From Minimum Tillage to No Tillage, Reaction of Waha, Variety of Durum Wheat in Algerian Semi-arid Region

Benkherbache N. Benniou R., Merat M. ,Mekhalfia T. & *Makhlouf M.

Department of agronomy, University of M'sila, Algeria
*ITGC Sétif, Algeria
nbenkher@yahoo.fr

Abstract: The cereal grain producing regions in Algeria are semi-arid characterized by climatic constraints such as frost, the sirocco and especially irregular rainfall their deficit coincides with the demand for the cereal. To address this deficit, increased production must be achieved by improving efficiency, by correcting the climate constraint. Several studies have been conducted with the aim of diagnosing the behavior of grain and develop technical routes for different regions of the country.
Our study is to compare three crop management practiced on durum wheat. The trial was conducted in the semi arid region of Setif. The techniques applied are conventional tillage (CT), the minimum tillage (TM) and direct drilling (SD).
The direct drilling gives good results with high leaf area and plant height which directly influenced the yield and its components. The length of the ear was very similar for both SD and CT techniques. For root development the SD has a tendency to expand horizontally in contrast to the TC and TM. The TM has a higher stomatal resistance than the TC and SD. From stage swelling the water content is high in SD. The technique of direct seeding promotes water retention especially at critical times. This shows the interest that can provide direct seeding in Algeria, where water shortages due to deficient rainfall is the main factor limiting cereal.

Key words: crop management, direct drilling, conventional tillage, minimum tillage, stomatal resistance, RWC, variety WAHA.

Introduction

According Arabi and Roose (1989), limited production is generally attributed to several factors, some beyond the control of man like climate conditions as irregular rainfall, the climate accidents as frost and sirocco at the end of the cycle of plant. The other factors controlled by the man can improve this production are application of new crop management.

The general approach adopted in this study is to compare three differents crop management: direct drilling, conventional tillage and minimum tillage to bring out the most efficient technique to saving water, adjusting and improving performance variety Waha.

Materials and Methods

The trial was conducted in the Experimental Station of the Agricultural Technical Institute average (ITMAS) located 3km south-west of Setif, at an altitude of 1081m. The latitude is 36 ° 9 North and 5 ° 21 longitude. The study area is characterized by a Mediterranean semi-arid climate with cold winters and hot dry summers. The cumulative rainfall from September 2008 to June 2009 was 369.7 mm. The rainfall peaked during the month of April with 77.5 mm and a minimum during the month of May with 3.4mm.

The soil of the experimental plot is clay to silty clay with a pH of 8.5. The plant material is a variety of durum wheat (*Eastivum durum*) the variety Waha. Our test was conducted on the same plot and on the same crop management of the previous year, on an area of 2340 m². The field is divided into 3 units; each unit has a different crop management, direct driling (DS) The conventional tillage (TC) and minimum tillage (MT). In each unit, the number of repetition of 4 has been adopted. Direct drilling was sown directly by a direct seed drill. The conventional tillage plot has been prepared by the moldboard followed by the Cover crop and the harrow. The minimum tillage has been using only the chisel and the harrow. Weeds were controlled using chemical herbicides. An addition of phosphate (TSP 46%) and nitrogen (ammonium nitrate 34.5%) were performed.

The notations and measurements were made during every cycle of the plant. For morphological traits we measured the following parameters: leaf area (LA, mm ²) with a planimeter at boot, heading and flowering stages. Height (H, cm) of the plant is measured from the soil to the base of the spike at maturity. The length of the ear (LE, cm) was measured at maturity, the barbs not included. The root development was studied by the implementation of soil profiles on the three plots (SD, TC and TM). The depth of each profile is 45cm, the roots are carefully removed from the ground and then photographed.

For physiological traits we measured stomatal resistance (Rs; s.cm-1) determined using a diffusion porometer type AP4. For each treatment we considered the upper surface of the middle part of the leaf. Measurements were performed every stage of culture. The relative water content (RWC) on water content was measured using the method described by Barrs and Weatherley (1968). RWC was measured in each phenological stage of culture. The weight of fresh leaf (Pf) and saturated leaf with water (Psat) and dry leaf (Ps) were measured and repeated 4 times. The number of plant is measured at early stage. The number of spikes (NE) and the number of grains per ear (NGE), the 1000 grain weight (PMG), grain yield (RTD) are measured at maturity. The statistical analysis was performed using the software Stat Box Pro Version 7.1.0; it focused on an analysis of variance, a comparison of averages by the test of Newman and Keuls at 5%.

