentation value: To determine the sedimentation value of wheat flour, 50 ml water was taken in a 100 ml graduated cylinder and 3.2 g flour sample added to it. The contents were shaken 12 times to make suspension. After shaking and standing, 25 ml isopropyl alcohol lactic acid reagent was added. Then reading was noted after five minutes standing period.

Gluten content: Weighed sample of wheat flour (20 g) was made into dough ball by adding approximately 12.5 ml of distilled water. The ball was kept in water for 30 min and then washed under tap water in muslin cloth to remove starch and other solubles, and separate the gluten.

Grain appearance score: It was evaluated subjectively out of a maximum score of 10.

Grain hardness: It was measured by using the grain hardness tester by crushing randomly taken ten grains one by one, taking into account the weight, diameter and moisture of the grain.

Protein content in grain: Protein was analyzed using automatic whole grain analyzer (Infratech-1241 supplied by FOSS analytical AB, Sweden).

Hectolitre weight: It was measured by using the hectolitre weight apparatus designed by Directorate of Wheat Research, Karnal.

Statistical analysis: To test the statistical significance of treatment effects, Analysis of Variance (ANOVA) was carried out for studied parameters in the experiment. General Linear Model (GLM) procedure in SAS® 9.4 version 6.1.7061 for Windows (SAS Institute 2013) was used for statistical analysis of experimental data.

RESULTS AND DISCUSSION

Rice crop

Grain yield: Grain yield varied significantly with the application of different amendments and nitrogen levels at both locations i.e. Ludhiana and Amritsar. At Ludhiana, among different amendments, the treatment in which PM was applied recorded significantly higher grain yield than treatment with GM followed by FYM treated plots which were at par with each other during both years of study. Whereas, at Amritsar, among different amendments, the treatment in which PM was applied recorded significantly higher grain yield followed by GM and FYM treated plots which were at par with each other. Among different N levels, N_{100} recorded higher grain yield which was significantly superior than treatments with application of N_{50} and was at par with N_{75}. Whereas, the grain yield of rice was found to be significantly lower in N_0 as comparison to all other treatments.

Brown rice recovery: At both locations, brown rice recovery (Table 1) was found to be increased with the use of different amendments and with increased level of nitrogen as compared to control treatments i.e. NA and N_0 during both the years, although the result were found to differ non-significantly among different treatments. In the first year of experiment, it was observed that when PM applied as amendment there was about 12% increase in brown rice recovery as compared to NA i.e. no application of amendment. Whereas among different nitrogen levels, highest brown rice recovery was obtained with N_{100} followed by N_{75}, N_{50}. Application of PM and increased level of N resulted in better brown rice recovery of grain.

Table 1 Quality parameters, grain yield of rice and succeeding wheat crop (Pooled data of 2 years) as influenced by different amendments and nitrogen levels at PAU, Ludhiana and Dyal Bharang, Amritsar

