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Nitrogen Levels Effects on Different Maturity Duration Hybrid Rice at Parwanipur, Bara, Nepal

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ABSTRACT

Two years field experiments were conducted at Directorate of Agricultural Research, Parwanipur, Bara, Nepal from 2016 to 2017 to assess the effect of different hybrid rice varieties and nitrogen levels on yield attributes, yield and economics of rice. The experiment was arranged in two factorial Randomized Complete Block Design with three replications. The experiment comprised 12 treatment combinations of three different maturity duration hybrid rice varieties (Arize 6129 Gold, Arize Tej Gold and Arize 6444 Gold) and four nitrogen levels (0, 60, 120 and 180 kg ha^{-1}). The two years combine analysis revealed that the hybrid varieties Arize 6444 Gold (4313 kg ha^{-1}) and Arize Tej Gold (4274 kg ha^{-1}) recorded significantly higher grain yield over Arize 6129 Gold (3731 kg ha^{-1}). These two hybrid varieties (Arize 6444 Gold and Arize Tej Gold) also recorded significantly higher plant length and grains $panicle^{-1}$. The nitrogen level of 180 kg ha^{-1} recorded significantly the highest grain yield at 6357 kg ha^{-1}. Effective tiller m^{-2} and grains $panicle^{-1}$ were significantly higher with nitrogen level of 180 kg ha^{-1}. The thousand grains weight was found significantly higher with 180 kg N ha^{-1}, which was statistically similar with 60 and 120 kg ha^{-1}. Moreover, interaction effect between nitrogen levels and varieties revealed that Arize 6444 Gold and Arize Tej Gold equally produced the highest mean grain yield with 180 kg N ha^{-1}. The highest gross return, net return and B:C ratio were observed with 180 kg N ha^{-1} with Arize 6444 Gold and ArizeTej Gold. Therefore, 180 kg N ha^{-1} could be optimum dose for Arize 6444 Gold and Arize Tej Gold for Parwanipur, Bara, Nepal.

Keywords: Grain yield, hybrid rice, nitrogen, maturity duration

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INTRODUCTION

In Nepal, hybrid rice area and production is increasing but the average yield is so far below than the average production of neighboring countries. In China, average yield of hybrid rice was recorded more than 7.0 t/ha (IRRI 2005). Rice yield can be increased in many ways, by developing new high yielding variety and by adopting proper agronomic management practices (Alam et al 2009). There are many hybrid varieties with different maturity duration (early, medium and long) with yield potentials are available in Nepal. The adaptation of appropriate high yielding variety is very crucial for higher grain yield. Hybrid rice is reported to give a grain yield advantage over the best conventional varieties mainly due to presence of larger sink. The yield obtained from rice hybrids are also 20% higher than conventional varieties (Rao et al 2002). It has a yield advantage of more than 30% over conventional pure line varieties (Yuan 1994).

Among the proper agronomic management practices of hybrid rice, adequate crop nutrition, nitrogen fertilization is the most important one. Nitrogen is normally a key factor in achieving optimum lowland rice grain yields (Fageria et al 1997). It is also a prime nutrient for protein and carbohydrate synthesis, growth and development of plant body. Hybrid rice responds in variably to nitrogen nutrition. The effect of nitrogen on rice growth and grain productivity are derived from several bio-chemical, physiological and morphological processes in the plant system. Increasing rice yield per unit area through use of appropriate nitrogen management practices has become an essential component of modern rice production technology (Fageria and Baligar 2001). Effective nitrogen management plays an important role in increasing the response of the rice crop to fertilizer (Zaidi and Tripathi 2007). Hybrid rice is highly fertilizer responsive but information on hybrid rice nutrition is negligible. So, adequate fertilization and the right time to apply are the most essential to achieve potential yield of rice hybrids (Meena et al 2003). Its rate and the timings of application are the crucial factor for the successful production of hybrid rice but there is less information available on it in Nepal. So, the present field investigation was carried out to study the effect of nitrogen levels and varieties on yield and yield attributes of hybrid rice.

