The Pharma Innovation Journal 2022; 11(7): 1959-1964

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(7): 1959-1964

www.thepharmajournal.com
Received: 07-04-2022
Accepted: 11-05-2022

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Effects of nitrogen levels and date of sowing on growth, yield and quality of direct seeded paddy (*Oryza sativa* L)

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Abstract
A field experiment was conducted during *Kharif* season in 2021-2022 at the Research farm, Department of Agronomy, AKS University, Satna (M.P.), to evaluate the effect of nitrogen levels and dates of sowing on growth, yield and quality of direct seeded paddy (*Oryza sativa* L.). The experiment was laid out in Factorial Randomized Block Design comprising four nitrogen levels *viz.* 00kg N ha^{-1}, 80kg N ha^{-1}, 100kg N ha^{-1}, 120kg N ha^{-1} and three dates of sowing *viz.* 10th July, 20th July, 30th July and treatments were replicated thrice. Results revealed that different levels of nitrogen affected the growth parameters as well as yield attributes and yield of direct seeded paddy. Incorporation of 120kg N ha^{-1} (N_3) recorded maximum plant height at 90 DAS (74.55cm), number of tillers $plant^{-1}$ at 90 DAS (9.89), number of panicles $plant^{-1}$ (4.8), length of panicles (19.49cm), grain yield (30.79q ha^{-1}), straw yield (71.81q ha^{-1}), test weight (26.64g), and protein content (10.24%), however, number of leaves $plant^{-1}$ at 90 DAS (37.38) and harvest index (30.41%) were higher with incorporation of 100kg N ha^{-1}. Among different sowing dates, maximum number of tillers per plant at 90 DAS (9.22), number of leaves per plant at 90 DAS (34.47), grain yield (25.24q ha^{-1}), test weight (25.69g), harvest index (30.04%), and protein content (9.98%) were observed when crop was sown on 10th July (D_1). However, plant height at 90 DAS (66.29cm), number of panicles $plant^{-1}$ (3.88), length of panicles (17.01cm) and straw yield (60.11q ha^{-1}) were maximum when sowing was done on 20th July (D_2).

Keywords: Nitrogen levels, date of sowing, direct seeded paddy, growth, yield, quality

Introduction
Paddy (*Oryza sativa*. L) Is the most important and popular cereal crop after wheat and one of the most widely consumed grains in the world. In India, paddy is grown in an area of 43.9 million hectares, producing around 106.77 million tones (Anonymous, 2018) [1]. India is the second largest consumer of paddy with 100 million metric tons after China which consumes 143.8 million metric tons of paddy (Anonymous, 2019) [2].

Nitrogen is an essential element and a constituent of protoplasm, proteins and chlorophyll. It plays an important role in many physiological and biochemical activities of plant such as synthesis of nucleotides, phosphatides, enzymes, hormones, and vitamins (Tiwari *et al*., 2015) [8]. Mahajan and Timsina (2011) [7] reported that increasing N application rate up to 150kg N/ ha caused significant improvement in grain yield. So, managing application time and rate of nitrogen fertilizer is very important.

The date of sowing is an important non-monetary input and an indispensable agronomic factor for obtaining optimum paddy yields (Deshmukh and Patel, 2013) [4]. An optimum date of sowing in a particular ecological setting provides an accumulation of desired heat units necessary for proper growth and development of paddy crop. Timely sowing ensures greater yield attributing parameters and grain yield. However, late sowing results in reduced yield promoting parameters and also limits the growth duration which further leads to a reduction in leaf area, productive tillers and test weight (Bashir *et al*. 2010) [3].

