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Analysis of the mechanical performance of no-till seed drills in Algeria: Impact on crop yield

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ABSTRACT/RESUME

Abstract: *The present work discussing one of direct seeding constraints in Algeria. The expensive price of seeder according to its availability for farmers slowed the adoption of this agricultural system in our country. Indeed, specific seeder "Boudour" have made in Algeria by CMA of Sidi Bel Abbes. To study the performance of this machine, an experiment was conducted during 2016/2017 agricultural season. The objectives are to compare the effects of different seeders on wheat and lentil development. The results show that "Boudour" is more performant in the soil with regular seeding depth (6 cm) and high yield value observed.*

I. Introduction

Soil management in agriculture by choosing the adequate agricultural technique is the source of sustainable production. The conventional technique using plow generates erosion, soils compaction as well as the impoverishment of organic matter [1,2,3,4].

Therefore, soil conservation can be an alternative. In Algeria, the adoption of conservation agriculture as direct seeding system aims to limit soil erosion, improve soil fertility and increase crop yields. This practice, which has been widely disseminated in Tunisia and Morocco, is beginning to develop among farmers in our country, especially in semi-arid areas [5]. The development of direct sowing (SD) in Algeria is according to economic, social and technical constraints [6].

One of the constraints for the adoption of this system by Algerian farmers is the availability and high cost of special seed drills. Direct seeding consists to put the seeds directly into the soil covered by the residues of the previous crop, to be profitable. This technique should be practiced in favorable situations. But its success depends on the seed drill used [1]. The most important role of seeders is the precision of burying the seed through the plant cover and ensuring good seed-soil contact. In general, there are two types of seed drills that differ by seeding units: discs or tines. The tines type is tending to be used on soils which have high resistance to penetration, but this often results in problems with equipment clogging by residue. In addition, this type is difficult to use it on stony soils with high roots density. On the other hand, the disc seeding units have a low soil penetration capacity, especially in clay soils but need low tractor puissance. In 2016, the Complexe des Machines Agricoles "CMA" in Sidi Bel Abbes (Algeria) have developed a prototype of no till seed drill that response to farmer's objectives as: tractors power, low price and good work quality.

The aim of this work is to study the performances of the innovated seed drill "Boudour", by comparing it with two other seed drills (direct and row sowing) and their consequences on durum wheat the yields (Triticum durum) and lentil (Lens Culinaris).

II. Material and methods

II.1. Soil and climate characteristics of the experimental site

The experiment was carried out during the 2016/2017 agricultural season at the demonstration and seeds production farm of "*ITGC" (Institut technique des grandes cultures)* in Sidi Bel Abbes. The site is located at an altitude of 490 m, at latitude 35 ° 10'25.20 "N and longitude: 0 ° 40'22.32" W. The soil is characterized by a silty-clay texture with a low

content of organic matter. The soil pH is alkaline soil (pH = 8) according to very high calcareous content, which varies between 19 to 36%.

The study area belongs to the Mediterranean, semi-arid bioclimatic stage [7]. According to ombrothermal diagram (Fig.1), 2016/2017 season is marked by drought that occurred from February with the noticeable drop in precipitation and the increase in maximum temperatures. The cumulative precipitation recorded is 316.6 mm, with -33.4 mm from the average for the last decade.

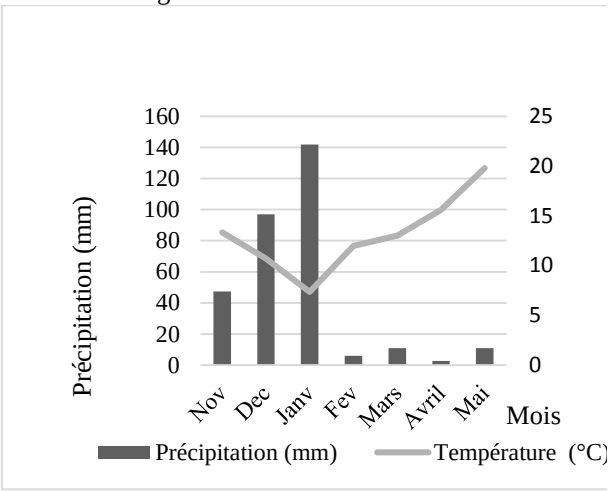


Figure 1. *Bagnouls and Gaussen ombrothermal diagram for the 2016/2017 crop season.*

II.2. Conduct of the experiment

The experiment area is 3000 m², divided between wheat and lentil. The plot is infested by a diverse weed flora mono and dicotyledons, with a strong presence of perennials as *Centaurea* and *Carduus*.