Treatment	Brown Rice recovery (%)				Milled Rice recovery (%)				Head Rice recovery (%)				Grain L:B ratio				Broken percentage				Grain yield (q/ha)			
	2018		2019		2018		2019		2018		2019		2018		2019		2018		2019		Rice		Wheat	
	LDH	ASR	LDH	ASR	LDH	ASR	LDH	ASR	LDH	ASR	LDH	ASR	LDH	ASR	LDH	ASR	LDH	ASR	LDH	ASR	LDH	ASR	LDH	ASR
Amendments application																								
GM	78.8^{a}	76.1^{a}	78.5^{a}	75.9^{a}	69.8^{b}	67.9^{b}	70.5^{b}	68.7^{ab}	57.4^{b}	56.4^{b}	58.3^{b}	57.4^{b}	3.96^{b}	3.42^{a}	3.99^{b}	3.44^{b}	17.2^{a}	17.9^{a}	17.4^{a}	18.2^{a}	80.1^{b}	79.2^{a}	57.1^{b}	55.5^{b}
FYM	77.2^{a}	74.6^{a}	76.8^{a}	74.4^{a}	68.5^{b}	66.6^{b}	69.3^{b}	67.3^{b}	56.8^{b}	55.8^{b}	57.8^{b}	56.8^{b}	3.91^{b}	3.37^{a}	3.94^{b}	3.39^{b}	17.4^{a}	18.2^{a}	17.7^{a}	18.4^{a}	78.9^{b}	78.0^{a}	58.7^{b}	57.2^{b}
PM	80.3^{a}	77.7^{a}	80.0^{a}	77.4^{a}	71.5^{a}	69.6^{a}	72.2^{a}	70.4^{a}	60.3^{a}	59.4^{a}	60.9^{a}	60.3^{a}	4.27^{a}	3.73^{a}	4.31^{a}	3.75^{a}	15.9^{a}	16.7^{a}	16.1^{a}	16.9^{a}	82.5^{a}	81.6^{a}	61.2^{a}	59.7^{a}
NA	71.8^{a}	69.3^{a}	71.6^{a}	69.0^{a}	62.4^{c}	61.8^{c}	63.1^{c}	62.5^{c}	48.5^{c}	47.7^{c}	49.4^{c}	48.6^{c}	3.52^{c}	2.98^{b}	3.56^{c}	3.00^{c}	19.2^{a}	19.9^{a}	19.4^{a}	20.2^{a}	50.5^{c}	49.5^{b}	49.2^{c}	48.0^{c}
Nitrogen levels																								
N_0	70.2^{a}	67.8^{a}	69.8^{a}	67.6^{a}	61.4^{c}	59.5^{c}	62.1^{c}	60.3^{c}	46.3^{c}	45.3^{c}	47.2^{c}	46.3^{c}	3.40^{c}	2.86^{c}	3.43^{c}	2.88^{c}	19.9^{a}	20.7^{a}	19.9^{a}	20.9^{a}	50.0^{c}	49.6^{c}	47.4^{c}	46.1^{c}
N_{50}	76.3^{a}	73.7^{a}	76.1^{a}	73.5^{a}	67.9^{b}	66.0^{b}	68.5^{b}	66.7^{b}	55.7^{b}	54.7^{b}	56.7^{b}	55.7^{b}	3.71^{b}	3.17^{b}	3.73^{b}	3.19^{b}	19.0^{a}	19.8^{a}	19.7^{a}	20.0^{a}	74.6^{b}	73.9^{b}	55.4^{b}	54.0^{b}
N_{75}	79.8^{a}	77.2^{a}	79.4^{a}	77.0^{a}	70.3^{a}	69.5^{a}	71.3^{a}	70.2^{a}	59.7^{a}	58.7^{a}	60.8^{a}	59.7^{a}	4.26^{a}	3.72^{a}	4.30^{a}	3.74^{a}	15.4^{a}	16.9^{a}	15.7^{a}	16.4^{a}	83.0^{a}	81.8^{a}	61.5^{a}	59.7^{a}
N_{100}	81.6^{a}	79.0^{a}	81.3^{a}	78.7^{a}	72.5^{a}	71.0^{a}	73.6^{a}	71.8^{a}	61.5^{a}	60.6^{a}	61.9^{a}	61.5^{a}	4.30^{a}	3.76^{a}	4.35^{a}	3.78^{a}	15.4^{a}	16.7^{a}	15.7^{a}	16.4^{a}	84.5^{a}	83.6^{a}	62.1^{a}	60.5^{a}

The same alphabetical letters within a column denote no differences at the P<0.05 level based on Tukey's multi comparison test.

LDH, Ludhiana; ASR, Amritsar; GM, green manure; FYM, farmyard manure; PM, poultry manure; NA, No application of amendment; N_0, Control; N_{50}, 50 kg N/ha; N_{75}, 75 kg N/ha; N_{100}, 100 kg N/ha.

Milled rice recovery: At Ludhiana and Amritsar, significantly higher milled rice recovery percentage was obtained with treatment in which PM was applied (71.5, 72.2 and 69.6, 70.4) followed by GM (69.8, 70.5 and 67.9, 68.7) found to be statistically similar with treatment where FYM applied as amendment (68.5, 69.3 and 66.6, 67.3) during 2018 and 2019, respectively. Among different N levels, during the first year of experimentation, N_{100} recorded higher milled rice recovery (72.5, 71.0) at Ludhiana and Amritsar. Similar trend of milled rice recovery was observed during 2019. This might be due to better amenability for shelling, good grain size and less number of chalky grains as observed under optimum N and organic amendments application (Zhou *et al.* 2020).