Materials and Methods
The present investigation was carried out during 2021-2022 in *Kharif* season at the Research farm, Department of Agronomy, AKS University, Satna (M.P.). Mean temperature and humidity ranged from 21.71ºC (min) to 32.39ºC (max) and 70.67% (morning) to 55.33% (evening), respectively. The soil of experimental field was silty clay loam with low level of organic carbon (0.46%), available nitrogen (178.4kg ha^{-1}), available phosphorus (13.2kg ha^{-1}) and medium level of available potassium (196.00kg ha^{-1}) having 7.4 pH and 0.17 ds/m EC Twelve treatment combinations (N_0D_1, N_0D_2, N_0D_3, N_1D_1,. N_1D_2, N_1D_3, N_2D_1, N_2D_2, N_2D_3,

N_3D_1, N_3D_2, N_3D_3) of four levels of nitrogen *viz*. N_0 = 00kg N ha^{-1}, N_1 = 80kg N ha^{-1}, N_2 = 100kg N ha^{-1}, N_3 = 120kg N ha^{-1} and three dates of sowing *viz* D_1= 10th July, D_2= 20th July, D_3 = 30th July were laid out in Factorial Randomized Block Design and replicated thrice.

Variety MTU-1010 was used and seeds at the rate of 100kg ha^{-1} were broadcasted in experimental units. The experimental plots were fertilized as per treatments. Urea (46% N), single super phosphate (16% P_2O_5) and muriate of potash (60% K_2O) were used as a source of nitrogen, phosphorous and potassium, respectively. Full recommended dose of phosphorus at the rate of 60kg P_2O_5 per ha and potassium @ 40 K_2Okg/ha was uniformly applied to each plot as basal dose before seed sowing. Nitrogen was supplied to experimental units as per treatment through Urea. Half dose of nitrogen was applied as basal dose at the time of sowing and remaining half dose of nitrogen was applied in two equal splits at tillering and panicle initiation stage.

Results and Discussion

Experimental results on the effect of treatments are explained as under:

The beneficial effect of different levels of nitrogen on mean plant height at 90 DAS, number of tillers plant^{-1}at 90 DAS, number of leaves plant^{-1} at 90 DAS, number of panicles plant^{-1}, panicles length, grain yield (q ha^{-1}), straw yield (q ha^{-1}), test weight, harvest index, protein content were evident during active growth and maturity period of the direct seeded paddy crop.

Incorporation of 120kg N ha^{-1} (N_3) produced significantly higher mean plant height at 90 DAS (74.55cm), number of tillers plant^{-1} at 90 DAS (9.89), followed by incorporation of 100kg N ha^{-1}(N_2), however, maximum number of leaves plant^{-1} at 90 DAS (37.38) was observed with application of 100kg N ha^{-1} (N_2) followed by 120kg N ha^{-1} (N_3) (Table 1).

Data on yield and yield contributing traits *viz*. number of panicles plant^{-1}, length of panicles (cm), grain yield (q ha^{-1}), straw yield (q ha^{-1}), test weight, harvest index as influenced by different nitrogen levels was found to be significant and have been presented in Table 2. Incorporation of 120kg N ha^{-1} (N_3) produced maximum number of panicles plant^{-1} (4.8), length of panicles (19.49cm), grain yield (30.79 q ha^{-1}), straw yield (71.81 q ha^{-1}), test weight (26.64 g), followed by incorporation of 100 and 80kg N ha^{-1}, respectively. However, harvest index (30.41%) was highest when crop was supplied 100kg N ha^{-1}. All above mentioned yield and yield attributes were recorded to be lowest with control treatments. The results are in conformity with those of Jyoti *et al*. (2018) and Kumar *et al*. (2019) [5, 9].

Protein content also influenced by different levels of nitrogen. Highest protein content (10.24%) was noted with application of 120kg N ha^{-1} followed by 100, 80kg N ha^{-1}, respectively.

The beneficial effect of different dates of sowing on mean plant height at 90 DAS, number of tillers plant^{-1}at 90 DAS, number of leaves plant^{-1} at 90 DAS, number of panicles plant^{-1}, panicles length, grain yield (q ha^{-1}), straw yield (q ha^{-1}), test weight, harvest index, protein content were evident during active growth and maturity period of the direct seeded paddy crop.

Crop sown on 10th July (D_1) produced maximum number of tillers plant^{-1} at 90 DAS (9.22), number of leaves plant^{-1} at 90 DAS (34.47), however, highest plant height (66.29cm) at 90 DAS was recorded when crop was sown on 20th July (D_2).