The plant material used for the experiment is durum wheat with "Vitron" variety and lentil with "Syria 229" variety. Considering the factors studied and soil topography, the experimental device adopted is a complete random block with three repetitions for each crop and three treatments: SD1: direct seeding with the "John Shearer" seeder, SD2: direct seeding with the seeder "Boudour" and TC: conventional technique (Fig.2).

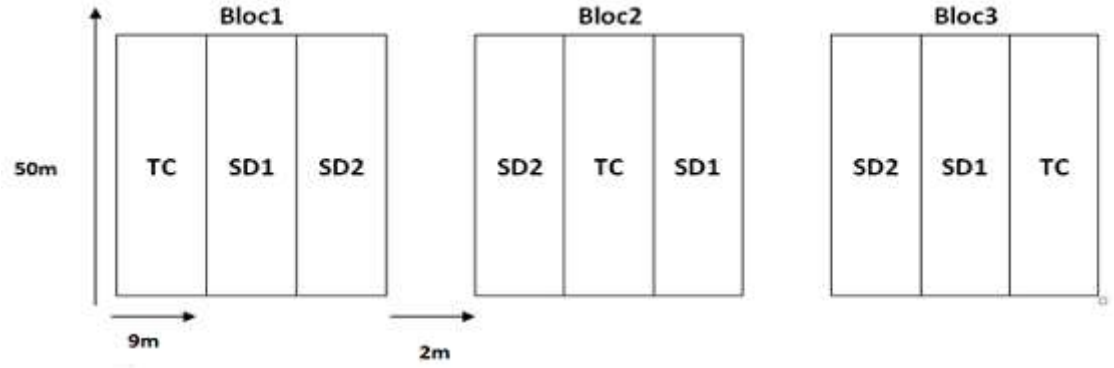


Figure 2. *Experimental plan*

The technical characteristics of the seed drills indicate a difference in the shapes and widths of the sowing units, on the other hand all the seed drills are tine seed drills (Table 01).

Table 01. *Technical characteristics of the different seed drills used*

Technical characteristics	TC (Simple seeder)	SD_1 (John Shearer seeder)	SD_2 (Boudour seeder)
Type of seeding unit	Tines		
Seeding width (m)	3	2,3	2,5
Spacing (mm)	150	230	180
Recovery	Herse	wheels	Herse
Groove width (mm)	15	7 at the beginning and at the end	14
Hopper	Simple	Combined	Combined

The experiment was conducted from the date of seeding to harvest step to evaluate the effect of seeding methods on yields and its components.

III. Results and discussion

The study of a seed drill performance affects the behavior of the crop and its development in relation to the yield and its components.

III.1. Crops cycle development

For the three treatments SD1, SD2 and TC, wheat cycle spreads out from December to June. While for lentil culture, pod abortion has been observed during the reproductive phase due to high heat and cumulative water stress ahead, knowing that lentil culture is sensitive to prolonged drought [8]. Therefore, the yield and its components have not been measured, but for the evaluation of the quality of the seedling, the "emergence" stage is sufficient. According to Table (02), the emergence of the first seedlings was observed in the plots seed with the "Boudour" tine seeder. Therefore, the development of phrenological stages in wheat is early in SD2. In addition, lens lifting was observed for the three treatments (SD1, SD2 and TC). But it should be noted that emergence was early for SD2 compared to SD1 and TC (Table 3).

Table 2. *Durum wheat crop development schedule*

Seeding November 21, 2016			
	TC/ difference in days	SD_1/ difference in days	SD_2/ difference in days
Emergence	22	24	17
Tillering	75	77	72
Upstream	104	106	102
Heading	124	127	122
Flowering	134	137	133
Physiological maturity	187	189	185

Table 3. *Lentil culture development schedule*

Seeding December 13,2016			
	TC/ difference in days	SD_1/ difference in days	SD_2 / difference in days
Emergence	23	26	20
Branching	52	57	52
Pod formation	63	67	62

III.2. Plant behavior in the soil

a. Emergence stage

The success of the vegetative phase of the crop depends largely on soil and seeding conditions. Good seed-soil contact is the result of good seed placement in fine soil by a powerful seed drill [9]. As a result, a variability in the emergence rate for wheat and lentil crops was observed for the three treatments studied (Fig. 3). During the seeding period, soil moisture is 18.36% and 17.37% for TC and SD respectively with a cumulative rainfall of 286.2 mm and 10.46 ° C of temperature, which favors seeds. On the other hand, the lifting rate obtained is greater for SD2 where seeding was carried out by the "Boudour" and TC seeder (Fig. 3).

