NOUN Jour. of Agric. Res. & Dev. Vol. 1, No.1, Page 94 - 101

p-ISSN: 1595-1405

NOUN Journal of Agricultural Research and Development (NJARD)

The Official Journal of the Faculty of Agricultural Sciences, National Open University of Nigeria, Kaduna Campus

Journal homepage: https://journal.agric.nou.edu.ng

Original Article

OPEN ACCESS

Effect of Intra Row Spacing and Nitrogen on Some Yield Characters of Pearl Millet *(Pennisetum glaucum* (L.) R.Br.) in Jigawa State, Nigeria.

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Editor: *Dr. Sunday N. Obasi*
National Open University of Nigeria

Received: *April 3, 2025*
Accepted: *May 20, 2025*
Published online: *June 4, 2025*
Peer-review: Externally peer-reviewed

Conflict of Interest: *The authors have no conflicts of interest to declare*

Financial Disclosure: *The authors declared that this study has received no financial support*

ABSTRACT

Field trials were conducted during 2020 rainy season at Birnin Kudu Local Government (11°21' 48.4"N, 9°52' 35.3"E) and Jikas area in Maruta ward under Gwaram Local Government (11°28' 16.4"N, 9°27' 33.2"E). Both sites were located in Jigawa State and fall within Sudan Savannah agro ecological zone of Nigeria; The experiment evaluated the performance of pearl millet as affected by intra row spacing and nitrogen levels. The treatments consisted of three intra row spacing (25, 50 and 75cm) and four nitrogen levels (0, 40, 80 and 120kg N/ha). The treatments were factorally combined and laid out in a randomized complete block design and replicated three times. Panicle diameter, panicle weight, Stover yield, 1000 grains weight, grain yield and harvest index were observed as yield characters. Results revealed that, intra-row spacing had significant (P<0.05) effect on panicle diameter, panicle weight, stover yield, 1000 grains weight and grain yield. The interaction between the intra-row spacing and nitrogen fertilizer application was statistically significant (P<0.05) on panicle diameter, panicle weight, Stover yield, 1000 seeds weight and grain yield. From this study, it could be concluded that an intra-row spacing of 75cm combined with application of 120kgN/ha may be recommended to farmers in the study area, as such would be beneficial to improve the production of pearl millet.

Keywords: *Intra Row Spacing, Nitrogen, Yield Characters and Pearl Millet (Pennisetum glaucum (L.) R.Br.)*

1.0 INTRODUCTION

Pearl millet is one of the most important cereals and a staple grain for over 150 million people in West Africa and India (FAOSTAT, 2019). It makes up about two-third of the total cereal production in Africa therefore, regarded as one of the worlds essential cereal crops (millet, rice, wheat, maize and sorghum) (Umar, 2018). It has the ability to withstand stress and thrive in hot region, with wide range of soil, which has made it quite popular in hot region and especially across many African countries (Bhagavatula *et al*, 2013). African countries have accounted for about 55 percent of the global total pearl millet and also take up to 59 percent of the global total area under pearl millet cultivation (FAO, 2015). The global production of pearl millet has estimated to 26 million hectares spread over 40 countries that are mostly arid and semi-arid, where rain fall is not sufficient (200-600mm).

within Africa, more than 13.65 million hectares were put in use; accounting for about 74 percent of the total area cultivated in Africa and 28 percent of the world total production is in West Africa. Nigeria, as one of the most important millet producing country in the world, produces almost half (40 percent) of total African millet production (FAO, 2019). The Northern part of Nigeria provides an ideal agro-ecological condition for the production of pearl millet. For this reason it is predominantly produced and consumed within the region, which made staple for over 40 percent of the populace (Jirgi *et al.*, 2010).

