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Effect of different doses of NPK fertilizer on the growth and yield of rice in Ndop, North West of Cameroon

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This study was conducted in 2015 in Ndop, Ngoketujia Division in the North-West region of Cameroon. Four varieties of rice were used: NERICA3, NERICA7 (upland rice), NERICA36 and NERICA42 (lowland rice). Two types of fertilizers N-P-K (23-10-05 and N-P-K (20-10-10) were tested at different doses (0 kg-contol; 180 kg, 200 kg, 220 kg-treatments). The trial was set up in a Randomized Complete Block Design (RCBD) in a manner following conventional methods. Application of fertilizers was done at 21 and 51 days after planting (DAP). The growth parameters were evaluated weekly while yield parameters were collected at maturity. The fertilizer N-P-K (23 10 05) gave a better growth with appropriate doses compared to N-P-K (20 10 10) in all the varieties used in this study while fertilizer N-P-K (20 10 10) gave a better yield than N-P-K (23 10 05) in the same varieties. In terms of output of rice, fertilizer N-P-K (20 10 10) proves better at dose 200 kg than fertilizer N-P-K (23 10 05) at the same dose. For good growth and yield the use of appropriate doses of fertilisers will significantly improve the yield of rice.

Key words: Rice varieties, fertilisers, fertilizers doses.

INTRODUCTION

Rice (*Oryza sativa* L.) is an important cereal in the world and can be grown in different habitats as lowland, irrigated and upland rice (FAO, 2004). It originated from China and India and later spread into other parts of the continent and Africa of tropical climatic settings and is regarded as the 3th cereal after wheat and maize (FAO, 2011). Rice is cultivated for its quality grains which are rich in carbohydrate. Despite the importance of rice, the major constraints to its productivity in Cameroon are poor soil, poor cultivation methods, use of low yielding seeds, high costs of agricultural inputs, pests such as birds, insects, insufficient rice researchers and disease (Piebiep, 2008).

FAO (2011) reported that the annual production of rice in 2010 was 699 million tons, with Asia recording 90% production and America 5% production. Africa only contributed 3% of this production with Cameroun having a low production rate which keeps decreasing from 107.000 tons in 1985 to 65.000 tons in 2010 (FAO, 2013). The outputs of rice per hectare in Cameroun are estimated to be 1 ton for upland rice and 2 tons for lowland rice (AfricaRice, 2011). Rice production

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nationwide in Cameroon is cultivated on 100.000 ha by about 98000 household. Most of the production comes from irrigated areas of the Far North, North, North-west (Ndop plain), and Mbam basin (Tonga and Makenene) regions. From these regions, the Far North region produces about 2/3 of the nation's rice (Malaa et al., 2011).

The African continent shelters only 12% of the world population but absorbs 32% of the world rice imports (Nguefack et al., 2008). The rate of rice yearly consumption in Africa increases by 4.5% (SNDR, 2009).The national demand for this rice in Cameroon was estimated at 300.000 tons in 2009 and in 2013 it was estimated at 500.000 tons (Folefack, 2014).

To nourish the world population which is continuously increasing and which will reach 9 billion in 2050, it is necessary that the world production of rice increases by 50% (FAO, 2008).To improve on the situation in Cameroon, the use of fertilizers are an option to improve on the soil chemical properties and to compensate for the potassium, phosphorus and nitrogen deficiencies (Roose et al., 2008; Konate et al., 2012). Thus, this study was to investigate how the use of different doses of fertilizer will improve on the growth and yield of NERICA rice under field conditions.

MATERIALS AND METHODS

Study site

The study was carried out in Ndop plain in the experimental plots of Institut de la Recherche Agricole pour le Developpement (IRAD) and at the Upper Nun Valley Development Authority (UNVDA), Ngoketujia Division in the North-West region of Cameroon. The town lies between longitude 1015' and 1050' east, and between latitude 54' and 510' North with an altitude of about 300 m. The climate is of equatorial type and is characterized by a rainy season (from March to November), and a dry season (from November to February).The annual average temperature is 27.2°C and annual average pluviometry is 2500 mm. The rainfall pattern is monomodal (DDMN, 2015). The topography of Ndop is dominated by plains and erosion of volcanic materials from the surrounding mountainous chains, which makes the soil ferralitic and fertile.

Setting up of trial

The trial was set up in a Randomized Complete Block Design (RCBD) in a manner following conventional methods. Each block had four treatments: 0, 180, 200 and 220 kg/ha, replicated three times. 100 kg/ha of urea was uniformly applied to all the treatments during tilling and before flowering. These treatments were separated by border rows of 1 m wide. Four varieties of rice were used for this study (NERICA3 NERICA7 NERICA36 and NERICA42). NERICA3 and NERICA7 were upland varieties and NERICA36 and NERICA42 were lowland varieties. For each variety 24 plots of 9 m^2 were used. The seeds were planted at 25 × 25 cm apart and this gave a density of 16 plants per m². Application of fertilizer was done 21 days after planting (DAP). The second application of fertilizer was done at 51 DAP. Weeding was done 3 times. Two types of fertilizers were used (N-P-K (20 10 10) and N-P-K (23 10 05).

