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Combined effect of soil practices and chemical treatments on weeds growth, soil features, and yield performance in field wheat crop under Mediterranean climate

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Abstract. Soil management techniques influence the biological and physicochemical properties of the soil and lead to changes in soil quality and cover and thus on crop profitability and yield. In this study, the effects of short-term tillage and no-tillage methods combined with a chemical treatment using Glyphosate on weed abundance, selected soil physical properties and yield components were evaluated in durum wheat under Mediterranean climatic conditions. The no-tillage (NT) treatment resulted in higher weed community density during wheat cultivation and moisture consumption than the conventional tillage treatment. The tillage practice and the application of Glyphosate showed a very high efficiency on weeds. Furthermore, the results obtained showed a significant variation and effect of the treatments on the soil characteristics. The application of the no-tillage technique induced a small increase in soil moisture at the seed germination stage (25.6%), while at the last sampling a small increase was recorded in the CT treatment (9.5% for CT and 8.8% for NT). The results of the soil porosity, showed during the whole test period high values in the conventional technique (with or without herbicide application); but for the resistance to soil penetration, the results showed higher values in the no-till technique. Finally, the effect of the tillage system on crop yield was evaluated. In our study, the results showed that significant increases in the number of heads per m^2 (351.3 heads per m^2), the number of grains per head (45.8) and the weight of 1,000 grains (41.2 g) were obtained with the tillage treatment combined with glyphosate application. When comparing the two tillage methods, the highest values were always revealed with the tillage technique.

Key words: tillage system, no tillage system, herbicides, weeds, soil features, wheat.

INTRODUCTION

Soil management practices are a fundamental step to improve soil quality and crop yields. It is the essential way to ensure the sustainability of the agro-systems under the growing demand for food. In recent years, various studies have been realized to compare between these practices and to demonstrate their effect on biological, chemical and physical soil properties that, in turn, affect plant performance (Weber et al., 2017).

Conventional tillage practices are mechanical operations aimed at turning over the soil to create ideal conditions for seedling development and plant nutrient uptake (Garane et al., 2017). This practice is carried out using a chain of tillage tools that mainly consists of a plough, a cover crop and other tillage tools. Tillage often has a positive effect on soil moisture, bulk density, porosity, organic matter and microbiome abundance (Kaurin, et al., 2015; Niewiadomska, 2020). The tillage method regulates the sustainable use of crop soil resources, improves soil penetration, increases root absorption and development, and promotes crop growth and yield (Laurent et al., 2014).

Several studies compared different tillage techniques (conventional and conservation tillage) (Blevins et al., 2018; Hu et al., 2021), with the aim of getting the best from each technique.

Conventional practices based on tillage with turning are fundamental agro-technical operations in agriculture because of their influence on soil properties, the environment and agricultural production aimed at creating ideal conditions for seedling development and plant nutrient uptake. It is a technique that positively affects certain soil characteristics; soil loosening and leveling for seedbed preparation, as well as, soil fertilizer mixing and crop residue management (Busari et al., 2015). This technique helps in weed control, as well as, crop residue management and organic matter burial (Garane et al., 2017; Boko et al., 2020).

In addition, plowing can negatively influence soil bulk density, penetration resistance, increase soil compaction, the average weight diameter of aggregates and surface roughness (Carman, 1996). Mechanical properties, can also be affected by conventional tillage can, by disrupt soil structure becoming more vulnerable to wind, runoff, and general erosion. On cereal farming, there is a tendency to reduce tillage, motivated by the desire to reduce production and mechanization costs, to protect the soil from erosion or to promote carbon storage at the rate of soil mineralization by reducing the mineralization of organic matter (Roger-Estrade et al., 2011).

Conservation agriculture practices aimed at permanent soil cover followed by reduced tillage could be an innovation in farmers' strategies for sustainable agriculture (Kouelo et al., 2017). Conservation tillage (minimum tillage and direct seeding), is a method of reducing the use of implements to the point of allowing only one implement to minimize pressure on the soil and avoid compaction problems. No-till management, or direct seeding, is supposed to eliminate the undesirable consequences of conventional tillage, including soil degradation, and to improve several soil properties and water retention capacities; ploughed soil has a damaged pore network and so less water and mineral constituents. Furthermore, by inhibiting water infiltration, the crust increases the danger of erosion and runoff (Avramovic et al., 2022).

No-till has been shown to have a positive effect on increasing organic matter levels and structural stability (Moussadek, 2011). Many studies have confirmed that, compared to conventional tillage, conservation tillage can reduce soil erosion (Roger-Estrade et al., 2011). Other studies have also shown that no-till and reduced tillage methods, such as chisel tillage, reduced soil losses significantly compared to conventional mouldboard tillage. The increase in structural stability is directly proportional to the increase in stable organic matter content (Hu et al., 2021).