Head rice recovery: Significantly higher head rice recovery was obtained at Ludhiana and Amritsar, with treatment in which PM was applied (60.3, 60.9 and 59.4, 60.3) followed by GM (57.4, 58.3 and 56.4, 60.3) which found to be statistically similar with treatment where FYM applied as amendment (56.8, 57.8 and 55.8, 56.8) during 2018 and 2019, respectively. Among different N levels, during the first year of experiment, N_{100} recorded higher head rice recovery percentage (61.5, 60.6) at Ludhiana and Amritsar. The absolute control had shown lower milling recovery, head rice percentage and higher broken rice percentage (Sangeetha *et al.* 2013).

Rice grain length: breadth: Significantly higher L:B ratio of rice grain was obtained at Ludhiana and Amritsar with treatment in which PM was applied (4.27, 4.31 and 3.73, 3.75) during 2018 and 2019, respectively. Among different N levels, N_{100} recorded higher L:B ratio which was at par with N_{75} and statistically superior than N_{50}. Grain length and breadth was maximum in recommended N fertilizer and it was on par with enriched poultry manure compost, composted poultry manure followed by farmyard manure (Sangeetha *et al.* 2013).

Percent broken of rice grain: The results revealed that at Ludhiana and Amritsar, the highest broken rice was obtained in treatment where no application of amendments applied and found to be higher than other treatments (Table 1). The minimum brokens were obtained in treatment where PM was applied which is almost similar to treatments where GM and FYM were applied as amendments during both the years of study. Similarly, among different nitrogen levels, highest brokens were obtained with control treatment i.e. N_0 whereas minimum brokens were obtained in treatment with N_{100} during both the years of study. Though N was supplied on equivalent N basis, the enriched poultry manure compost contains more P, K and micronutrients which might have helped to reduce broken percentage and in turn increased head rice recovery (Zhou *et al.* 2020).

Wheat crop

Grain yield: Data pertaining to grain yield of wheat showed that grain yield was vary significantly with the application of different amendments and nitrogen levels at both locations, viz. Ludhiana and Amritsar. Among

different amendments, the treatment in which PM was applied to rice recorded significantly higher grain yield of wheat than treatment with FYM followed by GM treated plots which were at par with each other during both years of study. Whereas, N_{100} recorded higher grain yield which was significantly superior than treatments with application of N_{50} and was at par with N_{75}.

Physical grain characteristics: Data (Table 2) shows that grain appearance score of wheat vary significantly with the application of different amendments and nitrogen levels to rice at both locations. At Ludhiana and Amritsar, significantly higher grain appearance score was obtained with treatment in which PM was applied (5.9, 6.0 and 5.8, 5.9). Whereas statistically lower grain appearance score was obtained in NA i.e. no application of amendment. For different nitrogen levels, the highest values of grain appearance score were reported under the treatment N_{100}. The increased protein content at increase levels of nitrogen before anthesis might have caused the development of more prominent network around the starch granules resulting in more glossy appearance contributing to both grain hardness and protein content.

The hectolitre weight values reflect the conditions during the grain filling period of the crop. At Ludhiana and Amritsar, significantly higher hectolitre weight was obtained with treatment in which PM was applied (75.0, 75.9 and 74.4, 75.7 kg). Among different N levels, N_{100} recorded higher hectolitre weight which was significantly superior than treatments N_{75} and N_{50}. The hectolitre weight is positively and linearly co-related to the flour recovery as higher hectolitre weight is indicative of an improved endosperm to bran ratio (Angelidis *et al.* 2016)**.** At Ludhiana and Amritsar, significantly higher grain hardness was obtained with treatment in which PM was applied (11.7, 12.1 and 11.3, 11.8) during 2018–19 and 2019–20, respectively. For different nitrogen levels, the highest values of grain hardness were reported under the treatment N_{100} (12.1, 11.7). It was reported earlier also that the grain hardness increased with increase in nitrogen level (Bassi *et al.* 2021).