The yield and yield contributing traits like number of panicles plant^{-1}, length of panicles, grain yield (q ha^{-1}), straw yield (q ha^{-1}), test weight, harvest index were also significantly influenced by different dates of sowing. Highest grain yield (25.24 q ha^{-1}) was obtained with D_1 (10th July) which was statistically at par with D_2 (20th July). In addition to that crop sown on 10th July also gave highest test weight (25.69 g) and harvest index (30.04%), however, number of panicles plant^{-1} (3.88), length of panicles (17.01cm), and straw yield (60.11 q ha^{-1}) were recorded higher when crop was sown on 20th July.

Protein content was also influenced by different dates of sowing. Crop sown on 10th July had more protein content (9.98%) than rest of the sowing dates. This might be due to the fact that late sowing delayed the peak growth of rice crop and nitrogen concentration decreases in the plant from the late reproductive period to harvest. The results are in conformity with that of Mahajan *et al*. (2011) [6].

Table 1: Effect of nitrogen levels and dates of sowing on growth parameters of direct seed paddy

Treatments	Plant height (cm) at 90 DAS	No of tillers per plant at 90 DAS	Number of leaves per plant at 90 DAS
Effect of Nitrogen			
N_0	56.98	7.8	22.49
N_1	60.25	8.67	31.27
N_2	70.62	9.6	37.38
N_3	74.55	9.89	37.13
S.Em±	0.14	0.096	0.384
C.D. (*p*=0.05)	0.41	0.282	1.128
Dates of sowing			
D_1	65.23	9.22	34.47
D_2	66.29	8.61	31.91
D_3	65.29	9.13	29.81
S.Em±	0.12	0.083	0.333
C.D. (*p*=0.05)	0.35	0.244	0.977

Table 2: Effect of nitrogen levels and dates of sowing on yield, yield attributes and quality of direct seed paddy

Treatments	Number of panicles per plant	Length of panicles (cm)	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Test weight (g)	Harvest index (%)	Protein content (%)
Effect of Nitrogen							
N_0	2.53	13.81	17.36	41.43	21.41	29.49	8.07
N_1	3.67	15.13	21.27	54.39	24.32	28.12	9.27
N_2	4.18	17.37	28.82	66.02	25.56	30.41	10.06
N_3	4.8	19.49	30.79	71.81	26.64	30	10.24
S.Em±	0.028	0.096	0.29	0.354	0.288	0.192	0.199
C.D (*p*=0.05)	0.084	0.282	0.85	1.038	0.846	0.564	0.584
Dates of Sowing							
D_1	3.71	16.79	25.24	59.108	25.69	30.04	9.98
D_2	3.88	17.01	25.18	60.11	24.41	29.39	9.37

D_3	3.79	15.55	23.27	56.03	23.34	29.1	8.87
S.Em±	0.025	0.083	0.25	0.306	0.25	0.166	0.172
C.D (*p*=0.05)	0.073	0.244	0.73	0.899	0.733	0.488	0.505

