Impact of Dry Cow Dung and NPK Fertilizers on Growth and Productivity of *Triticum aestivum L*. (Variety, Somps. 90) in a Semi-Arid Region

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ABSTRACT

This study was conducted during the winters of 2021 / 2022 in the research farm of the Higher Institute for Training Teachers in N'Djamena City, Chad. It is regarded as the first field experiment for the wheat crop ever implemented in N'Djamena. The purpose of the experiment was to compare the effects of chemical and organic fertilizers on wheat crop productivity. We used soft wheat, *Triticum aestivum* (variety, Somps. 90), that was obtained from (SODELAC). Dry cow dung and NPK fertilizers were applied at recommended doses of 40 tons ha^{-1} and one tons ha^{-1}, respectively. These fertilizers were applied separately three weeks before planting. In comparison to the control, the addition of dry cow dung and NPK significantly increased the following: leaf surface area (27.19 and 24.21 cm^2), weight of grains/m^2 (349.66 and 264.44 g), dry weight of the crop (284.44, 277.33 g), and the total productivity were 3.50 and 2.64 tons ha^{-1}, respectively. The outcomes also showed that there were no significant differences between the investigated treatments concerning leaves number, spike length, number of spikelets and grains per spike. Our study led to the conclusion that applying organic fertilizer (dry cow dung) with chemical fertilizer (NPK) gave the best result in the production of *T. aestivum* (variety, Somps. 90) so, we recommend using dry cow dung and NPK fertilizers to increase vegetative growth and obtain the highest wheat crop productivity in N'Djamena city.

Keywords: *Triticum aestivum*, dry cow dung, NPK fertilizers, vegetative growth and crop productivity.

INTRODUCTION

Organic fertilization is an effective way that raise the productive value of agricultural soil and reduce environmental pollution resulting from excessive use of chemical fertilizers (Al-Hamd and Al-Jarbou, 2021). It provides the basic requirements of nutrients for plants through the growth stages. The positive effect of organic fertilizer can continue in supplying nutrients after the end of plant growth for subsequent seasons (Mohammed, 2013). Organic matter in the soil plays an important role in improving the physical and chemical properties of various soils. Organic matter application is an important method to increase the availability of both macro- and micro-nutrients (Abo Nuqtah, 2004; Al-Balkhi, 2006; Al-Hamdani, 2008; Odah & Al-Hassan, 2007 and Niel, 2021). Nitrogen is one of the important mineral elements necessary for plant nutrition, growth and development, as the plant needs sufficient quantities of it compared to other mineral elements, and it is considered a limiting factor for high crop production (Costa Crusciol *et al.,* 2003). Many studies have confirmed that increasing plant height is due to the positive effect of nitrogen on the activity of meristematic tissues and its role in cell division (Shaba *et al.,* 2006), and it plays a critical role in the vegetative growth of plants, which ultimately leads to an increase in straw and grain yields of wheat plant (Abedi *et al*., 2011 and Marino *et al*., 2011).

Wheat (*Triticum aestivum* L.), which belongs to the Poaceae family, is one of the main and oldest cereal crops in the world. Wheat is grown in 33 percent of the cereal cropped area (Al-Hamd and Al-Jarbou, 2021). It constitutes a major food source for about 40% of the world's population and covers about 20% of the calories and protein in food (Mahfoud, 2018). The importance of this staple crop increases with the increase in the world's population and the growth of their nutritional needs (Nazco *et al.,* 2012). The cultivated area in the world is about 240 million hectares and the productivity is estimated about 760 million tons. The largest wheat producing country in the world is China (17.67%), India (12.96%), Russia (11.29%), United States (06.23%), and France (04.85%). These countries produce about 53% of the world's wheat production (FAO, 2022). The prominence of *T. aestivum* is due to its high nutritional value, as it outperforms all other grains (Al-Hamd and Al-Jarbou, 2021). It is also used in the manufacture of alcohol, and animal feed, either in the form of grains or crop residues (Hago *et al.,* 2016). Its leaves were used to produce juices because they contain all the essential nutrients for building the human body (Mahfoud, 2018).

