Effects of Blended Fertilizer and Nitrogen Rates on Yield and Yield Components of Rice (*Oryza sativa* L.) at Tole Village, Gimbi District West Wollega, Ethiopia

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Abstract: Rice (*Oryza sativa* L.) is the world leading cereal crop for human utilization, with cultivated area of almost 150 million hectares and a total production of almost 600 million mega grams annually. The cultivation of rice in Ethiopia is of more recent history than its utilization as a food crop. The production and productivity of the crop under farmers' field conditions is low (about 2600 kg of rice grain ha^{-1} on the average) compared to its yield levels under farmers' conditions in other parts of the world due to low soil fertility. Therefore, experiment was conducted at Tole village, Gimbi District, West Wollega, Oromia, Ethiopia from June - December during the main rainy season of 2019. The experiment consisted of factorial combination of four levels of blended fertilizer (0, 100,150 and 200kgha^{-1}) and four level of nitrogen fertilizer (0, 46, 69, and 92kgha^{-1}) which was laid out in a randomized complete block design with three replications. The data was recorded on phenology, growth and yield related parameters of the crop. The results had shown that the main effects of rates of blended fertilizer and nitrogen were significant ($P < 0.01$) difference on different growth parameters, yield and yield components of rice. There were significant interaction effect on rates of blended fertilizer and nitrogen on days to heading, days to maturity and grain filling period. Earliest days to heading and maturity were recorded by the interaction of no blended and no nitrogen fertilizer, whereas latest days to heading and maturity was recorded at 200kgh^{-1}BF and 200kgha^{-1}Urea. The maximum grain yield was obtained as fertilizer rates increased. However, the partial budget analysis indicated that application of 100kg of BF ha^{-1} and 46kg of N fertilizer resulted higher marginal rates of return (1,781% and 823.1%) respectively. It could, thus, concluded that application of 100kgBF ha^{-1} and 100kg Nha^{1} resulted in optimum growth and grain yield of the crop. Hence, application of inorganic fertilizer for the production of rice resulted the highest yield and benefits for the growers in the study area, but further study is needed in the future for recommendation.

Keywords: Blended Fertilizer, Integrated Nutrient Management, Soil Fertility, Grain Yield, Partial Budget, Biomass Yield

1. Introduction

Rice (*Oryza sativa* L.) belongs to the family Poaceae; it is an essential food crop and a major food grain for more than half of the world's population [24]. It is, a cereal crop, has been gathered, consumed and cultivated by many people worldwide for more than 10,000 years longer than any other crop [31]. Global rice cultivation estimated to cover 144 million farms, mostly smaller than 1 hectare. [12] In the world,

the largest volume of rice production is concentrated in countries China, India, Indonesia, Vietnam, Thailand, Bangladesh, Burma, Philippines, Brazil, and Japan. The percentage share of the above top ten rice producing countries accounts for about 32.9, 24.4, 11.0, 7.0, 6.0, 5.4, 5.3 2.9 and 1.8 % of the world production respectively. Ethiopia is 73rd in the world ranking with almost 0.0% [17].

Rice is an important staple food crop in Africa with a growing demand that poses an economic challenge for the

African continent. Annual rice production in Sub-Saharan Africa (SSA) is estimated at 14.5 million metric tons (MT), comprising 15 percent of the region's cereal production. Most of this rice is produced by smallholder farmers. In contrast, Africa's rice consumption is about 21 million MT creating a deficit of about 6.5 million MT per year valued at US$ 1.7 billion that is imported annually. Overall, imported rice accounts for roughly 40 percent of Sub-Saharan Africa local rice consumption [1]. This indicates that the region needs to increase production and productivity to fill the gap between demand and supply created in rice consumption.

The basis of livelihood of Ethiopia's population is predominantly rural and agricultural. About 82 percent of the Ethiopian population is living in rural areas and engaged in farming for their livelihood [36]. The high population Agriculture is the bastion of livelihood for Ethiopia's population as well as of the economy in general. It provides employment for about 85% of the active labor force, contributes to more than 45% of the GDP and 90% of foreign exchange earnings. Ethiopia has a total land area of about 112.3 million hectares [8]. Out of the total land area, about, 74.1 million hectares are suitable for the production of annual and perennial crops [3]. According to Ministry of Economic Development and Cooperation (MEDaC), crop production is estimated to contribute on average about 60%, livestock accounts around 27% and forestry and other sub-sectors around 13% of the total agricultural value.

In spite of the improvement of main macroeconomic indicators in recent years, food security remains as one of the most important issues in Ethiopia's development agenda. In fact, food insecurity in some vulnerable regions is one of the major obstacles to poverty reduction. Both transitory and chronic food insecurity is severe in Ethiopia. Moreover, food insecurity is one of the defining features of rural poverty affecting millions of people particularly in moisture-deficit and pastoral areas [27]. However, the country has been implementing different strategies to achieve food security, Diversification of crops, increasing the availability of food through domestic production, and encouraging the production of early maturing and high yielding crops in different agro-ecologies of the country are some of such strategies rice has become a commodity of strategic significance across many parts of Ethiopia for domestic consumption as well as export market for economic development [22]. Besides, rice is among the target commodities that have received due emphasis in the promotion of agricultural production, and as such, it is considered as the "millennium crop" expected to contribute by ensuring food security in Ethiopia. Although rice was introduced to the country very recently, it has proven to be a crop that can assure food security in Ethiopia [28].

Rice uses as food crop, income source and animal feed in Ethiopia . It is used in preparation of local food and beverages (*injera, dabbo, genffo, kinche shorba, tella*and *katikalla*) either alone or mixed with other crops (teff, millet, wheat, barley, sorghum and maize). It is an alternative crop available to farmers for efficient utilization of their resources such as land and water under swampy and waterlogged environments.