The absence of soil disturbance promotes denitrification processes (Labreuche et al., 2011). The main disadvantages of conservation agriculture concern weed management, in semi-arid zones, weeds such as brome that develop in the absence of deep tillage lead to increased control costs (Rouabhi et al., 2018). Weeds are plants that spread naturally without human intervention in natural habitats or natural seedlings and are undesirable herbaceous or woody plants at the site where they occur (Pipon, 2013). Competition between the latter and a given cereal constitutes a constraint to crop development through the competitive power of weeds (Morison et al., 2008).

According to Pipon (2013), the various socio-economic reasons plead today for an increased rationalization of weed control in order to avoid unnecessary or superfluous treatments as much as possible**.** Another approach to weed control could be practiced in the management of these bio-aggressors, an integrated control based on all mechanical, chemical and biological methods. These combined methods will give the best efficiency to keep the damage below the nuisance threshold (Néron, 2011). Indeed, many weed species are now resistant to herbicides, especially glyphosate (Heap, 2019 in Yash, 2020).

Given the importance of yield losses due to weeds, this study was designed to develop an environmentally adapted weed control system to minimize the use of plant protection products under two different tillage systems (conventional tillage and direct seeding).

MATERIALS AND METHODS

The experimentation was conducted in the National Higher School of Agronomy, ENSA; Algiers (36° 43’ N, 3°09’77’’ E) Fig. 1 under Mediterranean climate characterized with a wet winter between January & early May and a hot dry summer between May & October (average annual precipitation of approx. 63.6 mm and average annual temperature of 15.9 °C) Fig. 2. The soil analysis performed before experimentation were revealed rate of 25 %, 26% and 16% of clays, fine loam and coarse loam respectively, pH7, K 2.6 mg per 100 g and N 0.07%.

Figure 1. Satellite image of the experimental station (Google map, 2021).

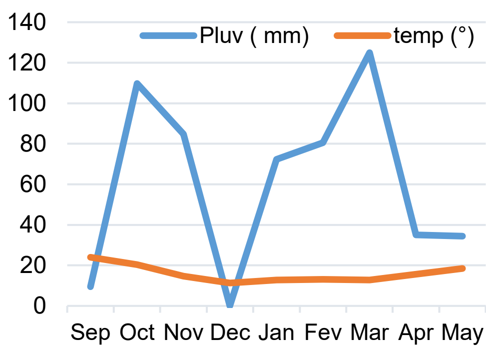

Figure 2. Umbrothermal graph for the 2015/2016 season.

Experimentation design

A 3744 m² (72 m × 52 m) plots were assigned for the treatments, divided into 12 micro-plots with 15 m long and 10 m wide (150 m²) Fig. 3. In this experiment, wheat (*Triticum durum L.*) '*Vitron*' was cultivated using the method of factorial block with two factors: tillage practice and chemical treatments. With 3 three replicates. Wheat was grown at a rate of 300 seeds m^{-2} in late November 2015, and was conducted using two tillage systems; conventional (CT) and no-till (NT), it is important to mention that the experimental plot is a fallow land. Each practice combined with or without glyphosate herbicide application respectively Fig. 3, tools used in soil preparation, a bisocs plough (25 cm deep) on 19 of November 2015, followed by one passage of a cover crop to crush large clumps, then using Roto-harrow to improve soil crumbling, on 22 November. No practice was carried out for NT method. For each practice, only nitrogen fertilizer was applied in the dose (100 kg ha^{-1}), in two terms in the form of 46% urea was applied, half at the early tillering stage and the other half at the ear 1cm stage for both techniques. Herbicides treatments were performed using Glyphosate© (3 L ha^{-1}) 10 days prior to crop planting was sprayed on 15 of November 2015. Moreover, sowing (CT and NT) 24 of November 2015 with two different seeders.

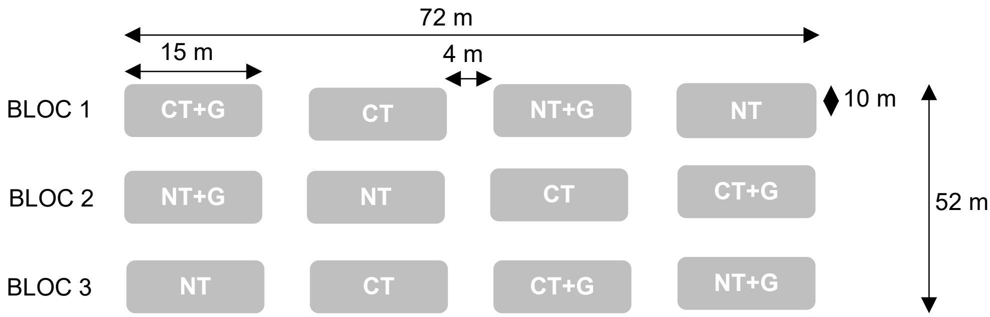

Figure 3. Experimental device of our study. NT: No tillage practice without glyphosate application; NT+G: No-tillage practice with application of glyphosate; CT: Conventional tillage method without glyphosate and CT+G: Conventional tillage method with application of glyphosate.