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Wheat is one of the non-endemic crops in Chad. This crop has been grown in winter season in the Lake Chad region by irrigation since 1980. Wheat cultivated area is estimated at 200 hectares with average yield of 1.74 tons (Al-Ahram Egyptian newspaper, 2017). As a result of the growth of societies, the increase in migration from the countryside's to Chad, and food patterns changed, the demand for wheat increased and became an alternative to millet and maize, thus it became as one of the strategic crops in Chad. Therefore, this study aims to know the effect of fertilizers on the grain yield in N'Djamena city (Chad).

MATERIALS AND METHODS

During 2021/2022 winter season, this research was carried out in the experimental field of the Higher Institute for Training Teachers in N'Djamena (Chad). This area is located in the Ardeeb Djoumal region, seventh district, at longitude (09" 10' 12˚ N) and latitude (18" 06' 15˚ E). The area is classified as coastal and semi-arid, because the drought season extends from October to May, with average daily temperature ranging from 20 to 42˚ C. Its soil is clayey sand with pH 6.65 according to National Research Centre in Sudan (2022).

The physical and chemical properties of the soil used in our experiment are shown in Table (1), including pH, electrical conductivity, available N, P and K elements, and textural analysis. Table (2) represents pH, electrical conductivity, and amount of organic carbon in dry cow dung fertilizer.

Table 1. Soil physical and chemical analysis

Physical properties	
Textural analysis	**Value**
Sand (g kg^{-1})	230
Silt (g kg^{-1})	150
Clay (g kg^{-1})	307
Textural class	Clayey sand
Chemical properties	
Parameter tested	**Value**
pH	6.65
Electrical conductivity (dSm^{-1})	1.32
Available nitrogen (mg kg^{-1})	69.76
Available phosphorus (mg kg^{-1})	20.05
Available potassium (mg kg^{-1})	103.50

(National Research Center in Sudan, 2022)

On 10th December (2021), the land was prepared and divided into experimental units in the form of basins with an area of 6m^2 (3m length and 2m width). Soil samples were taken randomly from a depth of approximately 0-30 cm for a laboratory to evaluate some physical and chemical analysis as shown in (Table 1). The dried cow dung utilized in the experiment was also chemically analyzed (Table 2).

Table 2. Chemical analysis of dried cow dung used in the experiment

pH	Electrical conductivity (dSm^{-1})	Organic carbon (%)	Total nitrogen (%)	Total phosphorus (%)	Total potassium (%)	C/N
5.33	4.57	30.85	2.50	1.05	1.37	12.34

(National Research Center in Sudan, 2022)

The experiment was set up using a randomized complete block design (RCBD) with three replicates, and then the experimental units became (9 units). following the preparation of these units, 24 kg of dry cow dung (40 tons/ha) and 2 kg of NPK fertilizer (one tons/ha) were added (Al-Hamd and Al-Jarbou, 2021). A treatment that was left without any fertilizer was used as a control. Thirty liters of tap water were used to irrigate each unit. After a week, the soil was fertilized and irrigated with the same quantity of water then again after two weeks, and left in that state. Planting took place on 9th January (2022), and the seeds were treated before planting with Gaucho pesticide against fungi. The wheat crop was sown in terraces, separated by 50cm between each terrace. Planting was done manually in small holes, seven seeds were put into each hole and the distance between the holes (50cm) was measured. The experimental units were irrigated with 30L tap water as soon as they were planted and persisted until maturity. Then, the growth parameters such as leaves number, plant height, flag leaf area, the number of days (100% flowering), spike length, number of spikes m^{-2}, number of spikelets per spike, spike weight, weight of spikes/m^2, number of grains in each spike, number of grains/m^2, grains weight per spike, grain weight/m^2, dry weight of plant and total productivity were recorded.

Statistically, our data were analyzed using analysis of variance (ANOVA). Means were compared using the least significant difference (LSD) test at $p \leq 5\%$.

RESULTS AND DISCUSSION

Effect of organic and chemical fertilizers on the number of wheat leaves and their surface area (cm^2):

Number of leaves in *T. aestivum* (variety, Somps. 90) per plant did not significantly differ between the fertilization treatments and the control according to the findings of the statistical analysis in Figure (1) at the 5% level.