Results and Discussion

The effect of management and phenological stages on the leaf area present was very highly significant. Comparison of average crop management has two homogeneous groups is conducted in the plant till the leaf surface which is higher with the 1712.96 mm ² compared to conventional work and work with minimum respectively 1414.83 and 1346.38 mm ² mm ². A highly significant effect was noted for the interaction of two factors (Table 1).

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Table1. Effect of crop management on the morphological traits of durum wheat inalgerian semi arid region.

Parameters	LE(mm²)	H (cm)	LE (cm)
Crop management (F1)			
SD	1712,96a	57,31a	5,50
TC	1414,83b	54,06ab	5,91
TM	1346,38b	52,31b	4,63
Phenologiaal stage (F2)			
Boot stage	1318,75b	-	-
Heading	1373,13b	-	-
Flowering	1782,29a	-	-
CV%	10,253	4,01	12,360
Proba F1	0,000***	0,029*	0,058 ns
Proba F2	0,000***	-	-
Proba F1xF2	0,005**	-	-
Average	1491,389	54,56	5,35

*,**,*** and ns =significant, highly significant, very highly significant and no significant
a, b…= groups formed by the test of Newman and Keuls at 5%.

The evolution of leaf area, at boot stage, was the highest in direct drilling followed by conventional tillage then minimum tillage (Fig. 2). This is probably due to water retains in each crop management. Indeed, species arrive to reduce leaf area by water regime (*Onyibe, 2004*).

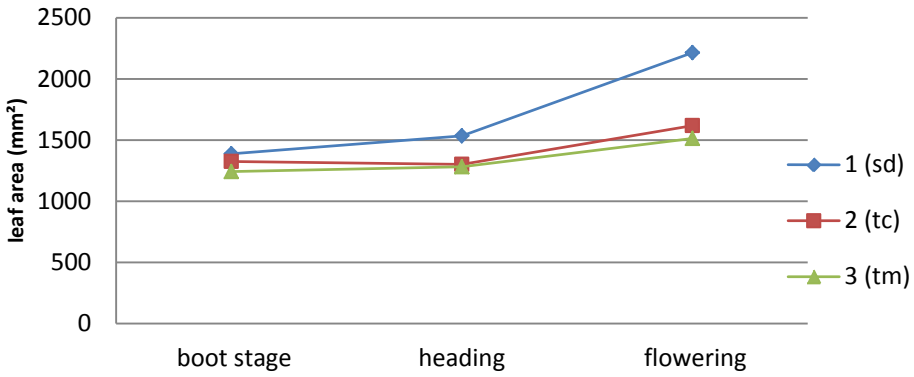

Fig. 1. Evolution of leaf area in different crop management

The height of stems shows a significant difference between the three crop management. Direct drilling presents the highest height with 57.31 cm above the minimum tillage with 52.31 cm and the conventional crop management with 54.06 cm. The height of Waha increases with the rate of rainfall and water supplies for irrigation (Ghouar, 2006). The length of the spike has not been greatly affected by the crop management.

On the ground (Fig.2), we see that roots tend to be developed horizontally in no-tillage because of the resistance of the soil which is quite important in not worked land. In conventional and minimum tillage, the roots tend to grow vertically or in depth in the soil which is till, that encourages deep rooting.

