



Research Article

Productivity and Profitability Analysis of Old Aged Hybrid Rice Seedling Using Nutrient-Rice Expert and Other Precision Nutrient Management Practices at Lamjung, Nepal

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Abstract

Rice (*Oryza sativa* L.) being the most important staple crop of Nepal its production and productivity is significantly reduced by old-aged seedling transplantation and imbalanced nitrogen, phosphorus and potassium application. A field experiment was conducted at Sundarbazar, Lamjung to evaluate the performance of 38 days old US-312 hybrid rice seedling under fully rain-fed condition with six precision nutrient management practices [Nutrient Expert® -Rice (NE) recommendation, Farmers Fertilizer Practices (FFP); Government Recommendation (GR); Leaf Color Chart (LCC) N and FFP (P & K); NE (N) and FFP (P & K); and LCC (N) and NE (P & K) replicated four times in RCBD design during July to December, 2017. The statistical results showed that there was a significant difference between the treatments in terms of plant height(105.38cm), leaf area index(4.26), crop growth rate (3.55), effective tillers m⁻²(374.25), tiller panicle conversion index (94.93%), panicle length (25.31cm), panicle weight (4.25g), fertility (82.35%), yield at 14% moisture (5.79t/ha), straw yield (7.96t/ha), net and gross revenues (Rs122503.1 and Rs272337/ha), B:C ratio (1.81), partial factor productivity(0.958) and total factor productivity (0.091). The grain yield increased by 37.62% in NE-Rice recommendation over the FFP, more than the NE estimated attainable yields (5.5t/ha) that signified further validation of Nutrient Expert –Rice Model under the mid-hill agro-ecological region of central Nepal.

Keywords: Hybrid Rice; Nutrient Expert; Government Recommendation; Leaf Color Chart

Introduction

Rice is the most important food crop in Nepal accounting for more than half of the cultivated cropped area and food production in Nepal (CBS, 2013). The area, production and productivity of paddy in Nepal is 1.36 million ha, 4.29 million metric tons and 3.15 ton/ha respectively (Statistical Information on Nepalese Agriculture, ASS, MOAD, 2015/2016). The rice is grown in each ecological region of the country from lowland terai to high mountain valley and in mountain slopes in Jumla-the highest altitude of rice

growing location in the world (Gauchan *et al.*, 2012). Rice contributes nearly 20% to the agricultural gross domestic product (AGDP), more than 50% in food grains and more than 50% of the total calories requirement of Nepalese people (FAOSTAT, 2013). The area, production and productivity of Lamjung district is 14,059ha, 37,772Mt and 2.687t/ha (Statistical Information on Nepalese Agriculture, ASS, MOAD, 2015/2016).

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The area and production of rice in the country has decreased by 4.4% and 10.2% respectively from F.Y 2014/15 to F.Y 2015/16 (Krishi diary, 2017). There is the wide gap between crop actual yield potential and farmers' yields (Dhami, 2004). The wide difference in yield is majorly due to the lack of the inappropriate production technology owing majorly to the improper fertilizer management. The use of inappropriate amount of fertilizer and the method of fertilization technology is the most limiting factor in low yield. Out of total 374,181 ha of paddy cultivation land in hills, 40% land is rain-fed that has the productivity of 2.61 t/ha (Statistical Information on Nepalese Agriculture, 2015/16) which signifies that the productivity is much more less than that can be achieved and besides rain-fed, the improper fertilization is the major constraint. Hence, a proper nutrient management is uttermost in a rain-fed farming to decrease the yield gap.

Site Specific Nutrient Management is an alternative approach for dynamic management of nutrients to balance the supply and demand of nutrients in the specific crop in specific cropping season (Dobermann *et al.*, 2004). The SSNM concept don't encourage the farmers to haphazardly use more chemical fertilizers, it aims on the optimum application of the required nutrients to increase farmers' profit, efficiency of nutrients and environment protection (Fertilizer Best Management Practices, 2007). The Nutrient Expert tool enables the pre-season nutrient input, present requirement of input along with the nutrients obtained from previous cropping to match the crop needs and sustain soil fertility (Buresh, 2010). This tool is applicable in presence or absence of soil testing results and more or less balanced application of not only Nitrogen but potassium and phosphorus too considering the site requirements. Nutrient Expert®, a new nutrient decision support system (DSS), based on the above mentioned principles of site specific nutrient management(SSNM) is a tool to maximize efficient nutrients use and improve the productivity of the crops and profit (Satyanarayana *et al.*, 2012) in the particular farming conditions.