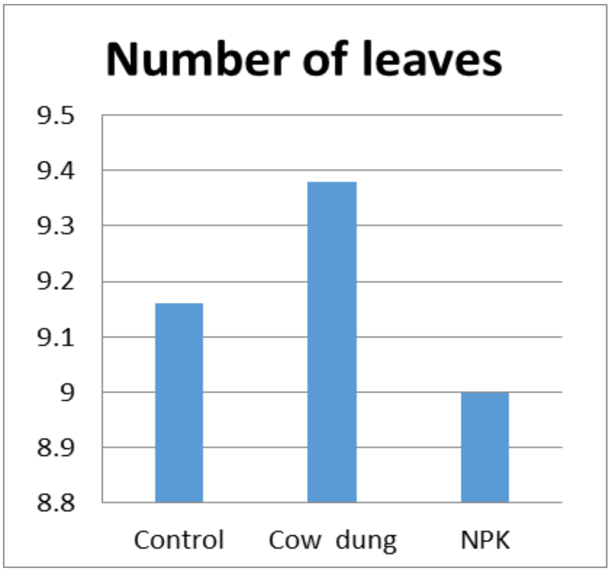

Fig. 1. Effect of organic and chemical fertilizers on number of leaves per wheat plant

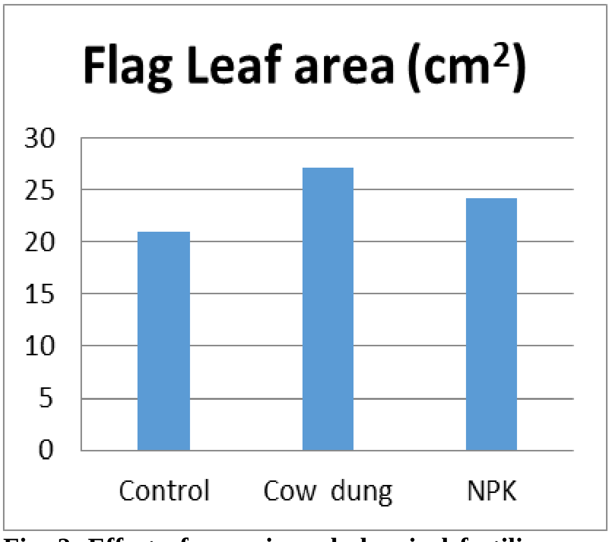

Fig. 2. Effect of organic and chemical fertilizers on leaf surface area of wheat plant (cm^2)

The treated plants with dried cow dung, (NPK) fertilizer, and control plants had leaf numbers of 9.38, 9.00, and 9.16 per plant, respectively. The similarity in number of leaves among the studied plants is due to that the number of leaves is a trait that is not greatly affected by changes in environmental conditions. Figure (2) demonstrated that there were notable variations in the leaf surface area of wheat plants at 5% level among the treatments. The plants treated with dry cow dung recorded the maximum value of leaf surface area (27.19 cm^2), which differed significantly to the treated plants with NPK (24.21 cm^2), with an increase of 12.30%, while control plants recorded the lowest leaf surface area of plants (21.04 cm^2), with a decrease of 22.61% compared to the dry cow dung treatment, and a decrease of 13.09% compared to the NPK treatment. These results can be explained by the fact that the amount of the organic fertilizer added before planting gave the soil a reasonable amount of nitrogen, which contributed well to increasing the leaf surface area of the treated plants. This is consistent with the results of Al-Zarqi (2012), who discovered that giving plants organic fertilizer had a positive effect in increasing leaf surface area.

Effect of organic and chemical fertilizers on wheat plant height (cm) and number of days to (100% flowering).

The plants treated with dry cow dung and those treated with NPK had the tallest plants (32.89 and 32.83 cm), respectively, while the control plants had the lowest height measuring 28.50 cm (Figure 3). The control plants showed decreases of 13.34 and 13.18% than cow dung and NPK treatment, respectively. The higher levels of organic matter, nitrogen, and phosphorus in the treated plants led to their superiority over the control treatment. These elements promote vegetative growth, help in building strong root systems, and consequently have a positive effect on the plant height. These results are consistent with Abbas *et al.* (2012), who noted that spring wheat plants grew taller when treated with a combination of organic and inorganic fertilizers. The number of days (100% flowering) in wheat plants varied significantly depending on the treatments that were applied (Figure 4). The plants exhibited flowering at 57.44 to 58.94 days after planting, but the control plants delayed flowering by 62.05 days. The added fertilizers were fermented before planting which made the organic components easier for the roots to absorb. This is why the fertilized- treated plants flowered faster. The plant grew more quickly as a result, and flowered earlier. According to the research of Ousman (2021) *Sorghum* plants treated with dry cow dung were significantly superior to control plants in the flowering characteristics.

