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# GROWTH RESPONSE OF LOWLAND RICE (Oryza sativa L.) VARIETY AS INFLUENCED BY PLANTING METHOD AND FERTILIZER MANAGEMENT IN NIGERIA SAVANNA

**BABAJI M.[1*] A. A. MUHAMMAD[2], I. U. ABUBAKAR[2], I. S. USMAN[3], ALI M. A[4]**

[1& 4]Aminu Saleh College of Education, Azare, Bauchi State. [2]Department of Agronomy, Ahmadu Bello University, Zaria, Nigeria. [3] Department of Plant Science, Ahmadu Bello University, Zaria, Nigeria.

## Abstract

Field trials were conducted at Institute for Agricultural Research, Samaru, and Irrigation Research Station, Kadawa in the northern Guinea and Sudan Savanna ecological zones of Nigeria respectively, during the 2021 wet season. Treatments consisted of three lowland rice varieties (FARO 44, FARO 52, and FARO 57), three planting methods (dibbling, drilling and broadcasting) and four rates of NPK and Agric-Zyme 3X organic liquid fertilizers (0:0:0 kg NPKha$^{-1}$ + 3.0 lha$^{-1}$, 60:30:30 kg NPKha$^{-1}$+1.5lha$^{-1}$, 60:30:30 kg NPKha$^{-1}$ + 3.0 lha$^{-1}$ and 120:60:60 kg NPKha$^{-1}$ + 0 lha$^{-1}$). The trials were replicated three times, in a factorial arrangement using split plot arrangement. Fertilizer rates and planting methods were the main plots and rice variety as subplot. FARO 44 recorded shorter plants heights and higher net assimilation rates, but took fewer days to 50 % flowering than FAROs 52 and 57. Effect of planting methods was generally not significant on rice, however, broadcasting recorded higher leaf area index, while dibbling recorded higher paddy yield. Application of 120: 60: 60 NPK kg ha$^{-1}$ alone out-performed other fertilizer management methods followed by 120: 60: 60 NPK kg ha$^{-1}$ +1.5 l ha$^{-1}$ Agric-Zyme 3X in all parameters alone. In conclusion, FARO 57 variety out-performed other varieties used in the study, Drilling method and application of 120: 60: 60 NPK kg ha$^{-1}$ alone were better for growth, yield and grain quality of lowland rice in the study areas.

**Key words:** FARO, Agric-Zyme 3X, Broadcasting, Dibbling, Drilling



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## Introduction

Rice (*Oryza Sativa*) is a staple food in many countries of Africa and other parts of the world. It is also the most important staple food for about half of human race (Udemezue, 2014). (Imolehin and Wada, 2000) reported that rice has become the second most important cereal in the world after wheat in terms of production due to a recent decline in maize production. West Africa accounts for 64.2% and 61.9% of total rice production and consumption respectively in sub-Saharan Africa. Nigeria ranks highest (first) both the producer and consumer of rice in the sub-region with figures slightly above 50% (Imolehin and Wada, 2000). Nigeria is currently the largest rice producing country in Africa.

Traditional rice varieties are more than 1metre tall, have a long growth and maturation period (5-6 months) and low yield (1.5-2.0 t $ha^{-1}$) tonnes per hectare. Improved varieties are shorter (less than 50 cm) and are more responsive to nutrients and have ~~a~~ higher yield (3.5-5 t $ha^{-1}$) and are short-duration (Mohammed, 2016). Improper sowing techniques usually affects yield potential of the crop, increase in yield may be ensured through different sowing methods such as drilling and dibbling. Sowing improved varieties using appropriate methods of seeding could produce a fast growing and uniform crop with higher yields which could compete with weeds effectively (Kawure *et al.*, 2018). The objectives of the research were to: 1. Determine the varieties for growth development of lowland rice varieties. 2. Determine the appropriate planting method for lowland rice for growth and development. 3. Determine the effect of combined NPK plus liquid organic fertilizers on growth and deployment of lowland rice.