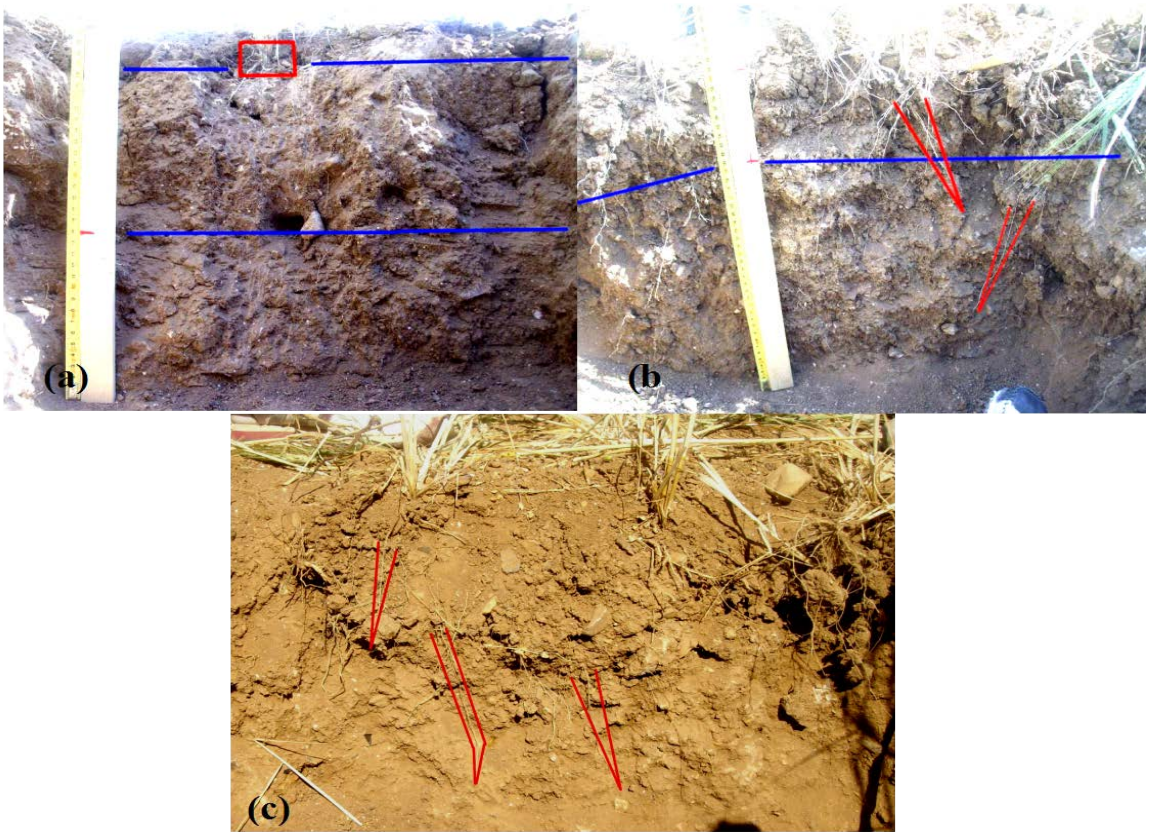

Fig. 2. Roots development in the three crop management conduced on durum wheat. *a: direct drilling, b : conventional tillage and c : minimum tillage. The blue lines are the limits of the horizons, the red arrows are the extension of roots.*

Table 2. Effect of crop management on the physiological traits of durum wheat in Algerian semi arid region.

Parameters	Rs (s/cm)	RWC (%)
Crop management (F1)		
SD	8,05 b	81,46
TC	9,12 b	79,19
TM	10,25 a	77,31
Phenological stage (F2)		
Boot stage	4,41 b	81,59
Heading	13,83 a	75,95
Flowering	14,85 a	71,31
CV%	13,643	9,947
Proba F1	0,000***	0,198 ns
Proba F2	0,000***	0,000***
Proba F1xF2	0,555 ns	0,677 ns
Average	9,140	79,320

*,**,*** and ns =significant, highly significant, very highly significant and no significant
a, b…= groups formed by the test of Newman and Keuls at 5%.

The stomatal resistance is very highly affected by the crop management and phenological stages (Table 2). Minimum tillage presented stomatal resistance highest with 10.25 $s.cm^{-1}$ compared to conventional tillage and direct drilling (fig. 3). Flowering and grain milky stages noted highest stomatal resistance.

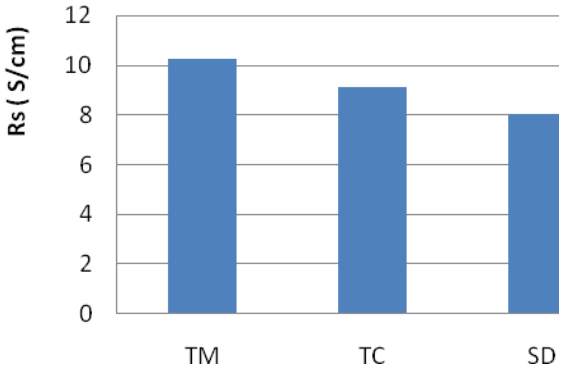

Fig. 3. Effect of crop management on the stomatal resistance.