The LCC can be more successful in integrated site-specific nutrient management strategy, in which the availability of other nutrients, such as P, K, S and Zn must not be limiting

to achieve optimum response of nitrogenous fertilizers (Marahatha, 2008; Paudel *et al.*, 2017).

This research thus aims at identifying the best ways of nutrient management for sustained higher rice production in rain-fed mid-hills of Nepal.

Materials and Methods

The research was conducted in Sundarbazar municipality of Lamjung district. The questionnaire was prepared and interview was taken by visiting individual farmer's field. The information was recorded and data were entered in NE rice software and the required amount of nitrogen, phosphorus and potassium doses in the form of urea, DAP and MOP was recommended. LCC doses were calculated by using leaf color chart after 14 DAT in interval of 2 weeks further. The used variety was US-312, a hybrid variety.

The nursery was prepared as per the farmers practice in the field of Lamjung Campus with the application of FYM at the nursery field. Due to the climatic constraint, no rainfall, the transplanting was done after 38 days. The main field was prepared with mini-tiller as tractor was not feasible. Final field was prepared after the rainfall. Random complete block design with 4 replications and 6 treatments was used. Treatments were NE fertilizer recommendation, government recommendation, farmers' field practice, LCC(N) and FFP (PandK), NE(N) and FFP (P and K) and LCC(N) with NE (P and K). Plots of 6m² was prepared for each plots and rice was transplanted at spacing of 20*20cm. The fertilizer recommended for each treatments are given in Table 1.

Harvesting was manually done at the first week of December. Various observations like plant height, effective tillers/m², dry matter weight, leaf area index, length and weight of panicle, test weight, biological yield was taken.

Comparison of attainable and observed yield and economics was done in between NE and FFP. Gross and Net revenue, B:C ratio, Partial factor productivity and Total Factor productivity were calculated for economic analysis. Data entry and analysis was done using excel and R-studio. ANOVA was done at 0.05% level of significance.

Table 1: Recommended fertilizer doses in each treatments.

Treatments	Recommendation per ha(N:P:K)
NE	109:35:41
GR	80:60:40
FFP	Farmers own practice (67:36:20)
LCC (N)+ FFP(P and K)	56kg N/ha and P and K as per the farmers practice
NE(N)+ FFP(P and K)	109kg N/ha and P and K from farmers practice
LCC(N) + NE(P and K)	56 kg/ha N and P and K as calculated from NE

Results and Discussions

The result showed that the relative performance of US-312 is better in NE than any other nutrient recommendation best performed in balanced application of N, P and K. The mean data showed the significant results indifferent attributes affected by different treatments. The mean value of various parameters like plant height, tillers, grain yield, fertility, test weight, are significantly higher in balanced application as

per the requirement in NE field despite same nitrogen in NE(N) with FFP (P and K).

The Table 2 below shows the significant result in plant height (105.38cm), LAI (4.262), effective tillers per sq. metre (374) and CGR (3.55) in NE followed by NE(N) with FFP (P and K). This depicts the major role of nitrogen in growth attribute as increasing N rates with balanced P and K assisted better crop growth. Ranabhat (2016) showed same results.

Table 2: Effect of different precision nutrient management on plant height, LAI, effective tillers/m² and CGR

Treatment	Plant height (cm)	LAI	ET/m ²	CGR (30 and 60 days)
NE	105.38a	4.262a	374.25a	3.553a
GR	100.56bc	3.17bc	312.50bc	2.73 bc
FFP	99.86bc	2.86cd	280.5cd	2.157 c
LCC(N)+ FFP(P and K)	98.15c	2.16e	252d	2.61bc
NE(N) + FFP (P and K)	101.94ab	3.505b	347.25ab	2.93b
LCC(N)+ NE(P and K)	100.49bc	2.59d	298.75c	2.69bc
Significance (P<0.05)	0.0198*	0.000135**	0.000205**	0.00465**
Sem(±)	0.511	0.046	5.675	0.80
LSD	3.77	3.37	41.90	0.5902
CV %	2.477	7.31	8.94	2.77

ns-nonsignificant, * significant, ** highly significant

Table 3: Yield attributes of hybrid rice under different nutrient management practices in Sundarbazar,