### MATERIALS AND METHODS

Field trials were conducted at the Institute for Agricultural Research, Samaru, in the Northern Guinea and Sudan Savanna ecological zones of Nigeria, during 2021 wet season. Treatments consisted of three lowland varieties (FARO 44, FARO 52, and FARO 57), four rates of combined NPK and Agric zyme 3X organic liquid fertilizers (0:0:0 kg $ha^{1}$ plus 3$lha^{-1}$, 60:30:30 kg NPK$ha^{-1}$plus 1.5$lha^{-1}$, 60:30:30 kg NPK$ha^{-1}$ plus 3$lha^{-1}$ and 120:60:60 kg NPK$ha^{-1}$ plus 0$lha^{-1}$), and three planting method (dibbling, drilling and broadcasting). These studies were designed as Randomized Complete Block Designs, laid out in split plots arrangements with fertilizer rates and planting methods as main plot and lowland rice varieties as sub plots. Gross and net plot sizes were 3.0 m x 4.0 m (12 $m^2$) and 2 m x3 m (6 $m^2$) respectively. The treatments were replicated three times. The experimental site was harrowed twice to obtain a fine tilth and marked out into plots (basins) and replicates Each main plot was separated by 1 m pathway, the sub-plot by 0.5 m. Seeds were sown according to treatments. Dibbling,



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at 20 cm inter and intra row spacings using 60 kg $ha^{-1}$ seed rate, while seeds were drilled in grooves 2-3 cm deep at 20 cm spacings using 80 kg $ha^{-1}$ seed rate. Seeds were manually sown at at 100 kg $ha^{-1}$ and covered lightly with soil. The crop was harvested at maturity when the entire plants turned yellowish or golden brown, using sharp locally made handheld sickles. Harvested plants were threshed. Growth data were collected on plant height (cm), leaf area index, net assimilation rate, days to 50 % flowering at 3, 6, 9 and 12 weeks after sowing effective grain-filling period and paddy yield.

**RESULTS**

Details of physical and chemical properties of the soil taken at the experimental sites (Samaru and Kadawa) at a depth of 0-30 cm in 2021 wet seasons are shown in Table 1. The soils were identified as loamy and sandy loam for Samaru and Kadawa respectively. In both locations, soil pH were slightly acidic (pH of 5.67 and 6.25), moderate in organic carbon (14.62 and 16.85 $gkg^{-1}$), and total nitrogen (1.68 and 1.95 $gkg^{-1}$) respectively, and low in available phosphorus (14.20 and 16.10 $mgkg^{-1}$). Exchangeable cations were low (K = 0.16 and 0.19 $cmolkg^{-1}$, mg 0.58 and 0.62 $cmolkg^{-1}$, Ca 3.02 and 3.55 $cmolkg^{-1}$, Na 0.25 and 0.27 $cmolkg^{-1}$, $Al^{+++}$+ $H^{+}$ 0.8 and 0.6 and low CEC 4.81 5.25 $cmolkg^{-1}$ respectively, were moderate for both locations, in the 2021 wet season. Chandrasekaran *et al*. (2007) reported that rice can be grown successfully on a variety of soils, the most important requirement been its ability to hold moisture.
Table 2: plant height of lowland rice varieties as influenced by planting methods and fertilizer management at Samaru and Kadawa, did not differ significantly. However, at Samaru, application of 120: 60: 60 NPK kg $ha^{-1}$ + 0 Agric-Zyme 3X l $ha^{-1}$ recorded taller ($p< 0.05$) plants followed by combined application of 60: 30: 30 NPK kg $ha^{-1}$ + 1.5 Agric-Zyme 3X l $ha^{-1}$ while application of 3 Agric-Zyme 3X l $ha^{-1}$ alone recorded shortest ($p< 0.05$) plant heights. At Kadawa application of 60: 30: 30 NPK kg $ha^{-1}$ + 1.5 Agric-Zyme 3X l $ha^{-1}$ recorded taller plant height, but was statistically similar with 120: 60: 60 NPK kg $ha^{-1}$ + 0 Agric-Zyme 3X l $ha^{-1}$ and 60: 30: 30 NPK kg $ha^{-1}$ + 1.5 Agric-Zyme 3X l $ha^{-1}$. Similarly, application of 3 Agric-Zyme 3X l $ha^{-1}$ alone recorded shorter plants and was also statistically similar with 120: 60: 60 NPK kg $ha^{-1}$ + 0 Agric-Zyme 3X l $ha^{-1}$ and 60: 30: 30 NPK kg $ha^{-1}$ + 1.5 Agric-Zyme 3X l $ha^{-1}$.
Varietal variations and effect of planting methods were not significant ($p< 0.05$) on leaf area index at both locations. Effect of fertilizer management on leaf area index (LAI) was significant across locations. At Samaru application of 120: 60: 60 NPK kg $ha^{-1}$ recorded higher leaf area index, followed by 60: 30: 30 NPK kg $ha^{-1}$ + 1.5 Agric-Zyme 3X l $ha^{-1}$ and 60: 30: 30 NPK kg $ha^{-1}$ + 3.0 Agric-Zyme 3X l $ha^{-1}$ which were statistically similar ($p< 0.05$) and 3.0 Agric-Zyme 3X l $ha^{-1}$ alone recorded lower leaf area index. At