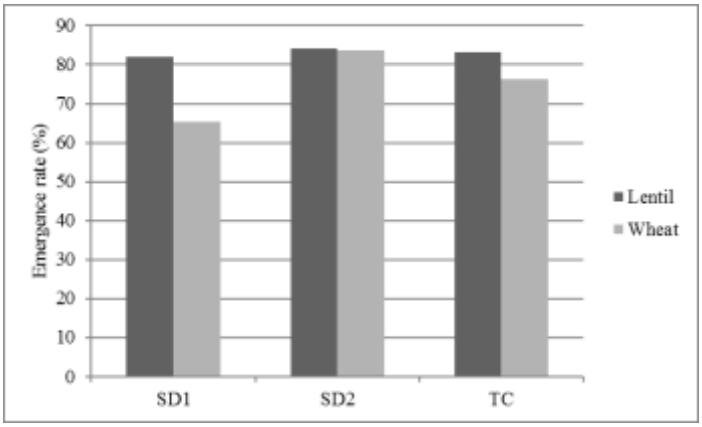
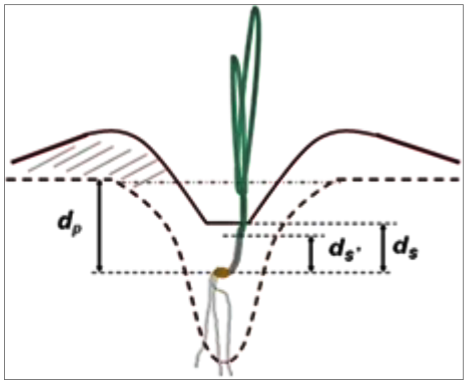


Figure 3. *Emergence rate of wheat and lentil*

b. Seeding depth

Successful emergence is linked to the seeding depth. Therefore, at the emergence stage, the seeding depth was measured for the three treatments. This key parameter was determined from the base of the leaf to the seed (Fig. 4).



Source : [9]
d_s = physical depth of soil cover over the seed
d_s is not the seed placement depth d_p (= distance below the reference soil surface)
d_s '= agronomic seeding depth
Figure 4. *Measuring the seeding depth*

The seeding depth varies between 6 to 9 cm for wheat and lentil for the three treatments (SD1, SD2 and TC) (Fig. 5). In TC, where the soil is plowed, the seeding depth is between 6 to 6.5 cm for lentil and wheat. While in SD, using the "John Shearer" tine drill, the seedling is deep and varies from 7 to 9 cm for lentil and wheat. While with "Boudour" seeder, the seeding depth is constant for both crops. Often, deep seeding results in late germination and emergence losses. According to the results of [10], in direct seeding, emergence is more homogeneous and the seeding depth is more regular, while in TC the emergence losses are very significant.
Generally, the seeding depth depends on the stability of the distribution elements in the soil. The distribution elements components of the innovated "Boudour" seed drill are ploughshare pointed openers, without fins and protected by tungsten carbide (CW), which increases their rigidity and stability in the soil as well as resistance to wear. Therefore, they ensure an even seeding depth. In fact, tine drills have the ability to spread residue and place the seed deep in the presence of fine soil [1].

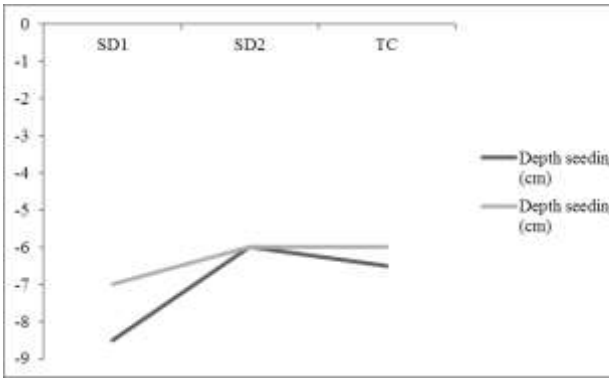


Figure 5. *Variation in the seeding depth of wheat and lentil crops depending on the drill used*

III.3. Development of root system

The development of the root system crops was measured at the seedling stage. In fact, the roots proliferation is linked to some soil physical parameters. The evaluation of soil porosity shows that in SD, the value is 60% and for TC, it is 68%. This variation in soil porosity is explained by the deep plowing in TC. As a result, the root system is developed well in TC compared to SD1 and SD2 for wheat (Fig. 6). In fact, root progression to deep soil layers is reduced in SD where the soil in surface is compacted [11]. In addition, a limited root progression in a soil can lead to reduced yields in terms of quality and quantity, especially during dry years.