MATERIALS AND METHODS

The experiment was conducted during the summer season of 2016 and 2017 at Directorate of Agricultural Research, Parwanipur, Bara, Nepal situated in Madhesh Province at an altitude of 120 meter above mean sea level with 27°2' North latitude and 84°53' East longitude. The soil of the experimental plot was loam in texture. The area has a subtropical type of climate highly influenced by southwestern monsoon. The twelve treatment combinations of three different maturity duration hybrid rice, i.e., Arize 6129 Gold (V1), Arize Tej Gold (V2) and Arize 6444 Gold (V3) and four nitrogen levels viz. 0, 60, 120 and 180 kg N ha^{-1} were laid out in Factorial Randomized Complete Block Design with three replications. The total rainfall of 1120.6 mm and 1430.97 mm were received in the rice growing period (from June to November) in 2016 and 2017, respectively.

Phosphorus and potassium were applied at the rate of 60 and 40 kg ha^{-1}, respectively, while nitrogen was applied according to the treatments. Phosphorus and potassium were applied at the time of transplanting while 50% nitrogen was applied as basal and remaining 50% was splitted in two equal doses and was top dressed at 25 and 45 days after transplanting (DAT). Seeding was done on 22nd June in the year 2016 and 23rd June in 2017. Rice varieties used in the experiment were Arize 6129 Gold, which was early maturity duration of 115-120 days, Arize Tej Gold, which was mid early maturity duration of 125-130 days, while Arize 6444 Gold that was medium maturity duration of 135-140 days.

The size of individual plot was 15 m^2 and spacing were 20 cm × 20 cm plant to plant and row to row. Plant height was measured on the third row from border of both side of each plot taking 10 plants randomly. Effective tillers were recorded from one square meter area of each plot and expressed as tiller m^{-2}. For panicle length and grains per panicle, 20 randomly selected panicles from net plot were recorded and averaged. Thousand grains were counted from the grain yield of net plot and weighed with the help of portable automatic electrical digital balance. Grain and straw yield were recorded from the net plot and converted into hectare basis. M-STATC software was used for analysis of variance.

RESULTS

Effect of Hybrid Varieties on Yield and Yield Attributes of Rice

The different maturity duration hybrid rice varieties had non-significant effect on plant height, effective tiller m^{-2}, thousand grains weight and sterility percentage during the both years of experiments. However, significant effect was observed in case of panicle length and grains $panicle^{-1}$ during the second year of experimentation. The combine analysis of two years' data revealed that the mid duration rice hybrid Arize 6444 Gold recorded significantly longer panicle size (22.76 cm) and higher number of grains $panicle^{-1}$ (133) which was statistically identical to early mid rice hybrid Arize Tej Gold in terms of panicle length (22.37 cm) and the number of grains $panicle^{-1}$ (129) (Table 1 and Table 2). Likewise, significant effect of different maturity duration hybrids on grain yield was observed during the both years (Table 3). The combine analysis revealed that the rice hybrid Arize 6444 Gold recorded significantly the highest grain yield (4313 kg ha^{-1}) but was also statistically similar with rice hybrid Arize Tej Gold (4274 kg ha^{-1}). Moreover, effect of varieties on straw yield and harvest index was non-significant in the both years.

Effect of Nitrogen Levels on Yield and Yield Attributes of Hybrid Rice

The nitrogen levels had significant effect on yield and yield attributes of different maturity duration hybrid rice varieties during the both years. The nitrogen levels significantly influenced the plant height and panicle length in both years. The combined analysis of two years' data revealed that plant height (102.30 cm) and panicle length

(23.95 cm) was significantly highest with the nitrogen levels of 180 kg ha^{-1}. Moreover, it was also statistically identical with 120 kg N ha^{-1} (Table 1). Furthermore, effective tiller m^{-2} (293) and grains $panicle^{-1}$ (152) was significantly higher with the nitrogen levels of 180 kg ha^{-1} (Table 1 and 2). Thousand grains weight was significantly higher with 180 kg N ha^{-1} (22.58g), which was also statistically similar with 60 kg N ha^{-1} (22.26g) and 120 kg N ha^{-1} (22.18g). Sterility percentage (21.55) was significantly highest under 0 kg N ha^{-1}.

