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Determination of the optimal level of the fertilizing elements N, P, K on the local varieties improved P1 and P2 of corn in the region of the Moyen-Chari in Chad

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Abstract

The objective of the test is to determine the best formula of the NPK elements for two local varieties improved of corn. The studied plant material is composed of local populations improved P1, P2. The factorial test is driven with two P1 varieties, P2 and four doses of NPK according to an experimental device in blocks of Fischer to four blocks. The doses of 20 - 10 - 10, 30 - 15 - 15, 10 - 5 - 5 and 40 - 20 - 20 correspond respectively to the T1 treatments, T2, T3 and T4. On the T2 (2,073 m ± 0,009) P1 is observed of the heights raised of stem. The T4 (1, 85 m ± 0,173) recorded a stem raise of P2. The T2 (30, 75 ± 1,500) P1 reached the highest number of grains in a row. The T1 (30, 75 ± 1,258) P2 got high number of grains in a row. Greater number of grains in an ear is observed on T3 (520 ± 15,491) of P1. The greatest number of grains per ear is noted on the T2 (510,5 ± 10,630) of P2. The T2 (4, 20 t ha^{-1} ± 0,12) P1 recorded better outputs in grains. The T1 (4,035 t ha^{-1} ± 1,831) P2 got the best output in grains. The corresponding T2 to the dose (30 - 15 - 15) could be kept for the P1. The corresponding T1 to the dose (20 - 10 - 10) could be recommended for the P2 to increase the productivity of corn in the zone of survey.

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Introduction

The FAO foresees that 60 millions of supplementary tons of cereal will be necessary in 2030 for the human food. In tropical zones, the cereal projections for 2020 let appear on the horizon, a deficit of several hundreds of millions of tons (Islam, 1995). To face this new demand, tropical agriculturists should increase their productions and their productivities. The corn (*Zea mays* L.) is a cereal of prime importance in the human and animal food (bovine, pigs and poultries) worldwide and the large variety ofits byproducts makes it be a strategic agricultural produce. So the corn is the most cultivated plant in the world and the first cereal produced before wheat (Tahir *et al.*, 2009; Missihoun *et al.*, 2012). The corn grain is a key element for the human food, in particular in Africa and in Latin America. It is certain that the corn will continue playing an important role in food security because the demand in corn grain for the food should increase in a spectacular way in the next years. In Chad, agricultural production, specially of corn, is insufficient (about 200 000 tons in 2009) for a population estimated to 9, 5 million inhabitants in 2009 (ONDR, 2010). Researches should be more focused on the development of cultural techniques appropriated to favour the increase of cultivation outputs of the cultures (Taffoua *et al.*, 2008). So, local varieties of corn springing out of recurrent selection (Goalbaye *et al.*, 2013; Goalbaye *et al.*, 2014), have been improved on the site of Doyaba in Chad. However, they have not yet been subject for a survey on linked doses in fertilizing elements of basis (NPK). Thus, one doesn't know the best levels precisely in nitrogen, in phosphor and potassium in order to foster the two local varieties to improve P1 and P2 varieties of corn in the region of the Moyen Chari. The formula of 15 - 15 -15 used during the selection didn't permit to determine the exact and optimal level of the fertilizing base elements because the corn is a very demanding plant in mineral elements and water. Otherwise, for outputs from 5 to 6 t/ha, the corn requires: 100 in 150 N kg/ha, 40 in 60 P_2O_5 kg/ha and 100 to 150 K_2O kg/ha, however soils can only provide 20 to 35% of the needs in N, P and K of the corn (Ndiaye and Sidibé, 1999). Furthermore, a culture of corn that produces an output in grains of 4 t ha^{-1} requires about 100 N kg/ha, of 18 P_2O_5 kg/ha, of 68 K_2O kg/ha (Sanchez, 1976). Therefore, a substantial contribution of these elements is indispensable to assure an at least sustained production of corn (Goalbaye, 2014). Taking nitrogen, it is the quantity of the mineral contained in the brought ternary fertilizer. Non availability of these elements for the plant results in characteristic deficiencies and constitutes one of the factors limiting the increase of corn productivity. However, several studies have been led to determine the level of the fertilizers (Asaduzzamen *et al.*, 2014; Bidzakin *et al.*, 2014; Diallo *et al.*, 2016) in order to improve the outputs of corn growing. The objective of the test is to determine the best formula of NPK elements for the two local improved varieties of P1 and P2 selected corn P2 in our ecological agro zone in the south of Chad.