Determination of growth and yield parameters

Growth parameter

The average plant height of three plants were chosen randomly from the middle of each plot and measured using a graduated ruler. Tiller number was counted at 7 days intervals 21 DAP before the onset the of flowering

Yield parameter

Data related to yield were collected as from 50% of flowering. This was done when at least 30% of the plants produced panicles with paddy filled with seeds. The yield parameters recorded were as follows:

i. Number of panicles per plant: This parameter enabled a more precise estimation of the yield level and the potential capacity of production. This was done by simple counting.

ii. Number of seed per panicles: Three plant were chosen randomly per treatment and the number of seeds per panicle were counted and an average recorded per plant.

iii. Percentage of filled seed per panicles: Filled seeds per panicle were separated from panicles without seeds and calculations done to obtain the percentage of filled seeds per panicle with respect to the total number of seeds per panicle.

iv. Weight of 1000 filled seeds: Among the filled seeds previously counted, samples of 1000 seeds were weighed. The different weights of the 1000 seeds were recorded. It should be noted that all the weighing were done at paddy moisture of 14%. This rate was obtained after sun drying for 48 h.

v. Yield: Yield of the different varieties of rice used for this study was calculated using the formula (Randrianarison, 2011):

$$Y = PL/m^2 \times Pan/C \times Gr/Pan \times \% FGr \times W1000Gr \times 10^{-7}$$

Where: Y = yield; PL/m² = number of plant per meter square; Pan/C = number of panicles per plant; Gr/Pan = total number of grain per panicles; % FGr = percentage of filled grains per panicle; W1000Gr = weight of 1000 filled grains; 10^{-7} conversion unit.

Data analysis

All data collected from the four varieties of rice used were subjected to analysis of variance (ANOVA) as described by Wichura, 2006 using the statistical software STATGRAPHIC version 16. Mean variability amongst the varieties were determined. Their treatment means were separated using Duncan Multiple Range Test (DMRT) for statistical significance at 95% confidence interval (P≤0.05).

RESULTS

Effect of the different doses of fertilizer ((N-P-K (20 10 10) and N-P-K (23 10 05)) on the vegetative growth of the different varieties of rice

The result represent two types of fertilizers ((N-P-K (20 10 10) and N-P-K (23 10 05)) applied on the different varieties of rice, NERICA3 (N3), NERICA7 (N7), NERICA36 (N36) and NERICA42 (N42) respectively) and at different dosage (0 kg-control, 180, 200 and 220 kg-

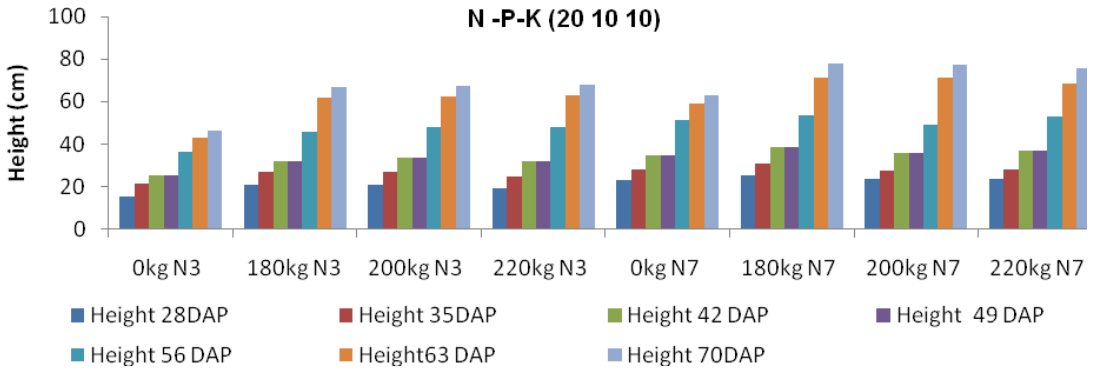

Figure 1. Effect of fertilizer N-P-K (20 10 10) on the height of upland rice. DAP, Day after planting; N3, NERICA3; N7, NERICA7.

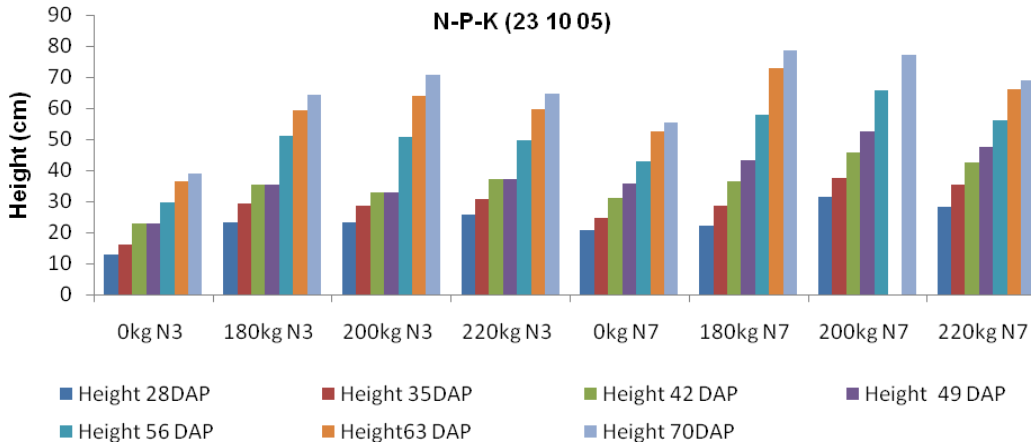

Figure 2. Effect of fertilizer N-P-K (23 10 05) on the height of upland rice. DAP, Day after planting; N3, NERICA3; N7, NERICA7.

treatments respectively). The results are presented in Figures 1 to 8 respectively. Each bar chat represents two varieties of rice showing plant height grown at different days after planting (DAP).

Plant height for upland rice: NERICA3 and NERICA7

Figure 1 show that the application of N-P-K (20 10 10) at different doses (180, 200 and 220 kg) increase the height of the plants at different DAP compared to the control (0kg). Varieties N3 and N7 had their highest heights of 70 and 80 cm respectively at a dose of 180 kg/ha, while the height of the control was not more than 30 cm.

Figures 2 also showed that the application of N-P-K (23 10 05) at different doses (180, 200 and 220 kg respectively) significantly increase the height of the plants compared to the control. N3 showed a height of 70 cm at a dose of 200 kg while the height of the control was 15 cm. N7 had a height of 83 cm at a dose of 180 kg while the control had a height of 30 cm.

