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Effect of moisture regimes split application of nitrogen on growth attributes, yield and quality of hybrid rice (*Oryza sativa* L.)

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Abstract
The experiment entitled ‘’ Effect of moisture regimes split application of nitrogen on Growth attributes, yield and quality of hybrid rice (*Oryza sativa* L.) was conducted during Kharif season at Student’s Instructional Farm of Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (U.P.). The soil was silt loam in texture with pH 8.78, organic Carbon 0.38%, available N 178.75, P 12.32, K 180.44 kg ha^{-1} in Split plot Design and replicated three times. The treatments comprised of four moisture regimes (W_1 5±2 cm water continuous submergence, W_2 5±2 cm water 1 Day After Disappearance of Water, W_3 5±2 cm water 3 Days After Disappearance of Water, and W_4 5±2 cm water 5 Days After Disappearance of Water) and three split application of nitrogen (N_1 1/2 Basal + 1/4 Maximum Tillering + 1/4 Panicle Initiation, N_2 1/3 Basal +1/3 Maximum Tillering + 1/3 Panicle Initiation and N_3 1/4 Basal +1/4 Maximum Tillering +1/4 Panicle Initiation +1/4 Grain Filling). Recommended dose of fertilizer was applied @ 150 N, 60 P_2O_5, 60 K_2O along with 25 kg $ZnSO_4$. The growth attributes like number of shots m^2, leaf area index, dry matter accumulation (g/m^2), yield of grain and straw and protein percent influenced by moisture regimes and split application of nitrogen. The maximum number of shots/m^2, leaf area index, dry matter accumulation (g/m^2) at all the growth stages in W_2 significantly superior over the W_3 and W_4 and at par with W_1. The maximum grain and straw yield (64.00 and 80.04q/ha.) obtain under W_2 significantly superior over the W_3 and W_4 at par with W_1 (62.7q/ha and 81.70q/ha.) respectively. The split application of nitrogen the growth parameter like number of shots m^2, leaf area index, dry matter accumulation (g/m^2) and yield of grain (63.7q/ha.) and straw (85.02q/ha.) were found maximum in N_3 (1/4 Basal +1/4 Maximum Tillering +1/4 Panicle Initiation +1/4 Grain Filling) significantly superior over the N_1 and N_2. The maximum protein % was found W_4 moisture regimes and found non-significant, in case of split application of nitrogen the maximum protein 7.798% found significantly superior over the rest treatments of nitrogen.

Keywords: moisture regimes split, growth attributes, hybrid rice

Introduction
In the immediate future hybrid rice is the practically feasible and adoptable technology for enhancement of rice production and productivity. Water and nitrogen management are the major practices that can interact the yield of rice. Submergence in paddy during entire crop period, a huge amount of water is lost through percolation and evapo-transportation, such losses can be reduced by adequate use of available water. Nitrogen moves very rapidly in the soil and subject to various loss mainly due to leaching, denitrification volatilization and surface run-off resulting reduced nitrogen use efficiency. Split application of nitrogen may increase the nitrogen use efficiency (Cabangon *et al.*, 2001) [3] by improving the yield of hybrid rice. Thus the judicious use of available irrigation water and suitable dose of split application of nitrogen may play an important role in minimizing the present gap between yield achieved and yield achievable.

Materials and Methods
Twelve treatments comprised of four moisture regimes viz., 5±2 cm water continuous submergence (W_1), 5±2 cm water 1 day after disappearance of water (W_2), 5±2 cm water 3 days after disappearance of water (W_3) and 5±2 cm water 5 days after disappearance of water (W_4) and three methods of split application of nitrogen viz., ½ basal + ¼ at maximum tillering + ¼ at panicle initiation stage (N_1), 1/3 basal + 1/3 at maximum tillering + 1/3 at panicle initiation stages (N_2) and ¼ basal + ¼ at maximum tillering + ¼ at panicle initiation + ¼ at milking stages (N_3) were replicated thrice in a split plot design having moisture regimes in main plot and splitting of nitrogen in sub-plots.

Nitrogen @ 150 kg ha^{-1} was applied in the form of urea as per treatments and a common dose of 60 kg P_2O_5, 60 kg K_2O and 25 kg zinc sulphate ha^{-1} was given as basal application in each treatment combination. The data given at different growth stages and at complete maturity, the crop was harvested and grain and straw yields were recorded. After nitrogen analysis calculate the protein percent by facter.

Results and Discussion

The recorded data in given table at all growth stages the number of shoots were counted maximum with W_2 (5±2 cm water 1 DADW followed by continuous submergence), W_3 (5±2 cm water 3 DADW) and W_4(5±2 cm water 5 DADW) at par with W_2. Similarly the maximum shoots per m^2 were also recorded at ¼ B + ¼ MT + ¼ PI + ¼ GF significantly superior over the N_1 and N_2 at all stages of plant growth. The highest number of shoots with 5±2 cm water 1 DADW and ¼ B + ¼ MT + ¼ PI + ¼ GF might be due to sufficient availability of moisture which maintain the adequate nutrient supply and led better growth environment which ultimately produced higher number of shoots per m^2 minimum number of shoots per m^2 with 5±2 cm water 5 DADW and ½ B + 1/4 MT + ¼ PI may be explained on the basis of poor availability of moisture and nutrients which decrease the number of shoots. This result corroborates with the findings of Singh and Ingram (1995) [7]. Maximum LAI was under continuous submergence(W_1) and found significantly superior over rest of the moisture regimes increased in LAI under continuous submergence(W_1) may be attributed to be fact that moisture and nutrients supply contributed more number of green leaves, size of leaves and higher leaf area which certainly improved the LAI. In case of nitrogen management system, the highest LAI with N3(¼ B + ¼ MT + ¼ PI + ¼ GF) over the rest of N_1 and N_2 may because of production of sufficient photosynthesis and better nitrogen use efficiency which led to increased the LAI. These results are in conformity with those obtained by Prasad *et al.* (1992) [6].