Materials and methods

Site of the experimentation

The experimentation has been achieved in June 2017 in the university of Sarh (UDS), site of Doyaba (latitude of 09,08189°N, longitude of 18,42947° E, altitude of 360 m). The climate is of sudan type, characterized by a dry and hot season spreading from November to April and an active humid and hot rainy season from May to October. The average temperatures vary from 24 to 38°C. Soils are washed ferruginous of red color, of uniformly clay-sandy to clay texture with a slightly acidic pH in surface and very acidic in depth (Naitormbaïdé, 2012). Vegetation is characterized by clear forests and savannah trees in the part south of Chad (DREM, 1998).

Materials

The studied plant material is composed of local improved P1, P2 of corn varieties with a of cycle of 95 days for the former and 100 days for the latter. They are kept for their interesting agronomic characters (resistant or tolerant to the Striga or to the illnesses). The average outputs got with these local improved varieties in improved culture are of 3 t ha^{-1} (Goalbaye *et al.*, 2013). The level of intensification is improved (ploughing, weeding, sanitary protection, fertilizers).

Methods

The factorial test is driven with two local varieties improved P1, P2 of corn and four doses of NPK according to an experimental device in blocks of Fischer with four blocks. The doses of 20 - 10 - 10, 30 - 15 - 15, 10 - 5-5 and 40-20-20 correspond respectively to the T1 treatments, T2, T3 and T4. Two factors are studied, main Factor: genetic potential of every variety, the secondary factor, the level of the fertilizing of basis (NPK).

Conducted of culture

The experimental parcels are ploughed to a depth of 15-20 cm, an organic manure equivalent to 5 t/ha is added before the ploughing. Then these parcels underwent a harrowing in order to prepare the sowing bed. The sowing is done after a useful rain of at least 20 mm. To avoid all factor limiting, seeds are dealt with a mixture of insecticide and fungicide named thioral (thirame and heptachlore). Sowing is carried on by placing two to three seeds, in a depth of about 5 cm. The spacing of 80 x cm 40 cm is kept. A first weeding is done 12th days after levee and a second weeding 21st days after levee. The thinning to one plant per mound is done the 15th day after levee; The doses of fertilizer of complex N cereal, P, K (20 - 10 - 10; 30 - 15 - 15; 10 - 5-5; 40-20-20) are brought as bottom fertilizer to an equivalent quantity of 100 kg/ha, they are buried in the furrows drawn to 10 cm of the line of seedling.

The formulas 20 - 10 - 10, 30 - 15 - 15, 10 - 5-5 and 40-20-20 correspond respectively to the T1 sub-treatments, T2, T3 and T4. The fertilizer of cover, urea is brought in two fractions to the 10 leaves stage and to the male flowering respectively to the equivalent quantities of 50 kg/ha and 30 kg/ha. This contribution of urea increased the level of nitrogen of 46 on the previous dose of N, P, K. No sanitary treatment is applied. The experimental parcel surface is of: 8 x m 6 m = 48 m², that is to say a surface of 48 m² x 32 = 1536 m² for the totality of the experimental parcels. A border of 50 cm is kept for passage and a space of 50 cm between the blocks.

The calculated measured or registered parameters

Agronomic parameters were height of stems, number of rows per ear, number grains per ear, output in grains.

Statistical analysis

Data have been analyzed with the software SPSS (Statistical Package heart Social Sciences version 16.0). The averages of the different parameters have been separated by the multiple relation test of Student - Newman - Keuls (SNK).

Results

The height of stems at harvest is represented on the Fig. 1.