Soil sampling and physical analyses

Soil samplings were performed, after seeds germination, tillering stage, and at seed filling at a depth the 15 to 30 cm using a 5 cm diameter auger. Soil sampling was carried out, before soil preparation and, considered as control. The soil samples, were firstly weighed, then oven-dried at 105 °C for 24 h, and stored for analysis. Soil physical properties such as soil penetration resistance, humidity soil and bulk density were calculated from each sample. Soil penetration resistance was evaluated to a maximum, depth of 30 cm at every 10 cm depth interval using a manual cone penetrometer with 2 cm^2 surface area in the base. Porosity, soil humidity and bulk density were calculated using formula, (1) (2) and (3) respectively, a value of real density (Rd) is 2.49.

$$P\% = \left(1 - \frac{\mathrm{Bd}}{\mathrm{Rd}}\right) \times 100 \quad (1)$$

P – Total Porosity (%); Bd – Bulk density; Rd – Real density.

$$H\% = \frac{Ww - Dw}{Dw} \times 100 \quad (2)$$

H – Soil Humidity (%); Ww – Wet weight (g); Dw: Dry weight (g).

However, bulk density was performed by collecting soil cores between 0–10 cm, 11–20 cm, and 21–30 cm depth, using a metal core with known volume by placing the core in the middle of each soil level.

$$Bd = \frac{Dw}{V} \quad (3)$$

Bd – bulk density; Dw – dry weight; V – volume of soil sample (cm^3).

Weed community survey

The number and the abundance (number of individuals per species) of weed species in each treatment were determined using aquadrat (0.2 m^2) per plot: before seeds sowing, after seeds germination, at tillering stage, and at the seed filling. Sampling quadrats were located along a linear itinerary, every time at least 2.5 m away from the plot borders and at least 6 m away from other sampling site. Three measures of weed diversity were computed in each treatment.

Yield parameters

Wheat grain yield were recorded as described in standard procedures. Number of heads per m^2 was counted using a quadrat (1 m^2) randomly placed in the micro-plot. Three replicates were performed for each treatment. Moreover, number of grains per ear, was recorded directly after wheat harvest, ten heads were randomly taken from each of three sampling sites in each micro-plot. heads were manually threshed then counted. 1,000-grain weight was measured using a precision balance from three repetitions of each treatment. Finally, estimated grain yield was determined for each sampling site using the formula (4).

$$Estimated\ yield\ (qx\ per\ ha) = number\ of\ head\ per\ m^2 \times \text{number of grainper head} \times \frac{1{,}000\ grain\ weight}{10{,}000} \quad (4)$$

Statistical analysis

A one-factor analysis of variance (Anova 1) was used to compare, conventional tillage with herbicide treatment, conventional tillage with no herbicide treatment, no-till with herbicide treatment and no-till with no herbicide treatment on the weeds and during the three stages of wheat. Differences between means were tested using the post-hoc tuckey test at the 5% significance level. Correlations at the 5% threshold were performed between the number of heads per m^2, the number of grains per head, the weight of 1,000 grains and the theoretical yield. All analyses were performed using Excel and Statigraphic 19.

RESULTS AND DISCUSSION

Soil practices and chemical treatments affect weed growth

The results of our study showed that during wheat cultivation, tillage with or without glyphosate treatment were very effective on weed survival. After seed germination, no weeds appeared under CT+G and CT. However, weed density decreased from 127.4 plants per m^2 to 0 plants per m^2.The weed density value is low under NT+G

(25 plants per m^2) and high for NT (176.6 plants per m^2) Fig. 4, A. The ploughing predicted a lower weed density and variety than direct sowing (Pilipavicius et al., 2009; Alletru & Labreuche, 2019). During the germination stage, the analysis of variance (Anova test) showed a very highly significant difference ($F = 76.9$; $P < 0.001$) observed between the treatment on weed density. At the tillering stage in the CT (after 45 days of treatment) Fig. 4, C the effect of the tested technical itineraries on weed density shows that there were still 22.1 weeds plants per m^2 in the treated methods, the CT showed low weed growth whose achieved density was 10 plants per m^2 Fig. 4, B. Woźniak (2018) confirmed this result as well distinguished that tillage and soil turning significantly reduce weed growth.