The straw is also used as a source of fuel, feed for animals and thatch making [28].

Production of rice depends on several factors: climate, physical conditions of the soil, agronomic and management practices, and water management [8]. Improvement of thus different especially nutrient retention practice in the soil, use of optimum rate of nitrogen fertilizer and blended fertilizer; proper seed rate, effective row and plant spacing, high yielding varieties and/or hybrid varieties are considered to be the major determinants of yield of rice.

Fertilizer is an expensive and precious input. The developing countries like Ethiopia are more sensitive to shortage of major fertilizer nutrients especially nitrogen, phosphorus and sulphur. The shortage nutrients also covers micro nutrients like zinc and boron, because the fertilizer input in these countries is less and expensive than its demand. Even when the fertilizer supply is satisfactory, the importance of increasing its use efficiency cannot be underestimated. Determination of an appropriate dosage of application would be both economical and appropriate to enhance productivity and consequent profit of the grower.

Nitrogen is the most essential element that is applied most frequently and with high amount in rice production [10, 25]. DAP and Urea by Ethiopia is estimated to have reached 400,000 tons and 320,000 tons, respectively. While, fertilizer uptake has increased of late, yields have not increased in a proportionate manner. Consequently, in 2011, the government launched Ethiopia soil fertility mapping project, helped by funding from Plant Production and Protection Division (AGP) of the Food and Agriculture Organizations [17] of the United Nations. Preliminary results have been generated from 225 administrative districts that had shown Ethiopia's soils to be deficient in a range of nutrients, including sulphur, boron, potassium, zinc and copper, underlining the need to treat plant nutrients to use in a more prescribed manner. Since the deficiency of micro nutrients in the Ethiopian's soil was reported there was a need to apply nutrient sources and determine the rate that reduces such deficiency. Blended fertilizers containing both macro (nitrogen, phosphorous) and micro elements (boron, zinc) may possess this characteristic. High population pressure and fragmented cultivated land associated with land degradation, resulted in soil fertility decline in Western Ethiopia; thus leads to low productivity in different major cereal crops. Single mineral fertilizer application alone and with blanket recommendation cannot maintain the productivity potential of the major crops and soil fertility. So that, there was a need of soil based blended fertilizer application with (macro and micro nutrients) and nitrogen fertilizer to optimize productivity of the major crops. But no more further research has been conducted yet in relation to blended fertilizer with proper level of nitrogen on rice production in western Ethiopia, specifically in the study area. So that, the research was conducted to address;

The effect of different rates of blended fertilizer and nitrogen on yield and yield components of rice in the study area.

2. Materials and Methods

2.1. Description of the Study Site

The experiment was conducted at Tole village, Gimbi District, West Wollega Zone, Oromia Ethiopia during the main rainy season (May-December) of 2019. The area is located at 36° 26′N latitude and 8°41′E longitude at an altitude of 1327 m.a.s.l with varying mean annual rain fall of 1477mm. The mean daily temperature ranges from 11.5°C and 22.5°C. The soil types of the area were predominantly luvi soils.

2.2. Planting Materials

During mid of May an improved rice variety" SUPERICA-4" was sown with four level of blended fertilizer (0kg/ha, 100kg/ha, 150kg/ha and 200kg/ha) and four level of nitrogen fertilizer (0kg/ha UREA, 100kg/ha UREA, 150kg/ha UREA and 200kg/ha UREA) in 100kg blended fertilizer 17.8N, 35.7P_2O_5, 7.7S, 2.2Zn, 0.1B is found.

2.3. Treatments and Experimental Design

The treatment consisted of two factors, four level of blended fertilizer (0kg /ha, 100kg/ha, 150kg/ha and 200kg/ha) and four level of nitrogen fertilizer (0kg/ha N, 46kg/ha N, 69kg/ha N and 92/ha N). The size of each plot was 2.7m × 3m long (9m^2 areas) with 0.5m and 1m space between plot and block, respectively. In accordance with the specifications of the design, each treatment was assigned randomly to the experimental units within the blocks. It was laid out in a randomized complete block design with three replications (Table 1).

Table 1. Factors and their combinations.

S/N	Treatment	Treatment combinations
1	T1	0kg/ha BF+0kg/haUREA
2	T2	0kg/haBF+100kg/ha UREA
3	T3	0kg/haBF+150kg/ha UREA
4	T4	0kg/haBF+200kg/haUREA
5	T5	100kg/haBF+0kg/haUREA
6	T6	100kg/haBF+100kg/haUREA
7	T7	100kg/haBF+150kg/haUREA
8	T8	100kg/haBF+200kg/haUREA
9	T9	150kg/haBF+0kg/haUREA
10	T10	150kg/haBF+100kg/haUREA
11	T11	150kg/haBF+150kg/haUREA
12	T12	150kg/haBF+200kg/haUREA
13	T13	200kg/haBF+0kg/haUREA
14	T14	200kg/haB F+100kg/haUREA
15	T15	200kg/haBF+150kg/haUREA
16	T16	200kg/haBF+200kg/haUREA

Where BF=blended fertilizer, kg=kilogram, ha=hectare.

2.4. Experimental Procedures

The land was ploughed three times by using to prepare the seed bed and the soil was leveled by using rakes. Row sowing method was used with seed rate of 80kg ha^{-1}. The distance between rows and between plants was 30cm and 10cm respectively. Nitrogen was applied on the 35th days after the seed was sown. Weed control and other agronomic practices were applied following the recommended practices. The entire net plot was harvested to get biomass yield and grain yield.

2.5. Collected Data

2.5.1. Soil Data

Prior to planting and after harvesting, 20 random soil samples were collected from 0-30 cm depth using a soil auger from the entire experimental plots. Samples were thoroughly mixed and pooled. The composite soil sample was air dried in the laboratory and analyzed for the following parameters.