Plant height of lowland rice: NERICA36 and NERICA42

The application of the different doses of fertilizers using N-P-K (20 10 10) in lowland rice as in upland rice (N3 and N7 respectively) increases the heights of N36 and N42 compared to the control. With fertilizers N-P-K (20 10 10) N36 had a height of 60 cm at a dose of 200 kg while the control had a height of 15 cm. N42 had a height of 83cm at a dose of 180 kg while the control had only 30 cm (Figure 3).

Figure 4 also showed that the application of N-P-K (23 10 05) significantly increases the heights of N36 and N42 using different dosage compared to the control. Variety N36 had a height of 75 cm at a dose of 220 kg/ha while the height of the control was 25 cm. N42 had a height of 85 cm at a dose of 180 kg/ha while the control had a

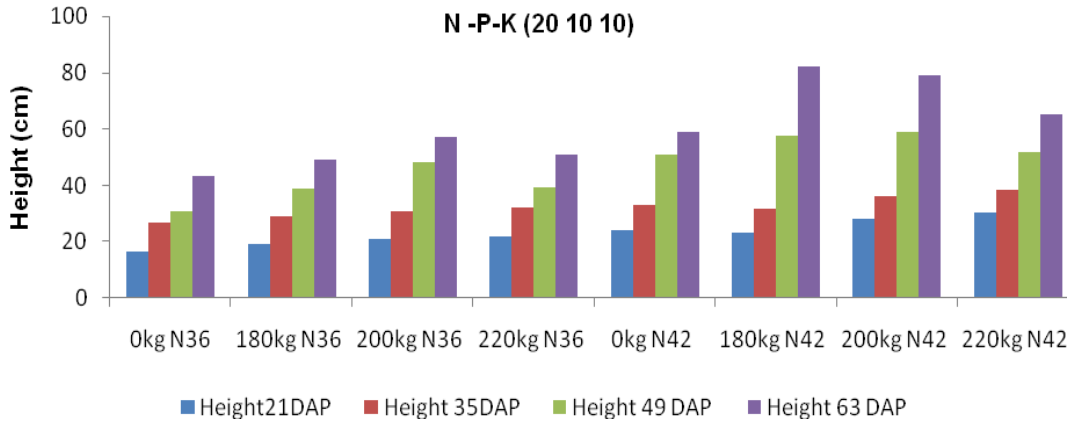

Figure 3. Effect of fertilizer N-P-K (20 10 10) on the height of lowland rice. DAP, Day after planting, N36, NERICA36; N42, NERICA42.

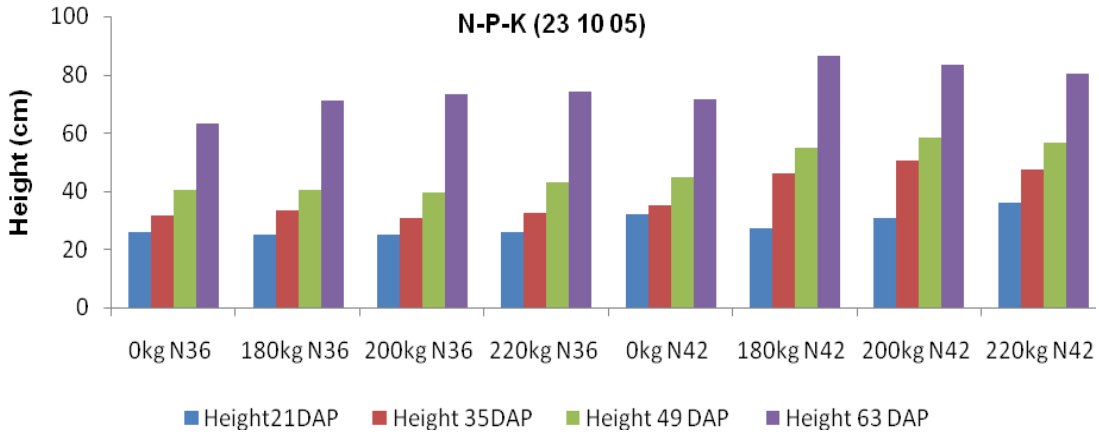

Figure 4. Effect of fertilizer N-P-K (23 10 05) on the height of lowland rice. DAP, Day after planting, N36, NERICA36; N42, NERICA42.

height of 30 cm.

Tiller number of upland rice

The application N-P-K (20 10 10) increase the number of tillers of N3 and N7 compared to the control. N3 showed the greatest number of tillers (5) at a dose of 180 kg whereas the control had only one (1) tiller. N7 produced 5 tillers at a dose of 180 kg while the number of tillers of the control was less than 2 (Figure 5).

The effect of fertilizer N-P-K (23 10 05) on the number of tillers of N3 and N7 also increased compared to the control. N3 produced the greatest number of tillers (7) at a dose of 200 kg whereas the control produced less than 2 tillers as in N7 (Figure 6).

Tiller number of lowland rice

Figure 7 shows that the application of the various doses of N-P-K (20 10 10) led to an increase in tiller number of the lowland rice varieties N36 and N42 respectively compared to the control. N36 had the greatest number of tillers (4) at a dose 200 kg of N-P-K (20: 10: 10) compared to the control that had 2. The greatest number of tillers for N42 was 6 at a dose of 180 kg compared to the control that had 3.