For no-tillage, the highest weed density was obtained without glyphosate (NT) application, with 176.6 plants per m^2 (Fig. 4, A). According to Gruber & Claupein (2009), the no-till method increases the weed seed reserve in the superficial soil layers, which leads to an intense manifestation of weeds with the crop. Under (NT+G) a decrease in weed density observed (25 plants per m^2) Fig. 4, A. Similarly, Hayden et al., (2012) were recorded a reduction of 78% in weeds after turning the soil under a tillage practice.

These results were in accordance with previous studies (Abdellaoui et al., 2011; Gathala et al., 2011; Alarcón et al., 2018), in which higher weed degradation under the tillage method and high weed density with no-till practices were observed. On the contrary, Streit et al. (2002) found that weed density was lower in the no-till technique compared to a conventional method.

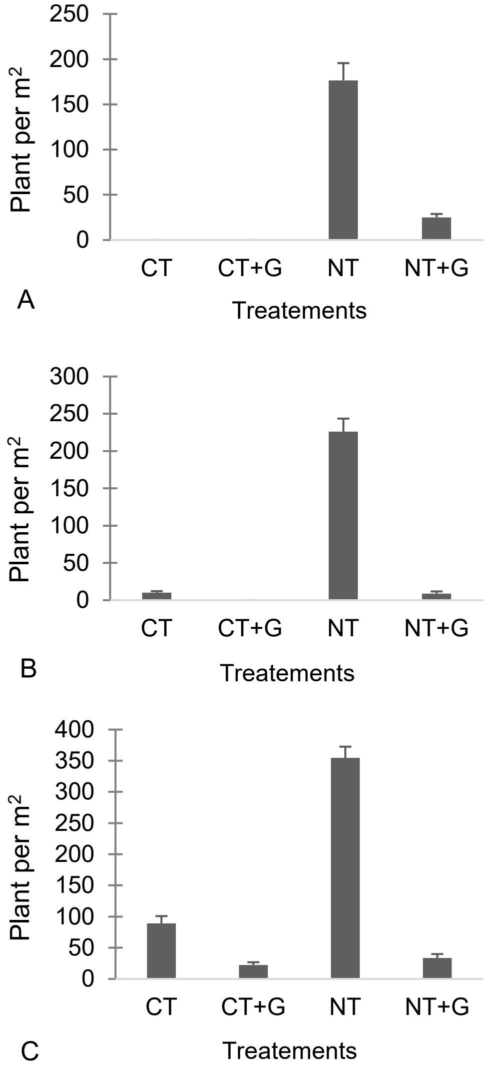

Figure 4. Weeds abundance under soil practices management and Glyphosate application under wheat crop cultivation, (A) after germination, (B) at the tillering stage and (C) the seed filling. Each value is the mean of ten replicates. Error bars represent ± standard deviation.

In addition, at tillering stage, NT showed the highest growth and weed level with a density of 226 plants per m^2 Fig. 4, B, At Seed filling stage, the highest weed level was always recorded with NT (354.4 plants per m^2). However, CT+G showed the lowest value with a density of plants m^{-2} while CT and NT+G showed a density of 33.4 plants m^{-2} and 89 plants m^{-2} respectively. At the tillering stage, a very highly significant difference ($F = 152.3$; $P < 0.001$) in the effect of the four technical itineraries (CT, CT+G, NT, NT+G).

According to Petit et al. (2013), reducing dependence on herbicides is a current issue. However, the actual state of knowledge does not provide enough solutions or generic alternatives to manage the weed flora and thus minimize losses to yield. In deed, for the seed filling stage, statistical analysis recorded a very highly significant difference ($F = 182.6$; $P < 0.001$), for the effect of the technical itineraries tested on weed density. Weed density was low 22.1 plants per m^2 and 33.4 plants per m^2 for CT + G, NT + G respectively; average 89 plants per m^2 for CT, and high 354.40 plants per m^2 for NT Fig. 4, C.

Soil features under different tillage management and chemical treatments
Humidity

Water conservation and maintenance of soil fertility is one of the major challenges of soil management. The results of this research showed that soil humidity was higher in no-till (CT) practices. At the germination stage, soil tests revealed 25.6% and 23.4% humidity under NT and NT+G treatments respectively Fig. 5, A. Our results are in agreement with several studies that report that no-till improves soil humidity and water storage compared to conventional techniques (Abdellaoui et al., 2011).

Statistical analysis showed a significant effect of the effect of soil itineraries on moisture at the germination stage with ($F = 5.3$; $P < 0.001$). According to Guzha (2004) a significant influence of tillage practice on soil humidity, and water storage, especially in dry climates, and by its ability to maintain or increase the availability of organic matter and improve the physical properties of the soil. Ji et al. (2013) found that the water content of the soil under the no-till (NT) method at 30–40 cm depth of loam soil was significantly higher than tillage method (CT).