Table 2. Analysis result of physical and chemical property of experimental soil.

parameter	PP	PH
Total nitrogen (%)	0.343	0.059
Organic carbon (%)	3.978	2.999
Available potassium (meq/100gm soil)	0.298	0.791
Extracted Zinc	-	-
Soil pH (0.01MCaCl)	5.06	4.94
Cation exchange capacity (meq/100gmsoil)	37.849	9.179
Soil electric conductivity (mS/cm)	0.096	1.055

Total nitrogen: It was determined using Kjeldahl method (Jackson, 1973).

Available Phosphorus: It was determined using the Olsen (NaHCO$_3$) extraction method (Olsen and Sommer, 1982) and the NaOH fusion method (Smith and Bain, 1982), respectively.

Available potassium: It was determined using neutral normal NH$_4$OAC method (Pratt, 1965).

Organic carbon: It was determined using Wakley and Black method (1934).

*Available sulfu*r: It was determined by treating 10 gm of 2 mm sieved soil with 25 ml. 0.01 M of CaCl$_2$·2H$_2$O extract ant and filtered.

Extracted Zinc: This was determined by using Houba, *et al*. method, 1989.

Soil pH: This was determined in a 1:2.5 soil water suspension using glass electrode pH meter (Von Reeuwijk, 1992).

Cation exchange capacity (CEC): of the soil was determined from ammonium-saturated. Samples that were subsequently replaced by sodium (Na) from a percolating sodium chloride Solution.

Texture: texture was carried out using the hydrometer method (Day, 1965).

2.5.2. Phenological Data

The following phonological data was recorded when the plants in each plot attained their respective growth stages:

Emergency date: this was the number of days at which 75% of plants of each plot germinates.

Days to heading (DH): The number of days from planting to a stage when 50% of the plants in plots were produced spikes.

Days to maturity (DM): The number of days from planting to physiological maturity where 75% of the plants became

mature in each plot.

Grain filling period (GFP days): The number of days from heading to maturity i.e. the number of days to maturity minus the number of days to heading.

2.5.3. Growth Data

The following growth parameters were recorded when the plants reach their respective growth stages:

Number of Tiller/plant (NT): tillers were counted on five randomly sampled plants from central rows of each plot.

Plant Height (PH): It was measured from ground level to the top of the panicle excluding the awn of five randomly taken plants from the middle two rows measured in cm.

Panicle Length (PL): the main panicle from the five sampled plants was measured in cm and averaged to represent the spike length in cm.

Number of spikelet per panicle (NSPP): The number of spikelet in main tillers of each of the five randomly plants from the central rows was taken.

Number of Seed per panicle (NSPP): number of seeds per panicle from the five randomly sampled plants from the central rows of each plot was counted.

Number of sterile spikelet per panicle (NSSKPP): number of sterile spikelet per panicle from the five randomly sampled plants from the central rows of each plot was counted.

Thousand Seeds Weight (TSW): Grain weight of thousand seeds sampled at random from total grain harvest of the experimental plot was recorded on analytical balance expressed in gm.

2.5.4. Yield Data

The following yield parameters were recorded when the plants reach their respective growth stages:

Biomass yield (TDW) (kg/plot): the total above ground biomass produced was recorded for each plot.

Grain yield (GDW) (g/plot): Grain yield in g/plot was taken from the central four rows.

Harvest index: was calculated from the ratio of the total grain yield threshed to the total biomass yield harvested from each plot.

Partial budget analysis: The recommended level of 10% was reduced from all treatments to obtain adjusted yield to reflect farmer's result. Net yield was multiplied by the market price to obtain gross field benefit. Costs and benefits were calculated for each treatment. All variable costs especially for fertilizers were reduced. The selling price of rice at the local market at the harvest time was estimated at Birr 1500 per quintal of rice. Since labor cost for ploughing, sowing managing and harvesting was the same for all treatment, costs were summed up and subtracted from gross benefits which was taken as the net benefit.

2.6. Statistical Analysis

The data obtained from the field was subjected to analysis of variance (ANOVA) using SAS, version 9.0, general linear model procedures (SAS Institute, 2004) and mean separation was done by least significant difference (LSD) test.

3. Results and Discussion

3.1. Effects of Blended Fertilizer and Nitrogen Rates on Phenological Parameters

3.1.1. Effects of Blended Fertilizer and Nitrogen Rates on Emergency

Both of the main effect and interaction had not shown any significant difference on days to emergency of rice (Table 4). It confirms that, different rates of blended fertilizer and nitrogen are not important for germination; like oxygen, moisture and temperature. The result is in contrary with the research conducted by [37] who reported the effect of different rates of nutrients on days to emergency which affected root initiation of embryo. On the other hand, the result is in agree with that of [29] who reported that days of emergency didn't affected by different rates of nitrogen.

3.1.2. Effects of Blended Fertilizer and Nitrogen Rates on Days to Heading

There were significant ($p < 0.01$) difference in days to heading due to the interaction effects of rates of blended fertilizer and nitrogen (Table 3). The earliest days to heading was recorded from the control treatment (83.33days), whereas the latest days to heading was recorded from interaction effects of 200kg/ha BF + 92kg/ha of N (121.33 days) which was followed by the treatment that had received 200kg/ha BF + 69kg/ha N (118.33days) which had not shown significant differences.

Table 3. *The interaction effect of rates of blended fertilizer and nitrogen fertilizer on days to heading.*

SN	Rates of BF	Rates of nitrogen fertilizer			
		0kg/ha	46kg/ha	69kg/ha	92kg/ha
1	0kg/ha	83.33[h]	96.00[g]	96.33[g]	97.00[g]
2	100kg/ha	96.33[g]	108.67[f]	110.33[ef]	114.00[cd]
3	150kg/ha	96.67[g]	110.33[ef]	112.00 [def]	116.00[bc]
4	200kg/ha	98.67[g]	113.67[cde]	118.33[ab]	121.33a
Mean=105.56, LSD (5%) =3.5759, CV (%)=2.03					

BF= blended fertilizer, kg = kilogram ha=hectare, CV= coefficient of variation, LSD=least significant difference.

