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Evaluation of rice establishment methods and nitrogen management criteria on wheat in relation to growth and productivity

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Abstract: *A field experiment was conducted during 2011-12 and 2012-13 in silty clay loam soil to study the effect of rice establishment methods at varying levels of nitrogen on wheat in rice-wheat system at Pantnagar,* Tarai *region of Uttarakhand. The experiment was laid out in strip plot design with three replication. The horizontal strip were comprised of three establishment methods i.e. zero tilled transplanted rice (ZTPR), transplanted rice (TPR), and dry direct seeded rice (DDSR) and vertical strip with five nitrogen management options viz., No nitrogen applied treatment (N_0), 75 kg N ha^{-1} (N_{75}), 150 kg N ha^{-1} (N_{150}), leaf color chart based nitrogen application (LCC) and soil plant analysis development(SPAD) based nitrogen application (SPAD). In 2011-12 and 2012-13, the highest grain yield, straw yield and total biological yield was recorded in DDSR planted wheat being at par with TPR planted wheat and among the nitrogen management options the N_{150} treatment was recorded highest yield being at par with SPAD based nitrogen application.*

Key words: *DDSR, TPR, ZTPR, LCC and SPAD*

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the second most important cereal crop next to rice in India. It is one of the oldest cereal food crops of the world, consumed by the human beings, covers the largest area and contributes maximum to food production. Wheat is consumed by 36 per cent of the global population providing more than 20 per cent of total food calories. India produced 92.56 mt. of wheat with an average productivity of 3.12 tones per hectare from gross area of 29.64 million hectare **(Directorate of Wheat Research, 2012-13)**. Rice (*Oryza sativa* L.) and wheat (*Triticum aestivum* L. emend. Fiori & Paol.) are the staple food crops, which have become the integral part of human diet of 800 million people in South-East Asia. The system is fundamental to employment, income and livelihood for 700 million populations in India. The rice-wheat cropping system fulfills 80 % of the food requirement and 60 % of the nutrition requirement of Indian population **(Timsina and Conor, 2001).** Due to some limitations of this system, the whole production system being faced certain level of challenges like soil degradation, environmental pollution etc. These challenges mostly affect the wheat productivity of system and requires suitable technologies to solve these problems. A shift in rice production system from transplanted rice to direct seeding is testimony of the resource conservation technologies **(Gupta *et al.*, 2006).** In view of conservation of natural resources more emphasis is needed to accelerate the adoption of cost effective and environment friendly management practices such as DDSR, puddle direct seeding ZTPR, LCC and SPAD need to be screened for better wheat productivity in this system ,. Keeping this views a experiment was excellent with the objective see the impact of differential rice establishment methods

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and nitrogen on wheat growth and productivity in rice-wheat cropping system.

MATERIALS AND METHOD

The study area comes under climate zone of western Himalyas region and is located in the foothills of Shivalik range of Himalyas and represents the tarai region of Uttarakhand, it lies at 79^0 E longitude, 29^0 N latitude and 243.84 m (above mean sea level) altitude. The experiment was conducted at Dr N.E. Barlaug Crop Research Center of G.B. Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar, Uttarakhand, during 2011-12 and 2012-13. The soil of experimental field at the beginning of the experiment was silty loam in texture (50.4 % sand, 33.1 % silt and 16.5 % clay) contain 0.72 % organic carbon 176.8 kg ha^{-1} available nitrogen , 26.4 kg ha^{-1} available phosphorus and 187.1 kg ha^{-1} available potassium. The pH of the soil was neutral, and it was recorded 7.3. The experiment was laid out in strip plot design with three main plots i.e. zero tilled transplanted rice (ZTPR), transplanted rice (TPR) and dry direct seeded rice (DDSR), five nitrogen management options, No nitrogen applied treatment (N_0), 75 kg N ha^{-1} (N_{75}), 150 kg N ha^{-1} (N_{150}), leaf color chart based nitrogen application (LCC) and soil plant analysis development based nitrogen application (SPAD).