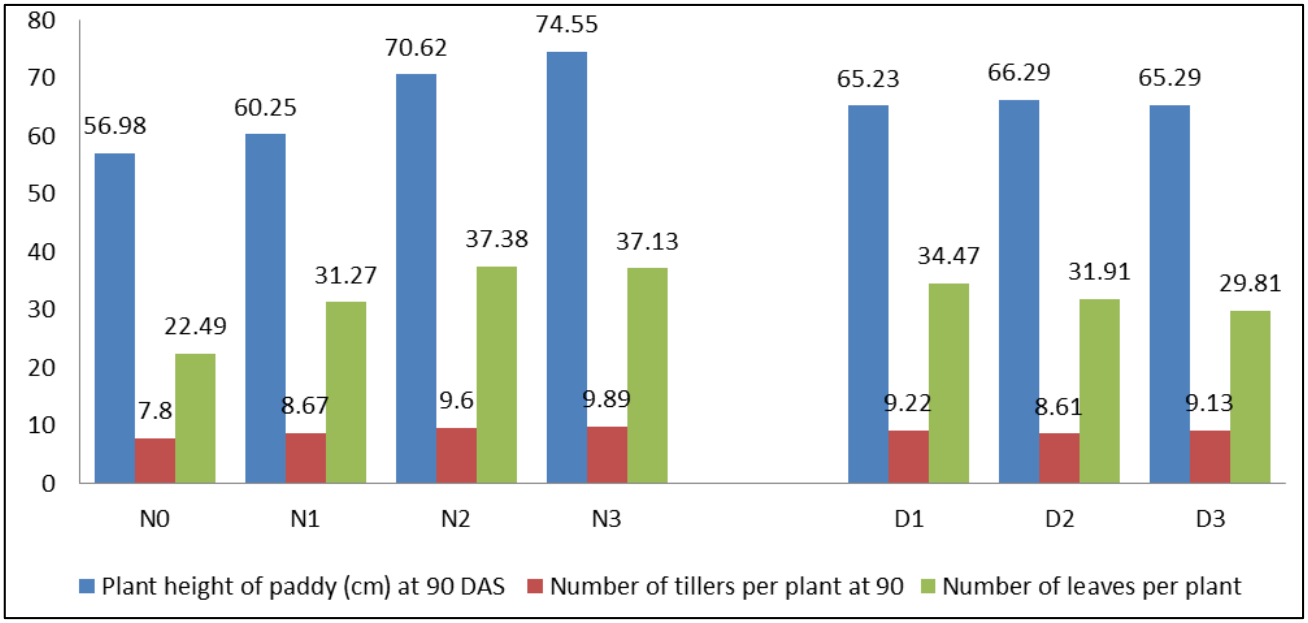

Fig 1: Effect of nitrogen levels and date of sowing on growth parameters of direct seeded paddy

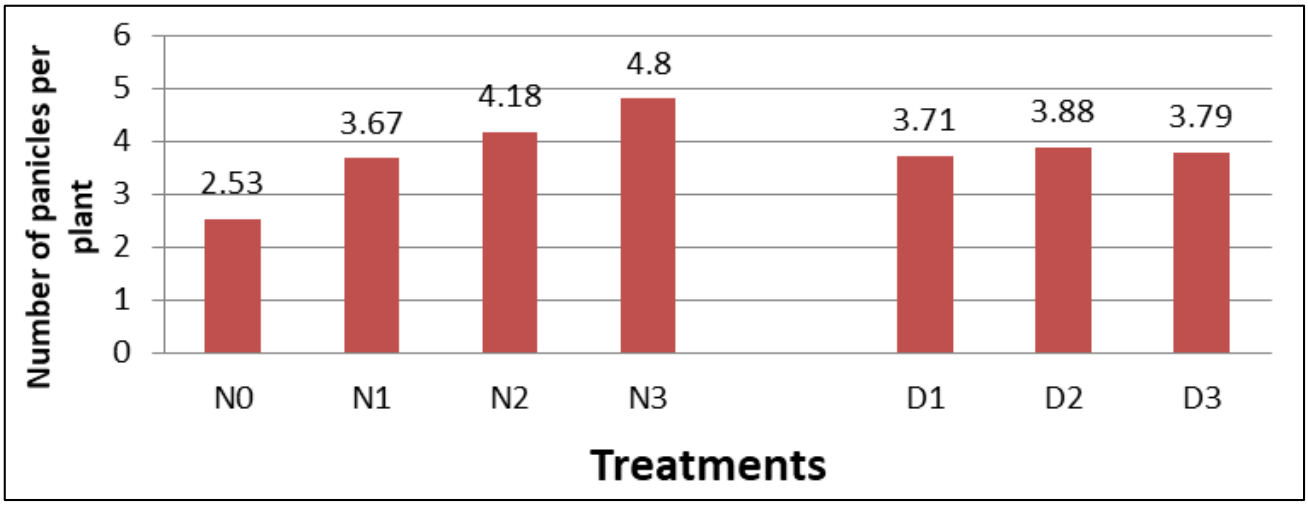

Fig 2: Effect of nitrogen levels and date of sowing on number of panicles per plant of direct seeded paddy