The nitrogen levels exerted significant effect on grain yield and straw yield which was increased steadily with the increased in nitrogen level up to the 180 kg ha^{-1} and the combine analysis revealed higher grain (6357 kg ha^{-1}) and straw yield (9030 kg ha^{-1}) with 180 kg N ha^{-1} (Table 3). The nitrogen levels of 120 and 180 kg ha^{-1} were equally effective for higher harvest index of hybrid rice.

Table 1. Plant height, effective tiller and panicle length as influenced by different varieties and nitrogen levels during 2016 and 2017

Treatments	Plant height (cm)			Effective tiller m^{-2}			Panicle length (cm)		
	2016	2017	Combined	2016	2017	Combined	2016	2017	Combined
Varieties									
V1	98.93^{a}	99.28^{a}	99.11^{a}	211.60^{a}	258.10^{a}	234.90^{a}	22.02^{a}	22.13^{b}	22.08^{b}
V2	98.57^{a}	99.40^{a}	98.99^{a}	212.60^{a}	259.40^{a}	236.00^{a}	22.20^{a}	22.50^{ab}	22.37^{ab}
V3	100.30^{a}	100.20^{a}	100.30^{a}	219.10^{a}	267.30^{a}	243.20^{a}	22.65^{a}	22.87^{a}	22..76^{a}
LSD	4.12	2.63	2.40	25.92	31.62	20.08	1.06	0.62	0.60
SEm ±	1.43	0.91	0.85	9.02	11.01	7.12	0.37	0.21	0.21
N levels (kg ha^{-1})									
0	95.71^{b}	95.93^{c}	95.82^{c}	127.40^{c}	155.50^{c}	141.50^{d}	20.57^{b}	20.22^{c}	20.39^{c}
60	98.80^{ab}	98.83^{bc}	98..82^{b}	220.90^{b}	269.50^{b}	245.20^{c}	21.73^{b}	22.10^{b}	21.92^{b}
120	100.90^{a}	100.90^{ab}	100.90^{ab}	245.30^{ab}	299.30^{ab}	272.30^{b}	23.19^{a}	23.51^{a}	23.35^{a}
180	101.70^{a}	102.90^{a}	102.30^{a}	264.00^{a}	322.10^{a}	293.00^{a}	23.68^{a}	24.22^{a}	23.95^{a}
LSD	4.75	3.04	2.40	29.93	36.51	20.08	1.22	0.71	0.60
SEm ±	1.65	1.06	0.85	10.42	12.72	7.12	0.42	0.24	0.21
CV%	5.01	3.19	4.20	14.59	14.59	14.66	5.75	3.33	4.69
Grand mean	**99.28**	**99.63**	**99.45**	**214.41**	**261.58**	**238.00**	**22.29**	**22.51**	**22.40**

Means followed by the common letter (s) within a column are statistically non-significant based on DMRT at P = 0.05. V1= Arize 6129 Gold, V2= Arize Tej Gold and V3= Arize 6444 Gold

Table 2. Grains $panicle^{-1}$, 1000-grain weight and sterility percentage as influenced by different varieties and nitrogen levels during 2016 and 2017

Treatments	Grains $panicle^{-1}$			1000-grain weight (g)			Sterility %		
	2016	2017	Combined	2016	2017	Combined	2016	2017	Combined
Varieties									
V1	123.40^{a}	126.00^{b}	124.00^{b}	21.74^{a}	21.9^{a}	21.82^{a}	17.57^{a}	16.81^{a}	17.19^{a}
V2	127.00^{a}	130.00^{ab}	129.00^{ab}	21.65^{a}	22.0^{a}	21.84^{a}	17.82^{a}	17.09^{a}	17.46^{a}
V3	131.00^{a}	136.00^{a}	133.00^{a}	21.86^{a}	22.0^{a}	21.97^{a}	17.48^{a}	15.37^{a}	16.43^{a}
LSD	8.09	5.72	4.86	0.72	0.45	0.41	1.98	3.24	1.86
SEm ±	2.81	1.99	1.72	0.25	0.15	0.14	0.69	1.12	0.66
N levels (kg ha^{-1})									
0	84^{c}	85^{c}	85^{d}	20.63^{b}	20.37^{c}	20.50^{b}	19.60^{a}	23.50^{a}	21.55^{a}
60	129^{b}	131^{b}	130^{c}	22.12^{a}	22.24^{b}	22.18^{a}	16.64^{b}	15.17^{b}	15.90^{b}
120	144^{a}	149^{a}	147^{b}	22.01^{a}	22.50^{ab}	22.26^{a}	17.18^{b}	13.53^{b}	15.35^{b}
180	149^{a}	155^{a}	152^{a}	22.23^{a}	22.92^{a}	22.58^{a}	17.08^{b}	13.51^{b}	15.29^{b}
LSD	9.34	6.60	4.86	0.83	0.52	0.41	2.29	3.74	1.86
SEm ±	3.25	2.30	1.72	0.29	0.18	0.14	0.79	1.30	0.66
CV %	7.68	5.29	6.56	4.00	2.49	3.33	13.59	23.81	19.05
Grand mean	**127.16**	**130.49**	**128.83**	**21.74**	**22.00**	**21.87**	**17.62**	**16.42**	**17.02**