However, a proportion of 22.2% and 21.4% was obtained for CT and CT+G respectively Fig. 5, A. Then, the humidity content has been decreased for the whole treatments in the second samples with slightly high values for the conventional techniques. In the NT treatment, the humidity was reduced to 8.1% and NT+G to 7.1%. While the highest value 9.1% was obtained with CT+G (Fig. 5, B) tillering stage at the last sample, slight increases were recorded compared to the 2nd sampling, the highest rates were revealed in CT and NT with 9.4% and 8.8% respectively.

At seed filling stage, soil humidity is high in CT 9.4%; it is stable in NT and NT+G with similar values (8.8% and 8.4% respectively). The lowest value is observed in CT+G (7.8%). the reduction of humidity observed in the last two stages is due to the climatic conditions (since March, significant drop in rainfall). The anova analysis revealed that no significant effect for all technical itineraries considerate on humidity for the last both stages ($F = 0.9$; $P > 0.05$ tillering stage and $F = 1.9$; $P > 0.05$ seed filling stage).

Nouiri et al. (2004) conducted a comparative study of water retention and humidity in soil layers, between the no-tillage technique and that of tillage carried out in Tunisia. The results obtained are in agreement with Sadeghi & Bahrani (2009), which confirm that there was little difference of soil humidity under conventional tillage compared to no-till and that no-till provides a better humidity than conventional tillage. The higher soil humidity content under no-tillage would be the result of reduced evaporation from the low runoff due to the presence of crop residues on the surface and/or the higher water retention.

Porosity and penetrometry

Soil porosity was not influenced by plant development stages, but rather by soil practices (tillage and no tillage). Soil porosity throughout the season, the highest rate was revealed under the tillage method with or without herbicide application. At the germination stage, as reported in several studies, tillage significantly increases porosity; a value of 62.7% was obtained with CT and 59.3% with CT+G Fig. 6, A.

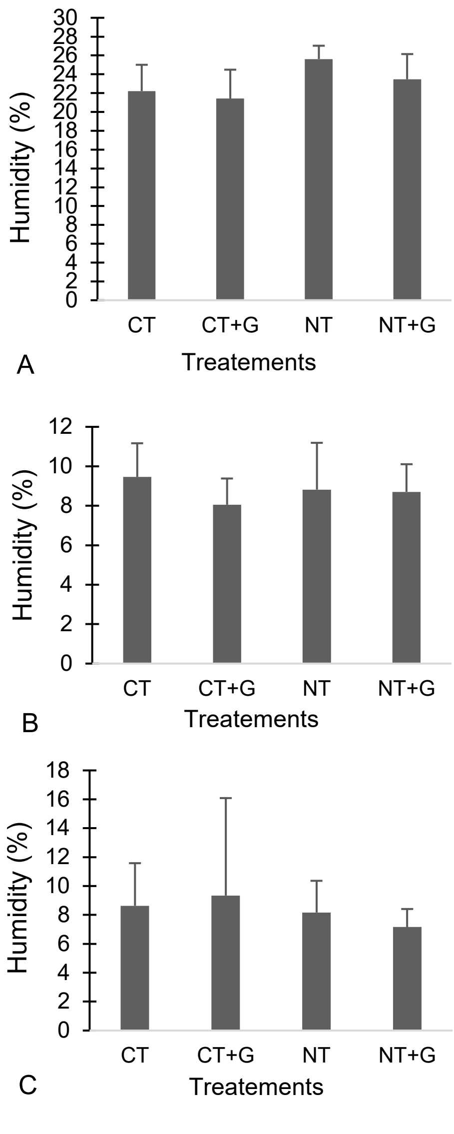

Figure 5. Effect of soil practices management and Glyphosate application on soil humidity under wheat crop cultivation, (A) after germination, (B) at the tillering stage and (C) the seed filling. Each value is the mean of ten replicates. Error bars represent ± standard deviation.