Chemical grain characteristics: The perusal of the data (Table 2) indicates that among different amendments at Ludhiana and Amritsar, significantly higher protein content (%) was obtained with treatment in which PM was applied (12.1, 12.3 and 11.3, 11.5%) followed by FYM (11.8, 11.9 and 11.0, 11.2%) which was found to be statistically similar with treatment where GM applied as amendment (11.7, 11.8 and 10.8, 11.0%) during 2018–19 and 2019–20, respectively. Among different N levels, N_{100} recorded higher protein content (12.2%). Application of PM, FYM and GM improved the nutritional level both at root zone and plant system. Increased accumulation of nutrients in vegetative plant parts with improved metabolism led to greater translocation of the nutrients to the reproductive portion of the crop. Similar findings were also reported by Zhou *et al.* (2020) that large grained lines had significantly higher yields, protein percentage and sedimentation value than small grained line.

Table 2 Quality parameters of wheat as influenced by different amendments and nitrogen levels at PAU, Ludhiana and Dyal Bharang, Amritsar

Treatment	Physical grain characteristics										Chemical grain characteristics									
	Grain appearance score (Max 10)				Hectolitre weight (Kg/hl)				Grain Hardness (Kg)				SDS- Sedimentation value (cc)				Protein content (%)				Gluten content (%) (Dry)			
	2018–19		2019–20		2018–19		2019–20		2018–19		2019–20		2018–19		2019–20		2018–19		2019–20		2018–19		2019–20	
	LDH	ASR	LDH	ASR	LDH	ASR	LDH	ASR	LDH	ASR	LDH	ASR	LDH	ASR	LDH	ASR	LDH	ASR	LDH	ASR	LDH	ASR	LDH	ASR
Amendments application																								
GM	5.7^{b}	5.5^{b}	5.8^{b}	5.7^{b}	74.4^{b}	73.8^{b}	75.3^{b}	75.1^{a}	11.3^{b}	10.9^{b}	11.5^{b}	11.2^{b}	47.0^{b}	46^{b}	49.0^{b}	48^{b}	11.7^{b}	10.8^{b}	11.8^{b}	11.0^{b}	9.80^{a}	8.57^{a}	10.2^{a}	9.21^{a}
FYM	5.7^{b}	5.6^{b}	5.8^{b}	5.7^{b}	74.5^{b}	73.9^{b}	75.4^{b}	75.2^{a}	11.4^{b}	11.0^{b}	11.7^{ab}	11.4^{b}	48.0^{b}	47^{b}	50.0^{b}	49^{b}	11.8^{b}	11.0^{b}	11.9^{b}	11.2^{b}	9.85^{a}	8.62^{a}	10.2^{a}	9.23^{a}
PM	5.9^{a}	5.8^{a}	6.0^{a}	5.9^{a}	75.0^{a}	74.4^{a}	75.9^{a}	75.7^{a}	11.7^{a}	11.3^{a}	12.1^{a}	11.8^{a}	53.0^{a}	52^{a}	54.0^{a}	53^{a}	12.1^{a}	11.3^{a}	12.3^{a}	11.5^{a}	10.3^{a}	9.07^{a}	10.7^{a}	9.68^{a}
NA	5.1^{c}	4.9^{c}	5.4^{c}	5.3^{c}	73.2^{c}	72.6^{c}	74.6^{c}	74.4^{c}	9.5^{c}	9.1^{c}	9.9^{c}	9.6^{c}	45.0^{c}	44^{c}	46.0^{c}	46^{c}	10.7^{c}	10.0^{c}	11.0^{c}	10.4^{c}	8.13^{b}	6.90^{b}	8.50^{b}	7.51^{b}
Nitrogen levels																								
N_0	5.1^{c}	4.9^{c}	5.3^{c}	5.2^{c}	73.1^{d}	72.5^{d}	74.4^{d}	74.1^{d}	9.3^{c}	8.9^{c}	9.8^{c}	9.4^{c}	43.0^{c}	42^{c}	44.0^{c}	44^{c}	10.6^{c}	9.9^{c}	19.3^{c}	10.0^{c}	8.10^{c}	6.87^{c}	8.49^{d}	7.50^{c}
N_{50}	5.5^{b}	5.3^{b}	5.7^{b}	5.5^{b}	73.6^{c}	73.0^{c}	75.0^{c}	74.8^{c}	10.9^{b}	10.5^{b}	11.3^{b}	10.9^{b}	47.0^{b}	46^{b}	48.0^{b}	47^{b}	11.4^{b}	10.5^{b}	22.2^{b}	10.8^{b}	9.11^{b}	7.88^{b}	9.48^{c}	8.49^{b}
N_{75}	5.9^{a}	5.7^{a}	6.0^{a}	5.8^{a}	74.7^{b}	74.1^{b}	75.5^{b}	75.3^{b}	11.6^{a}	11.2^{a}	11.9^{a}	11.6^{a}	51.0^{a}	50^{a}	52.0^{a}	51^{a}	12.1^{a}	11.3^{a}	25.7^{a}	11.6^{a}	10.1^{a}	8.92^{a}	10.7^{b}	9.73^{a}
N_{100}	6.0^{a}	5.8^{a}	6.1^{a}	6.0^{a}	75.7^{a}	75.1^{a}	76.5^{a}	76.2^{a}	12.1^{a}	11.7^{a}	12.3^{a}	12.0^{a}	53.0^{a}	52^{a}	55.0^{a}	54^{a}	12.2^{a}	11.4^{a}	26.1^{a}	11.7^{a}	10.7^{a}	9.50^{a}	10.8^{a}	9.88^{a}