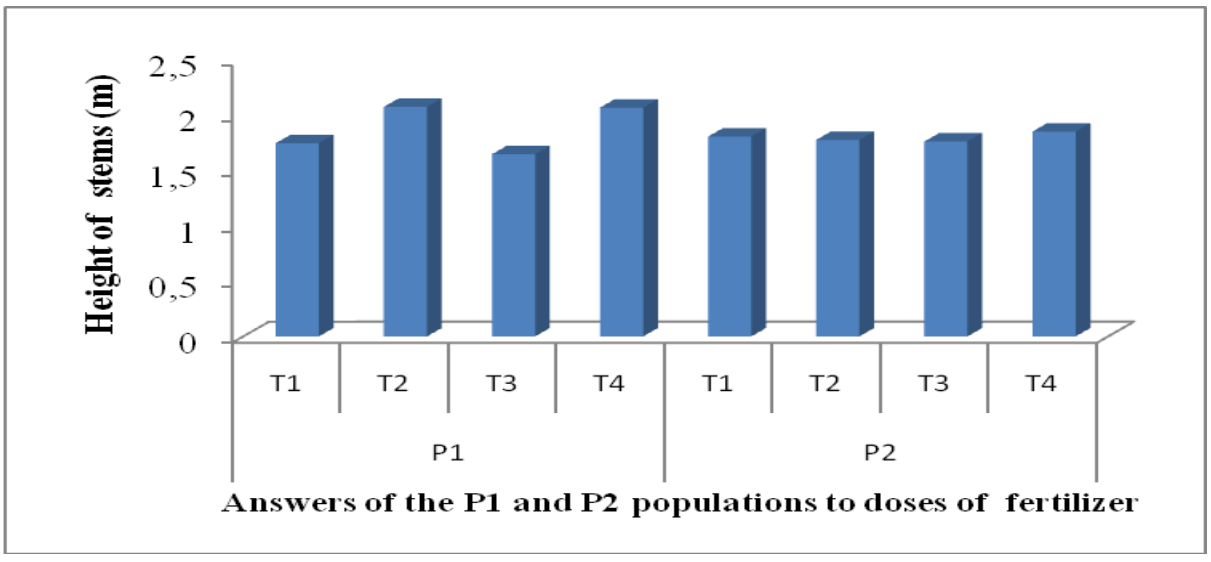

Fig. 1. Averages of the heights of stems.

On the T4 treatments (2,066 m ± 0,127) and T2 (2,073 m ± 0,009) of the P1 population are observed raised heights of stem. Also the T4 treatment (1,85 m ± 0,173) recorded the most elevated heights of stem of the population consistent P2 before T1 (1,80 m ± 0,122). The analysis of variance showed that a highly meaningful difference exists between the averages of the treatments with regard to the heights of stem to the doorstep 5% (F=8,780; P <0,01). The variance analysis revealed that meaningful difference of interaction doesn't exist between fertilizer doses and the varieties in the threshold of 5% (F=0,366; P < 0,01). However, the T2 treatments and T4 lead to a better growth of the P1 populations of corn.