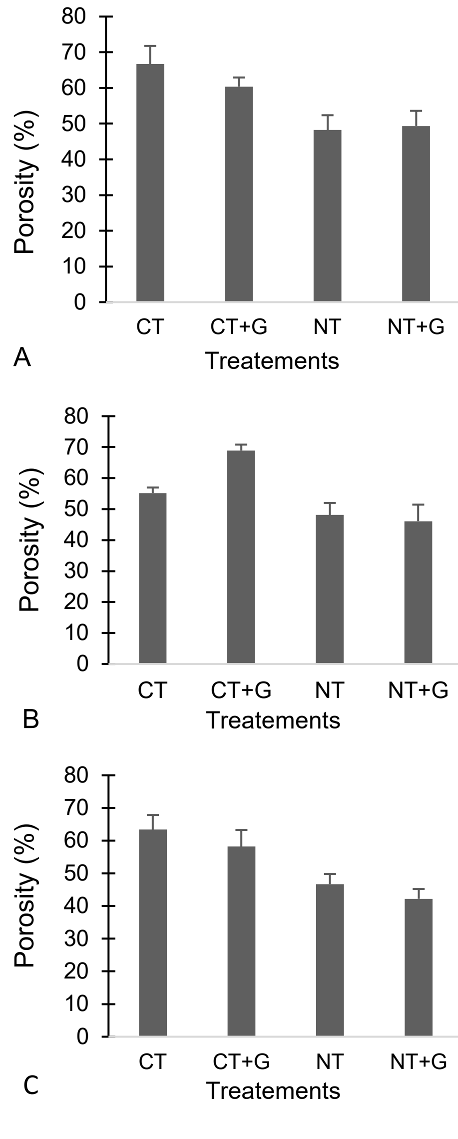

Figure 6. Soil practices management and Glyphosate application affected soil porosity under wheat crop cultivation, (A) after germination, (B) at the tillering stage and (C) the seed filling. Each value is the mean of ten replicates. Error bars represent ± standard deviation.

The results achieved by Lipiec et al. (2006) explained that porosity and pore size were highly influenced by the tillage method. In this study, the soil tillage conventional technique indicated the highest porosity and pore size especially in the surface layers of the soil. Moreover, at tillering stage, porosity increased by 68.9% with CT+G treatment and decreased for CT treatment (55.1%).

On the other hand, the porosity was around 48.1% and 46.1% with NT and NT+G respectively Fig. 6, B. At the end of cultivation, the analyses showed soil porosity of 63.3%, 58.1%, 46.6% and 42.1% with CT, CT+G, NT and NT+G respectively. A higher percentage of soil porosity under tillage than no tillage was obtained in the studies of Hill et al. (1985) and Kay & Vanden Bygaart (2002).

The grain filling stage shows high porosity values in the CT and CT+G techniques. An approaching value was found between germination and filling stage for the CT technique (about 60%), but these values drop in the NT and NT+G techniques (42% and 45.7% respectively) Fig. 6, C.

The Anova analysis shows a highly significant effect of the impact of the four techniques on porosity for all four stages of wheat with ($P < 0.0000$). Pastorelli et al. (2013) observed significantly an effect of the soil preparation ($p < 0.001$) on the total porosity in the first 10 centimeters.

Soil penetration resistance was the third trait studied. The results showed higher values in soils with no tillage practices. At germination, the NT treatment showed a penetration of 39.5 daN per cm^2, while the CT+G treatment showed the lowest penetration with 26.3 daN per cm^2 Fig. 7, A. At the second sample, the highest value was obtained with the NT+G treatment (32.4 daN per cm^2). The Anova-test following by tuckey-test indicated a significative difference between these four itineraries. Miyamoto et al. (2012) and Ji et al. (2013) found similar results in the previous study.

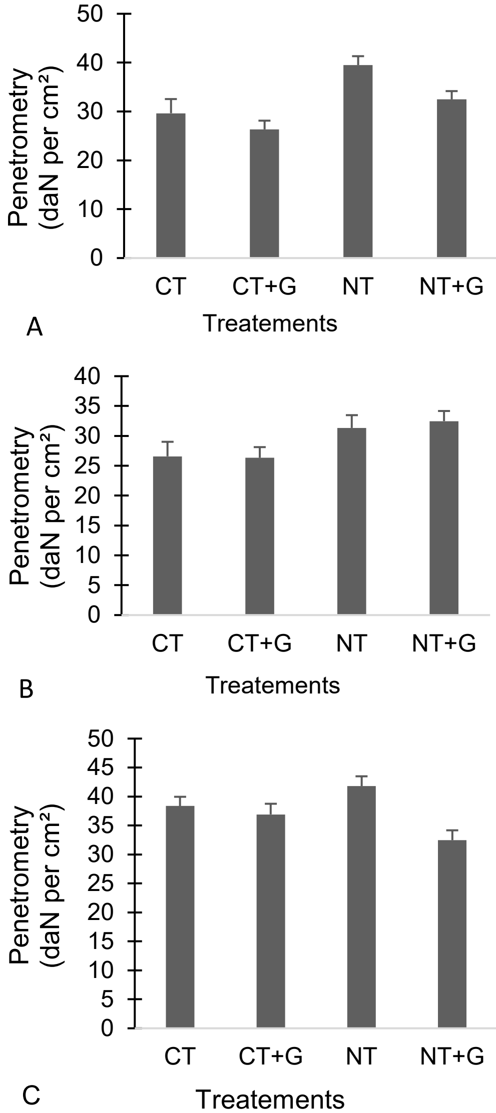

Figure 7. Effect of soil practices management and Glyphosate application on soil penetration resistance under wheat crop cultivation, (A) after germination, (B) at the tillering stage and (C) the seed filling. Each value is the mean of ten replicates. Error bars represent ± standard deviation.