Treatment	TPCI (%)	PW(g)	PL(cm)	TW(g)	FG	fertility%
NE	94.93558a	4.252a	25.3125a	22.4190a	179.75a	82.35362a
GR	91.0067ab	3.86bc	22.57bc	20.8475b	162.50ab	77.70932ab
FFP	86.229bc	3.64650cd	22.15bc	20.4050b	145.25bc	74.35009bc
LCC(N)+FFP(P&K)	81.88c	3.37d	20.977c	20.4500b	132.50c	68.29915c
NE(N)+FFP(P&K)	92.71854ab	4.13ab	23.18b	21.2475ab	172.50a	81.14028ab
LCC(N)+NE(P&k)	89.65885ab	3.68c	22.15bc	20.0850b	143.50bc	77.48300ab
Significance	0.0118*	0.000161**	0.00203**	0.026*	0.000395**	0.00379**
SEm	0.919	0.041	0.234	0.183	2.503	0.868
LSD	7.55	0.299	1.728	1.5022	18.48	6.4
CV (%)	5.033192	5.19541	5.0496	4.281722	7.86139	5.528579

ns-nonsignificant, * significant, ** highly significant

The Table 3 depicts the significant result in terms of TPCI being highest in NE (94.93) and lowest in combination of LCC with FFP (81.88). The highest panicle length is observed in NE (25.31cm) followed by NE combined with FFP treatments (23.18cm). The average panicle length observed is 22.709 cm. The panicle length is at par for GR, FFP and LCC combined with NE and lowest in LCC combination with FFP (20.97cm). Similarly, highly significant result in panicle weight being highest in NE (4.25g) followed by NE combination with FFP (4.13). The observation on filled grains per panicle being highest on NE (179) statistically with NE combined with FFP and GR. The filled grains are also statistically at par between FFP and LCC combined with NE being lowest in LCC combined with FFP. The higher fertility percentage in NE (82.35%) statistically at par with NE combined with FFP (81.14 %) and FFP (77.7%) and LCC with FFP (77.48%). The average

fertility obtained is 77.6 % that relates to the better partitioning of the dry matter.

Grain Yield

The above Table 4 depicts the significant result being highest in NE (5.79t/ha) followed by NE combination with FFP (5.13t/ha) as a result of lower potassium doses with equal application of nitrogen in both treatments. Further, the yield is decreased with the decrease in nitrogen rate. The yield of FFP and LCC combined with NE being at par and lowest in LCC combined with FFP. At low K level an increase in N supply depressed the yield and at higher K level, low N supply increases the yield (IPI, 2014). The results also showed the increase in panicle length, panicle weight, effective tillers/m², filled grains/panicle, test weight may be reasonable to the increased yield. Supported by Subedi, 2013 ; Aslam et al., 2015.

Table 4: Yield of different nutrient management practices in Hybrid rice production

Treatment	SY(t/ha)	Yield @ 14% (t/ha)	BY(t/ha)	HI(%)
NE	7.96a	5.79a	13.76a	42.07
GR	6.91bc	4.66bc	11.57bc	40.46
FFP	6.64cd	4.207cd	10.855cd	40.21
LCC(N)+FPP(P&K)	5.96d	3.88d	9.85d	39.566
NE(N)+FFP(P&K)	7.56ab	5.13b	12.69ab	38.81
LCC(N)+NE(P&k)	6.66bcd	4.463cd	11.12cd	40.05
SEm	0.118	0.089	0.184	0.419
Significance	0.00272**	0.000249***	0.000296***	NS
LSD	0.87	0.656	1.358	3.096
Grand mean	6.953	4.69	11.644	40.19
CV %	8.3367	9.28	7.73	5.11

Signifiacant “*” ; Highly significant “***” ; very highly significant “****”

Table 5: Profitability ratios of different nutrient management practices in Hybrid Rice at Sundarbazaar, 2017

Treatment	GR(Rs/ha) (*000)	NR(Rs/ha) (*000)	B/C	PFP	TFP
NE	272.337a	122.503a	1.81a	0.958a	0.091a
GR	223.040bc	71.509b	1.471bc	0.681c	0.0763bc
FFP	204.650cd	57.658bc	1.392bc	0.873ab	0.07384bc
LCC(N)+FPP(P&K)	187.713d	64.795bc	1.287c	0.874ab	0.06755c
NE(N)+FFP(P&K)	245.290ab	85.5656b	1.535b	0.90091a	0.07949b
LCC(N)+NE(P&k)	213.997cd	41.883c	1.434bc	0.7599bc	0.0745bc
Significance	0.000181**	0.000448**	0.000704**	0.0018**	0.00142**
SEm	3.821	3.821	0.1914	0.016	0.001
LSD	28216.56	28216.56	0.026	0.118	0.0092
CV %	8.339	25.304	8.524	9.31	7.9365

ns-nonsignificant, * significant, ** highly significant

Straw Yield

The mean data presented in Table 4 showed the significant result with highest straw yield (7.96t/ha) at par with NE combined with FFP followed by GR. Nitrogen influence vegetative growth in terms of plant height, and total tillers/hill and balance & optimum use of fertilizer resulted in increased straw yield.