For lentil culture, root development did not exceed 3 cm for the three treatments (SD1, SD2 and TC). Development of the root and aerial part of the lentil culture was not completed and the pods formed were aborted. So, the measures of yield and its components were limited for wheat.

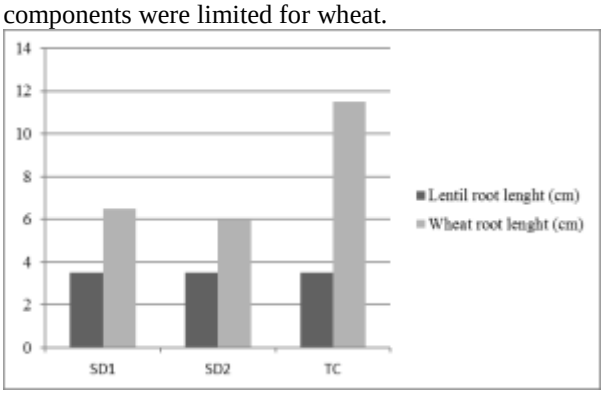


Figure 6. *Root development of crops at the seedling stage*

III.4. The yield and its components

Considering the climatic conditions recorded during the study period, the wheat yield values obtained are acceptable. The values vary between 19 to 22 q / ha. Plots cultivated in SD recorded a higher yield than TC (Fig. 7). Several research studies have shown the advantage of soil conservation on yields [11,12].
The difference obtained in the study case varies from 1.43 to 3.20 q / ha with a slight superiority of 1.77 q / ha for SD2 (Boudour seeder) compared to SD1 (John shearer seeder).

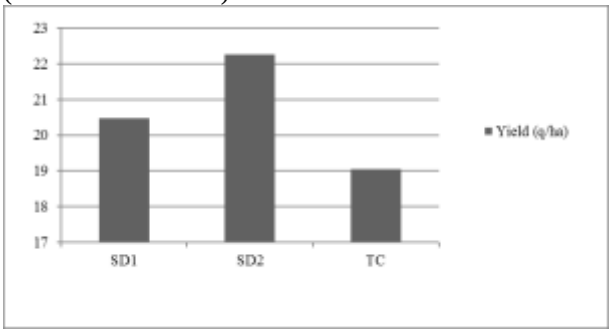


Figure 7. *Variations in durum wheat yield*

In addition, for the yield components, the number of grain / ear and the number of ears / m² are greater in SD compared to TC with the dominance of the "Boudour" seeder. While PMG (thousand grain weight) is better for TC (Fig. 8). In fact, the number of ears / m² is conditioned by the regularity of the distribution of seeds in the soil. The distribution units which ensure a good distribution of the seeds make it possible to enhance the yield in terms of number of ears / m². In addition, the PMG which is more important for TC, is directly related to the development of roots system in the soil. The roots proliferate in depth and benefit from the water stored deep down after the plowing operation. According to [13], water is the most important factor in increasing the thousand grain weight of crops.

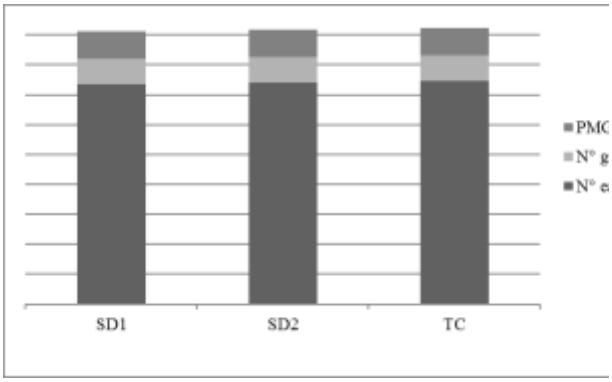


Figure 8. *Variation of yield components for durum wheat*

IV. Conclusion

The results of this test are in agreement with the results of previous research work on the positive effect of the conventional technique on soil porosity and root development. In addition, direct seeding with the innovative "Boudour" seeder, which is a tine seeder, reveals certain mechanical performance in terms of:

- ✓ Seeding depth
- ✓ Seed distribution and covering
- ✓ Rigidity and resistance on the ground.

