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Full Length Research Paper

Tests of direct sowing of the durum wheat under pivot in the Saharan zone: Influence on yield components

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Our experiment is mainly based on the comparison of two methods of tillage leading of cereal cultivation under pivot in the arid zone, a case of El Meniâa (wilaya of Ghardaia). To achieve this, we have tested the technique of direct sowing in the Saharan zone by applying a random block experimental device with two treatments, T1 and T2, representing, respectively, a direct sowing and a sowing preceded by soil tillage by means of a double passage of the tine cultivator. The results show that the obtained yields reveal no significant difference between the two treatments, which means that the leading of cereal cultivation under pivot can do without a prior tillage.

Key words: Arid zones, cereal cultivation, pivot, tillage, direct sowing, yield.

INTRODUCTION

The intensive cereal cultivation leading in the highlighted perimeters in the arid zones (Adrar, El Oued, Ghardaia and Ouargla) constitutes an interesting palliative to the cereal production deficiency in the humid and sub-humid zones of Algeria. In these zones, climatic and edaphic conditions are extreme; therefore, the leading of winter cereal cultivation irrigated by pivot is totally different from that practised for the pluvial cereal cultivation in the North of Algeria.

Indeed, the climate is excessively arid and highly evaporating; thus, the prevailing winds have a negative impact on shallow, very fragile soils (Daoud and Halitim, 1994). Also, land exploitation in these regions is not without troubles, particularly in the section of soil handling mechanization (Kheyar et al., 2006; Amara et al., 2007).

Accordingly, the preparation of the seedbed can properly be envisaged only with instruments that do not turn the soil as the chisel and the cultivator. This practice which requires tine tools is similar to the simplified cultivation technique or minimum work. Nevertheless, the use of the tine cultivator comes along with an on-surface stone rise prejudicial to the successful achievement of the sowing and emphasizes wind erosion of the finest particles, thus entailing a decline of the soil fertility.

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Numerous comparative tests have shown that, in general, cereal yields are not so much influenced by the cultivation technique, but rather by the quality of the sowing (depth and regularity). This is confirmed by the work of Anken et al. (1999) which showed that cereal crops can bear a much reduced tillage, even none. For Gardner et al. (1999), quoting many authors, they indicate that the cereal yields are little affected by the tillage techniques.

Under pivot, when the production conditions are gathered (normally leached salts, rational irrigation, optimization of the fertilization and weed control), the direct sowing, regarding the numerous advantages that it offers, isn't it the alternative solution to the current method of leading?

It is thus to this question that we intend to bring an answer through field tests.

MATERIALS AND METHODS

Our experiment took place in El Meniâa (El Golea), an oasis in the South of Algeria situated at 270 km in the Southwest of Ghardaïa. Its geographical details are 30° 34' of latitude North and 0° 52' of longitude East, and 397 m of altitude (Figure 1).

The region of El-Meniâa belongs to the hyper-arid bioclimatic zone with low and erratic rainfall, of about 79 mm per year. The temperatures are very high and in strong daily amplitudes, the insolation and the luminosity are very intense, therefore, the evapotranspiration is significant. The frequent winds of the North can reach velocities from 11 to 15 m/sec. In this austere environment, the agricultural activity is inconceivable without irrigation