Comparing tiller numbers for N36 and N42 with control (Figure 8) using N-P-K (23 10 05), N36 had the greatest

Influence of the different doses of fertilizers ((N-P-K (20 10 10) and N-P-K (23 10 05)) on the Yield of the different varieties of rice

Yield of NERICA3

The application of the different doses of fertilizers significantly improved the yield of the NERICA3 compared to the control. The yield of NERICA3 with

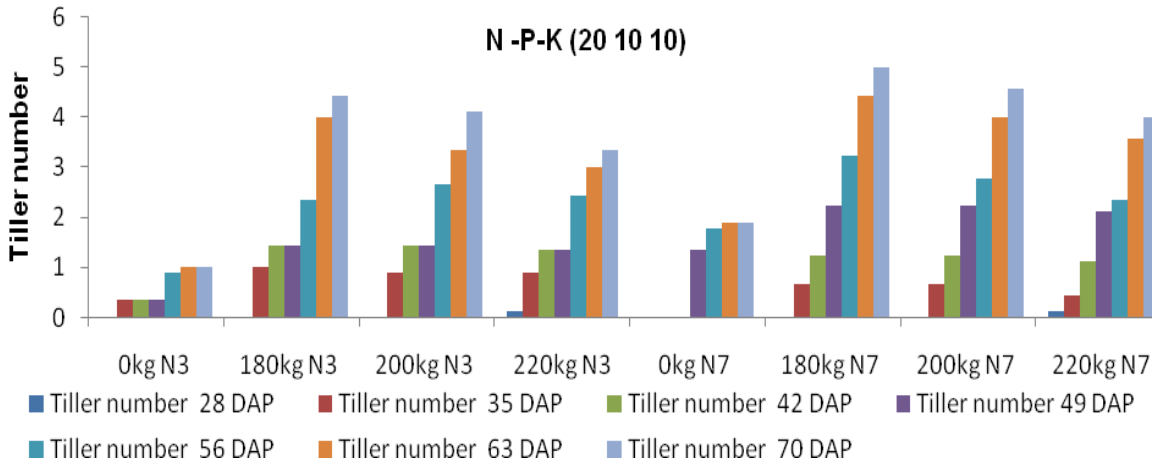

Figure 5. Effect of fertilizer N-P-K (20 10 10) on the tiller number of upland rice. DAP, Day after planting, N3, NERICA3; N7, NERICA7.

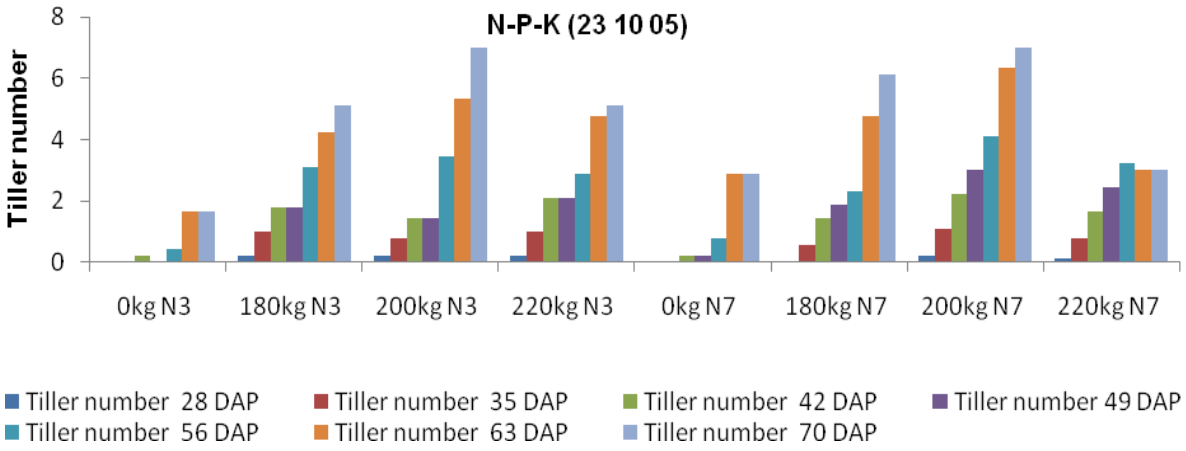

Figure 6. Effect of fertilizer N-P-K (23 10 05) on the tiller number of upland rice. DAP, Day after planting; N3, NERICA3; N7, NERICA7.

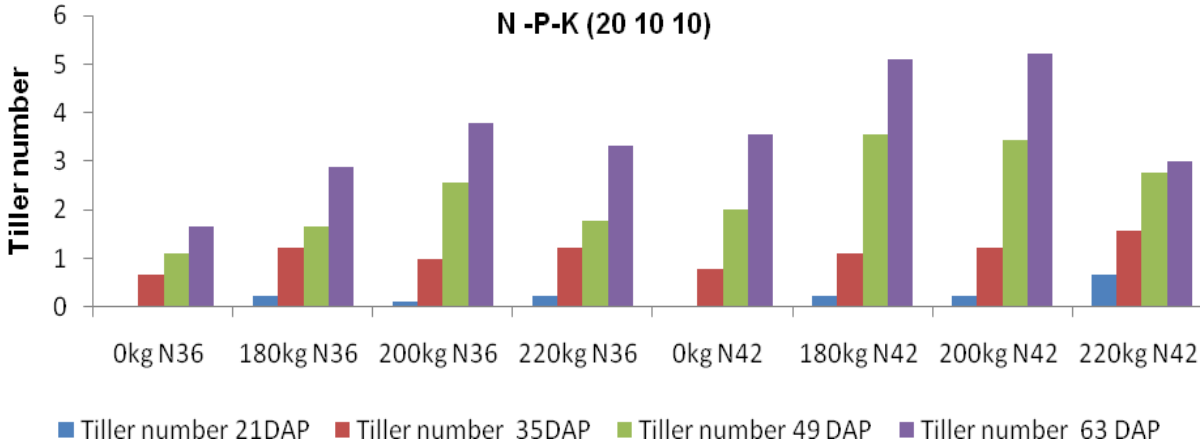

Figure 7. Effect of fertilizer N-P-K (20 10 10) on the tiller number of lowland rice. DAP, Day after planting, N36, NERICA36; N42, NERICA42.