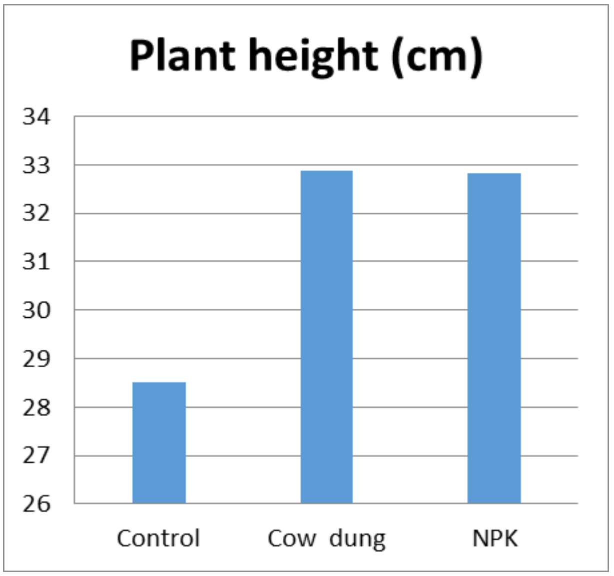

Fig. 3. Effect of organic and chemical fertilizers on the height of wheat plant (cm)

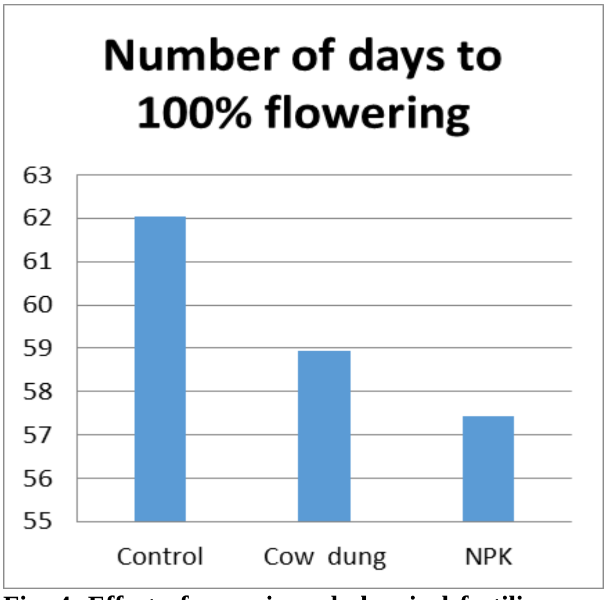

Fig. 4. Effect of organic and chemical fertilizers on the number of days to (100% flowering)

Effect of organic and chemical fertilizers on the spike length and number of spikelets/spike in the crop

Figure (5) illustrates, there were no significant changes in spike length characteristic at $p \leq 5\%$. The plants treated with dry cow dung, control plants, and plants treated with NPK recorded very similar length of spikes, 7.91, 7.80 and 7.72 cm, respectively. The results of the current study differ from the results of Mahfoud (2018), who noticed that the addition of organic fertilizer either separately or in a combination, increased the spike length compared to the control or as an application of chemical fertilizers alone. Figure (6) showed that there were no significant differences in the number of spikelets/spike between the treatments. Approximately identical numbers of spikelets/spike (18.45. 18.20 and 18.07 spikelets/spike) were recorded by each plant under observation. This can be explained by the fact that the organic and inorganic fertilizers added before planting have no direct effect on the number of spikelets. This could be because the length of the spike in all treated plants was found to be similar, and this was reflected in the equivalent number of spikelets per spike.