In practice, it is recommended to control the seeding depth to guarantee crop emergence. As a result, the "Boudour" seeder with its stability on the soil and its output in terms of quality, price and traction force seems advantageous for farmers. In reality, agricultural mechanization in Algeria requires this type of innovation in order to better adopt soil conservation systems, especially in arid and semi-arid areas where the soils are gradually degrading.

Perspectives

- ✓ Seeding in soil with residue requires good penetration of the burial components. The "Boudour" seed drill with the pointed coulter design ensures an even seeding depth. But this result remains to be confirmed under different soil types and climate conditions.
- ✓ In dry conditions and to ensure good seed-soil contact with the "Boudour" seeder, it is important to add press wheels as cover parts.

V. References

1. Mrabet, R. Le semis direct : une technologie avancée pour une agriculture durable au Maroc. *MADREF – DERD* 76 (2001) 4p. (http://agriculture.ovh.org)
2. Chervet, A. ; Ramseier, L. ; Sturny, W. G. ; Tschannen, S. Comparaison du semis direct et du labour pendant 10 ans. *Revue suisse Agriculture* 37 (6), (2005) 249-256.
3. Mrabet, R. Climate change and carbon sequestration in the mediterranean bassin : contribution of no tillage systems. Les actes des 4eRencontres Méditerranéennes du Semis Direct. Sétif Algérie 3,4,5 mai 2010. *Revue Recherche agronomique*. (2010) 106-126.
4. Boiffin, J. ; Malezieux, E. ; Picard, D. Cropping systems for the future. In Nösberger, J. ; Geiger, H. H. ; Struik, P. C. (eds.), *Crop Science : progress and prospects*, CABI Publishing, Oxon (UK) (2001) 261-280.
5. Labad, R. ; Hartani ,T. Analyse des performances de quelques exploitations agricoles céréalières en semis direct dans la wilaya de Sétif. *Revue Agriculture. Numéro spécial 1* (2016) 78 – 81.
6. Rouabhi, A. ; Laouar, A. ; Mekhlouf, A. ; Dhibi, B. What Are The Factors Affecting No-Till Adoption In The Farming System Of Sétif Province In Algeria? *Turkish Journal of Agriculture - Food Science and Technology* 6 (6) (2018) 636-641.
7. Haddouche, D. ; Benmansour, N. Cartographie de l'occupation des sols agricoles. Cas de la commune de Tabia, Wilaya de Sidi Bel Abbés. *Agriculture and Forestry Journal* (1) (2017) 62-67.
8. Halila, M.H. ; Haddad, N.I. ; Sakr, B. ; Küsmenoglu, I. Food legumes in the near East. ARegional review. International Food Legume. *Research Conference* III.Sept. 22 - 26, (1997) 107-114.
9. Desbiolles, J. Seed and fertilizer placement –issues to consider for zero till tine drills. ACIAR/AusAID Project CIM-2008-027 Phase III. Development of conservation cropping systems in the drylands of northern Iraq. *Fact sheet 3, Australia Government* (2013).
10. Fellahi, Z. A. ;Hannachi, A. ; Chennafi, H. ; Makhlouf, M. ; Bouzerzour, H. Effet des résidus et du travail du sol sur la cinétique de l'accumulation de la biomasse, le rendement et l'utilisation de l'eau du blé dur (TriticumdurumDesf.) variété MBB sous conditions climatiques des hautes plaines Sétifiennes. *Sciences et Technologie* (2010).
11. Lopez-Bellido, L. ; Loppez-Bellilo, R. J. ; Gasstillo, J.E. ; Lopez-Billilo, F.J. Effects of tillage, crop rotation and nitrogen fertilization on wheat under rainfed mediterranean conditions. *Agronmy Journal* 92 (2000) 1054-1063.

12. Bonfil, D. J.; Mufradi, I.; Klitman, S.; Asido, S. Wheat grain yield and soil profile water distribution in a no-till arid environment. *Agronomy Journal* 91 (1999) 368–373.

13. Bouthiba, A. A. ; Debaeke, P. ; Hamoudi, S. A. Varietal differences in the response of durum wheat (TriticumturgidumL. var. durum) to irrigation strategies in a semi-arid region of Algeria. *Irrigation Science* 26 (2010) 239-251.

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