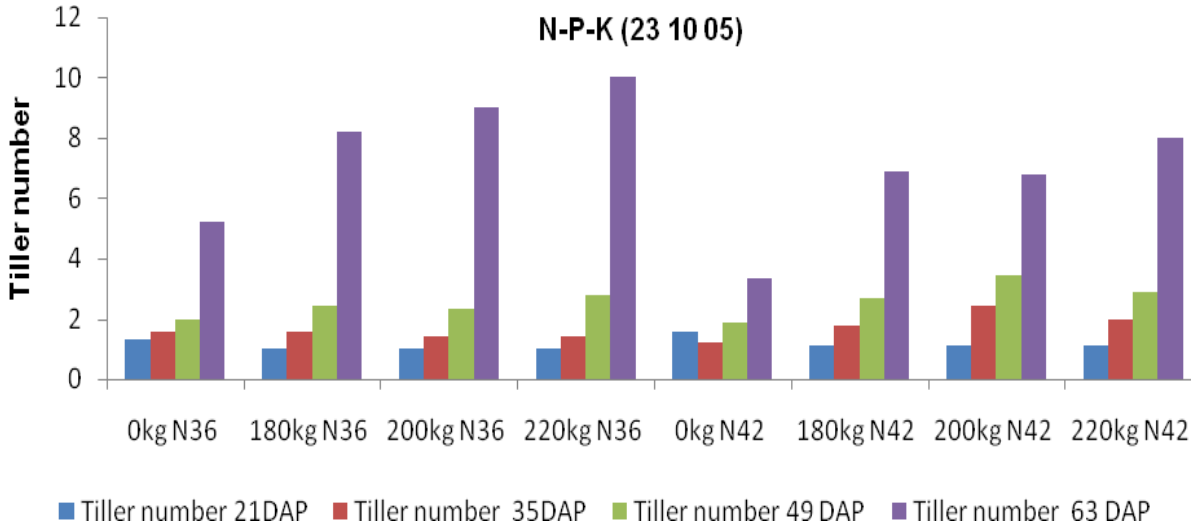

Figure 8. Effect of fertilizer N-P-K (23 10 05) on the tiller number of lowland rice. . DAP, Day after planting, N36, NERICA36; N42, NERICA42.

Table 1. Effect of the different doses of fertilizers ((N-P-K (20 10 10) and N-P-K (23 10 05)) on the yield of NERICA3.

Quantity (kg/ha)	P/t	Hp	P/m2	%FG	W1000	YD (t/ha)
NERICA3 N-P-K (20 10 10)						
0	3.00±0.57^{a}	15.67±0.33^{a}	121.00±36.67^{a}	60.30±3.70^{a}	23.66±2.18^{a}	0.63±0.15^{a}
180	10.33±1.20^{c}	20.67±0.33^{b}	237.00±23.45^{c}	81.42±4.61^{a}	32.00±3.00^{b}	5.69±0.23^{c}
200	12.33±0.88^{c}	20.33±0.33^{b}	312.67±21.36^{d}	54.43±6.70^{a}	28.00±1.52^{b}	5.65±0.25^{c}
220	7.00±3.05^{b}	20.00±2.00^{b}	181.33±99.44^{b}	74.45±15.91^{a}	29.33±0.88^{b}	3.99±0.80^{b}
NERICA3 N-P-K (23 10 05)						
0	3.50±0.47^{a}	14.67±0.13^{a}	119.00±33.57^{a}	59.20±3.10^{a}	21.56±2.08^{a}	0.61±0.9^{a}
180	7.66±0.33^{b}	23.00±0.57^{b}	183.33±4.63^{b}	89.81±2.1^{a}	24.00±.00^{b}	5.32±0.45^{b}
200	10.00±0.57^{c}	24.00±0.57^{b}	255.00±4.58^{c}	86.69±3.25^{a}	24.33±0.33^{b}	4.86±0.58^{b}
220	11.66±0.33^{c}	23.66±0.88^{b}	335.00±12.66^{d}	68.65±2.48^{a}	25.33±0.33^{b}	5.82±0.20^{b}

The values are expressed in averages more or less standard deviation in the same column and for each parameter the averages which are followed with the same letter are not significantly different using DMRT test P (≤0.05). W1000, Weight of 1000 full grains; P/t, Numbers of panicle per plant; Hp, Height of panicles; P/m2, Numbers of Panicle per m^{2}; %GP, Percentage of full grain per panicle. YD: (t/ha), yield in tons/ ha.

different doses of N-P-K (20 10 10) was recorded and it was observed that at a dose of 180 kg, the variety had an output of 5.69 tons/ha compared to the control whose output was 0.63 ton/ha. At the same rate of dose of N-P-K (23 10 05), an output of 5.32 tons/ha was recorded for the same variety whereas the control had an output of 0.61 ton/ha (Table 1).

Yield of NERICA7

Application of N-P-K (20:10:10) on NERICA7 with a dose of 220 kg showed that the variety had an output of 6.08 tons/ha while the control had output of 0.72 tons/ha. There was no significant difference between the dosage of 200 and 220 kg with an output of 5.95 tons/ha whereas the control had an output of 0.70 ton/ha (Table 2).

The application of N-P-K (23 10 05) was also monitored for NERICA36 using different doses and it was observed that a significantly difference (P≤0.05) was obtained compared to the control. At a dose of 220 kg the variety had output of 4.47 tons/ha compared to the control which had an output of 0.90 tons/ha. At a dose of 180 kg/ha there was an output of 4.39 tons/ha whereas an output of 0.9ton/ha was observed with the control (Table 3).

Looking at the application of N-P-K (23 10 05) on the yield of NERICA42, it was also observed that there was a significant difference (P≤0.05) in yield output compare to the control. At a dosage of 220 kg, the variety had an output of 6. 36 tons/ha compared to the control which had an output of 0.62 ton /ha. Also at 220kg rate of fertilizer

Table 2. Effect of the different amount of fertilizers ((N-P-K (20 10 10) and N-P-K (23 10 05)) on the yield parameters of NERICA7.