Pearl millet has become a valuable component of the people's livelihood, because no part of the plant is wasted (Umar, 2018). As a regional staple, the people have created diverse method and forms of processing it for consumption, such as thick paste (Locally called 'tuwo'), thick dough (Locally called 'fura'), dumpling, grits, porridge and gruel. Beyond food, it is used as animal feed while the stalks of some varieties are traditionally used as building materials and for fire wood (Usman *et al*, 2014). The importance of pearl millet extends beyond food; its production also serves as an important source of income to farmers (Akinsuyi, 2011). Pearl millet is the fifth most important cereal crop globally and ranks fourth amongst important tropical cereals (Ismail, 2012). In recognition of the vital role the pearl millet plays in food security, the Nigerian government in 1975 established 'lake chad-Research institute' (LCRI) mandated to facilitate research in millet production in the country. Over the years, the institute has made great achievement by releasing many varieties, such as LCICMV-1(SOSAT-C88) and LCICMV-3 (Super SOSAT) among others, with potential yields of 3.0-5.0 tones/ha (LCRI, 2018) Other special agencies, such as International Crops Research Institute for the semi-Arid Tropics (ICRISAT) with the similar purpose also have been in existence since 2008. With all the above-mentioned government's effort, to promote pearl millet production in Nigeria, the last decade has seen a decline in millet production. (Umar, 2018). FAO in 2018 listed the main factors undermining crop production in Nigeria, which include; law fertilizer application and plant population density among others.

1.1 Statement of the Problem

Although Pearl Millet plays important roles in food security and Nigerian economy, the yield recorded by the farmers in the country is still very low compared with the current increase in population (FAOSAT, 2021), there is therefore a need for measures that will increase millet production to meet the demand of the rapid growing population. As it serve as one of the major food for Human and used in livestock diet, Pearl millet is the fifth most important cereal crop in the world after rice, wheat, maize, and sorghum (National Research Council, 1996). For the cultivation of millet crop, narrow spacing discourages the production of tillers which finally reduces its yield (Kamal *et al*., 2013). Even though, many farmers have came to realize the influence of these factors, quite large numbers of them are yet to understand the use of suitable plants spacing so as to optimize their yields. However, it was generally observed that Millet fail to grow better and produces good grains in plots without adequate nutrients (Singh *et al*., 2016). To achieve optimum grain production, appropriate fertilizer application is essential. Being the most important plants nutrient, the use of Nitrogen fertilizers will increase the productivity of the millet Crops and inadequate available Nitrogen will reduce the crop growth and yield (Choudhary *et al*., 2017). It is also possible to lower the cost of millet production while maximizing its potentialities by limiting supply of N to the appropriate quantity using suitable spacing.

It is within this context that, this study was initiated to use Nitrogen and Intra-row spacing for Pearl Millet Variety, LCICMV-3 (Super Sosat) production at Correctional Farm Center, Birnin Kudu and Jikas area in Maruta ward under Gwaram Local Government in Jigawa State.

1.2 Justification of the Study

In view of the world's increasing population and high demand of Millet, its yield needs to be increased. This can be achieved by the application of Nitrogen Fertilizer in appropriate quantity to the plants using suitable spacing, which have been found to play important roles in plants, by increasing growth and yield (Bamboriya *et al*., 2017). However, Nitrogen absorbed quickly by the plant and provide high levels of nutrition, thereby given sudden responses on growth and yield performance of the crop and aid the plants in withstanding stress conditions, it also maintains optimum soil fertility conditions and improves crop quality. Although, accurate estimates of the amounts of nitrogen required by millet are still challenging, because, optimum nitrogen depends on conditions that are localized and dynamic (Wichelns, 2014), application of Nitrogen can solve problems associated with poor growth and yield of Millet (Leonard, 2004). Too much application has destructive effect while application of very low / small amount has the low yield effect. The use of suitable spacing encourages the production of tillers (Ajeigbe *et al*., 2019). That is why the research (Growth and Yield of pearl millet as affected by intra row spacing and levels of Nitrogen) has been conducted.

2.0 MATERIALS AND METHODS

2.1 Experimental Sites

The trial was conducted at two locations; Correctional Farm Center, located in Birnin Kudu Local Government Area, Latitudes (N 11°21'48.4") and Longitudes (E 009°52` 35.3") with an Elevation of (413m) above sea level , the mean annual rainfall is (1021.22mm/an), mean minimum annual temperature range of (29°C) and mean maximum annual temperature of (42°C) and Jikas

Area, located in Matura Ward, under Gwaram Local Government Area in Jigawa State, latitudes (N 11°28' 16.4") and longitudes (E 009° 27' 33.2") with an Elevation of (442m) above sea level, the mean annual rainfall is (915.12mm/an), mean minimum annual temperature range of (26°C) and mean maximum annual temperature of (43°C). The two sites, lie within the Sudan savanna agro-ecological zone of Nigeria. The trials were concurrently conducted from June to August, 2020.