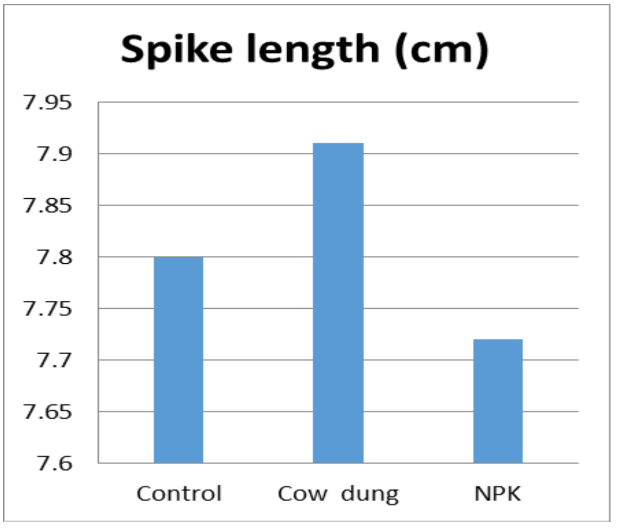

Fig. 5. Effect of organic and chemical fertilizers on the spike length of wheat plant (cm)

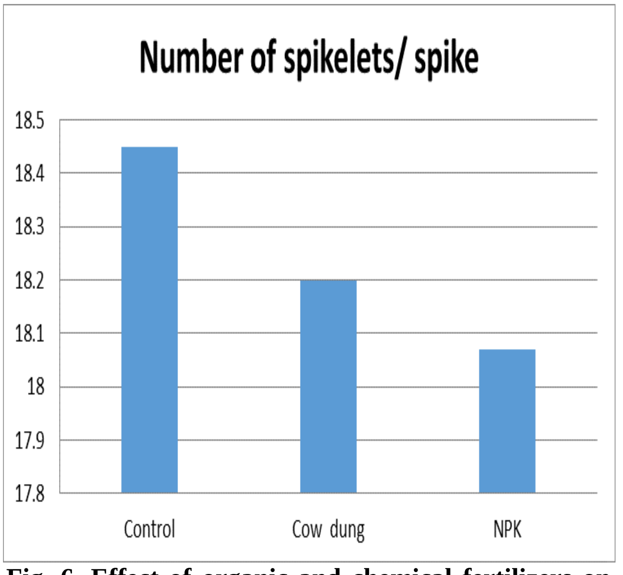

Fig. 6. Effect of organic and chemical fertilizers on the number of spikelets/spike in wheat plant

Effect of fertilizers on the number of grains/spike and spike weight (g) of the wheat crop.

Table (3) showed that there were no significant differences in the number of grains/spike of wheat plants between the fertilization and control treatments at $p \leq 5\%$. The number of grains per spike for the plants treated with dry cow dung, NPK fertilizer, and control were 52.32, 51.94, and 51.16, respectively. These values were extremely similar. The reason might also be that the characteristics like spike length and number of spikelets/spike are mostly unaffected by fluctuations in external factors. Therefore, the spike length measurements, number of spikelets, and number of grains in each spike were equal. However, the results in Table (3) showed that there are significant differences between the treatments of the spike weight (g) in the wheat crop. Dry cow dung outperformed the NPK fertilizer treatment and the control. The plants treated with dry cow dung had the largest weight of spike (2.58g), which differed significantly from the plants treated with NPK fertilizer (2.31g), with an increase of 11.68%. Conversely, the control plants had the lightest spike weight (1.94 g), with a decrease of 24.80 % from the dry cow dung-fertilized plants and 16.01% from the NPK-treated plants. This due to the amounts of organic fertilizer applied before planting improved the properties of the soil over time, increasing the leaf surface area of plants that get enough light energy and turn it into dry matter that helps the plant to grow by increasing the weight of its parts. Ibrahim *et al.* (2008) found that adding organic compounds and compost made the grains heavier than they were in the control group.

Table 3. Effect of dry cow dung and NPK fertilizers on number of grains/spike and the weight of spike/plant (g)

Treatments	Number of grains/spike	spike weight (g)
Control (un-fertilized)	51.16[a]	1.94[c]
Dry cow dung	52.32[a]	2.58[a]
NPK (chemical fertilizer)	51.94[a]	2.31[b]
SE	3.72	1.26
LSD (0.05)	NS	0.03*

Means followed by the same letter within the column do not differ significantly ($p \leq 5\%$)

Effect of organic and chemical fertilizers on the weight of spikes and grains /m² (g) in the plant