RESULTS AND DISCUSSIONS

Wheat yield had significant differences due to rice establishment methods during 2011-12 and 2012-13. The highest grain yield was recorded under DDSR (4228 kg ha^{-1} in 2011-12 and 4240 kg ha^{-1}2012-13) being at par with TPR (4138 kg ha^{-1} in 2011-12 and 4152 kg ha^{-} in 2012-13) which was significantly higher than of ZTPR (3874 kg ha^{-1} in 2011-12 and 3881 kg ha^{-1} in 2012-13). The variation in relation to grain yield between ZTPR and TPR was also found significant during both the years.

The nitrogen management options also revealed significant differences during both the years. The highest grain yield was obtained under N_{150} treatment (5018 kg ha^{-1}) followed by SPAD based nitrogen applied treatment (4902 kg ha^{-1}) and LCC based nitrogen applied treatment (4863 kg ha^{-1}). Whereas, it was significantly higher than that of N_{75} treatment (3445 kg ha^{-1}) during 2011-12. However, during 2012-13, the highest grain yield was obtained under N_{150} treatments (5031 kg ha^{-1}) followed by SPAD based nitrogen applied treatments (4908 kg ha^{-1}) and LCC based nitrogen treatments (4882 kg ha^{-1}) which was significantly higher than that of N_{75} treatments (3453 kg ha^{-1}). Straw yield also had significant differences due to rice establishment methods during 2011-12 and 2012-13. The highest straw yield was recorded under DDSR (6553 kg ha^{-1} in 2011-12 and 6565 kg ha^{-1} in 2012-13), being at par with TPR (6382 kg ha^{-1} in 2011-12 and 6382 kg ha^{-1} in 2012-13), which was significantly higher than that of ZTPR (5908 kg ha^{-1} in 2011-12 and 5896 kg ha^{-1} in 2012-13). The variation in relation to grain yield between ZTPR and TPR was also found significant during both the years.

The data pertaining to the straw yield of wheat due to various nitrogen management options revealed significant differences during both the years. The highest straw yield was obtained under N_{150} treatment (7527 kg ha^{-1}) followed by SPAD based nitrogen applied treatment (7304 kg ha^{-1}) and LCC based nitrogen applied treatment (7295 kg ha^{-1}), whereas it was significantly higher than that of N_{75} treatments (3845 kg ha^{-1}) during 2011-12. The lowest straw yield was obtained in no nitrogen applied treatments which was significantly lower than that rest of the nitrogen treatments. During 2012-13, the highest straw yield was obtained under N_{150} treatments (7540 kg ha^{-1}) followed by LCC based nitrogen applied treatments (7313 kg ha^{-1}) and SPAD based nitrogen applied treatments (7311 kg ha^{-1}), which was significantly higher than that of N_{75} treatments (3895.00 kg ha^{-1}).The highest biological yield was recorded under DDSR (10887 kg ha^{-1} in 2011-12 and 10918 kg ha^{-1} in 2012-13), which was significantly higher than that of TPR (10645 kg ha^{-1} in 2011-12 and 10632 kg ha^{-1} in 2012-13) and ZTPR (9848 kg ha^{-1} in 2011-12 and 9861 kg ha^{-1} in 2012-13). The variation relation to biological yield between ZTPR and TPR was also found significant during both the years. The highest biological yield was obtained under N_{150} treatment (12540 kg ha^{-1} in 2011-12 and 12570 kg ha^{1} in 2012-13) followed by SPAD based nitrogen applied treatments (12256 kg ha^{-1} in 2011-12 and 12217 kg ha^{-1} in 2012-13), LCC based nitrogen applied treatments (12128 kg ha^{-1} in 2011-