The result indicated that, as the rates of BF and N increases, the no of days to heading was also increased. According to [24] when the rates of nitrogen increases with no limitation of water the plants will get more vegetative period that plays a vital role in physiological activity of the plats. Similarly [13] explained that when plants face shortage of nutrient to carry out their normal physiological activity and water shortage throughout their growth period they will go to flower to perpetuate.

3.1.3. Effects of Blended Fertilizer and Nitrogen Rates on Days to Maturity

There were significant ($p < 0.01$) difference in days to maturity due to the interaction effects of rates of blended fertilizer and nitrogen (Table 4). As it was indicated on the result the shortest days of maturity was recorded from the treatment with no fertilizer (95.33days) whereas the latest

(144.33days) days of maturity was recorded from the interaction of effects of 200kg/ha BF and 92kg/ha of N fertilizer. Even though, there was differences in numerical among the treatment that had received (200kg/ha of BF + 92kg/ha of N), and (200kg/ha of BF + 69kg/ha of N), statistically there was no significance differences between them (Table 4). The earliest days of maturity due to no application of blended fertilizer and nitrogen that lacks of essential micro and macro nutrients which helps to stay in different normal growing stage rather they go for maturity to perpetuate [13].

Table 4. *The interaction effect of rates of blended fertilizer and nitrogen fertilizer on days to maturity.*

SN	Rates of BF	Rates of Nitrogen fertilizer			
		0kg/ha	46kg/ha	69kg/ha	92kg/ha
1	0kg/ha	95.33[i]	111.67[fgh]	113.00[fg]	115.67[f]
2	100kg/ha	107.67[h]	129.67[e]	131.00[e]	138.33[b]
3	150kg/ha	108.33[h]	132.33[de]	133.67[de]	136.67[cd]
4	200kg/ha	109.67[gh]	135.67[cd]	141.67[ab]	144.33[a]
Mean=124.04, LSD (5%) =4.4017, CV (%)=2.13					

BF= blended fertilizer, kg = kilogram, ha=hectare, CV= coefficient of variation, LSD=least significant difference.

But delayed dates of maturity in the application of 200kg ha^{-1}BF and 92kg ha^{-1} N might be due to the up taking of enough amount of nitrogen fertilizer and other macro and micro nutrients which that had caused longest duration of vegetative growth [17]. The result confirmed that zinc improved N use efficiency that caused prolong maturity of plants [19].

3.1.4. Effects of Blended Fertilizer and Nitrogen Rates on Grain Filling Period

Significant (p < 0.01) difference was observed in days to grain filling due to the interaction effects of rates of blended fertilizer and nitrogen (Table 6). As the result indicated, the shortest (11.00) days to grain filling was recorded from the treatment that had received 100kg of BF + no nitrogen which was not statistically different from all of the rates of BF + no Nitrogen. On the other hands the latest days (23.33) to heading was recorded from the interaction effects of 200kg/ha BF + 150kg/ha of N but, statistically not different from the interaction effects of (150kg/ha + all rates of N except no N and 200kg/ha of BF + all rates of N except no N) (Table 5). The result indicated that the higher the rates of blended fertilizer plus nitrogen rates were resulted in the latest days to reach reproductive stages, instead it stays on vegetative growth stage. The result confirmed the report of [34] who indicated the short grain filling period was due to lack of macro and micro nutrient which brings the plants to grain filling to perpetuate and nitrogen fertilizer use efficiency made the plants to stay in long vegetative growth stage rather than grain filling. Similarly [33] stated that the presence of zinc, sulphur and boron improve plants N use efficiency which improves the use of N that elongates vegetative phase of the plants.

Table 5. *The interaction effect of rates of blended fertilizer and nitrogen fertilizer on grain filling period.*

SN	Rates of BF	Rates of Nitrogen fertilizer			
		0kg/ha	46kg/ha	69kg/ha	92kg/ha
1	0kg/ha	12.00[g]	15.67[f]	16.67[ef]	18.67[d]
2	100kg/ha	11.67[g]	21.00[bc]	20.67[cd]	22.33[abc]
3	150kg/ha	11.33[g]	22.00[abc]	21.67[abc]	22.67[abc]
4	200kg/ha	11.00[g]	22.00[abc]	23.33[a]	23.00[ab]
Mean=18.479, LSD (5%) = 2.1980, CV (%) = 7.13					

BF= blended fertilizer kg = kilogram ha=hectare CV= coefficient of variation, LSD=least significant difference.

3.2. Effects of Blended Fertilizer and Nitrogen Rates on Rice Growth Parameters

3.2.1. Effects of Blended Fertilizer and Nitrogen Rates on Rice Height

The main of the application of blended fertilizer was significantly (P < 0.01) affected plant height, likely the application of nitrogen fertilizer was also significantly affected (P < 0.01) the plant height however, and the interaction effects was non-significant (Table 6). The tallest plant (112.25cm) was obtained at the rate of 92 kg N /ha which was statically par with the rate of 100 and 69 kg N/ha, whereas, the shortest plant height (77.25cm) was obtained from the control plot (Table 7). This significant increment might be attributed to the fact that N usually favors vegetative growth, resulting in highest stature of plants. A similar result was reported by [1] on rice plant height who applied 92 kg N ha^{-1}.

On the other hand, the longest plant (123.25cm) and the shortest (105.8 cm) were recorded from 200 kg blended fertilizer ha^{-1} and control plots respectively.