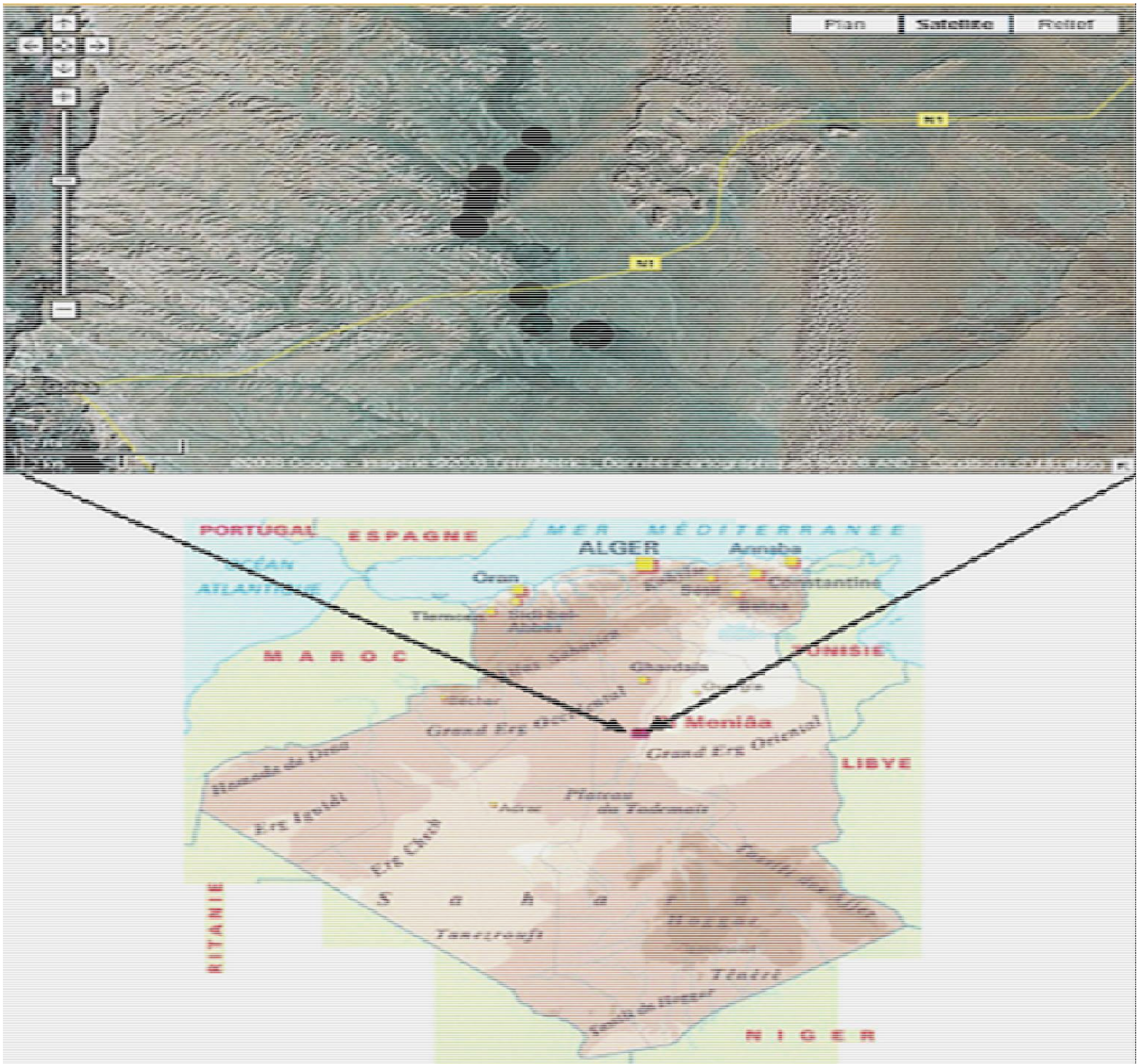

Figure 1. Location of test site.

and without an effective protection of the soil against wind erosion.

Field tests were conducted on pivot 8 where the soil is characterized by a sandy texture (99% of sand, 1% of silt, and 0% of clay), an average to low rate of stone loading in some places and a weak cover by the rests of the previous cultivation (barley).

In addition to adjusting the sowing depth, both seeders were tested in a fixed position to verify the uniformity of the distribution and to adapt the rotation speed of the distributing elements to the recommended seedling dose. The experimental device is a device with two treatments (a conventional sowing noted as CS and a direct sowing noted as DS) and three repetitions. Each elementary plot has a length of 100 m and a width of 18 m. A border of 0.5 m separates two adjacent plots. All relative data to the test are given in Table 1.

For each elementary plot and on small areas of 1 m^2, we have estimated to the three-leaf stage, the population density (raised stems/m^2) and to the maturity stage, the average height of stems, average root length, number of ears/m^2, the number of grains/ear and the thousand grain weight (TGW). The crop yield (q/ha) is the cumulative weight of grains in a small area per hectare.

RESULTS AND DISCUSSION

The regular follow-up of the plots from sowing to harvest has enabled the collecting of results in relation to crop growth and to yield components.

Table 1. Data relating to the test.

Operation	Conventional sowing	Direct sowing
False sowing	Pre-irrigation to help the removal of weeds	
Weeding	Pre-sowing herbicide : Round up	
Soil preparation	Two crossed passages with a tine cultivator allowance	None
Fertilization	Centrifugal fertilizer spreader	
Dose	Two proportions of 92 units of P_2O_5 (TSP 46%) One proportion of 100 units of K_2O (potassium sulphate 50%). Proportion of 280 units of nitrogen as UAN (urea, ammonia, nitrate).	
Seeder	On line seeder 'AGRIC' Ploughshare burying elements	Direct seeder 'VADERSTAD' Milled disc burying elements
Characteristics	Density: 350 (seeds/m²); TGW : 55 g ; Germinative faculty : 93% Dose : 214 kg/ha Sown population : 349158 plants/ha Sowing speed : 6 km/h	

Table 2. Sowing qualitative indications.

Parameter	Conventional sowing	Direct sowing	p<0.05	Statistical significance
Sowing depth (cm)	3. 35	2.25		
Covering rate %	97	85	0.195065	NS
Number of raised stems /m²	208.93	197.76	0.407759	NS

NS : not significant.

Table 3. Effect of the type of sowing on the growth.