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Kadawa, application of 60: 30: 30 NPK kg $ha^{-1}$ + 1.5 Agric-Zyme 3X l $ha^{-1}$ and 60: 30: 30 NPK kg $ha^{-1}$ + 3 Agric- Zyme 3X l $ha^{-1}$ and 120: 60: 60 NPK kg $ha^{-1}$ + 0 Agric-Zyme 3X l $ha^{-1}$ were statistically similar and recorded higher leaf area index, while 3 Agric-Zyme 3X l $ha^{-1}$ recorded lower leaf area index.

FAROs 44 and 57 recorded similar and higher ($p< 0.05$) net assimilation rates than FARO 52 at Samaru. However, FARO 52 variety was also statistically similar ($p< 0.05$) with FARO 57. Planting method had no significant effect on net assimilation rates at both locations. At both Samaru and Kadawa, application of 120:60:60 kg $ha^{-1}$ NPK alone or 60:30:30 with 1.5 l $ha^{-1}$ Agric-Zyme 3X registered statistically similar ($p< 0.05$) and higher net assimilation rates than other fertilizer management rates. There were significant interaction between fertilizer management with varieties and planting methods with fertilizer management at ($p< 0.05$) at Samaru and Kadawa respectively.

Table 3: The interaction between varieties and fertilizer management at Samaru, FARO 44 with 60: 30: 30 NPK kg $ha^{-1}$ + 1.5 Agrizyme l $ha^{-1}$ produced higher net assimilation rate and FARO 57 with 0: 0: 0 NPK kg $ha^{-1}$ + 3 Agrizyme l $ha^{-1}$ produced lower net assimilation rate. The interaction between planting methods and fertilizer management on net assimilation rate at Kadawa, FARO 52 with broadcasting produced higher assimilation rate and FARO 57 with dibbling produced lower net assimilation rate.

presents the interaction between planting methods and fertilizer management on net assimilation rate at 12WAS during the 2020 wet season at Kadawa, broadcasting with application of 3 Agrizyme l $ha^{-1}$ alone recorded higher net assimilation rate and dibbling with application of 120: 60: 60 NPK kg $ha^{-1}$ alone recorded lower net assimilation rate.