Plants treated with dry cow dung had the highest value for the weight of spikes/m^2 (485 g) (Table 4), which was substantially different from the plants treated with NPK, which showed 6.20% increase in weight of spikes/m^2 (456.66 g). With a decrease of 11.27% compared to the dry cow dung treatment, and a loss of 05.69% compared to the NPK treatment, the control plants had the lowest weight of spikes/m^2 (430.33 g). Those results can be interpreted with the same explanation mentioned before in the weight of the spike/plant. These findings agree with that of Al-Hamd and Al-Jarbou (2021) who indicated in their experiments that adding fermented cow dung with nitrogen fertilization increased the weight of spikes/m^2. For the grain weight/m^2 in the wheat crop, the treatment with dry cow dung had a higher grain weight than the NPK fertilizer and control treatments (Table 4). The plants that were treated with dry cow dung had the highest weight of the grain/ m^2, (349.66 g), which differed significantly from the plants treated with NPK fertilizer (264.66 g), with an increase of 32.11%. The weight of grains/ m^2 (121.66 g) was lowest in the control plants, with a decrease of 65.20% compared to plants treated with dry cow dung and 54.03% to plants treated with NPK. The explanation could be that adding a significant amount of dry cow dung before planting improved the soil properties, which increased the flag leaf area of plants receiving sufficient light energy and converting it into dry matter, which increased the weight of grains. Ofosu and Leitch (2009) observed that when spring barley was grown with added cow dung, weight grain of the plant increased.

Table 4. Effect of dry cow dung and NPK fertilizers on the weight of spikes and grains /m² (g) in the plant

Treatments	Weight of spikes/m^2 (g)	Weight of grains/m^2 (g)
Control (un-fertilized)	430.33[c]	121.66[c]
Dry cow dung	485.00[a]	349.66[a]
NPK (chemical fertilizer)	456.66[b]	264.66[b]
SE	5.27	4.89
LSD (0.05)	10.57*	43.63*

Means followed by the same letter within the column not differ significantly ($p \leq 5\%$)

Effect of organic and chemical fertilizers on the number of grains/m^2, the dry weight of the plant/m^2 (g), and the productivity of tons ha^{-1}.

The plants fertilized with NPK recorded (17123.77), whereas the plants treated with dry cow dung recorded the highest number of grains/m^2 (18656.07), outperforming both the NPK treatment and the control. The control had the lowest number of grains/m^2 (15709.25), decreasing by 15.79% when compared to the plants treated with dry cow dung and 8.26% compared to plants treated with NPK (Table 5). The fact that cow dung contributed to high levels of elements in the soil, which increased the flag leaf area, in turn, had a favorable impact on the number of grains /m^2, may explain why the dry cow dung treatment outperformed the other treatments. These results are related to those of Taher *et al.* (2011) who reported in their research that all treatments in which organic fertilizer was added had an impact on production components of the wheat crop when compared to the control. Table (5) showed that there were significant differences at $p \leq 5\%$ in the dry weight of the wheat crop between the applied treatments. In contrast to the control plants, which recorded the lowest dry weight/m^2 (253.33 g), the plants treated with dry cow dung gave the highest dry weight/m^2 (284.66 g), followed by treatment with NPK fertilizer (277.33 g). A decrease of 11.00 and 08.65% were noted when comparing control treatment to the plants fertilized with dried cow dung and NPK, respectively. In this context, we observe that in comparison to the control and chemically fertilized plants, the organically fertilized plants showed the highest dry weight/m^2. This may be as a result of the cow dung that was added prior to planting was fermented over time and turning into an organic substance that absorbed by the roots, then affected the plant ability to grow and achieve a superior dry weight characteristic/ m^2. This outcome agreed with the findings of Ousman (2021) which showed that applying dry cow dung increased the dry weight of *Sorghum* plants. The highest production value (3.50-ton ha^{-1}) was obtained from the plants treated with dried cow dung (Table 5). The plants treated with NPK recorded the second-highest production value (2.64-ton ha^{-1}). The plants treated with dry cow dung differed significantly from the plants treated with NPK, with an estimated increase rate of 32.57%, while, the control plants recorded the lowest production value (01.21-ton ha^{-1}), so a decrease rate of 65.42 and 54.16% was recorded compared to plants treated with dry cow dung and NPK fertilizers, respectively. The physical and chemical properties of the soil were improved by the addition of cow dung, which had a positive effect on plant growth, the flag leaf area, spike weight, grains weight in each spike, and weight of the spikes and grains/ m^2. Increasing these characteristics in the plants led to an increase in the productivity of the wheat crop (variety, Somps. 90), and these findings were supported by Cheraghi *et al*. (2016) who explained that adding organic fertilizer to the soil increased the components of wheat crop and ultimately its grain yield.