Table 6. *The main effect of rates of blended fertilizer and nitrogen fertilizer on plant height.*

S/N	treatments	Plant height (cm)
Rates of blended fertilizer		
1	0kg/ha	71.42[c]
2	100kg/ha	98.42[b]
3	150kg/ha	104.17[b]
4	200kg/ha	123.25[a]
lsd (5%) =12.310		
significance level=**		
Rates of nitrogen fertilizer		
1	0kg/ha	77.25[b]
2	46kg/ha	101.83[a]
3	69kg/ha	105.42[a]
4	92kg/ha	112.75[a]
LSD (5%) =12.310		
Mean=99.313		
CV=14.87		
Significance level=**		

BF= blended fertilizer kg = kilogram ha=hectare CV= coefficient of variation LSD=least significant difference.

Similar to this finding, [20] reported that plant height of rice was significantly affected by the application of P and N, in contrary to this [32] reported that plant height of rice was not significantly affected by the rate and type of different blended fertilizers.

3.2.2. Effects of Blended Fertilizer and Nitrogen Rates on Number of Tiller Per Plant

Number of tiller per plant was significantly affected by the main effect of blended fertilize rates and nitrogen (Table 7). The highest (11.83) number of tillers per plant was recorded by the application of 200kg blended fertilizer/ha which was followed by 150kg/ha of N, whereas the least (5.83) was recorded on the no fertilizer. The possible reason for increment in number of tillers might be due to availability of N which would have played a positive role in cytokinin synthesis and cell division.

Table 7. The main effect of rates of blended fertilizer and nitrogen fertilizer on number of tiller per plant.

S/N	Treatments	NTPP
Rates of blended fertilizer		
1	0kg/ha	5.83[c]
2	100kg/ha	9.17[b]
3	150kg/ha	10.08[ab]
4	200kg/ha	11.83[a]
LSD (5%) =2.1377		
Significance level=**		
Rates of nitrogen fertilizer		
	0kg/ha	6.50[b]
	46kg/ha	9.25[a]
	69kg/ha	10.33[a]
	92kg/ha	10.83[a]
LSD (5%) =2.1377		
Mean=9.2292		
CV=27.78		
Significance level=**		

BF= blended fertilizer, kg = kilogram, ha=hectare, CV= coefficient of variation, LSD=least significant difference.

The result was in line with the report of [1], who reported that increasing the level of blended fertilizer (both macro and micro nutrient) was increased the number of tillers. On the other hand, contrary to this result, [14, 30] who reported that the application of nitrogen fertilizer had shown positive impact on all yield components of wheat when applied up to 60kg per ha and 28 kg phosphorous, but beyond this rate there was non-significant effect on the yield components of wheat. In consistent with this result [29, 18] reported significantly difference in number of total tillers in response to the rate of N to rice.

3.3. Effects of Blended Fertilizer and Nitrogen Rates on Yield and Yield Components

3.3.1. Effects of Blended Fertilizer and Nitrogen Rates on Number of Spikelet Per Panicle

Number of spikelet per panicle was significantly affected by the main effect of blended fertilize rate and nitrogen (Table 8). As the result indicated, the highest number of spikelet per panicle was recorded at 200kg BF/ha (131.25) and lowest number of spikelet per panicle was recorded at control (86.42).

Table 8. The main effect of rates of blended fertilizer and nitrogen fertilizer on number of spikelet per panicle.

S/N	Treatment	NSPP
Rates of blended fertilizer		
1	0kg/ha	86.42[c]
2	100kg/ha	116.75[b]
3	150kg/ha	127.33[ab]
4	200kg/ha	131.25[a]
LSD (5%) =10.866		
significance level=**		
Rates of nitrogen fertilizer		
	0kg/ha	90.25[c]
	46kg/ha	118.33[b]
	69kg/ha	123.92[ab]
	92kg/ha	129.25[a]
LSD (5%) =10.866		
Mean=115.44		
CV=11.29		
Significance level=**		

BF= blended fertilizer, kg = kilogram ha=hectare, CV= coefficient of variation, LSD=least significant difference.

The result was in line with the report of [24]. who reported that increasing the level of blended fertilizer application both macro and micro nutrient increase the number of spikelet per panicle due to the application of those nutrients. On the other hand, contrary to this result [7], reported that application of nitrogen fertilizer has positive impact on all yield components of rice when applied N fertilizer up to 60kg/ha and 28kg phosphorous/ha beyond this rate there was non-significant effect on wheat components.

On the other hand number of spikelet per panicle was significantly (P < 0.01) affected by the main effect of N fertilizer application. The result indicated that higher number of spikelet per panicle was recorded at 200kg UREA /ha (129.25) and lower number of spikelet per panicle was recorded on the control (90.25) one. In line with this result, [4] reported that the number of spikelet per spike of rice was increased in response to the rate of nitrogen fertilizer.

3.3.2. Effects of Blended Fertilizer and Nitrogen Rates on Number of Seed Per Panicle

There were significance (p < 0.01) difference in number of seed per panicle due to rate of blended fertilizer. The highest number of seed per panicle was recorded on the treatment that had received 200kg ha^{-1} of BF ha^{-1}, followed by 150kg ha^{-1} of BF, but statistically there was no significance difference between these two treatments. On the other hands the lowest (81.17) number of seed was recorded on the treatment that had received no BF (Table 9). The result indicated that the higher the rate of blended fertilizer the higher the number of seed per panicle. This might be due to the presence of micro nutrient that could improve nitrogen use efficiency rather than directly involve in physiological activity [24]. This confirmed that as the rate of blended fertilizer increases the amounts of phosphorus and sulpher applied increase which is essential

nutrient for plants. In addition the amount of zinc and boron increases which improves fertilizer use efficiency [37].