Means followed by the common letter (s) within a column are non-significantly differed based on DMRT at P = 0.05. V1= Arize 6129 Gold, V2= Arize Tej Gold and V3= Arize 6444 Gold

Table 3. Grain yield, straw yield and harvest index of hybrid rice as influenced by different varieties and nitrogen levels during 2016 and 2017

Treatments	Grain yield (kg ha^{-1})			Straw yield (kg ha^{-1})			Harvest index (%)		
	2016	2017	Combined	2016	2017	Combined	2016	2017	Combined
Varieties									
V1	3557^{b}	3905^{b}	3731^{b}	6804^{a}	6991^{a}	6897^{a}	37.67^{a}	38.47^{a}	38.07^{a}
V2	4125^{a}	4423^{a}	4274^{a}	6857^{a}	6964^{a}	6910^{a}	38.24^{a}	39.03^{a}	38.63^{a}
V3	4128^{a}	4499^{a}	4313^{a}	6819^{a}	6953^{a}	6886^{a}	38.04^{a}	38.98^{a}	38.51^{a}

LSD	537.40	414.10	333.200	410.50	317.700	254.90	2.90	2.39	1.85
SEm ±	187.20	144.20	118.2	143.00	110.6	90.39	1.01	0.83	0.65
N levels (kg ha^{-1})									
0	1921^{d}	1859^{d}	1890^{d}	3500^{d}	3567^{d}	3534^{d}	30.94^{b}	32.18^{b}	31.56^{c}
60	3409^{c}	3702^{c}	3555^{c}	6396^{c}	6558^{c}	6477^{c}	39.44^{a}	39.68^{a}	39.56^{b}
120	4374^{b}	4870^{b}	4622^{b}	8412^{b}	8690^{b}	8551^{b}	40.64^{a}	41.21^{a}	40.92^{ab}
180	6043^{a}	6671^{a}	6357^{a}	8999^{a}	9062^{a}	9030^{a}	40.91^{a}	42.25^{a}	41.58^{a}
LSD	620.60	478.20	333.200	474.00	366..80	254.9	3.35	2.76	1.85
SEm ±	216.10	166.60	118.2	165.10	127.80	90.39	1.17	0.96	0.65
CV %	16.47	11.69	14.10	7.25	5.50	6.42	9.24	7.44	8.37
Grand mean	**3936.63**	**4275.59**	**4106.11**	**6826.69**	**6969.18**	**6897.93**	**37.98**	**38.82**	**38.40**

Means followed by the common letter (s) within a column are non-significantly differed based on DMRT at P = 0.05. V1= Arize 6129 Gold, V2= Arize Tej Gold and V3= Arize 6444 Gold

Interaction Effect of Varieties and Nitrogen Levels on Yield and Yield Attributes

Interaction effect between nitrogen levels and varieties on grain yield and straw yield revealed that Arize 6444 Gold produced the highest grain yield and straw yield with 180 kg N ha^{-1} (Table 4). Hence, 180 kg N ha^{-1} could be optimum dose for Arize 6444 Gold and Arize Tej Gold for Central Terai condition (Fig 1).