FARO 44 took shorter ($p< 0.05$) days to attain 50 % flowering followed by FARO 52, while FARO 57 took relatively longer ($p< 0.05$) days to flower. At both Samaru and Kadawa, application of 120:60:60 kg $ha^{-1}$ NPK alone recorded longer days for flowering, and at Samaru application of 3 Agric-Zyme 3X l $ha^{-1}$ recorded shorter days for flowering while at Kadawa application of 60: 30: 30 NPK kg $ha^{-1}$ + 3 Agric- Zyme 3X l $ha^{-1}$ recorded shorter days for flowering but it was statistically similar with 60:30:30 with 1.5 l $ha^{-1}$ Agric-Zyme 3X and 3 Agric-Zyme 3X l $ha^{-1}$. There were significant interaction between planting methods and varieties at Samaru at ($p< 0.05$) while at Kadawa at ($p< 0.01$), fertilizer management with varieties at ($p< 0.05$) at Kadawa. Planting methods with fertilizer management at ($p< 0.01$) at both locations. Table 4: the interaction between planting methods and varieties on days to 50% flowering at Samaru, broadcasting with FARO 57 takes longer time before flowering and broadcasting with FARO 44 takes shorter time for flowering. The interaction between planting methods and varieties on days to 50% flowering at Kadawa, broadcasting



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with FARO 57 takes longer time before flowering and broadcasting with FARO 44 takes shorter time for flowering. The interaction between varieties and fertilizer management on days to 50% flowering at Kadawa, FARO 57 with 120: 60: 60 NPK kg $ha^{-1}$ + 0 Agrizyme l $ha^{-1}$ takes longer time before flowering and FARO 44 with 60: 30: 30 NPK kg $ha^{-1}$ + 3 Agrizyme l $ha^{-1}$ takes shorter time for flowering. The interaction between planting methods and fertilizer management on days to 50% flowering at Samaru, broadcasting with 120: 60: 60 NPK kg $ha^{-1}$ + 0 Agrizyme l $ha^{-1}$ takes longer time before flowering and dibbling with 0: 0: 0 NPK kg $ha^{-1}$ + 3 Agrizyme l $ha^{-1}$ takes shorter time for flowering. The interaction between planting methods and fertilizer management on days to 50% flowering at Kadawa, broadcasting with 120: 60: 60 NPK kg $ha^{-1}$ + 0 Agrizyme l $ha^{-1}$ takes longer time before flowering and dibbling with 60: 30: 30 NPK kg $ha^{-1}$ + 3 Agrizyme l $ha^{-1}$ takes shorter time for flowering.

Varietal and planting method did not differed on effective grain filling period, while fertilizer management application of 3 Agric- Zyme 3X l $ha^{-1}$ recorded higher value at both locations. At Samaru application of 60:30:30 with 1.5 l $ha^{-1}$ Agric-Zyme 3X recorded lower value of effective grain filling period and was statistically similar with 120:60:60 kg $ha^{-1}$ NPK + 0 Agric- Zyme 3X l $ha^{-1}$ and 60:30:30 kg $ha^{-1}$ NPK with 3 l $ha^{-1}$ Agric-Zyme 3X, while at Kadawa application of 60:30:30 kg $ha^{-1}$ NPK with 1.5 l $ha^{-1}$ and was statistically similar with 120:60:60 kg $ha^{-1}$ NPK + 0 Agric- Zyme 3X l $ha^{-1}$ and 60:30:30 kg $ha^{-1}$ NPK with 1.5 l $ha^{-1}$ Agric-Zyme 3X

Paddy yields of three varieties were statistically similar ($p< 0.05$) at both locations, while dibbling, followed by broadcasting out-yielded drilling in paddy at Kadawa. Application of Agric-Zyme 3X alone at Samaru recorded least ($p< 0.05$) paddy yield than other fertilizer management methods. Similar trend was observed at Kadawa. Treatments interactions on all parameters assessed were not significant. The contrasting varietal responses (largely non-significant) observed on growth parameters and paddy yield is supported by Islam *et al.,* (2010), who reported that varieties with longer growth duration produced higher grain yields than varieties with shorter growth duration. Usman *et. Al.,* (2022) reported that FARO 44, isan early maturing variety. This conforms with these findings, while Fasina and Adeyanju, (2006) reported that FARO 52 was a medium maturing rice variety. Djomo *et al*., (2017) observed that application of N-P-K fertilizer increased growth parameters such as height. They recorded higher leaf area index, ant this agrees with Gala *et al.,* (2011), who reported that increasing amount of NPK improved considerably, the vegetative growth of rice. The larger the leaf area of a plant the more the photosynthetic area and consequently, the output. Wu *et al*. (1998) reported similar results on increasing rates of N, P, and K fertilizers favoured vigorous growth of the rice plant. Higher number of tillers gave more panicles consequently translating to higher paddy yields.