2.2 Treatments and Experimental Design

The experiment consisted of twelve (12) treatments, which were replicated three (3) times in a Randomized complete block design (RCBD), with a total of Thirty six (36) plots. The treatments comprised of three (3) intra-row spacings (25cm, 50cm and 75cm) and four levels of nitrogen (0kgN/ha, 40kgN/ha, 80kgN/ha and 120kgN/ha) The plot size was 3.0m x 3.75m (11.25 m^2).

2.3 Cultural Practices

2.3.1 Land Preparation

The land was cleared, harrowed, followed by ridging. The ridges were later marked out in to plots, discard and pathway using measuring tape, ropes and pegs.

2.3.2 Seed and Seed Protection

The Millet seed was obtained from ICRISAT and treated with Imidacloprid 10% + Thiram 10% (Seed Care), before planting which is a very effective systemic insecticide and fungicide seed treatment on cereals.

2.3.3 Description and Major Features of the Variety

Pearl millet variety PEO5532, was released as LCICMV-3 and called Super sosat by Lake Chad Research Institute (LCRI) and ICRISAT in the year 2011. It was considered for its outstanding characteristics of early maturity (75 – 80days), high yield 5.0t/ha and resistance to downy mildew disease, as well as its stout stalk used for fencing. It is recommended for production in the Sudan and Sahel savanna Agro ecological Zones of Nigeria (Angarawai *et al.*, 2015).

2.3.4 Sowing

Millet variety (Super sosat) was used as a test crop. The sowing was done on 14 June and 18 June, 2020 in Birnin Kudu and Jikas Sites respectively, immediately after the rain was established, at a spacing of 25, 50 and 75cm within rows and 75cm between the rows, 5-15 seeds were planted per hole. Each replication consisted 12 plots, each plot consisted 5 ridges and each ridge carried a number of stands depending on the intra-row spacing allocated to each particular plot.

2.3.5 Weeding and Thinning

Weeding was carried out at 3 and 5WAS, over all the plots to clear the unwanted grasses while the Seedlings were thinned to three (3) plants per stand at two weeks after sowing.

2.3.6 Fertilizer Application

Nitrogen fertilizer in form of Urea was applied in two split doses, the first dose at 3 weeks after sowing and the second dose was applied at 2 weeks after the first application. The fertilizer was applied by side placement at 5cm apart.

2.4 Harvesting

The Plants were harvested on 27 and 29 August, for the two sides respectively, using Cutlass by cutting the plants at their base close to ground, tagged and allows drying in the sun for further observation and recording.

2.5 Data Collection

The data was collected on crop Growth and yield parameters. Five Millet plants were selected at random from three inner Ridges of each plot, tagged, measured and then recorded. The yield parameters were Panicle Diameter, Panicle weight,1000 seeds weight, Grain yield, Stover yield and harvest index) were observed during and after the harvest.

2.5.1 Panicle Diameter (cm)

The diameter of the Panicles was determined by measuring the width of Panicle of the tagged plants in each plot, using a Veneer caliper, The Mean value was then computed and recorded in cm.

2.5.2 Panicle Weight (g)

The weight of the panicle was measured using a sensitive weighing balance, after been dried before de-husking the grains of each tagged plants in each plot, the Mean value was then computed and recorded in gram.

2.5.3 1000 Seeds Weight (g)

The 1000 seed from the harvested tagged plants of each plot was counted manually, weighed using a sensitive weighing balance and then recorded in gram.

2.5.4 Grain Yield (t/ha)

The Grains yield was estimated from seed weight per net plot. This was determined by harvesting the Panicles in the net plots, dried, threshed and weighed using a sensitive weighing balance. The yield was also converted to ton/ha.

2.5.5 Stover Yield (t/ha)

The Stover weight of the five tagged plant of each plot was measured using a sensitive weighing balance after been dried and then converted to ton/ha.

2.6 Statistical Analysis of Data

Statistical analysis was conducted with standard procedure, all the data collected were subjected to analysis of Variance (ANOVA) using the Genstat statistical package, as described by Snedecor and Cochran (1967). Finally, Students new Mann Kurl (SNK) was used to separate and compare the treatment means at 5% level of significance.