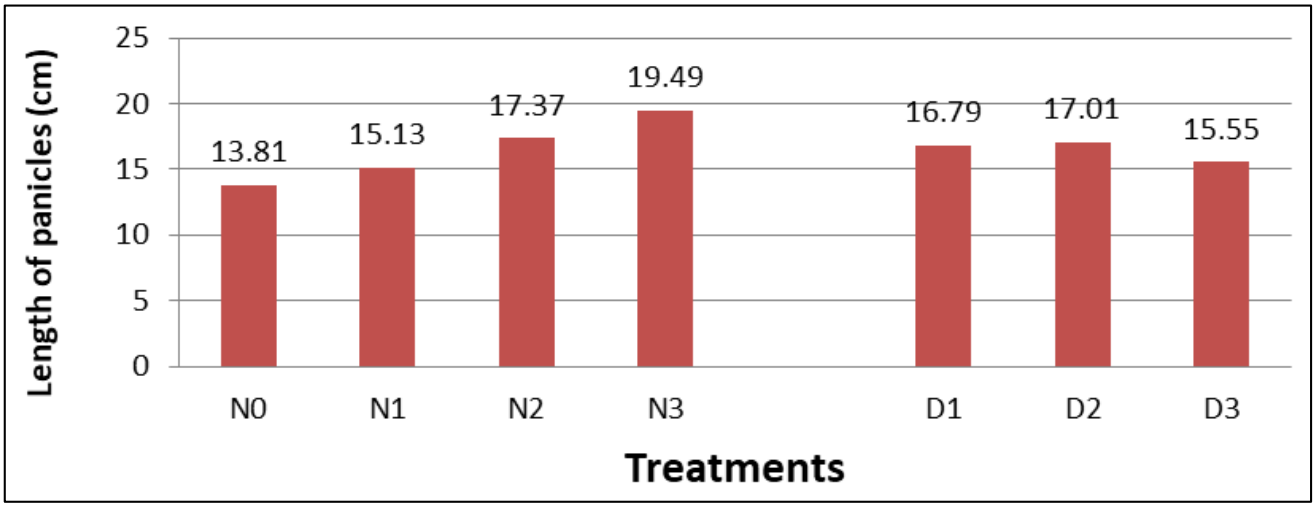

Fig 3: Effect of nitrogen levels and date of sowing on length of panicles (cm) of direct seeded paddy