Similarly there were significance (p < 0.01) difference in number of seed per panicle due to the rate of nitrogen fertilizer. The highest (127.58) number of seed per panicle was observed on the rate of 200kg N ha^{-1}, which was followed by 150kg N ha^{-1}, whereas the lowest (82.33) number of on no N (Table 9). As the result indicated when rate of nitrogen fertilizer was increased the number of seed per panicle was also increased. This confirms that increasing N levels increases grain yield by increasing the magnitude of yield attributes. The increase in yield attributes characters would increase better N uptake leading to greater dry matter production and its translocation to the sink [13].

Table 9. The main effect of rates of blended fertilizer and nitrogen fertilizer on number of seed per panicle.

S/N	Treatment	NSEPP
Rates of blended fertilizer		
1	0kg/ha	81.17[c]
2	100kg/ha	112.92[b]
3	150kg/ha	124.50[a]
4	200kg/ha	129.08[a]
LSD (5%) =11.072		
Rates of nitrogen fertilizer		
	0kg/ha	82.33[c]
	46kg/ha	116.00[b]
	69kg/ha	121.75[ab]
	92kg/ha	127.58[a]
LSD (5%) =11.072		
Mean=111.92		
CV=11.87		
Significance level=**		

BF= blended fertilizer, kg = kilogram, ha=hectare, CV= coefficient of variation, LSD=least significant difference.

3.3.3. Effects of Blended Fertilizer and Nitrogen Rates on Number of Sterile Spikelet Per Panicle

There were significance (p < 0.01) difference in number of sterile spikelet per panicle due to the rate of blended fertilizer and N rates (p < 0.01) but not their interaction. The result had shown that the highest (5.27) number of sterile spikelet per panicle was recorded on the treatment that received 0kg ha^{-1} of BF and the least (2.45) number of sterile spikelet per panicle was recorded on 200kg of BF/ha followed by 150kg /ha (Table 10). Zinc deficiency affects several biochemical processes in the rice plant, such as cytochrome and nucleotide synthesis, auxin metabolism, chlorophyll production, enzyme activation and membrane integrity and growth [23]. Its deficiency shows dusty brown spots on upper leaves of stunted plants, uneven plant growth, decreased tiller, and increased spikelet sterility in rice [16]. [32] Observed that in rice, the most commonly observed micronutrient disorder is zinc deficiency. Therefore, the application of zinc is felt necessary throughout the growth cycle of rice crop [11].

In the case of N rates the least (1.69) number of sterile spikelet per panicle was recorded on the treatments that had received 200kg ha^{-1} of N, followed by 150kg ha^{-1} of N which

had no differences statistical, whereas the highest number recorded with no N fertilizer (Table 10). The result indicated that when rate of nitrogen fertilizer was increased, the number of seed per panicle was also increased, but, flower sterility was decreased which will increases yield and yield attributes. This was the result of better N nutrient uptake [3] that led to large dry matter production and its translocation to the sink that was decreased flower sterility [13].

Table 10. The main effect of rates of blended fertilizer and nitrogen fertilizer on number of sterile spikelet per panicle.

S/N	Treatments	NSSPP
Rates of blended fertilizer		
1	0kg/ha	5.27[a]
2	100kg/ha	4.01[b]
3	150kg/ha	3.08[c]
4	200kg/ha	2.45[c]
Rates of nitrogen fertilizer		
1	0kg/ha	8.28[a]
2	46kg/ha	2.51[b]
3	69kg/ha	2.32[b]
4	92kg/ha	1.70[b]
LSD (5%) =0.8895		
Mean=3.6354		
CV=31.61		
Significance level=**		

BF= blended fertilizer, kg = kilogram, ha=hectare, CV= coefficient of variation, LSD=least significant difference.

3.3.4. Effects of Blended Fertilizer and Nitrogen Rates on Thousand Seed Weight (TSW)

The results of analysis of variance revealed that the main effect of blended fertilizer rate and Nitrogen fertilizer significantly affected thousands seed weight (Table 11); however, the interaction effects were not significant. Numerically the highest seed weight (31.33gm) was recorded by the treatments that received 200kg BF/ha, although statistically identical with the treatment that received 200 kg/ha blended fertilizer, and lowest (27.33 gm) was obtained from treatments that had received no fertilizer. Highest seed weight is a reflection of improved nutrient use efficiency as a result of increased application of nitrogen level and blended fertilizer. The result was in harmony with [16] who reported the that the amplification of micro (especially Zn, B) and macro nutrient and when N–level application increase there was a positive impact on yield component of rice crop especially on 1000 seed weight.

On the other hand, there were significance (p < 0.01) difference in thousand seed weight due to the rate of nitrogen fertilizer. The highest (31.17gm) thousand seed weight was recorded by the application of 200kg ha^{-1} of N, but there was no significance difference with the application of 150kg ha^{-1} of N; whereas, the lowest thousand seed weight was recorded by the treatment that had received 0kg ha^{-1} (Table 11). The finding indicated that when the rate of nitrogen fertilizer increased the number of seed per panicle was increased and decreased in flower sterility.

Table 11. *The main effect of rates of blended fertilizer and nitrogen fertilizer on TSW.*

S/N	Treatments	TSW (gm)
Rates of blended fertilizer		
1	0kg/ha	27.33[c]
2	100kg/ha	30.00[b]
3	150kg/ha	30.75[ab]
4	200kg/ha	31.33[a]
Rates of nitrogen fertilizer		
1	0kg/ha	27.58[c]
2	46kg/ha	30.00[b]
3	69kg/ha	30.67[ab]
4	92kg/ha	31.17[a]
LSD (5%) =0.9149		
Mean=29.854		
CV=3.68		
Significance level=**		

BF= blended fertilizer, kg = kilogram ha=hectare CV= coefficient of variation LSD=least significant difference.