3.0 RESULTS AND DISCUSSION

3.1 Panicles Diameter

The effect of intra row spacing and levels of nitrogen on growth and yield of pearl millet on panicle diameter is present in Table 1. The effect of intra row spacing on panicle diameter was significant across the locations, the diameter at two intra row spacing (25 and 50cm) were statistically similar but differ from the value obtained at 75cm spacing in both locations. The effect of nitrogen levels on panicle diameter was also significant at both locations. At control plots the panicles were thinner, hence smallest in diameter, while (80kg N/ha and 120kg N/ha) were statistically similar with thicker panicles. The interaction between the intra row spacing and nitrogen levels on panicle diameter at Birnin Kudu and Jikas was presented in Table 2. At both locations, the largest panicle diameter was obtained from 120kgN/ha followed by 80kgN/ha at 75cm intra row spacing and the smallest diameter was recorded from 0kgN/ha at 25cm intra row spacing.

Table 1. Effect of Intra Row Spacing and Different Levels of Nitrogen on Panicle Diameter (cm) of Pearl Millet at Birnin Kudu and Jikas in 2020 Rainy Season.

Treatment	**Birnin Kudu**	**Jikas**
Spacing (cm)		
25	2.34c	2.60c
50	2.48b	2.77b
75	2.65a	2.97a
SE±	0.16	0.19
Significant level	*	*
Nitrogen (kg/ha)		
0	1.99c	2.16c
40	2.34b	2.60b
80	2.77a	3.17a
120	2.84a	3.19a
SE±	0.40	0.50
Significant level	*	*
Interaction		
Spacing* N levels	*	*
SE±	0.07	0.08

Means with the same letter in the same column of any set of treatments are not significantly different at P ≤ 0.05% using SNK (students Newmann -Keuls test).
NS: Non-Significance.

Table 2. Interaction between intra row spacing (cm) and nitrogen levels (kg/ha) on Panicle diameter (cm) at Birnin Kudu and Jikas.

	Birnin Kudu				Jikas			
	Nitrogen levels (kg/ha)							
Spacing (cm)	0	40	80	120	0	40	80	120
25	1.92	2.16b	2.77ab	2.49 b	2.02	2.54	3.10	2.73 c
50	1.97	2.41 a	2.67 b	2.90 a	2.16	2.67	3.12	3.20 b
75	2.09	2.46 a	2.97 a	3.17 a	2.29	2.66	3.36	3.57 a
SE±		0.1117				0.1455		

Means followed by the same letter(s) within a column are not statistically different at 5% level of significant using SN

3.2 Panicle Weight

The effect of intra row spacing and nitrogen level of growth and yield of pearl millet, on panicle weight at Birnin Kudu and Jikas in 2020 rainy season is presented in Table 3. The result indicated that, at Birnin Kudu, the intra row spacing has significant effect. The plot with closer spacing (25cm) produced less heavy panicles while those with wider spacing (75cm), produced the heaviest panicles. The same trend was observed in Jikas, intra row spacing of (75cm) has the highest mean value which was decreased by reducing the intra row spacing. At both locations, nitrogen levels were significantly affected the panicles weight. The plot with 0kgN/ha produced the lighter panicles while those with 120kg N/ha gave the highest mean value than the rest, although the result indicated higher performance in Jikas than in Birnin Kudu. The interaction between the intra row spacing and nitrogen levels on panicle weight in Birnin Kudu was presented in Table 4. The heaviest panicle was obtained from 120kgN/ha followed by 80kgN/ha at 75cm intra row spacing and the lighter ones were observed from 0kgN/ha at 25cm intra row spacing.

Table 3. Effect of Intra Row Spacing and Different Levels of Nitrogen on Panicle Weight (g) of Pearl Millet at Birnin Kudu and Jikas in 2020 Rainy Season.

Treatment	Birnin Kudu	Jikas
Spacing (cm)		
25	54.33c	95.83c
50	72.33b	107.00b
75	93.67a	120.33a
SE±	19.69	12.27
Significant level	*	*
Nitrogen (kg/ha)		
0	47.11d	60.67d
40	62.22c	99.11c
80	83.33b	128.44b
120	101.11a	142.67a
SE±	23.68	36.23
Significant level	*	*
Interaction		

Spacing* N levels	*	NS
SE±	2.64	5.15

Means with the same letter in the same column of any set of treatments are not significantly different at P ≤ 0.05% using SNK (students Newmann -Keuls test).
NS: Non-Significance

Table 4. Interaction between intra row spacing (cm) and nitrogen levels (kg/ha) on Panicle weight (g) at Birnin Kudu.