Table 4. Interaction effect of different levels of nitrogen and varieties on grain and straw yield combined data of 2016 and 2017

Treatments	**Grain yield (kg ha^{-1})**			**Straw yield (kg ha^{-1})**		
	Varieties			**Varieties**		
	V1	V2	V3	V1	V2	V3
N levels (kg ha^{-1})						
0	1713^{f}	1896^{f}	2061^{f}	3415^{g}	3597^{g}	3589^{g}
60	3759^{e}	3429^{e}	3478^{e}	7055^{d}	6431^{e}	5946^{f}
120	4513^{d}	5158^{c}	4195^{d}	8268^{c}	8763^{b}	8621^{b}
180	4938^{c}	6613^{b}	7520^{a}	8850^{b}	8850^{b}	9389^{a}
LSD		333.2			254.9	
SEm ±		118.2			90.39	

Means followed by the common letter (s) within a column are statistically non-significant based on DMRT at P = 0.05. V1= Arize 6129 Gold, V2= Arize Tej Gold and V3= Arize 6444 Gold

Economic Perspective over Hybrid Varieties, Nitrogen Rate and Hybrid Varieties × Nitrogen Rate

There was significant effect of nitrogen levels and varieties on gross return, net return and B:C ratio (Table 5). The combined analysis revealed that 180 kg N ha^{-1} recorded the highest gross return (NRs. 195000), net return (NRs. 147000) and B:C ratio (4.05). In case of varieties, Arize 6444 Gold recorded higher gross return (NRs. 135000), net return (NRs. 87000) and B:C ratio (2.81), which was also statistically similar with Arize Tej Gold. Interaction effect of nitrogen levels and varieties on B: C ratio, Gross return and net return revealed that 180 kg N ha^{-1} with variety Arize 6444 Gold recorded the highest B: C ratio, Gross return and net return (Table 5).

Table 5. Gross return, net return and B:C ratio as influenced by different varieties and nitrogen levels during 2016 and 2017

Treatments	**Gross return (000' Rs. ha^{-1})**			**Net return (000' Rs. ha^{-1})**			**B: C ratio**		
	2016	2017	Combined	2016	2017	Combined	2016	2017	Combined
Varieties									
V1	116.10^{a}	125.60^{b}	120.90^{b}	70.24^{a}	75.37^{b}	72.80^{b}	2.52^{a}	2.50^{b}	2.51^{b}
V2	130.60^{a}	138.40^{a}	134.50^{a}	84.66^{a}	88.19^{a}	86.43^{a}	2.84^{a}	2.75^{a}	2.80^{a}
V3	130.50^{a}	140.30^{a}	135.40^{a}	84.58^{a}	90.06^{a}	87.32^{a}	2.84^{a}	2.79^{a}	2.81^{a}
LSD	14.10	10.69	8.69	14.10	10.69	8.69	0.30	0.21	0.18
SEm ±	4.91	3.72	3.08	4.91	3.72	3.08	0.10	0.07	0.06
CV %	13.53	9.57	11.59	21.32	15.26	18.37	13.54	9.56	11.76
N levels (kg ha^{-1})									
0	62.03^{d}	60.74^{d}	61.38^{d}	16.13^{d}	10.51^{d}	13.32^{d}	1.35^{d}	1.20^{d}	1.28^{d}
60	110.80^{c}	118.80^{c}	114.80^{c}	64.91^{c}	68.55^{c}	66.73^{c}	2.41^{c}	2.36^{c}	2.39^{c}
120	143.00^{b}	156.50^{b}	149.80^{b}	97.09^{b}	106.30^{b}	101.70^{b}	3.11^{b}	3.11^{b}	3.11^{b}
180	187.10^{a}	203.00^{a}	195.00^{a}	141.20^{a}	152.80^{a}	147.00^{a}	4.07^{a}	4.04^{a}	4.05^{a}
LSD	16.28	12.35	8.69	16.29	12.35	8.68	0.35	0.24	0.18
SEm ±	5.67	4.30	3.08	5.67	4.30	3.08	0.12	0.08	0.06
Grand mean	**125.72**	**134.76**	**130.24**	**79.82**	**84.53**	**82.18**	**2.73**	**2.68**	**2.71**

Means followed by the common letter (s) within a column are non-significantly differed based on DMRT at P = 0.05. V1= Arize 6129 Gold, V2= Arize Tej Gold and V3= Arize 6444 Gold