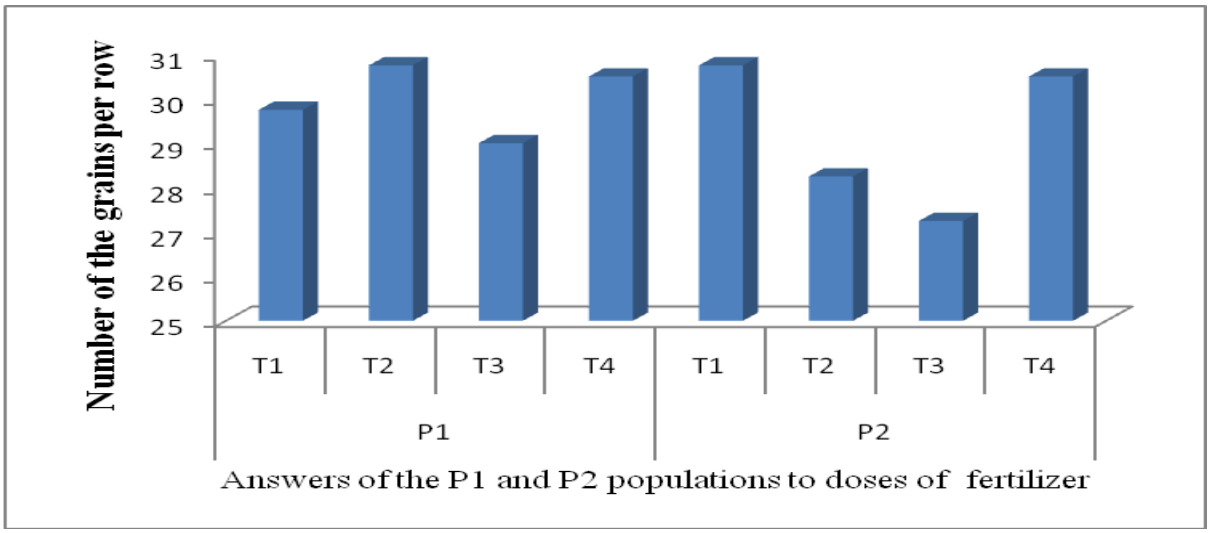

Fig. 2. Averages of number of the grains per row.

The number of grains per row is reported on the Fig. 2. The T2 treatments (30, 75 ± 1,500) and T4 (30,5 ± 1,290) of the P1 population recorded the most elevated number of grains in a row. The T1 treatments (30, 75 ± 1,258) and T4 (30, 50 ± 1,290) of the P2 population got a raised number of grains in a row.

The analysis of variance showed that highly meaningful difference exists between the averages of the treatments of the viewpoint numbers grains by row in the threshold 1% (F=3,7227 P <0,01). In the same way the statistical analysis showed that some highly meaningful differences exist between the effects of the factor doses of fertilizer in the threshold 1% (F = 4,9514; P <0,01). However, the analysis of variance revealed that meaningful difference doesn't exist between the averages of the varieties in the threshold of 5% (F=2,869; P < 0, 01), as well as the interaction between fertilizer doses and the varieties (F = 2, 7784; P < 0, 01).

The number of grains in an ear is reported on the Fig. 3. The best number of grains by ear is recorded on T3 (520 ± 15,491 and T2 (519,5 ± 10,115) of the P1 population.

The best number of grains per ear is noted on the T2 treatments (510, 5 ± 10,630) and T1 (509,5 ± 9,848) of the P2 population.

The analysis of variance showed that highly meaningful difference exists between the averages of the treatments of the viewpoint numbers grains per ear in the threshold of 1% (F = 11,9876; P = 0,0573).

In the same way the statistical analysis showed that some highly meaningful differences exist between the effects of the factor fertilizer doses (F = 17, 3351; P = 0,354) and also the interaction between fertilizer doses and varieties (F= 9, 2301; P = 0,156). On the other hand, the analysis of variance revealed that meaningful difference doesn't exist between the averages of the varieties in the threshold of 5% (F = 4,2171; P < 0,01).

The T2 dose leads a better interaction with the two P1 populations and P2, followed by T3 for this parameter, in occurrence the number of grains per ear.

The output in grains is represented on the Fig. 4. The T1 treatments (3, 22 t ha^{-1} ± 0,169) and T4 (3, 28 t ha^{-1} ± 0,095) of the P1 population got the weakest outputs in grains. The T2 treatment (4, 20 t ha^{-1} ± 0, 12) recorded the highest output in grains followed by T3 (3, 74 t ha^{-1} ± 0,080). The T4 treatments (3, 02 t ha^{-1} ± 0,101) and T3 (3, 17 t ha^{-1} ± 0,242) of the P2 population recorded weak outputs in grains. On the other hand the T1 treatment (4,035 t ha^{-1} ± 1,831) got the highest output in grains before T2 (3, 54 t ha^{-1} ± 0,449). The analysis of variance showed that highly meaningful difference exists between the averages of the treatments of the viewpoint output in grains to the threshold 1% (F = 17,3684; P = 0,225). Also the statistical analysis showed that some highly meaningful differences exist between the effects of the factor doses of fertilizer (F = 17, 2022; P= 0, 0223) and also the interaction between fertilizer doses and varieties (F = 21,538; P = 0,587). Otherwise, the analysis of variance revealed that meaningful difference exists between the averages of the varieties in the threshold of 5% (F = 5, 3523; P < 0, 01). The T2 dose leads a better interaction with the two P1 populations and P2, before T1 and T3 for the parameter of output in grains.