3.3.5. Effects of Blended Fertilizer and Nitrogen Rates on Biomass Yield (TDW)

There was significance (p < 0.01) difference in biomass yield due to the rate of blended fertilizer and nitrogen (p < 0.05) (Table 12). As the result indicated the highest (226.33qt/ha) biomass yield was recorded by the treatment that had received 200kg BF/ha followed by 150kg BF/ha (199.59qt/ha) whereas, lowest (80.25qt/ha) biomass yield was recorded from the treatment that had received 0kgBF/ha. The result was in conformity with the findings of [9, 5] who reported that above ground dry biomass yield was significantly affected by the application of blended fertilizer. There was another report by [26] the application of 120kg ha^{-1} NPS fertilizer produced the maximum biomass yield of rice.

On the other hand the analysis of variance showed that highly significantly (P < 0.01) difference was observed on above ground dry biomass yields due to the effect of N fertilizer rate. The highest (233.54qt ha^{-1}) biomass yield was recorded with the highest N rate (200 kg Urea ha^{-1}) and, the lowest dry biomass yield (84.35qt ha^{-1}) was obtained from the control treatment (Table 12).

Table 12. *The main effect of rates of blended fertilizer and nitrogen fertilizer on TDW.*

S/N	Treatments	TDW quintal/ha
Rates of blended fertilizer		
1	0kg/ha	80.25[c]
2	100kg/ha	181.11[b]
3	150kg/ha	199.63[ab]
4	200kg/ha	226.30[a]
Rates of nitrogen fertilizer		
	0kg/ha	84.32c
	46kg/ha	179.01b
	69kg/ha	190.37b
	92kg/ha	233.58a
LSD (5%) =2.6794		
Mean=13.917		
CV=23.09		
Significance level=**		

BF= blended fertilizer, kg = kilogram, ha=hectare, CV= coefficient of variation, LSD=least significant difference.

The highest above ground dry biomass yield was obtained from highest amount of nitrogen might be due to the increased in investment of assimilates to leaves and stems which has finally increased dry matter yield. Similar results was reported by [15] in which the average maize stover yield increased by the application of N and green manure treatments ranged with yield increments of 25 to 75% and 6 to 68% over the control treatments, respectively.

3.3.6. Effects of Blended Fertilizer and Nitrogen Rates on Grain Yield (GY)

The ANOVA reveled the significant (P < 0.05) main effects of applied blended fertilizer rates and significant (P<0.01) effects of N rates on grain yield of rice. Grain yield of rice was significantly (P < 0.01) influenced by the main effect of blended fertilizer. The highest grain yield (58.64 ha^{-1}) was obtained at the rate of 200 kg of BF ha^{-1} which was statistically similar with 150kg of BF ha^{-1} and 100kg ha^{-1} of BF while the smallest (21.60qt ha^{-1}) was obtained from the control treatment (Table 14). Moreover, increased rates of application of blended fertilizer up to 100kg of BF ha^{-1} significantly increased grain yield, but further increasing blended fertilizer rates did not increased statistically the grain yield. In line with this [32] reported that the application of P and Zn nutrients in soil [35]. ls which are marginal deficit in P, Bo, and Zn improves crop yield, indicating positive interaction of P and Zn. Positive and highest response to blended fertilizer is an indication to the deficiently of soils to the nutrients (S, B and Zn). This result was in harmony with that of [7] who reported that the grain yield increases by the application of both macro and micro nutrients.

Table 13. *The main effect of rates of blended fertilizer and nitrogen fertilizer on GY.*

S/N	Treatment	GY quintal/ha
Rates of blended fertilizer		
1	0kg/ha	21.60[b]
2	100kg/ha	53.33[a]
3	150kg/ha	53.46[a]
4	200kg/ha	58.64[a]
Rates of nitrogen fertilizer		
	0kg/ha	34.94[b]
	46kg/ha	48.40[a]
	69kg/ha	49.38[a]
	92kg/ha	53.46[a]
LSD (5%) = 0.5310		
Mean=3.7708		
CV=16.89		
Significance level=**		

BF= blended fertilizer, kg = kilogram, ha=hectare, CV= coefficient of variation, LSD=least significant difference.

The highest grain yield (53.46qt ha^{-1}) was obtained at the rate of 92kg of N ha^{-1} which was statistically similar with 69kg N ha^{-1} and 46kg of N ha^{-1} while the smallest (21.60qt ha^{-1}) was obtained from the control treatment (Table 13). This might be attributed to the asynchrony in the time of availability of sufficient amounts of the nutrient in the soil proportionate with the demand of the plant for uptake. The highest response to N is understandable because of the total N in most Vertisols is

low. Hence due to the rapid nitrification, most of the N added as fertilizer containing NH_4 or NH_2 is subject to leaching or denitrification soon after application. Ammonia fixation also affects fertilizer efficiency in heavy Vertisol [8]. Studies under taken by [4] on the response of rice to N application revealed that application of N significantly increased the grain yield. Increased grain yield due to the rates of N application was also reported for different cereal crops.

3.3.7. Effects of Blended Fertilizer and Nitrogen Rates on Harvest Index (HI)

Harvesting index of rice was significantly (P < 0.01) influenced by the main effect of N fertilizer rates. As the result had shown harvesting index is inversely promotional to nitrogen fertilizer rates and the highest (43.41%) amount was recorded on the control treatment; whereas the lowest (24.5%) percentage was recorded on the treatment that had received 200kg/ha followed by 150kg of N/ha with no significance statistical differences (Table 14).

This might be due to the fact that highest nitrogen fertilizer rates increases the proportion of total dry matter to grain yield more vegetative production. The result was agreed with the finding of [6] who had reported that the better nutrition or

N uptake has increased total dry matter to yield by leading to greater dry matter production and its translocation to the sink [13, 2]. However, increasing N beyond the optimum requirement of crop resulted in decline of grain yield due to excess vegetative production [21].