Table 6. Interaction effect of levels of nitrogen and varieties on B:C ratio, gross return and net return combined data of 2016 and 2017

Treatments	B: C ratio			Gross return (000' Rs. ha^{-1})			Net return (000' Rs. ha^{-1})		
	Varieties			Varieties			Varieties		
	V1	V2	V3	V1	V2	V3	V1	V2	V3
N levels (kg ha^{-1})									
0	1.18^{g}	1.29^{g}	1.37^{g}	56.49^{h}	61.79^{gh}	65.87^{g}	8.43^{h}	13.72^{gh}	17.81^{g}
60	2.54^{e}	2.32^{f}	2.30^{f}	122.2^{e}	111.4^{f}	110.7^{f}	74.14^{e}	63.39^{f}	62.67^{f}
120	3.03^{d}	3.41^{c}	2.90^{d}	145.9^{d}	164.0^{c}	139.4^{d}	97.85^{d}	115.9^{c}	91.29^{d}
180	3.30^{c}	4.17^{b}	4.69^{a}	158.9^{c}	200.7^{b}	225.6^{a}	110.8^{c}	152.7^{b}	177.5^{a}
LSD		0.18			8.69			8.69	
SEm ±		0.06			3.08			3.08	

Means followed by the common letter (s) within a column are non-significantly differed based on DMRT at P = 0.05. V1= Arize 6129 Gold, V2= Arize Tej Gold and V3= Arize 6444 Gold

Yield Response Curve with Nitrogen Variance

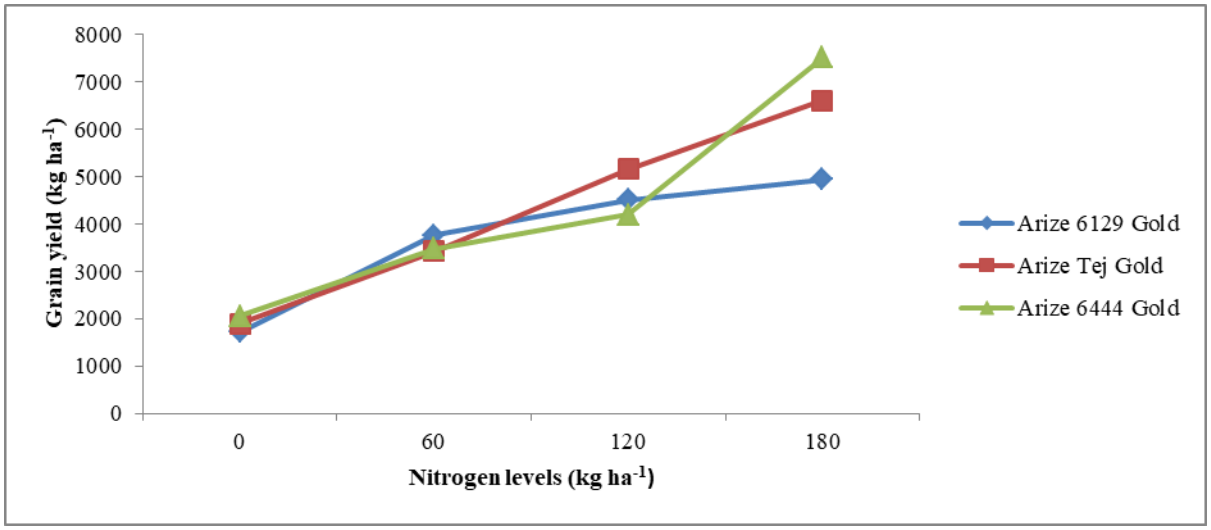

Figure 1. Nitrogen response curve in different maturity duration rice hybrids combined data of 2016 and 2017.