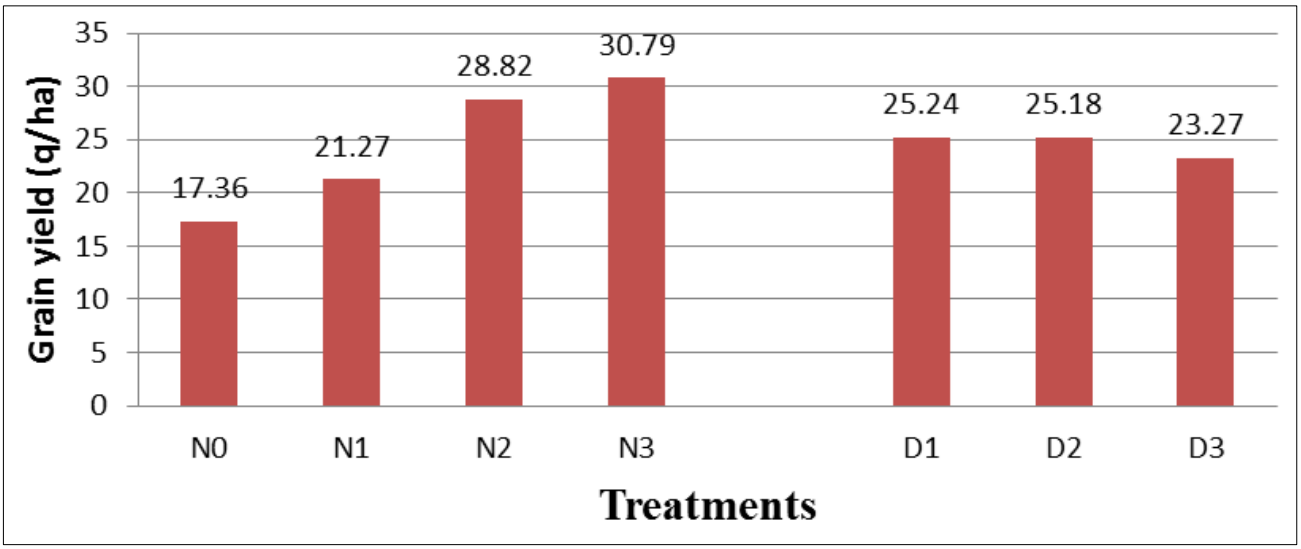

Fig 4: Effect of nitrogen levels and date of sowing on grain yield (q/ha) of direct seeded paddy

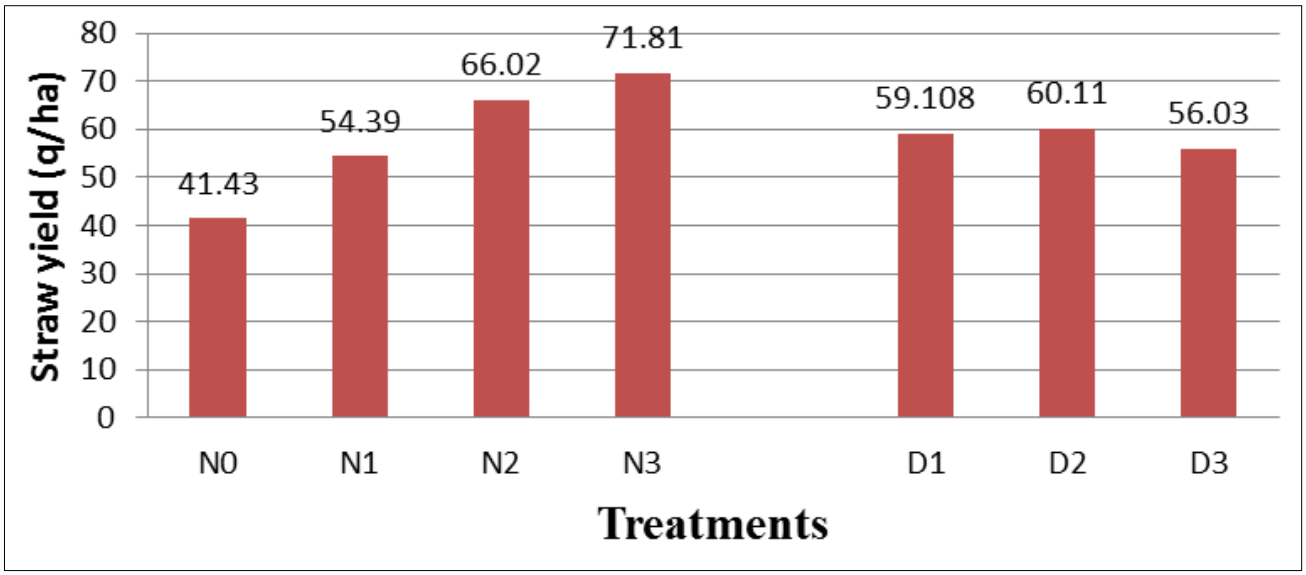

Fig 5: Effect of nitrogen levels and date of sowing on straw yield (q/ha) of direct seeded paddy