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**DISCUSSION**

The growths of rice varieties were poor in both locations at all sampling period. This observation could be attributed to the differences in the agro-climatic condition during the growth period of rice plant as manifested by lower temperature, relative humidity ranges and rainfall. The poor grain yield per $ha^{-1}$ obtained in both locations could be attributed to the atmospheric temperature has considerable effect on growth and development of rice plant. Rice required relatively high temperature (25-35°c) for optimum growth and development (Chandrasekaran *et al*. 2007) the mean maximum temperature during reproduction phase (23.27 and 36.69°c), relative humidity (78.33 and 46.37%) in both locations respectively, Chandrasekaran *et al*. (2007) reported that solar radiation during ripening reduces grain yield considerably because of a decrease in the percentage of filled spikelets. Solar radiation at the reproductive stage has the greatest effect on grain yield. In tropics, solar radiation is higher in the dry season than wet season. Chandrasekaran *et al*. (2007) reported that rice can be grown successfully on a variety of soil. The most important requirement of the soil is its ability to hold moisture. The soils textural classes were found to be loam and sandy loam for Samaru and Kadawa respectively. Soils from both locations were also found to be slightly acidic, low pH of 5.31 and 5.95. Daudu *et al.* (2014) reported that rice plant required heavy soil, slightly acidic to neutral (pH 5.5-7.0) high clay content of 40-60% and moderate organic matter. Moreso, during the expiremental period there was a long drought spilled and high weeds infestation which affected the yield of the crops.

The rice varieties used for this research were improved ones, which were shorter in height and more responsive to nutrients. FARO 44 had recorded higher values of net assimilation rate and effective grain filling period. FARO 57 takes longer days to 50% flowering, Islam *et al.,* (2010), who reported that varieties with longer growth duration usually produce more grain, yield than the varieties with shorter growth duration. Usman *et. Al.,* (2022) reported that FARO 44 and 52 are an early maturing variety and all varieties flowers according to genetic make-up and environmental conditions. FARO 44 and 52 took shorter time to flower, hence they are early flowering varieties. FARO 52 is medium maturing variety with about <130 days (Fasina and Adeyanju, 2006) while FARO 44 is an early maturing variety with <120 days to maturity.

Planting methods have greater roles on crop growth and development, appropriate planting methods produces fast growing and uniform crops with higher growth and development. Broadcast planting recorded higher value of growth parameters



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measured such as plant height, leave area index and dibbling planting method recorded higher value of paddy yield.

Nitrogen, phosphorus and potassium are very important nutrients for growth and development of rice as they were to other crop plants. Each nutrient has a specific role on plant growth and development and absence of any in the soil may retard growth and development of rice. However, soil of the Nigerian Savanna are generally low in N and P, while K deficiency had been occasionally reported in some areas most especially on intensely or continuously cultivated fields (Okonkwo *et al.,* 2012).