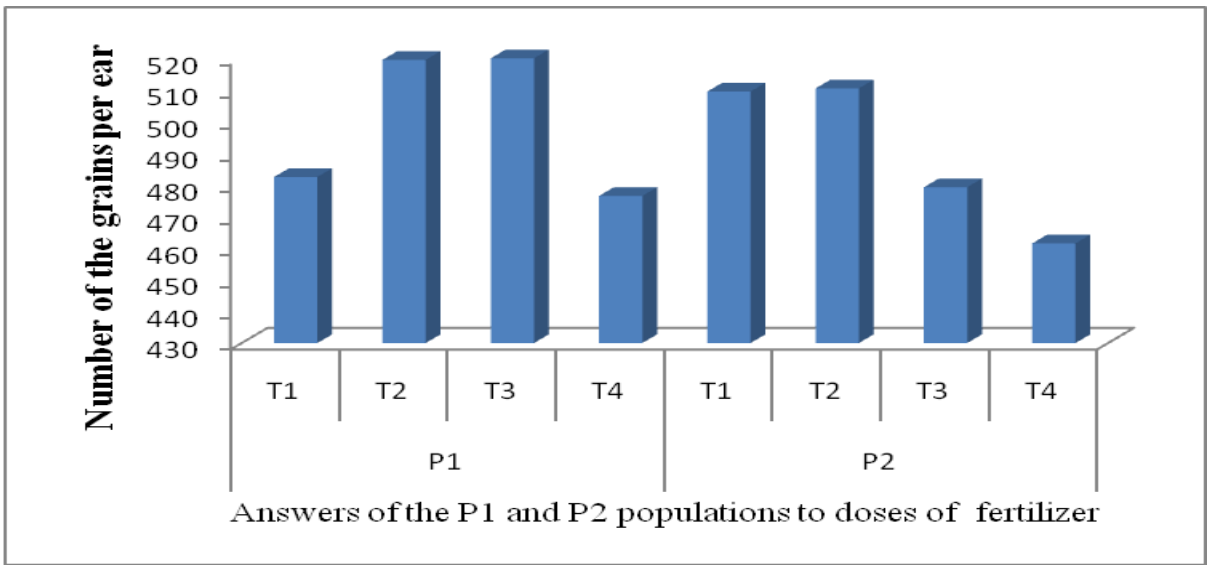

Fig. 3. Averages of number of the grains per ear.

Discussion

The results got in relation to the height of stems showed that the customary dose (T2) and the strong dose (T4) of mineral fertilization generated a better height of stems of the P1 population but not of the P2 population. These results are not conform to those got by Diallo *et al.* (2016) that worked also on the mineral fertilization of corn. Indeed, these authors got a better height of stems of a variety solely with a customary dose of fertilizer. According to Useni *et al.* (2012), the nitrogen excess leads to an exaggerated vegetative growth and a delay in maturity like a delay or an absence of flowering. The results got in number grains per row in a year showed that the highest number of grains per row are got with the T2 dose of the mineral fertilization on the P1 population of corn. Whereas on the P2 population of corn the highest number of grains per row is observed with the T1 doses (average dose) and T4 (strong dose). These results confirm the conclusion of the works of Batiano *et al.* (2004) according to which mineral fertilization has a meaningful effect on the corn. As for the number of grains per ear, the highest number grains by ear are gotten with the T2 treatments and T1 that correspond respectively to customary doses of the mineral fertilization on the P2 population. On the P1 population of corn the highest number of grains per ear is recorded on the other hand with the two T2 treatments and T3 that are customary and weak doses of this mineral fertilization. Otherwise, the T2 dose (customary dose) induced a better interaction with the two P1 and P2 corn populations followed by the

T3 dose (low dose) for the parameter numbers of grains per ear. These results don't join those gotten by Diallo *et al.* (2016) that observed a better number of grains solely per ear with a weak mineral fertilization dose on two varieties of corn.