Table 14. The main effect of rates of blended fertilizer and nitrogen fertilizer on HI.

S/N	Treatments	HI (%)
Rates of nitrogen fertilizer		
1	0kg/ha	43.42[a]
2	100kg/ha	30.17[b]
3	150kg/ha	29.35[bc]
4	200kg/ha	24.50[c]
LSD (5%) = 5.2703		
Mean= 31.860		
CV= 19.84		
Significance level=**		

BF= blended fertilizer, kg = kilogram, ha=hectare, CV= coefficient of variation, LSD=least significant difference.

3.4. Partial Budget Analysis

Partial budget analysis averaged over both blended fertilizer and nitrogen fertilizer is presented in (Tables 15 and 16).

Table 15. Partial budget analysis of rice grain yield in response to blended fertilizers rate.

Treatment	AVGY (qt ha⁻¹)	AdGY (qt ha⁻¹)	GFB (Birr ha⁻¹)	TVC (Birr ha⁻¹)	NB (Birr ha⁻¹)	MRR (%)
0kgha⁻¹BF	21.61	19.45	29,175	0	29,175	-
100kgha⁻¹BF	53.33	47.98	71,970	1,950	64,020	1,781
150kgha⁻¹BF	53.49	48.14	72,210	2,925	69,285	540
200kgha⁻¹BF	58.03	52.23	78,345	3,900	74,445	529.23

Where AVGYqt ha⁻¹ = Average grain yield quintal per hectare, AdGYqt ha⁻¹ =Adjusted grain yield qt per hectare, GFB Birr = Gross field benefit in Birr, TCV Birr.

Regarding with blended fertilizer the highest marginal rates of return (MMR%) was recorded at the blended fertilizer treatment that received 100kg/ha that is 1,781% (Table 16).

And also the net benefit which recorded from this treatment is that 64,020birr h⁻¹ that exceeds the control treatment by 34,845birr ha⁻¹.

Table 16. Partial budget analysis of rice grain yield in response to nitrogen fertilizers rate.

Treatment	AVGY (qt ha⁻¹)	AdGY (qt ha⁻¹)	GFB (Birr hª¹)	TVC (Birr ha⁻¹)	NB (Birr ha⁻¹)	MRR (%)
0kgha⁻¹N	34.98	31.5	47,250	0	47,250	-
100kgha⁻¹N	48.35	43.5	65,250	1,950	63,300	823.1
150kgha⁻¹N	49.38	44.44	66,660	2,925	63,735	44.62
200kgha⁻¹N	53.5	48.2	72,300	3,900	68,400	478.5

Where AVGY qt ha⁻¹ = Average grain yield quintal per hectare, AdGYqt ha⁻¹ =Adjusted grain yield qt per hectare, GFB Birr = Gross field benefit in Birr, TCV Birr.

On the other hand as partial budget analysis (CIMMYT, 1998) were done in relation nitrogen fertilizer higher marginal rates of return (MMR%) were recorded from `the treatment that had received 100kg of N ha⁻¹ which was 823.1% (Table 16), and the net benefit of this treatment was 63,30 birr h⁻¹ that exceed the control treatment by 16050birr ha⁻¹.

4. Conclusion and Recommendation

Now a day's rice production is widely practiced in Ethiopia. But the existing productivity is very low despite of the high potential for production of the crop in the country. The low productivity of the crop was caused by poor agronomic practice, poor soil fertility, poor cultural practices, diseases

and pests. The crop requires a variety of elements for growth and development of which N, P, S, Zn and B are the most important nutrients, because, they are required for good physiological activity in the plant. So sustaining soil and soil fertility in intensive cropping systems for best yield and quality of crops could be achieved through optimum levels of fertilizer application, best agronomic practices and crop management. Thus, information on fertility status of soil and crop response to different soil fertility management is very important to come up with profitable and sustainable crop production. Therefore, this experiment was carried out with the objective of the effect of blended fertilizer on yield and components of rice.

The result of the experiment indicated that different rates of

blended fertilizer had shown significant differences on yield and yield components of rice. The ANOVA reveled the significant ($P < 0.05$) main effects of applied blended fertilizer rates and significant ($P < 0.01$) effects of N rates on grain yield of rice. The highest grain yield (53.46qt ha^{-1}) was obtained at the rate of 92kg of N ha^{-1} which was statistically similar with 69kg N ha^{-1} and 46kg of N ha^{-1} while the smallest (21.60qt ha^{-1}) was obtained from the control treatment. Grain yield of rice was significantly ($P < 0.01$) influenced by the main effect of blended fertilizer. The highest grain yield (58.64 ha^{-1}) was obtained at the rate of 200 kg of BF ha^{-1} which was statistically similar with 150kg of BF ha^{-1} and 100kg ha^{-1} of BF while the smallest (21.60qt ha^{-1}) was obtained from the control treatment.

Even though biomass yield was increased as rates of blended and nitrogen fertilizer increased, farmers invest their money to get high grain yield rather than biomass yield. So that, the increase of grain yield should be considered to recommend the proper rates of blended and nitrogen fertilizer. Hence the result of the study have clearly demonstrated that rice respond best yield to the application of different rates of blended and nitrogen fertilizers, as partial budget analysis had shown the highest marginal rates of return (MMR%) was recorded from the treatment that received 100kg of BF ha^{-1} and 46kg of N ha^{-1} which was 1,781% and 823.1% respectively. So that, the finding indicated that farmers better to use 100kg of BF ha^{-1} and 46kg of N ha^{-1} to increase their grain yield and to get high net benefit. However, for further recommendation, it is necessary to conduct further experiments on the effects of rates of fertilizer to investigate the chemical composition of the grain, nutritional value and its impact on soil in line with the economic benefit. In addition to that, further site specific investigation should be applied to recommend fertilizer rate for the specific site.

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