Parameter	Conventional sowing	Direct sowing
Stem height (cm)	54.58	56.07
Root length (cm)	12.83	12.21
Standard deviation	2.04	2.17

Effect on the number of raised stems

Table 2 synthesizes the results of the qualitative indications of sowing (depth, seed covering rate and rising rate). For a sowing density of 350 seeds per m^2, the rising percentage in the conventional sowing is 59% (209 feet) compared with that of the direct sowing which is only 52% (198 feet). In direct sowing, the shallow depth of location (2.25 cm) and the insufficient seed covering (bad closure of the sowing line) by the burying elements of the direct seeder have contributed in reducing the rising percentage. Over 15% of seeds per m^2 have not been covered and remain on the surface exposed to predators (in particular crows which dig up the superficial or badly covered seeds). The speed of movement of the seeder, even if it is not very important (6 km/h), seems to be the main cause of this situation.

Effects on plant growth

The comparison of the results (Table 3) of plots conducted in conventional sowing and in directs sowing, the stem heights and the root length, do not show a significant difference. The analysis of variance, likewise, shows that the sowing method had no significant effect on both parameters measured.

As regards the development of the root system and in the presence of soils which are little fertile and which are very poor in organic matter, the lengths of the roots obtained are approximately identical and the maximum value does not exceed 13 cm. Field observations have shown that it is the spatial distribution of roots only that differs between the two sowing methods.

In direct sowing (undisturbed soil), the roots tend to develop horizontally. These results confirm those obtained by Dwyer et al. (1996) and Carof (2006) who report a significant concentration of roots on the surface in the no-till technique. This concentration is attributable to an increase in resistance of the soil to root penetration (Breune, 1997). This phenomenon is particularly marked

Table 4. Effect of the sowing method on the yield and its components.

Studied variable	Sowing type		p<0.05	Statistical significance
	Conventional	Direct		
Ears/m²	403.1	407.093	0.804066	NS
Grains/ear	29.03	30.34	0.573323	NS
Grains/m²	11702	12348	0.407759	NS
TGW (g)	48.83	52.94	0.090570	NS
Yield (q/ha)	56.35	65.38	0.076692	NS

NS: not significant.

Table 5. Working time to carry out the operations.

Technique	Tillage (h/ha)	Sowing (h/ha)	Total time (h/ha)
Conventional sowing	0.8	0.8	1.6
Direct sowing	00	0.8	0.8

in the presence of sandy soils susceptible to settling (Lesturgez, 2005). On the other hand, in the conventional sowing, initial soil disturbance by the cultivator tines has created a structural state favourable to the growth of roots that arrive up to the base of the searched area by the ploughing tool to reach the water and the nutrients (Nicou, 1974). Therefore, the roots follow the easiest path to assure their growth.

Effect on the yield and its components

The results presented in Table 4 indicate that the sowing method had no influence on the yield components; the TGW shows a difference of 4 g between the two types with a value of 53 g for the direct sowing against 49 g for the conventional sowing.

Concerning the number of ears in the m^2, and despite the weak density of plot population carried out in the direct sowing, the number of ears obtained is slightly higher (407 ears / m²) than the conventional sowing (403 ears / m^2). The same observation was made by Harrad (2003) on similar soils. It seems that the weak density of population at the rise helps improve the number of ears per m^2. It is the same for the voluntary settling of the sowing line. The 'settling' pneumatic wheels equipping the direct seeder have enabled to assure a better contact of the seed with the soil, a contact which would also be responsible for the number of ears obtained.

Even if the statistical analysis confirms that the sowing type had no significant effect on the yield, it appears for the reasons previously mentioned that the direct sowing has enabled obtaining relatively better grain yield, thanks to an ear population, a number of grains per ear and a TGW higher than the conventional sowing; at least as regards our test conditions.

Evaluation of the execution time of the work

Table 5 gives the real estimation of the working time devoted to each cultivation operation according to the sowing type. For an average speed of movement of 6 km/h and considering only the available equipment at the farm (a tractor with 4 wheel drive, 3 m seeders, and a 4 m tine cultivator), the results which are limited to the execution time of the work only (labor not included) indicate that the time taken to complete the sowing in the conventional technique is double that of the direct sowing. Notwithstanding the operations common to both techniques (weeding and fertilization), we can deduce that limiting the interventions to the sole seeder helps to decrease the number of passages and to reduce soil settling (Faure, 1981). From an economic standpoint, even if the price of the direct seeder is high (USD 25 000), investment is offset by the time of executing the work much less than the conventional seeding. The time savings will translate into reduced fuel consumption, reduced average costs of mechanization charges and production of wheat (Mrabet, 2001).

Conclusion

Our preliminary results have shown that in a Saharan environment (light textured soils, very poor in organic matter), the disturbance of the soil by the tine cultivator does not provide any additional benefits with regard to the no-tillage represented by the direct sowing, particularly in terms of yield. On the other hand, the direct sowing has enabled the obtaining of a relatively better yield (65.38 q / ha against 56.35 q / ha) thanks to an ear population (407) and a higher number of grains per ear (30.34).

From the techno-economic point of view, the farm size (over 100 ha) combined with topography (flat land), to the nature of the soil (full with stones in general), is a motivation for the adoption of the direct sowing which enables reduce the mechanization costs and preserve the soils from physical degradation related to their work.

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