Application of 120: 60: 60 NPK kg $ha^{-1}$ alone recorded taller plants in all the sampling period in both locations this cannot be surprise because of the higher nutrients it contained. Djomo *et al*., (2017) observed that Increased in the dosage of fertilizer N-P-K had a greater influenced on the height of the rice varieties. Recorded the higher leave area index in all the sampling periods at both locations this is also in line with Gala *et al.,* (2011) reported that increasing amount of NPK improves considerably the vegetative growth of rice. The larger the leaf area of a plant the more the photosynthetic area and consequently the output is also high. Wu *et al*. (1998) reported similar results that increasing the rates of N, P, and K fertilizers favoured vigorous growth of the rice plant. Also, a good number of tillers give a good number of panicles which is a significant component of the output which occurs during the vegetative phase, takes longer time before flowering. Plants grown with organic fertilizer alone may supper from nutrient deficiencies and produce low yields. Combined application of 60: 30: 30 NPK kg $ha^{-1}$ + 1.5 Agric-Zyme 3X L $ha^{-1}$ recorded the higher values of leaf area index at Kadawa, net assimilation rate at both locations and paddy yield at Kadawa, this could be attributed to combined effect of NPK and liquid organic fertilizer.

## CONCLUSION

In conclusion, FARO 57 variety out-performed other varieties, Drilling planting method and application of 120: 60: 60 NPK kg $ha^{-1}$ alone were better for growth, yield and grain quality of lowland rice in the study area.

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Table 1: Physio-chemical characteristics of the experimental sites during the 2021 wet season at Samaru and Kadawa.

| Soil depth 0-30cm | | |
|---|---|---|
| | **Samaru** | **Kadawa** |
| Soil Composition | **2021** | **2021** |
| **Particle size (g/kg)** | | |
| **Clay** | 140 | 120 |
| **Silt** | 380 | 360 |
| **Sand** | 480 | 520 |
| **Textural class** | Loam | Sandy loam |
| Chemical Properties | | |
| **pH in water** | 5.67 | 6.25 |
| **pH in 0.01mCaCl$_2$** | 4.89 | 5.08 |
| **Organic carbon gkg$^{-1}$** | 14.62 | 16.85 |
| **Available P (gkg$^{-1}$)** | 14.20 | 16.10 |
| **Total nitrogen (gkg$^{-1}$)** | 1.68 | 1.95 |
| Exchangeable Cation (cmolkg$^{-1}$) | | |
| **K (cmolkg$^{-1}$)** | 0.16 | 0.19 |
| **Mg (cmolkg$^{-1}$)** | 0.58 | 0.62 |
| **Ca (cmolkg$^{-1}$)** | 3.02 | 3.55 |
| **Na (cmolkg$^{-1}$)** | 0.25 | 0.27 |
| **Al$^{+++}$+ H$^{+}$ (cmolkg$^{-1}$)** | 0.8 | 0.6 |



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| | | |
|---|---|---|
| **CEC (cmolkg$^{-1}$)** | 4.81 | 5.25 |

Source: Soil analytical laboratory, Agronomy Department, Faculty of Agriculture, ABU, Zaria.