12 and 12194 kg ha^{-1} in 2012-13) whereas it was significantly higher than that of N_{75} treatment (9620 kg ha^{-1} in 2011-12 and 9556 kg ha^{-1} in 2012-13). The lowest biological yield was obtained in no nitrogen applied treatments (5755 kg ha^{-1} in 2011-12 and 5814 kg ha^{-1} in 2012-13), which was significantly lower than rest of nitrogen treatments during both the years. The differences in wheat harvest index due to various rice establishment methods were non-significant during both the years (**Table 1**). However, the highest value was recorded under ZRPR (39.20) followed by DDSR (38.60) and lowest under TPR (38.28) during 2011-12, whereas during 2012-13 the highest value was recorded under DDSR (39.05). Similarly, the various nitrogen management options was non-significant effect on harvest index 2011-12. However, the highest value was recorded under N_{150} treatment (40.01) followed by SPAD based nitrogen applied treatment (39.99), LCC based nitrogen applied treatment (39.74), N_{75} treatment (37.89) and lowest was recorded under no nitrogen applied treatment (35.85).During 2012-13, the nitrogen management options had significant effect on harvest index. Due to better seed bed preparation in DDSR will be available more nutrient over transplanted rice methods it is only due to flooding of rice fields cause major chemical changes in soil that affect the transformation and availability of nutrients puddling creates anaerobiosis in soil, which is helpful in relative proliferating of anaerobic micro flora, which in tern is responsible for slow degradation of sol organic matter in contrast to aerobic soil under direct establishment dry bed where the aeobic microflora predominates and causes rapid degradation of the soil organic matter ultimately improve the yield (**Takahashi *et al.*, 2003**).

Nitrogen content

The data pertaining to nitrogen content by wheat at active tillering stage are presented in (**Table 2**) revealed that different rice establishment methods and varying real time nitrogen management options had significant effect on nitrogen content in wheat at active tillering stage but interaction was found non significant during both the years.

At flowering stage, N content was significantly influenced by rice establishment methods and nitrogen management options.. The highest nitrogen content was obtained under DDSR (2.39% in 2011-12 and 2.39 in 2012-13) which was significantly higher than that of TPR (2.25% in 2011-12 and 2.25% in 2012-13) and ZTPR (2.12% in 2011-12 and 2.13% in 2012-13). The nitrogen content in what plant at flowering stage was contained highest in TPR (2.25% in 2011-12 and 2.25% in 2012-13) was also found significant over ZTPR (2.12% in 2011-12 and 2.13% in 2012-13) during both the years.Among the real time nitrogen management options during 2011-12, the highest nitrogen content by wheat at flowering stage was obtained in SPAD based nitrogen applied treatment (3.14%) followed by N_{150} treatment (3.05%) being at par with LCC based nitrogen applied treatment (3.02%) which was significantly higher than that of N_{75} treatment (1.18%).

The highest range of nitrogen content was obtained under DDSR (1.72% in 2011-12 and 1.72% in 2012-13) which was significantly higher than that of other establishment methods i.e. TPR (1.69% in 2011-12 and 1.69% in 2012-13). The variation in relation to nitrogen to nitrogen content in grain in TPR (1.69% in 2011-12 and 1.69% in 2012-13) being statistically at par with ZTPR (1.68% in 2011-12 and 1.70% in 2012-13) during both the years. Among the real time nitrogen management option during 2011-12, the highest content in grain was recorded in SPAD based nitrogen applied treatment (1.99%) followed by LCC based nitrogen applied treatment (1.98%) and N_{150} treatment (1.96%) which was significantly higher than that of N_{75} treatment (1.76%). The nitrogen content in grain in LCC based nitrogen applied treatment (1.98%) which was statistically at par with N_{150} treatment (1.96%). The lowest content of nitrogen in grain was recorded in no nitrogen applied treatment (0.605%) which was significantly lower than that of rest of other real time nitrogen management options during 2011-12.Rice establishment methods and varying real time nitrogen management options had significant effect on nitrogen content in wheat straw The highest nitrogen concentration was contained in DDSR (0.371% in 2011-12 and 0.379% in 2012-13) which was significantly higher than that of TPR (0.369% in 2011-12 and 0.374% in 2012-13) and ZTPR (0.365% in 2011-12 and 0.367% in 2012-13). The variation of