Quantity (kg/ha)	P/t	Hp	P/m2	%FG	W1000	YD (t/ha)
NERICA7 N-P-K (20 10 10)						
0	2.00±0.57^{a}	23.33±3.17^{a}	99.66±17.35^{a}	72.26±2.17^{b}	23.67±0.33^{a}	0.72±0.27^{a}
180	6.33±0.33^{b}	22.33±0.33^{a}	184.00±3.60^{b}	69.65±7.12^{b}	29.00±0.57^{b}	4.70±0.23^{b}
200	7.00±0.57^{b}	22.66±1.45^{a}	183.00±4.04^{b}	75.79±5.07^{b}	28.00±0.57^{b}	4.03±0.30^{b}
220	11.66±0.33^{c}	23.00±0.57b^{a}	351.33±9.20^{c}	46.81±1.01^{a}	28.00±0.57^{b}	6.08±0.25^{c}
NERICA7 N-P-K (23 10 05)						
0	3.00±0.27^{a}	21.31±2.97^{a}	95.56±16.55^{a}	69.22±3.17^{b}	20.67±0.23^{a}	0.70±0.47^{a}
180	7.00±0.50^{b}	23.67±0.67^{b}	189.33±4.05^{b}	84.58±1.43^{c}	24.00±1.73^{b}	5.02±0.11^{b}
200	8.66±0.67^{b}	25.00±0.57^{b}	211.33±6.64^{c}	74.34±3.06^{b}	25.67±1.02^{b}	5.94±0.59^{b}
220	11.00±0.58^{c}	24.33±0.67^{b}	370.00±3.2^{d}	48.56±3.13^{a}	28.00±0.58^{b}	5.95±0.23^{b}

The values are expressed in averages more or less standard deviation in the same column and for each parameter the averages which are followed with the same letter are not significantly different using DMRT test P (≤0.05). **W1000**, Weight of 1000 full grains; **P/t**, numbers of Panicle per plant; **Hp**, height of panicles; **P/m2**, numbers of Panicle per m^{2}; **%GP**, percentage of full grain per panicle. **YD,** (t/ha):yield in tons/ ha.

Table 3. Effect of the different rates of fertilizers ((N-P-K (20 10 10) and N-P-K (23 10 05)) on the yield parameters of NERICA 36.

Quantity (kg/ha)	p/t	Hp	P/m2	%FG	W1000	YD (t/ha)
NERICA36 N-P-K (20 10 10)						
0	2.90±0.67^{a}	15.13±0.36^{a}	91.50±3.98^{a}	7.92±3.99^{c}	22.00±0.67^{a}	0.90±0.24^{a}
180	7.00±0.54^{b}	19.33±0.67^{b}	216.60±5.00^{b}	76.67±1.14^{c}	25.66±0.33^{b}	3.78±0.14^{b}
200	10.00±0.49^{c}	19.67±0.34^{b}	264.65±4.91^{c}	56.89±2.12^{a}	26.66±0.88^{b}	3.81±0.15^{b}
220	10.00±0.56^{c}	20.67±0.32^{b}	287.33±2.33^{d}	69.21±3.37b^{b}	26.67±0.33^{b}	4.47±0.25^{c}
NERICA36 N-P-K (23 10 05)						
0	3.00±0.57^{a}	14.33±0.66^{a}	93.00±2.88^{a}	76.92±4.96^{b}	23.00±0.57^{a}	0.92±0.14^{a}
180	8.00±0.57^{b}	19.00±0.57^{b}	207±22.51^{b}	74.34±3.06^{b}	26.00±0 57^{b}	4.39±0.29^{c}
200	8.33±0.33^{b}	20.00±0.00^{bc}	222±8.08^{bc}	54.89±2.95^{a}	29.00±0.00^{cd}	3.90±0.06^{bc}
220	9.66±0.88^{b}	20.66±0.33^{c}	257.33±10.17^{c}	69.21±3.37^{b}	28.66±0.66^{c}	3.67±0.17^{b}

The values are expressed in averages more or less standard deviation in the same column and for each parameter the averages which are followed with the same letter are not significantly different using DMRT test P (≤0.05). W1000, Weight of 1000 full grains; P/t, numbers of Panicle per plant; Hp, height of panicles P/m2, numbers of Panicle per m^{2}; %GP, Percentage of full grain per panicle. YD, (t/ha): Yield in tons/ ha.

Table 4. Effect of the different rates of fertilizers ((N-P-K (20 10 10) and N-P-K (23 10 05)) on the yield parameters of NERICA42.

Quantity (kg/ha)	p/t	Hp	P/m2	%FG	W1000	YD (t/ha)
NERICA42 N-P-K (20 10 10)						
0	2.00±0.57^{a}	17.66±0.88^{a}	138.33±0.88^{a}	72.26±2.17^{a}	26.00±1.00^{a}	0.62±0.12^{a}
180	9.66±0.33^{b}	21.33±0.88^{b}	207.00±17.15^{b}	63.98±2.78^{a}	28.00±1.00^{a}	4.67±0.09^{b}
200	9.00±0.57^{b}	21.33±0.33^{b}	278.66±5.20^{c}	72.46±2.78^{a}	27.00±0.57^{a}	5.42±0.21^{c}
220	12.33±0.88^{c}	22.66±0.33^{b}	305.33±1.76^{d}	69.48±1.84^{a}	28.66±0.33^{a}	6.36±0.21^{d}
NERICA42 N-P-K (23 10 05)						
0	2.30±0.67^{a}	16.60±0.78^{a}	139.31±0.98^{a}	70.21±2.37^{a}	25.00±3.00^{a}	0.60±0.22^{a}
180	8.00±0.57^{b}	21.33±0.29^{b}	191.00±4.71^{b}	69.12±2.34^{a}	29.00±1.00^{b}	4.68±0.20^{b}
200	9.66±0.33^{b}	22.33±0.33^{b}	213.00±4.16^{c}	61.81±2.34^{a}	26.66±0.88^{a}	4.65±0.21^{b}
220	12.66±0.87^{c}	22.67±0.30^{b}	294.33±2.40^{d}	54.60±1.71^{a}	26.00±0.57^{a}	5.19±0.44^{b}

The values are expressed in averages more or less standard deviation in the same column and for each parameter the averages which are followed with the same letter are not significantly different using DMRT test P (≤0.05). W1000, Weight of 1000 full grains; P/t, Numbers of panicle per plant; Hp, Height of panicles P/m2: numbers of Panicle per m^{2}; %GP, Percentage of full grain per panicle. YD (t/ha), Yield in tons/ ha.

dose, an output of 5.19 tons/ha was observed compared to the control that had an output of 0.60 ton/ha (Table 4).