| Treatment | Plant height (cm) | | Leaf area index (cm$^2$) | | Net assimilation rate | | days to 50% flowering (days) | | Effective grain filling period (days) | | Paddy yield (Kg ha$^{-1}$) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Samaru** | **Kadawa** | **Samaru** | **Kadawa** | **Samaru** | **Kadawa** | **Samaru** | **Kadawa** | **Samaru** | **Kadawa** | **Samaru** | **Kadawa** |
| Variety | | | | | | | | | | | | |
| **FARO 44** | 39.694 | 53.778 | 2.800 | 1.389 | 0.742a | 0.912 | 87.444c | 85.778c | 18.500a | 16.778 | 1806.0 | 2588.0 |
| **FARO 52** | 42.306 | 52.617 | 2.955 | 1.504 | 0.436b | 1.108 | 90.889b | 90.111b | 17.694b | 16.556 | 1881.5 | 2754.6 |
| **FARO 57** | 41.389 | 53.300 | 2.882 | 1.624 | 0.593ab | 0.962 | 103.611a | 104.500a | 17.889ab | 15.417 | 1850.5 | 2606.5 |
| **SE±** | 1.109 | 0.667 | 0.109 | 0.114 | 0.099 | 0.103 | 0.748 | 0.744 | 0.247 | 0.662 | 86.594 | 114.779 |
| Planting method | | | | | | | | | | | | |
| **Dibbling** | 39.815b | 53.667 | 2.700b | 1.596 | 0.669 | 0.873 | 93.750 | 93.056 | 18.333 | 15.889 | 1961.6 | 3106.5a |
| **Drilling** | 39.204b | 53.356 | 2.638b | 1.479 | 0.681 | 1.081 | 93.361 | 92.972 | 17.944 | 16.194 | 1758.3 | 2236.1c |
| **Broadcasting** | 44.370a | 52.672 | 3.299a | 1.443 | 0.421 | 1.028 | 94.833 | 94.361 | 17.806 | 16.667 | 1818.1 | 2608.5b |
| **SE±** | 1.109 | 0.667 | 0.109 | 0.114 | 0.099 | 0.103 | 0.748 | 0.744 | 0.247 | 0.662 | 86.594 | 114.779 |
| Fertilizer management (NPK kg ha$^{-1}$ + Agrizyme l ha$^{-1}$)Nitrogen rate (kg ha$^{-1}$) | | | | | | | | | | | | |
| **0: 0: 0 + 3** | 28.296d | 51.256b | 1.642c | 0.980b | 0.279c | 0.853ab | 90.963c | 94.148ab | 18.593a | 17.852a | 1603.1b | 1765.4c |
| **60:30:30 + 1.5** | 43.790b | 54.978a | 3.124b | 1.745a | 0.866a | 1.168a | 93.333bc | 93.407ab | 17.482b | 15.926ab | 1885.8ab | 3037.0a |
| **60:30:30 + 3** | 40.099c | 53.467ab | 2.837b | 1.511a | 0.464bc | 0.764b | 93.667b | 91.704b | 17.963ab | 15.037b | 1969.8a | 2543.2b |
| **120: 60:60 + 0** | 52.333a | 52.956ab | 3.913a | 1.788a | 0.753ab | 1.191a | 97.963a | 94.593a | 18.074ab | 16.185ab | 1925.3a | 3253.1a |
| **SE±** | 1.281 | 0.770 | 0.127 | 0.131 | 0.115 | 0.119 | 0.863 | 0.859 | 0.285 | 0.764 | 99.993 | 132.540 |
| Interaction | | | | | | | | | | | | |
| **P x V** | NS | NS | NS | NS | NS | NS | * | ** | NS | NS | NS | NS |
| **F x V** | NS | NS | NS | NS | * | NS | NS | * | NS | NS | NS | NS |
| **P x F** | NS | NS | NS | NS | NS | * | ** | ** | NS | NS | * | ** |
| **P x F x V** | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |

Table 3: Interaction between varieties, planting methods and fertilizer management on Net assimilation rate at Samaru and Kadawa

| Treatment | Fertilizer management (NPK kg ha$^{-1}$ + Agrizyme l ha$^{-1}$) | | | |
|---|---|---|---|---|
| | **0: 0: 0 + 3** | **60:30:30 + 1.5** | **60:30:30 + 3** | **120: 60:60 + 0** |
| Samaru | | | | |
| Variety | | | | |
| **FARO 44** | 0.325ef | 1.496a | 0.529cd | 0.616c |
| **FARO 52** | 0.304ef | 0.501cde | 0.394def | 0.546cd |
| **FARO 57** | 0.207f | 0.602c | 0.468cde | 1.096b |
| **SE±** | 0.199 | | | |
| Kadawa | | | | |
| **Dibbling** | 0.551g | 1.039bc | 0.914cde | 0.988cd |
| **Drilling** | 1.199b | 1.426a | 0.726efg | 0.973cd |
| **Broadcasting** | 0.809def | 1.039bc | 0.652fg | 1.611a |
| **SE±** | 0.206 | | | |

Means followed by the same letter (s) within the same columm or treatment are not significant at 5% level of significant of probability using Duncan multiple rage test (DMRT).