	Nitrogen levels (kg/ha)			
Spacing (cm)	0	40	80	120
25	36.6667 b	41.3333 c	62.6667 c	76.6667 c
50	42.6667 b	62.0000 b	82.6667 b	102.0000 b
75	62.0000 a	83.3333 a	104.6667a	124.6667 a
SE±		3.63		

Means followed by the same letter(s) within a column are not statistically different at 5% level of significant using SNK

3.3 1000 Seeds Weight

The effect of intra row spacing and nitrogen levels on growth and yield of pear millet at Birnin Kudu and Jikas on 1000 grain weight in 2020 rainy season is presented in Table 5. The effects of intra row spacing and nitrogen levels were significant across the locations. The wider spacing (75cm) produced the heavier 1000 grains while the closer spacing (25cm) gave out the lighter 1000 grains across the locations. Nitrogen levels have also significantly affected the 1000 grains weight in both locations. The control plot with 0kg N/ha recorded the lowest mean value while the highest mean value was obtained from the plots served with 120kg N/ha followed by 80kg than 40kg N/ha. The interaction between the intra row spacing and nitrogen levels on 1000 seed weight in Birnin Kudu was presented in Table 6. It revealed that, 120kgN/ha followed by 80kgN/ha gave the highest 1000 seed weight at 75cm intra row spacing and the smallest weight was recorded from 0kgN/ha at 25cm intra row spacing. At Jikas there was no significant effect observed.

Table 5: Effect of Intra Row Spacing and Different Levels of Nitrogen on 1000 Seeds Weight of Pearl Millet at Birnin Kudu and Jikas in 2020 Rainy Season.

Treatment	**Birnin Kudu**	**Jikas**
Spacing (cm)		
25	7.42b	8.42c
50	9.33a	10.33b
75	9.75a	11.00a
SE±	1.24	1.34
Significant level	*	*
Nitrogen (kg/ha)		
0	5.67d	7.11d
40	8.56c	9.22c
80	9.89b	10.67b
120	11.22a	12.67a
SE±	2.38	2.34
Significant level	*	*
Interaction		
Spacing* N levels	*	N
SE±	0.29	0.29

Means with the same letter in the same column of any set of treatments are not significantly different at P ≤ 0.05% using SNK (students Newmann -Keuls test).
NS: Non-Significance.

Table 6: Interaction between intra row spacing (cm) and nitrogen levels (kg/ha) on 1000 seed weight (g) at Birnin Kudu.

	Nitrogen levels (kg/ha)			
Spacing (cm)	0	40	80	120
25	5.0000 b	6.6667 b	8.3333 b	9.6667 c
50	5.6667ab	9.6667 a	10.6667 a	11.3333 b
75	6.3333 a	9.3333 a	10.6667 a	12.6667 a
SE±		0.4660		

Means followed by the same letter(s) within a column are not statistically different at 5% level of significant using S

3.4 Grain Yield

The effect of intra row spacing and levels of nitrogen on growth and yield of pearl millet on grain yield at Birnin Kudu and Jikas in 2020 rainy season is presented in Table 7. The effect of intra row spacing on grain yield was significant across the locations. Lower mean value was obtained from plot served with 25cm spacing, while 50 and 75cm spacing have recorded highest value, though, they were statistically similar. The grain yield was significantly affected by nitrogen levels at both locations. The higher nitrogen level (120kg N/ha) gave out higher grain yield than the rest levels with lowest mean value in control plot at both locations. The interaction between the intra row spacing and nitrogen levels on grain yield in Birnin Kudu and Jikas was presented in Table 8. At both locations, the highest grain yield was obtained from 120kgN/ha followed by 80kgN/ha at 75cm than 50cmintra row spacing while the smallest grain yield value was recorded from 0kgN/ha at 25cm intra row spacing.

Table 7: Effect of Intra Row Spacing and Different Levels of Nitrogen on Grains Yield (t/ha) of Pearl Millet at Birnin Kudu and Jikas in 2020 Rainy Season.