DISCUSSION

Studies on the use of different fertilizers on different varieties of rice at different dosage on the growth and yield of rice indicated that the heights of all the varieties increased with the different doses of fertilizers. Variety NERICA42 had the highest height whereas NERICA3 had the smallest height. This difference in height could be attributed to the genetic materials of these varieties. Increased in the dosage of fertilizer N-P-K (23-10-05) had a greater influenced on the height of the rice varieties used in this study compared to the fertilizer N-P-K (20-10-10). These results corroborate with those of Gala et al. (2011) who reported that the increasing amount of nitrogen improves considerably the vegetative growth of rice. The effect of height in the control experiment with no fertilizer had a greater influence in the height of all the rice varieties, which in turns affected the number of leaves hence leading to a lower foliar index. Thus, when the foliar index of a plant is high the more the photosynthetic rate and the higher the output. The larger the leaf area of a plant the more the photosynthetic area and consequently the output is also high. Oladele and Awodum (2014) specified that the biofertilisations of rice starting from symbiotic microorganisms increase growth parameters and that the number of leaves of a rice plant is a very significant component in the production of paddy.

The number of tillers increased significantly with the fertilization between the 49 and 63 days after planting for all the varieties of NERICA compared to the control. However, the plants treated with N-P-K (23-10-05) had the greatest number of tillers compared to those with N-P-K (20-10-10). This could be due to the fact that the more the amount of nitrogen in a combined fertilizer the higher the tilling. Sanogo et al. (2014) reported that combined fertilizer containing more nitrogen influences more tilling of NERICA. 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, influenced by factors such as the fertilization, water stress and other farming techniques (Lacharme, 2001).

Lowland rice produces more tillers than upland rice in this study, which could be due to the presence of enough water present in lowland. Water stress during tilling considerably reduces the number of tillers in rice (Mohamed, 2005; Saidou et al., 2014). Also, Excess fertilizer increases the percentage of empty grains. This would be explained by the fact that when the number of panicle is high, energy for their metabolisms are insufficient, which could influence the filling of the grains coupled with water stress which has a negative impact on the filling of the grains. This is similar to the work of Gala et al. (2011) and of Saidou et al. (2014) who reported that after fecundation, the plant is very sensitive to water stress.

The average output of NERICA3 with high dosage of fertilizer yielded 5.4 tons of paddy per hectare and that of NERICA7 that yielded 5.0 tons per hectare. This result could be explained by the fact that NERICA3 had more full grains than NERICA7 which could be concluded that NERICA3 yields better than NERICA7. These results are similar to those of Sanogo et al. (2014) and of Suh et al. (2015) who reported that, with an adequate fertilization of NERICA varieties, the yield is increased. With a dose of varieties of lowland rice we noticed that the fertilizer N-P-K (20-10-10) has the highest output at the 220 kg, NERICA36 yielded 4.47 tons per hectare and NERICA42 yielded 6.36 tons per hectare contrary to the fertilizer N-P-K (23-10-05) whose outputs was lower. NERICA36 had an output of 4.39 tons per hectare at a dose of 180 kg and NERICA42 yielded 5.42 tons per hectare at a dose of 200 kg. This could be explained by the fact that rice fertilized with N-P-K (23-10-05) gives more tillers than when treated with N-P-K (20-10-10) because of high amount of nitrogen present. This could lead to the production of a high percentage of empty grains. These results are similar to those of Didace et al. (2006) who reported that high amounts of nitrogen increases the vegetative growth and lowers the quantity of full grains which is an important component in the output. Approximately 30% of the grains of rice treated with N-P-K (23-10-05) were infected contrary to the rice fertilized with N-P-K (20-10-10) where only 6% of grains were infected, and such a percentage of infected grains considerably decrease the production. This could be due to the inadequacy between the various major elements of N-P-K (23-10-05) in the fertilization of rice. The fertilizer N-P-K (23-10-05) had a significant effect ($P \leq 0.05$) on all the yield parameters. This could be as a result of increasing rate of nitrate present. This is in accordance with works of Dekhane et al. (2014) who reported that the increasing rate of nitrate fertilizer considerably improves yield parameters such as: The number of panicle per plant, the number of panicle per m^2 and the weight of 1000 grains. The average yield of NERICA3 between the different doses was 5.33 tons per hectare, which was a little bit less than that with N-P-K (20-10-10) that yielded 5.66 tons per hectare. This difference in rice yield fertilized with N-P-K (23-10-05) compared to the rice yield fertilized with N-P-K (20-10-10) could be due to the nitrogen rate present in the two types of fertilizers used. Because when there is more nitrogen than the other elements the vegetative part is higher and there is less energy for the grains thus, when more grains are empty, the yield decreases following reports of Sanogo et al. (2010) and Bagayoko (2012).

Conclusion

This study carried out on the effect of different rates of NPK fertilizer on the growth and yield of rice revealed that

the different doses of NPK fertilizer significantly improved the output of rice compared to the control. Thus, with an adequate fertilization of NERICA, a better output will be achieved. Comparing varietal performance, the best yield was obtained with NERICA3 at a dosage of 200 kg of the fertilizer N-P-K (20-10-10) and N-P-K (23 10 05) while that of NERICA7 was obtained at a dosage of 220 kg of the two fertilizers. Yields of 6.08 t/ha with N-P-K (20-10-10) and 5.95 t/ha with N-P-K (23-10-05) were obtained. However, at a dosage of 220 kg with N-P-K (20-10-10), NERICA36 had an output of 4.47 and 3.90 t/ha with N-P-K (23-10-05). NERICA 42 on the other hand had its best output of 6.36 t/ha with N-P-K (20 10 10) and 5.19 t/ha with N-P-K (23 10 05) at a dosage of 220 kg/ha. This study has given significant indications on the type and on the adequate dosage of fertilizer NPK for a better output per hectare in the upland and lowland rice grown in Cameroun.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

REFERENCES

AfricaRice (2011). Acquis de la crise politique pour la sécurité alimentaire en Afrique. Cotonou, Benin. 22p.