At tillering stage, high values of resistance to penetration were observed in NT and NT+G treatment respectively 41.7 daN per cm^2 and 41.1 daN per cm^2 the CT+G and CT treatment showed the lowest penetration with 36.9 daN per cm^2 and 38.3 daN per cm^2 Fig. 7, A. The Anova-test and tuckey-test indicated significative difference between these four itineraries. Miyamoto et al. (2012) and Ji et al. (2013) and Das et al. (2014) showed similar results in a previous study, where tillage and soil depth, and soil penetration resistance significantly affected soil penetration resistance was significantly affected by tillage and soil depth. (Das et al., 2014) reported the same observation. Soil penetration resistance was increased after tillage (Alesso et al., 2019), followed by NT (31.3 daN per cm^2) and CT (26.5 daN per cm^2) treatment Fig. 7, B.

Finally, at Seed filling stage, the values of this parameter were significantly increased compared to the other two samples. A penetration of 41.7 daN per cm^2 and 38.3 daN per cm^2 was recorded in the NT and CT treatments, respectively Fig. 7, C.

However, after comparing between tillage systems Özgöz et al. (2007) reported higher soil penetration after no tillage application than a soil beforehand managed by conventional tillage. Soil compaction can cause unfavorable physico-chemical and biological properties of the soil that affect root growth and crop yield. The results of Dahou et al. (2018) have specified that tillage techniques have a direct influence on penetration resistance and root depth.

Weeds modulate yield growth parameters of Wheat

In this work, the soil practices and/or herbicide treatments significantly affected their various yield components as the number of heads per m^2, and the number of grains per heads and the weight of the 1,000-grains that assesse the yields capacity of wheat. The results showed that notable increases for the three yield components studied were obtained with the treatment tillage combined with glyphosate application. The effect of different treatments on number of heads per m^2 is shown in Fig. 8, A. The highest values 351.3heads per m^2 and 252 heads per m^2 were recorded with the treatments CT+G and CT respectively. Through the results of linear correlations, there are high positive correlations (the correlation coefficient r ranked between (0.7 and 0.9) and highly significant ($P < 0.01$) between all the yield parameters such as number of heads per m^{-2}, number of grains per head, weight of 1,000 grains and the theoretical yield.

These results are in agreement with those of Abdellaoui et al (2011), who show that conventional tillage techniques, when newly applied, especially in semi-arid lands, have the highest yields compared to the no-till method. The effect of tillage method on yield was significantly affected by the interaction between the tillage system, and the years of application, under the no-till method yields are lowest in the first years and are highest after five or six years (Alarcón et al., 2018).

The lowest value was obtained by NT (28.6 heads per m^2), which explains the effect of weeds and caused by the competition that weeds have on crops and primarily affects crop yields. This competition was related to space, light, water expressed as the difference between the yield with weeding and the yield without weeding. The anova test reported a very highly significant difference ($F = 50.7$; $P < 0.001$) in the number of heads per m^2 between the techniques tested.

According to our results, anova-test revealed a very highly significant difference ($F = 139.8$; $P < 0.001$). In effect, the CT+G treatment had a significant influence on the number of grains per head. The application of glyphosate increased this parameter up to an average of 45.8. Furthermore, CT and NT+G were showed a similar effect with an average of 40 grains per heads Fig. 8, B.

However, for the weight of 1,000 grains, only a slight increase was obtained with CT+G, which showed a value of 41.2 g, compared to the other treatments. On the other hand, the lowest weights, 25.2 g and 29.8 g, were recorded with CT and NT, respectively. However, NT+G increased the weight of 1,000 grains to an average of 33.5 g Fig. 8, C, while, Rieger et al. (2008) reported that at the maturity stage of wheat, shoot, and biomass was 2% higher in the no-tillage system compared to the tillage method, but grain yield was 3% lower in the no-tillage system compared to the tillage method. According to the statistical analysis the anova-test, there was a highly significant difference between the techniques itineraries and the 100-weights ($F = 8.6$; $P > 0.05$). Anova analysis noted that there was a very highly significant difference ($F = 42.6$; $P < 0.001$) for the yield parameter. The lowest estimated yield levels, (1.3 q ha^{-1}), was recorded in the treatment NT, CT and NT+G. The values were increased up to 18.4 q ha^{-1} à 31 q ha^{-1} respectively compared to NT, while the results showed a yield of 66.3 q ha^{-1} with the treatment CT+G Fig. 8, D. Ciha (1982) was observed an average grain yields and a 100-seed weight with no-tillage significantly greater than yields using tillage system. According to De Vita et al. (2007), there were no effects of NT system during the first 2 years in either wheat yield or quality under Mediterranean climate conditions.