Table 1: Effect of moisture regimes and split application of nitrogen on Growth parameters and yield of hybrid rice

Treatment	Number of shoots per m^2				Leaf Area Index			Dry matter accumulation (g/m^2)				Yield (q/ha.)		Protein content in grain (%)
	20 DAT	40 DAT	60 DAT	At harvest	20 DAT	40 DAT	60 DAT	*20 DAT*	*40 DAT*	*60 DAT*	*At harvest*	grain	straw	
Moisture regimes														
W_1	240.0	338.0	432.6	434.0	3.10	5.15	6.23	128.50	359.80	604.46	1057.81	62.70	81.70	7.486
W_2	244.2	341.0	436.5	437.8	3.02	5.01	6.07	135.13	378.37	635.67	1112.42	64.00	80.04	7.355
W3	225.0	314.0	401.9	403.9	2.81	4.66	5.64	122.40	342.72	575.77	1002.60	53.10	74.10	7.598
W_4	206.0	289.0	369.9	371.5	2.75	4.57	5.52	120.10	336.28	564.95	988.66	48.60	69.00	7.711
SEm±	4.65	8.05	10.7	9.41	0.07	0.11	0.13	2.77	7.81	12.48	22.55	1.18	1.72	-
CD (P=0.05)	16.08	27.87	36.93	32.57	0.23	0.37	0.45	9.57	27.03	43.20	78.03	4.10	5.95	NS
Split application of nitrogen														
N_1	205.9	288.5	369.2	371.83	2.60	4.32	5.22	113.96	319.10	536.08	938.15	49.60	66.20	7.286
N_2	228.8	320.5	410.2	412.0	2.93	4.86	5.89	126.53	354.29	595.21	1041.62	58.00	77.41	7.528
N_3	251.7	352.6	451.3	452.2	3.23	5.36	6.49	139.10	389.49	654.34	1145.10	63.70	85.02	7.798
SEm±	5.25	6.90	8.49	8.55	0.07	0.11	0.13	2.27	6.34	10.81	18.74	1.37	1.37	0.047
CD (P=0.05)	15.73	20.69	25.46	25.62	0.20	0.32	0.39	6.81	19.02	32.42	56.19	4.11	4.09	0.142

Dry matter accumulation (g/m^2) influenced significantly due to different moisture regimes at all the growth stages highest dry accumulation was recorded under 5±2 cm water 1 DADW(W_2) which was at par with continuous submergence(W_1). This might be due to increased plant height, LAI and number of shoots through adequate moisture supply. All these contributed for all turgidity and opened leaves activity of crops resulted in higher dry matter accumulation. The lowest dry matter accumulation was obtained under 5±2 cm water 5 DADW. This might be due to lack of optimum level of moisture, which resulted reduced photosynthetic activity and ultimately reflected in lowest dry matter accumulation. However, Tyagi *et al.* (1990) [9] observed that continuous submergence (5 cm) favoured better dry matter accumulation. In case of split application of nitrogen the highest dry matter accumulation with N3 ¼ B + ¼ MT + ¼ PI + ¼ GF significantly superior over the N1 and N2 may be explained on the basis of sufficient nitrogen availability which led to increased the dry matter accumulation these result corroborates with the findings of Damodaran *et al.* (2004) [4]. Grain and straw (80.04q/ha) yield significantly influenced by different moisture regimes. Highest grain yield Grain (64.00q/ha) was recorded under moisture regimes (W_2) 5±2 cm water 1 DADW at par with W_1 and straw yield (81.70q/ha.) was recorded under continuous submergence and at par with W_2. This might be due to adequate moisture availability, which contributed to better growth parameters roots character and yield attributes. Productivity of crop collectively determined by vigor of the vegetative growth and yield attributes. Better vegetative growth coupled with higher yield attributes resulted in higher grain yield and straw yield. Moisture regimes of 5±2 cm water 5 DADW recorded lowest yield due to poor moisture supply during the period of growth. Poor moisture supply during critical stage reduced the yield attributes and resulted in poor grain and straw yield. Similar finding were reported by Andani and Gowda (1995) [1] and Singh and Ingram (1995) [7] Grain and straw yield of rice influenced significantly due to three-split application of nitrogen. Split application of nitrogen as ¼ B + ¼ MT + ¼ PI + ¼ GF (63.70q/ha.) and (85.02q/ha.) resulted in significant highest yield over 1/3 B +1/3 MT + 1/3 PI and ½ B + ¼ MT + ¼ PI. Yield is the function of complex inter-relationship between growth, development and yield attributes. The reasons for significant superiority of ¼ B + ¼ MT + ¼ PI + ¼ GF in the data pertaining to growth, development and yield attributes. The findings obtained are well supported by Singh *et al.* (1982), the protein content in moisture regimes is not affected. In case of split application of nitrogen the maximum protein 7.798%

found significantly superior over the rest treatments of nitrogen. The multiplication effect of nitrogen content in grain which their corresponding yield ultimately produced a basic to increase the nitrogen uptake in grain under timely and adequate fertilization of nitrogen higher protein content with proper spilt application of nitrogen were also reported by Cabangon *et al.* (2001) [2], Bhuyan (1997) [2].

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