This increase in stomatal resistance is caused by the closure of stomata which are opposed to the diffusion of water vapor and gases (Denden and Leumeur, 2000). The stomatal resistance was relatively low infrom tillering to boot stage, this is due to large amounts of rain and low temperatures recorded in April, which coincided with those stages.

From the boot stage to flowering, stomatal resistance increases rapidly for three treatments. These stages were held in the month of May when rainfall was the lowest (3.4 mm). Chartzoulakis et *al*. (1999) consider that the stomatal resistance increases with the degree of water deficit.

The relative water content was affected by the phenological stages and not by the crop management (Table 2). The conventional tillage gives a better result at the 3 leaves stage followed respectively by the minimum tillage and direct drilling. From the boot stage, direct drilling gives the best results followed by conventional and minimum tillage, this is due principally to: i) the water economy in the last stages of culture, the RWC of plants is based on the level of soil moisture (Kasraoui et *al*., 2004) and ii) the tillage allowed the conventional crop management a better use of depth water contrary with minimum tillage (no deep tillage).

Table 2. Average and statistical results yield and its components in relation to different cultural practices applied.

Parameters	NE	NGE	PMG	RDT
Crop management (F1)				
SD	462,00 a	23,67	36,37 a	40,33 a
TC	364,00 b	23,67	36,75 a	31,75 a
TM	336,00 b	20,83	31,10 b	21,72 b
CV%	13,778	13,517	3,364	23,761
Proba F1	0,003 **	0,215ns	0,000***	0,002**
Average	387,333	22,722	34,739	31,27

*,**,*** and ns =significant, highly significant, very highly significant and no significant
a, b…= groups formed by the test of Newman and Keuls at 5%.

Direct seeding has presented a high number of spikes with 462 ears / m². Conventional and minimum tillage have presented a lowest number of ears with 364 and 336 ears/m² respectively. This is related to the number of emerged plants in each technique. According to Kribaa (1992), a good water and nitrogen nutrition of wheat (Waha) leads to the achievement of good number of ears that can reach the thresholds of 423,2 ears/m².

The average fertility of Waha is at around 22.72 kernels per ear. Cultivation techniques have exceeded this average, except for minimum work. The highest number of grains per spike is the presented by the direct drilling or no-tillage and conventional tillage with 23 kernels per ear. The minimum tillage presented the lowest value with 20 kernels per ear. Fertility is determined from early tillering to flowering, the period when the growth rate is most important. According Couvreur (1981), the number of kernels per ear is strongly influenced by the condition of the vegetative especially its volume.

A very highly significant effect of crop management was noted on the weight of thousand grains. Direct seeding and conventional tillage provided a high PMG compared to minimum tillage (fig. 3). This difference may be due to the conservation of soil moisture in dry periods during grain filling, which has enabled them to complete the growth cycle and also a better grain filling (Belguerri et *al*., 2007). In wheat, the lifting stages, stem elongation and grain filling are considered key stages of development of major components of performance: the number of seeds/m² and weight of thousand gras.

Fig. 4. Effect of crop management on the weight of thousand grains in Waha, durum wheat variety.

The yield shows a very high significant difference between the three crop management tested. We notated two homogeneous groups: the first group is formed by direct drilling and conventional tillage, the second group is formed by the minimum tillage. The no-tillage and conventional crop management showed a high yield with 33.23 q/ha for direct drilling and 29.86q/ha for conventional tillage. The minimum work presented only 22.67q/ha with a difference of about 6 q/ha. The yield is based on water available in late stage (Belaid, 1987).

Conclusion

The results of our experiments show that direct drilling or no-tillage gives good results compared to other crop management. The morphological parameters studied, show that the cultivation of wheat in direct drilling has presented the highest leaf area and stem height which has directly affect the yield and its components. The length of the ear was very close between the two techniques no tillage and conventional tillage. For root development is superficial in direct drilling. For the physiological parameters studied, direct drilling has exhibited low stomatal resistance and higher relative water content than the other techniques, what makes a good water supply plants.

The conventional crop management presented a highest weight of thousand grains. The yield wasn't different between prepared and no prepared soil.

If we look to the techno-economic aspect, we can say that direct drilling is widely economic than the other two techniques. With an economy of time spent in the field, which implies a gain of fuel, labor and machinery.

So, it remains to follow this technique for several years to confirm which is stable before the integration into the production system at the regional and national levels.

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