Treatment	Birnin Kudu	Jikas
Spacing (cm)		
25	2.47b	3.35c
50	2.52b	3.64b
75	3.91a	4.08a
SE±	0.82	1.44
Significant level	*	*
Nitrogen (kg/ha)		
0	1.13d	1.48d
40	2.15c	3.12c
80	3.50b	4.07b
120	4.10a	4.76a
SE±	1.72	2.07
Significant level	*	*
Interaction		
Spacing* N levels	*	*
SE±	0.31	0.46

Means with the same letter in the same column of any set of treatments are not significantly different at P ≤ 0.05% using SNK (students Newmann -Keuls test).
NS: Non-Significance.

Table 8. Interaction between intra row spacing (cm) and nitrogen levels (kg/ha) on Grain yield (t/ha) at Birnin Kudu and Jikas.

	Birnin Kudu				Jikas			
	Nitrogen levels (kg/ha)							
Spacing (cm)	0	40	80	120	0	40	80	120
25	0.87	2.09	2.77 b	3.02 c	1.02 b	2.63 b	2.53 c	3.31 c
50	1.02	1.82	2.87 ab	3.37b	1.17 ab	2.74b	3.02 b	3.81 b
75	1.50	2.53	3.77 a	3.89 a	2.24 a	2.98 a	3.84 a	4.26 a
SE±		0.3305				0.3468		

Means followed by the same letter(s) within a column are not statistically different at 5% level of significant using SNK.

3.5 Stover Yield

The effect of intra row spacing and nitrogen levels on growth and yield of pearl millet at Birnin Kudu and Jikas on Stover yield in 2020 rainy season is presented in Table 9. The effects of intra row spacing on Stover yield were significant across the locations. The closer spacing (25cm) has recorded the highest mean value, followed by (50cm) and (75cm) which were statistically similar at both location. Nitrogen levels significantly affected the Stover yield. The control plot with 0kg N/ha has the least Stover yield while the highest rate of nitrogen (120kgN/ha) has recorded the highest mean value, followed by the lower levels across the locations. The Stover yield increases by the increase in nitrogen levels. The interaction between the intra row spacing and nitrogen levels on stover yield in Jikas was presented in Table 10. The highest stover yield was obtained from 120kgN/ha followed by 80kgN/ha at 25cm intra row spacing while the lowest yield was recorded from 0kgN/ha at 75cm intra row spacing.

Table 9: Effect of Intra Row Spacing and Different Levels of Nitrogen on Stover Yield (t/ha) of Pearl Millet at Birnin Kudu and Jikas in 2020 Rainy Season.

Treatment	Birnin Kudu	Jikas
Spacing (cm)		
25	9.41a	10.97a
50	5.77b	8.31b
75	6.65b	7.79b
SE±	2.13	2.28
Significant level	*	*
Nitrogen (kg/ha)		
0	2.47d	2.88d
40	4.92c	6.61c
80	9.10b	10.59b
120	11.28a	12.35a
SE±	5.29	5.87
Significant level	*	*
Interaction		
Spacing* N levels	NS	*
SE±	0.84	0.78

Means with the same letter in the same column of any set of treatments are not significantly different at P ≤ 0.05% using SNK (students Newmann -Keuls test).
NS: Non Significance.

Table 10: Interaction between intra row spacing (cm) and nitrogen levels (kg/ha) on Stover yield (t/ha) at Jikas.

	Nitrogen levels (kg/ha)			
Spacing (cm)	0	40	80	120
25	4.2700 a	7.7767	14.7233 a	21.1267 a
50	2.3267 ab	5.7300	10.1800 b	14.9900 b
75	2.0400 b	6.3333	9.8600 b	12.9433 b
SE±		0.9966		

Means followed by the same letter(s) within a column are not statistically different at 5% level of significant using SNK

4.0 CONCLUSION

The result of this experiment revealed that, the wider intra row spacing (75cm) has higher influence on the yield of pearl millet, as it was evidently observed from the plots served with wider intra row spacing (75cm), which resulted to higher grain yield compared to the plots served with closer spacing (25cm) which produced lowest grain yield in all the experimental sites. It also revealed that, higher Nitrogen rates promotes the width and weight of panicle, Stover yield, 1000 grain weight as well as grain yield. It was clearly observed that, plots served with 120kgN/ha gave the highest grains yield followed by 80kgN/ha while plots served with 0kg and 40kgN/ha resulted to lowest grain yield in each of the experimental sites.

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