Table 5. Effect of dry cow dung and NPK fertilizers on the number of grains/ m^2, dry weight of the plant/m^2 (g) and the productivity of the crop (tons/ha)

Treatments	Number of grains/m^2	Dry weight of the plant/m^2 (g)	Productivity (ton ha^{-1})
Control (un-fertilized)	15709.25^c	253.33^c	01.21^c
Dry cow dung	18656.07^a	284.66^a	03.50^a
NPK (chemical fertilizer)	17123.77^b	277.33^b	02.64^b
SE	3.58	0.76	3.80
LSD (0.05)	85.33*	5.12*	00.23*

Means followed by the same letter within the column not differ significantly ($p \leq 5\%$)

CONCLUSION

The current study demonstrated that surface irrigation may be used to develop and produce wheat crops in N'Djamena city during the winter. Treating the wheat crop with dry cow dung at (40 tons/ha) led to an increase in grain productivity compared to the control (plants without any treatment) and the plants that were fertilized with (NPK) at (1 tons/ha).

RECOMMENDATIONS

According to the data that were obtained, we suggest the following:

1. Encouraging farmers to plant wheat crops in N'D jamena city as the city provides a suitable environment for the crops development and output.
2. Moving towards the use of all organic fertilizer types which have an important economic and environmental effect and accordingly, the side effects of chemical fertilizers will be reduced.
3. Before using organic fertilizers, they must undergo fermentation because this process offers major advantages for plants and soil.

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الملخص العربي

تأثير روث الابقار الجاف وسماد الـ NPK على نمو وإنتاجية محصول القمح *Triticum aestivum L.* (الصنف *Somps.90*) فى المناطق شبة الجافة

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إجريت هذه الدراسة خلال شتاء ٢٠٢١/٢٠٢٢ في المزرعة البحثية للمعهد العالي أعداد المعلمين بمدينة نجامينا بتشاد. كان الغرض من التجربة هو مقارنة تأثير الأسمدة الكيماوية والعضوية على إنتاجية محصول القمح. استخدم القمح الطري *Triticum aestivum* صنف (Somps.90) الذي تم الحصول عليه من شركة (SODELAC). وتم استخدام روث البقر الجاف والأسمدة NPK بالجرعات الموصى بها وهي ٤٠ طن/هكتار، و واحد طن/هكتار على التوالي. تم إضافة هذه الأسمدة بشكل منفصل قبل ثلاثة أسابيع من الزراعة. بالمقارنة مع معاملة الكنترول، قد أدت إضافة روث البقر الجاف و NPK إلى زيادة معنوية في ما يلي: مساحة ورقة العلم (٢٧,١٩ و ٢٤,٢١ سم٢)، وزن الحبوب/م٢ (٣٤٩,٦٦ و ٢٦٤,٤٤ جم)، الوزن الجاف للمحصول (٢٨٤,٤٤، ٢٧٧,٣٣ جم)، وبلغت الإنتاجية الإجمالية ٣,٥٠ و ٢,٦٤ طن/هكتار على التوالي . كما أظهرت النتائج عدم وجود فروق معنوية بين المعاملات المدروسة فيما يتعلق بعدد الأوراق وطول السنبلة وعدد السنابل والحبوب لكل سنبلة. وقد أوصت الدراسة إلى أن إضافة السماد العضوي (روث البقر الجاف) مع الأسمدة الكيماوية (NPK) أعطت أفضل نتيجة في إنتاج *T. aestivum* صنف (Somps.90) ، لذا ننصح باستخدام روث البقر الجاف والأسمدة الكيماوية NPK لزيادة النمو الخضري والحصول على أعلى إنتاجية لمحصول القمح في مدينة نجامينا.

الكلمات المفتاحية: القمح، روث الأبقار الجاف، التسميد المعدنى NPK، النمو، الإنتاجية.