DISCUSSION

Yield of hybrid rice is based on its yield components like panicle number, number of grains per panicle and thousand grains weight. Likewise, it also depends on genotype and environment. Depending upon the maturity, these hybrid rice varieties are classified as three maturity group i.e., early maturity (Arize 6129 Gold), mid early maturity (Arize Tej Gold) and medium maturity (Arize 6444 Gold). It was observed that medium maturity hybrid have significantly higher grain yield over early maturity hybrid rice variety but it was also statistically similar with mid early hybrid rice. Haque et al (2015) also reported superiority of medium duration group of hybrids rice in terms of grain yield over early maturity group of hybrids. It was observed that larger panicle size was associated with these medium and mid early maturity hybrids which had positive correlation with grain yield. Laza et al (2004) also reported positive correlation of panicle size with grain yield for higher yield. Higher grain yield was also due to the greater effective translocation of carbohydrates during grain filling period and higher net photosynthetic rate (Bai et al 2016).

The plant height increased with the application of increasing rate of nitrogen fertilizer was due to enhanced rate of translocation of nitrogen from culms to leaves and leads to the production of photosynthates, which enhanced the translocation of nutrients for developing panicle. This result was supported by Singh et al 2014 and Somasundaram et al 2002, when levels of nitrogen ranged from 0 to 200 kg N ha^{-1} and 0 to 150 kg N ha^{-1}, respectively. The maximum plant height was observed in the both season at 120 and 180 kg N ha^{-1}. The tiller bearing capacity was enhanced might be due to the more availability of nitrogen, that helps for cell division. The maximum tiller was observed with 180 kg N ha^{-1} and least with 0 kg N ha^{-1}. Elevation of nitrogen input enhanced tiller bearing capacity of rice hills. This might be due to adequate in vegetative growth and better root

development that helps to increase the nitrogen absorption rate. Similar result was reported by Meena et al 2003 and Singh et al 2014.

The panicle length, grains per panicle, thousand grains weight, grains yield, straw yield and harvest index were influenced with elevation of nitrogenous fertilizer but reverse effect in sterility. The similar results were explored by Manzoor et al 2006 and Kumar et al 2008. Banerjee and Pal 2011 and Tripathi et al 2011 also reported significantly higher grain yield of hybrid rice due to higher levels of nitrogen fertilization which was directly related to the significant improvement of all the growth parameters and yield attributing traits. Pramanik and Bera 2013 reported highest grain yield of hybrid rice from 150 kg N ha^{-1} and decreased with further increase of applied N fertilizer. The crop at no nitrogen level produced the lowest grain yield which was significantly lower than all other nitrogen levels due to lack of supply of nitrogen into the soil solution to meet the required nutrients for physiological processes, which in turn lower the yield. Salem et al 2011 also reported higher panicle length, number of grains $panicle^{-1}$ with increased nitrogen levels from 0 to 164 kg ha^{-1}. The nitrogen being indispensible nutrient to rice production and its' utilization is determined by soil types, source of fertilizer, time of application, doses and environment factor. Instead, main effect of nitrogen contributes dry matter accumulation in leaves and culms and in grain filling during grain filling stages as a photosynthates.

The development of sink size directly influenced by nitrogen by decreasing the number of degenerate spikelets and increasing the hull size and grain filling period, so, a large amount of nitrogen is required (Mae 2013). The application of optimum N increased plant N before heading is highly effective in maximizing productive spikelet's and filled grains that promotes higher grain yield (Kamiji et al 2011) which support the statement of higher sterility % in less N applied field but controversial result was reported by Srividya et al 2010 explained number of chaffy grain or sterile spikelet's with excess application of nitrogen and show relatively higher response to N fertilization. Peng et al 2008 reported the curvilinear response of rice yield to nitrogen. Increase in nitrogen improves the grain production. The higher Gross return, Net return and B: C ratio was obtained with 180 kg N due to significantly increase in yield and other character.

CONCLUSIONS

From this experiment, it can be concluded that different nitrogen levels and maturity duration rice varieties had differential effect on different parameters of hybrid rice. Combine analysis of the two years suggested that higher productivity of hybrid rice under sub-tropical climate of Nepal can be achieved from 180 kg N ha^{-1} with hybrid rice variety Arize 6444 Gold (medium maturity duration) and Arize Tej Gold (mid early maturity duration).

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AUTHOR'S CONTRIBUTION

P Shah conceptualized, conducted the experiment and prepared the manuscript while other authors assisted in field work and manuscript write-up.

CONFLICTS OF INTEREST

The authors have no any conflict of interest to disclose.

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