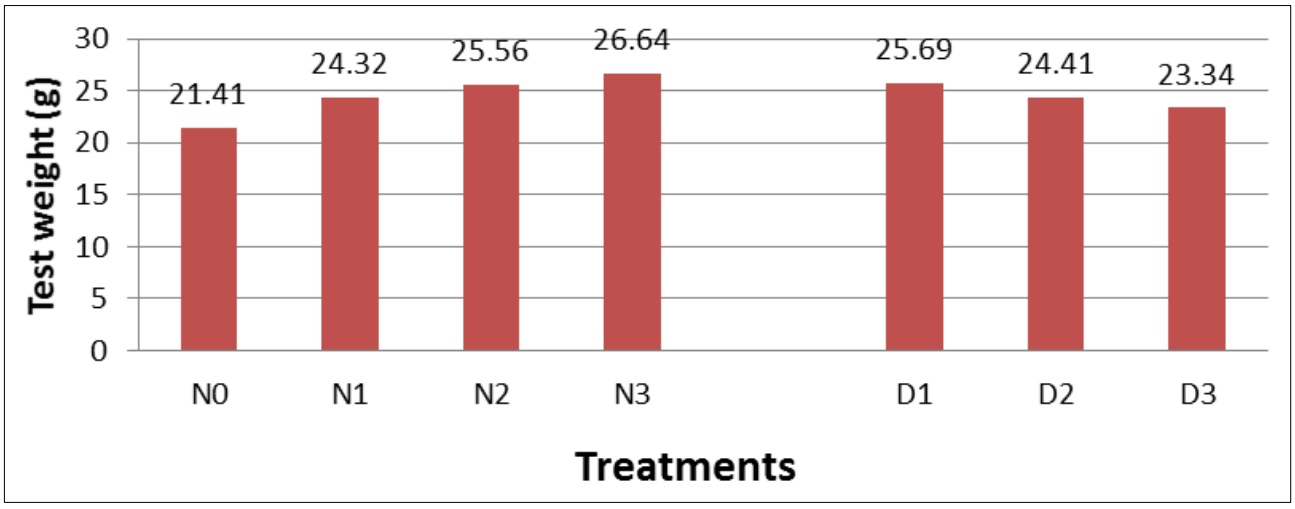

Fig 6: Effect of nitrogen levels and date of sowing on test weight (g) of direct seeded paddy

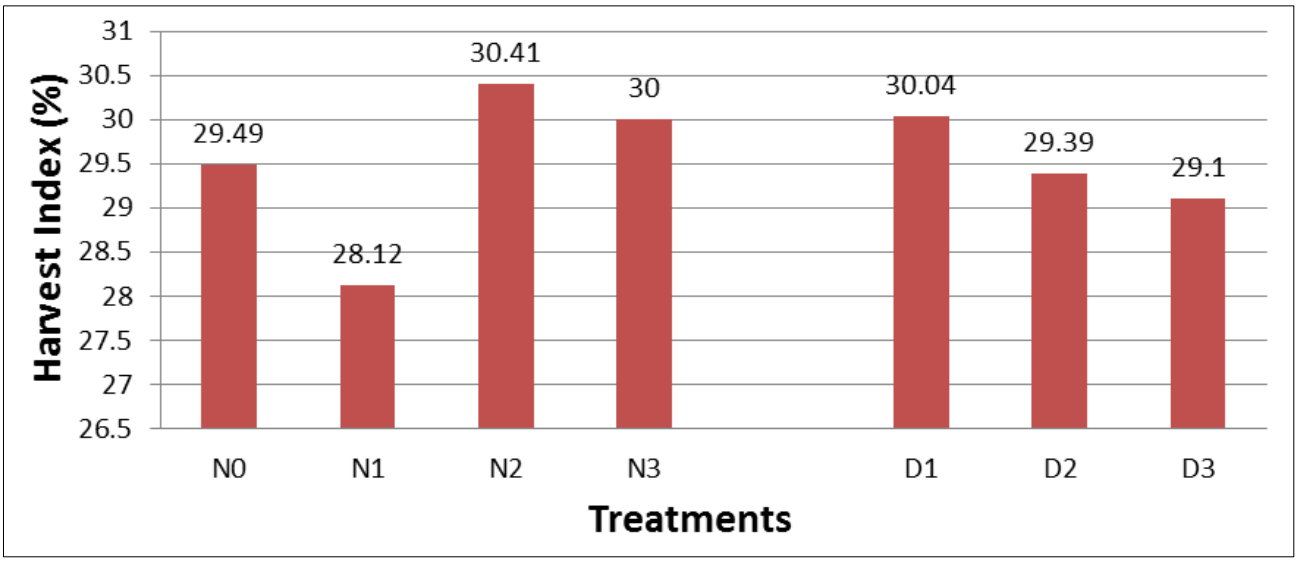

Fig 7: Effect of nitrogen levels and date of sowing on harvest index (%) of direct seeded paddy