Table 1
Effect of different rice establishment methods and nitrogen levels at different growth stages on yield ($kg\ ha^{-1}$) of wheat during 2011-12 and 2012-13

Treatments	*Yield ($kg\ ha^{-1}$)*					
	Grain yield		*Straw yield*		*Biological yield*	
	2011-12	*2012-13*	*2011-12*	*2012-13*	*2011-12*	*2012-13*
Establishment methods						
ZTPR	3874	3881	5908	5896	9848	9861
TPR	4138	4152	6368	6382	10645	10632
DDSR	4228	4240	6553	6565	10887	10918
S.Em.±	61	74	94	93	161	137
CD (P = 0.05)	241	267	371	368	633	538
Nitrogen levels						
N_0 ($kg\ ha^{-1}$)	2173	2181	3845	3895	5755	5814
N_{75} ($kg\ ha^{-1}$)	3445	3453	5772	5746	9620	9556
N_{150} ($kg\ ha^{-1}$)	5018	5031	7527	7540	12540	12570
LCC based ($kg\ ha^{-1}$)	4863	4882	7295	7313	12128	12194
SPAD based ($kg\ ha^{-1}$)	4902	4908	7304	7311	12256	12217
S.Em.±	103	81	94	160	89	109
CD (P = 0.05)	336	267	310	522	270	356

ZTPR = zero tilled transplanted rice, TPR = Transplanted rice, DDSR = Dry direct seeded rice

Table 2
Effect of different rice establishment methods and nitrogen levels at different growth stages on nitrogen content (%) of wheat during 2011-12 and 2012-13

Treatments	*Nitrogen content (%)*					
	At flowering stage		*Grain*		*Straw*	
	2011-12	*2012-13*	*2011-12*	*2012-13*	*2011-12*	*2012-13*
Establishment methods						
ZTPR	2.12	2.13	1.68	1.70	0.365	0.367
TPR	2.25	2.25	1.69	1.69	0.369	0.374
DDSR	2.39	2.39	1.79	1.72	0.371	0.379
S.Em.±	0.2	0.02	0.02	0.01	0.002	0.002
CD (P = 0.05)	0.08	0.11	NS	NS	NS	0.078
Nitrogen levels						
N_0 ($kg\ ha^{-1}$)	0.85	0.87	0.61	0.60	0.205	0.208
N_{75} ($kg\ ha^{-1}$)	1.18	1.19	1.76	1.75	0.404	0.407
N_{150} ($kg\ ha^{-1}$)	3.05	3.06	1.96	1.97	0.409	0.418
LCC based ($kg\ ha^{-1}$)	3.02	3.03	1.98	1.98	0.411	0.415
SPAD based ($kg\ ha^{-1}$)	3.14	3.14	1.99	1.98	0.412	0.420
S.Em.±	0.05	0.03	0.004	0.002	0.006	0.003
CD (P = 0.05)	0.18	0.12	0.011	0.071	0.019	0.010
Interaction	NS	NS	NS	NS	NS	NS

ZTPR = zero tilled transplanted rice, TPR = Transplanted rice, DDSR = Dry direct seeded rice nitrogen content in wheat straw in TPR (0.369% in 2011-12 and 0.374% in 2012-13). The lowest nitrogen in straw was contained in ZTPR (0.365% in 2011-12 and 0.367% in 2012-13) and it was significantly lower than that of rest of the other rice establishment methods during both the years. Among the real time nitrogen management options during 2012-13, the highest nitrogen content in wheat straw was contained in SPAD based nitrogen applied treatment (0.409%). The LCC based nitrogen applied treatment (0.411%) being statistically at par with N_{150} treatment. The lowest content of nitrogen of straw in the treatment of no nitrogen applied treatment (0.205%) which was significantly lower than that rest of other real time nitrogen management options during 2011-12.

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