Gross and Net Revenue

From the above mentioned Table 5 the highest gross observed in NE, Rs 272337 not significantly higher than NE combined with FFP Rs 245290 followed by GR Rs 223040. The gross revenue from FFP and LCC combined with NE is at par lower than GR. Likewise lowest gross revenue is obtained from LCC, Rs 187713. The reason behind the highest revenue is the highest yield both grain and straw.

Similarly, there was a significant difference between the nutrient management in terms of net revenue. The highest net revenue was obtained from NE (Rs 122503.1) followed by GR and NE combined with FFP (both statistically at par). FFP and LCC combined with FFP are significantly lower than GR. The lowest net revenue is observed in LCC combination with NE (Rs 41883). Though the cost of cultivation is higher in NE than other management practices, the gross and net revenue is higher, reason-higher grain and straw yield,

B:C Ratio

Highly significant result was accorded in the B: C ratio. The highest B: C ratio was obtained in NE (1.8) followed by NE combined with FFP (1.535). GR, FFP and LCC combined

NE are statistically at par with each other with both NE combined FFP and significantly lowest LCC with FFP management.

Partial and Total Factor Productivity

Highly significant results were accorded in partial factor productivity (PFP) and Total factor productivity (TFP) of hybrid rice. The results depicted highest PFP of NE (0.958) which is at par with NE combined with FFP management practice. The PFP of both FFP and LCC with FFP are at par being slightly lower than the highest. The lowest PFP is obtained from GR and LCC combined with NE being at par.

Similarly TFP was significantly highest in NE (0.091) followed by NE combined with FFP (0.0794). GR, FFP and LCC with NE are at par and slightly lower than the leading. The lowest TFP was accorded from LCC combined with FFP.

PFP measures normally show higher rates of growth than TFP because growth in productivity could result from more intensive use of inputs, including fertilizer and machinery, rather than TFP increase.

From the Table 6 it is clear that over the general farmers practiced culture NE nutrient management practice is best over various precision nutrient management. The grain yield is 37.6 % more than the FFP yield whereas the both straw and biological yield is highest in NE over FFP. LCC (N) combined with FFP (P and K) resulted lowest productivity in terms of both grain and straw yield as in old aged planting the nitrogen deficiency in seedling resulted poor growth as LCC used 14 DAT and lower amount of K along more or less equal P couldn't increase nitrogen efficiency required for proper growth and development.

Table 6: Effect of various treatments on grain yield, straw yield and biological yield over FFP of hybrid rice at Sundarbazar, Lamujung, 2017

Treatments	Grain yield (t/ha)	Yield diffn over FFP (t/ha)	Increased % in grain yield over FFP	Straw yield	Increased % of straw yield over FFP	Biological yield (t/ha)	Increased % of biological yield over FFP
NE	5.79	1.583	37.6	7.96	19.8	13.76	26.76
GR	4.66	0.453	10.76	6.91	4.066	11.57	6.58
FFP	4.207	0	0	6.64	0	10.855	0
LCC(N)+ FFP (P and K)	3.88	-0.327	-7.77	5.96	-10.24	9.85	-9.258
NE(N) + FFP (P and K)	5.13	0.923	21.93	7.56	13.855	12.69	16.905
LCC(N)+ NE(P and K)	4.463	0.256	6.08	6.66	0.3	11.12	2.44

Conclusion

The research conducted during July-December, 2017 at Sundarbazaar, Lamjung recorded the effect of Nutrient Expert® based recommendation in hybrid rice of 38 days seedling over other 5 precision nutrient management practices including Farmers Field Practice and Government Recommendation in Lamjung Campus field with highest yield accorded 5.79t/ha in NE and lowest yield was in LCC combined with FFP treatment (3.88 t/ha). Comparison showed that Nutrient Expert® (NE) was superior among the rest 5 treatments in terms of growth, yield attributing characters, yield and economic analysis followed by NE(N) combined with FFP(P and K). Henceforth, NE recommendation was found better over GR and FFP along other precision nutrient management practices as it make use of the right source of fertilizer, at right time, in right amount and in right place. The actual yield was higher than the attainable yield in that specific site, hence further calibration of the model is required to develop confidence and for its wider applicability.

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