Refer to the footnote of Table 1 for amendments abbreviations and details of nitrogen levels.

Sedimentation value is a measure of functional quality of wheat proteins differed significantly among different amendments and nitrogen levels during both years (Table 2). At Ludhiana and Amritsar, among different amendments, the highest sedimentation values for both the years were reported in PM (53, 54 and 52, 53 cc). During both the years, under different nitrogen levels, the highest sedimentation values (53, 55 and 52, 54 cc) were reported under the treatment N_{100}. Highest values for dry gluten content (%) were reported in PM which was significantly superior to FYM. During both the years, under different nitrogen levels, the highest values of dry gluten were reported under the treatment N_{100}. Improved rice and wheat grain quality, in terms of chemical, physical grain characteristics and grain recovery (%) was achieved under organic manures application (Sangeetha *et al.* 2013).

The results of this study illustrate that various quality parameters of rice and wheat were improved with the application of organic amendments as compared to chemically treated plots. Milling quality such as brown rice recovery, milled rice recovery as well as head rice recovery were found significantly higher with treatmnt in which PM was applied followed by GM and FYM. N_{100} recorded better milling quality which was at par with N_{75}. Physical and chemical grain characteristics of wheat were recorded higher in PM which was significantly superior than GM and FYM. Whereas, N_{100} and N_{75} found to be superior as compared to N_{50} and control. It can be concluded that the application of organic sources improved the quality parameters of rice and wheat due to uninterrupted availability of nutrients coupled with increased absorption and assimilation by plants on long term basis.

REFERENCES

Ahmed S, Alam M J, Hossain A, Islam A K, Awan T H, Soufan W, Qahtan A A, Okla M K and El Sabagh A. 2021. Interactive effect of weeding regimes, rice cultivars, and seeding rates influence the rice-weed competition under dry direct-seeded condition. *Sustainability* **13**: 3–17.

Angelidis G, Protonotariou S, Mandala I and Rosell C M. 2016. Jet milling effect on wheat flour characteristics and starch hydrolysis. *Journal of Food Science and Technology* **53**: 784–91.

Bassi D, Kaur K, Singh T P and Kaur J. 2021. Quality attributes and chapatti making property of biofortified wheat as influenced by particle size. *Journal of Food Science and Technology* **58**: 1156–64.

Kakar K, Nitta Y, Asagi N, Komatsuzaki M, Shiotau F, Kokubo T and Xuan T D. 2019. Morphological analysis on comparison of organic and chemical fertilizers on grain quality of rice at different planting densities. *Plant Production Science* **22**: 510–18.

Maqbool A, Ali S, Rizwan M, Arif MS, Yasmeen T, Riaz M, Hussian A, Noreen S, Abdel-Daim M M and Alkahtani S. 2020. N-fertilizer (urea) enhances the phytoextraction of cadmium through Solanum nigrum L. *International Journal of Environmental Research* **17**: 3850.

Sangeetha S P, Balakrishnan A and Davasenapathy P. 2013. Influence of Organic Manures on Yield and Quality of Rice (*Oryza sativa* L.) and Black gram (*Vigna mungo* L.) in Rice-Black gram Cropping Sequence. *American Journal of Plant Science* **4**: 1151–57.

Zhou H, Xia D and He Y. 2020. Rice grain quality-Traditional traits for high quality rice and health-plus substances. *Molecular Breeding* **40**: 1–17.