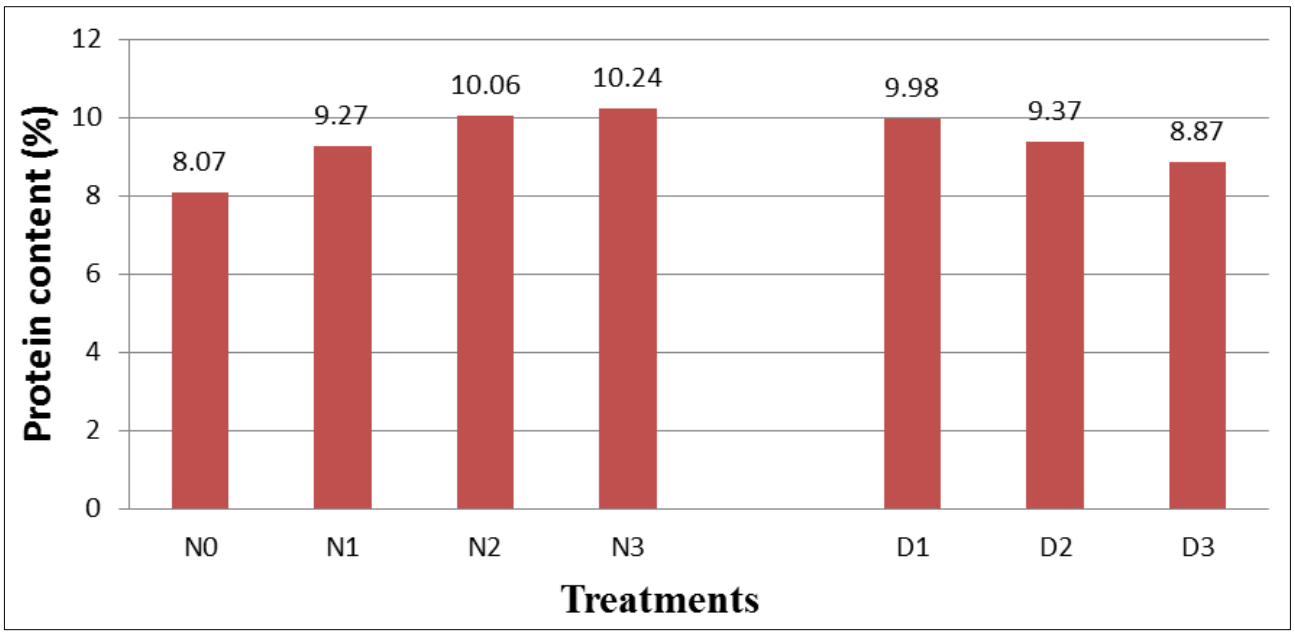

Fig 8: Effect of nitrogen levels and date of sowing on protein content (%) of direct seeded paddy

Summary and Conclusion

All growth parameters except number of leaves per plant at 90 DAS were highest with the application of 120kg N ha^{-1}. Crop sown on 10th July produced maximum number of tillers and leaves at 90 DAS whereas highest plant height was obtained when crop was sown on 20th July. Yield attributes *viz.* number of panicles per plant and length of panicles were higher with the incorporation of 120kg N ha^{-1} and sowing of crop on 20th July. The significant higher grain yield per hectare, test weight and protein content of direct seeded paddy was recorded with the incorporation of 120kg N ha^{-1} and with the sowing of paddy crop on 10th July.

Acknowledgement

First author of this manuscript is very much thankful to Dr. T. Singh, Prof. & Head Agronomy, AKS University, Sherganj, Satna for providing all the experimental facilities and critical suggestions for successful conduct of the experiment and preparation of manuscript.

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