Table 4: Interaction between planting methods and varieties on Days to 50% flowering at Samaru and Kadawa

| Treatment | Variety | | |
|---|---|---|---|
| Planting Method | **FARO 44** | **FARO 52** | **FARO 57** |
| Samaru | | | |
| **Dibbling** | 88.750ef | 89.750df | 102.750b |



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| | | | |
|---|---|---|---|
| **Drilling** | 88.083f | 90.417d | 101.583b |
| **Broadcasting** | 85.500g | 92.500c | 106.500a |
| **SE±** | 1.295 | | |
| Kadawa | | | |
| **Dibbling** | 86.583e | 90.000c | 102.583b |
| **Drilling** | 87.167e | 88.667d | 103.083b |
| **Broadcasting** | 83.583f | 91.667c | 107.833a |
| **SE±** | 1.288 | | |
| **Means followed by the same letter (s) within the same columm or treatment are not significant at 5% level of significant of probability using Duncan multiple rage test (DMRT** | | | |

Table 5: Interaction between planting methods, varieties and fertilizer management on Days to 50% flowering at Samaru and Kadawa

| Treatment | Fertilizer management (NPK kg ha$^{-1}$ + Agrizyme l ha$^{-1}$) | | | |
|---|---|---|---|---|
| Variety | **0: 0: 0 + 3** | **60:30:30 + 1.5** | **60:30:30 + 3** | **120: 60:60 + 0** |
| Kadawa | | | | |
| **FARO 44** | 88.667e | 86.444f | 81.889g | 86.111f |
| **FARO 52** | 90.222d | 91.556d | 88.444e | 90.222d |
| **FARO 57** | 103.556c | 102.222c | 104.778b | 107.444a |
| **SE±** | 1.488 | | | |
| Samaru | | | | |
| **Dibbling** | 87.556f | 96.778b | 94.111c | 96.556b |
| **Drilling** | 90.889e | 92.222d | 92.556d | 97.778b |
| **Broadcasting** | 94.444c | 91.000e | 94.333c | 99.556a |
| **SE±** | 1.495 | | | |
| Kadawa | | | | |
| **Dibbling** | 91.222d | 96.778a | 91.000d | 93.222bc |
| **Drilling** | 96.556a | 92.111c | 90.556d | 92.667c |
| **Broadcasting** | 94.667b | 91.333d | 93.556bc | 97.889a |
| **SE±** | 1.488 | | | |

Means followed by the same letter (s) within the same columm or treatment are not significant at 5% level of significant of probability using Duncan multiple rage test (DMRT

Table 6: Interaction between planting methods and fertilizer management on paddy yield at Samaru and Kadawa

| Treatment | Fertilizer management (NPK kg ha$^{-1}$ + Agrizyme l ha$^{-1}$) | | | |
|---|---|---|---|---|
| Planting method | **0: 0: 0 + 3** | **60:30:30 + 1.5** | **60:30:30 + 3** | **120: 60:60 + 0** |
| Samaru | | | | |
| **Dibbling** | 1322.222g | 2164.815ab | 2196.296a | 2162.963ab |
| **Drilling** | 1474.074g | 1718.519ef | 1879.629cde | 1961.111cd |
| **Broadcasting** | 2012.963bc | 1774.074ef | 1833.333de | 1651.852f |
| **SE±** | 173.188 | | | |
| Kadawa | | | | |
| **Dibbling** | 2203.704e | 3685.185b | 2500.000d | 4037.037a |
| **Drilling** | 1740.741f | 2351.852e | 2129.629e | 2722.222d |
| **Broadcasting** | 1351.852g | 3074.074c | 3000.000c | 3000.000c |
| **SE±** | 229.559 | | | |

Means followed by the same letter (s) within the same columm or treatment are not significant at 5% level of significant of probability using Duncan multiple rage test (DMRT)



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