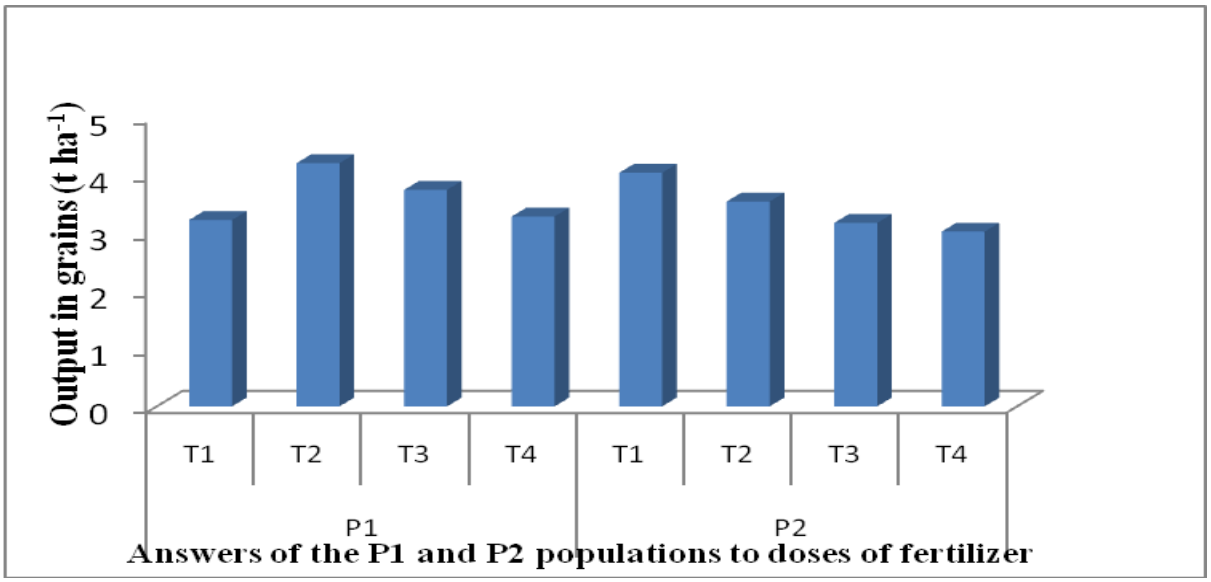

Fig. 4. Averages of the outputs in grains.

These results confirm the thesis of Hauck (1990) and of Lafond (2004) according to which the effect of the nitrogenous fertilization on the productivity of the cultures is very variable. Considering outputs in grains, the results of our survey show that the highest output in grains is got with the T2 dose before T3 (customary dose and weak) on the P1 population of corn. On the other hand, the best output in grains is recorded with the T1 dose (average dose) followed by T2 (customary dose) on the P2 population of corn. Strong dose (T4) mineral fertilization of our survey drew a fall of the productivity of the P1 populations and P2 of corn. And the T2 dose leads to a better interaction between the two P1 and P2 populations of corn.

These results reach those got by Nyembo *et al.* (2012) that noted the fall of output in grains with the strong dose of fertilizer. They showed that the phase of replenishment of the grains is a determining stage in the development of the output and that would have been disrupted. On the other hand other studies showed the opposite. Diepenbrock *et al.* (1995) got high grain number rates with an increase of the dose of the nitrogenous fertilization.

Conclusion

The results gotten in this survey showed that the T2 treatment led to an increase of the components of output of the P1 population. On the other hand the T1 treatment caused the increase of the components of output of the P2 population. In relation to the length of the stems, all treatments didn't give any meaningful effect on the two P1 populations and P2. Thus, to rentabilise the culture of the two improved populations of corn, in addition to the contribution of urea (46 N), the treatment corresponding T2 to the dose (30 - 15 - 15) complex cereal could be kept for the P1 population of corn. And the treatment corresponding T1 to the dose (20 - 10 - 10) complex cereal could also be recommended for the P2 population of corn to increase the productivity and producers income in the zone of survey.

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