Bagayoko M (2012). Effects of plant density, organic matter and nitrogen rates on rice yield in the system of rice intensification (sri) in the “office du Niger” in Mali. J. Agric. Biol. Sci. 7:1990-6145.

DDMN (2015). Délégation Départementale du MINADER Ngoketunjia.

Dekhane SS, Patel DJ, Jadhav PB, Kireeti A, Patil NB, Harad NB (2014). Effect of organic and inorganic fertilizer on growth and yield of paddy cv gr 11. Int. J. Inf. Res. Rev. 2:26-28.

Didace K (2006). The effect of land factors and management practices on rice yields (case study in Cyili in land valley, Gikonko District, Rwanda). Master thesis. International institute for information science and earth observation Enschente, the Netherlands 85 p.

FAO (2004). Organisation des Nations Unies pour l'Alimentation et l'Agriculture, Production year book. Vol. 58 Rome 1.

FAOSTAT, (2008). FAO statistical databases. Available online at htt://faostat.fao.org/site/342/ default. aspx. Accessed January 2013.

FAO (2011). Annuairestatistique de la FAO (FAOSTAT). www.fao.orgInternational Seed Testing Association (2001). International Rules for Seed Testing. Seed Sci. Technol. 335 p.

FAOSTAT (2013). FAO statistical databases. Available online at htt://faostat.fao.org/site/342/ default. aspx. Accessed January 2015.

Folefack DP (2014). Booster la production locale du riz pour le renforcement de la sécurité alimentaire au Nord Cameroun. J. Appl. Biosci. 82:7449-7459.

Gala B, Camara Y, Keli Z (2011). Rentabilités des engrais minéraux en riziculture pluvial de plateau cas de la zone de Gagnoa dans le centre ouest de la cote d’ivoire. J. Appl. Biosci. 46:3153-3162.

Konate Z, Gala Bi T, Jérémie MF, Sekou A, Yaokouame A, Maméri K, Zagbahi J (2012). Alternatives à la fertilisation minérale des sols en riziculture pluviale de plateau: apports des cultures du soja et du niébé dans la fertilité d’un ferralsol hyperdystrique au Centre-ouest de la Côte d’Ivoire. J. Appl. Biosci. 54:3859-3869

Lacharme M (2001). «Fascicule2» le plant de riz: données morphologiques et cycle de la plante. Memento technique de riziculture: 22 p.

Malaa D, Ntam F, Kouebou C (2011). Suivi du marché du riz, l'utilisation mondiale de riz 14 p.

Mohamed D (2005). Analyse du fonctionnement d’une parcelle de riz irrigué sur sol alcalin. Application à la gestion intégrée de la fertilisation azotée et du calendrier cultural dans le delta intérieur du fleuve Niger (Mali). Thèse de doctorat. Ecole nationale supérieure agronomique de Montpellier 176 p.

Nguefack J, Leth V, Lekagne Dongmo JB, Torp J, Amvam Zollo PH, Nyasse S (2008). Use of Three Essential Oils as Seed Treatments Against Seed-borne Fungi of Rice (*Oryza sativa* L.). American-Eurasian. J. Agric Environ. Sci. 4:554-560.

Oladele S, Awodum M (2014). Response of lowland rice to biofertilizers inoculation and thier effects on growth and yield in southwestern Nigeria. J. Agric. Environ. Sci. 3:371-390.

Piebiep G (2008). Evaluating the constraints and opportunities for sustainable rice production in Cameroon. Res. J. Agric. Biol. Sci. 6:734-744.

Randrianarison L (2011). Contribution à l’étude économique de la fertilisation du sol sur culture de riz en sri: cas de l’utilisation du compost tananamadio et du taroka dans la commune rurale de behenjy. Mémoire d’ingénieur Agronome université d’Antananarivo 66 p.

Roose E, De Noni G, Sabir M, Laouina A (2008). Efficacité de la GCES en milieu semi-aride, AUF, EAC et IRD éditeurs, Paris 425 p.

Saidou A, Gnakpenou KD, Balogoun I, Hounnahin SR, Kindomihou MV, (2014). Effet de l’urée et du NPK 15-15-15 perlés et super granulés sur la productivité des variétés de riz IR841 et NERICA-L14 en zone de bas-fond au Sud-Bénin. J. Appl. Biosci. 77:6575-6589.

Sanogo S, Camara M, Zouzou M, Keli Z, Messoum F, Sekou A (2010). Effets de la fertilisation minérale sur des variétés améliorées de riz en condition irriguée à Gagnoa, Côte d’Ivoire. J. Appl. Biosci. 35:2235-2243.

SNDR (2009). Stratégie nationale de développement de la riziculture au Cameroun. Mouture III. Yaoundé 21 p.

Suh C, Malaa D, Woin N, Mbong G, Djomo SH (2015). Fertilizer requirement for productivity of upland rain fed rice (*Oryza sativa* L.) in the western highlands of Cameroon. Abstracts in innovative bioscience for a sustainable and competitive agriculture. 22^{ht} annual conference Camaroon Biosience Society, IRAD Nkolbisson Yaoundé, Cameroun.

Wichura MJ (2006). The coordinate free approach to linear models. Cambridge Series in Statistical and Probabilistic Mathematics. Cambridge. Cambridge University press, 14: 199 ISBN 978-521-86842-6.MR2283455 available: http://www.ams.org/mathscinet-getitemmr=228345.