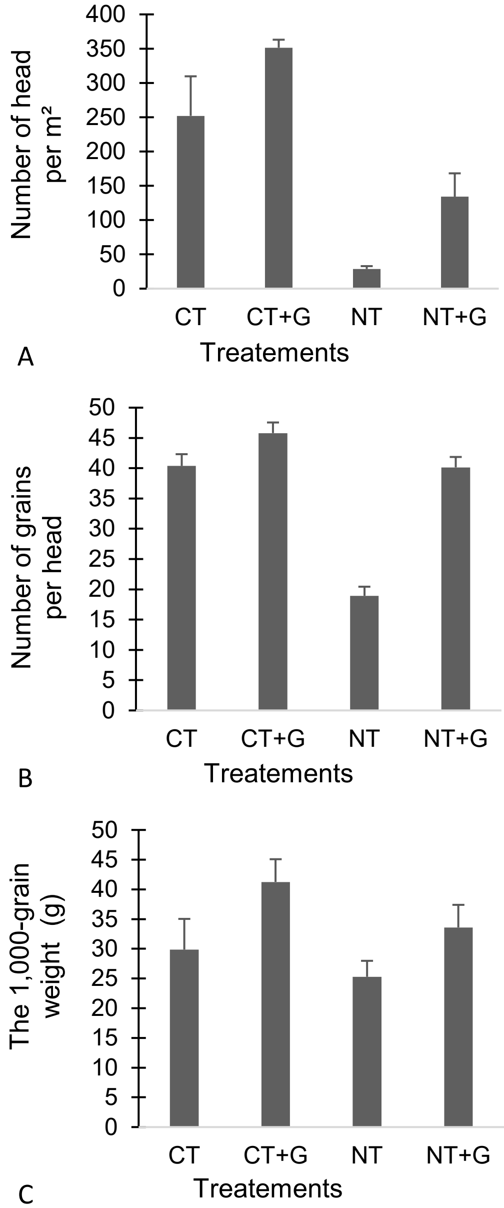

Figure 8. Effect of soil practices management and Glyphosate application on wheat yield components parameters, (A) Number of heads par m^2, (B) Number of grains per head and (C) The 1,000-grain weight. Each value is the mean of ten replicates. Error bars represent ± standard deviation.

Through this results, there are strong positive correlations (the correlation coefficient r located between (0.7 and 0.9) and highly significant (*P* < 0.01) between all the yield parameters such as; number of heads per m², number of grains per head, weight of 1,000 grains and the theoretical yield. Results showed a slight effect of weeds on yield Fig. 9. Alarcón et al. (2018) were mentioned that higher cereal yields were associated with a negative impact on weed diversity and richness. Increasing density of weeds affect directly crop yields (Pretty & Bharucha, 2014). Management, weeds and yield component relationship using the Scatterplot Matrix Fig. 9 demonstrate that weeds are strongly related to the NT and NT+G treatments. Whereas, the number of grains per head, the number of heads per m² and the 1,000-grain weight have a close relationship with CT and CT+G treatments.

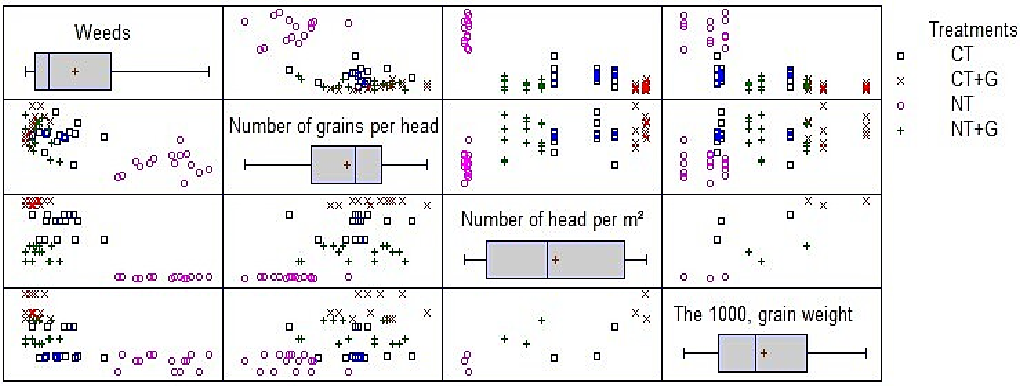

Figure 9. Scatterplot Matrix analysis of the correlations between weeds abundance and the three yield components parameters under soil practices management and Glyphosate application. Each value is the mean of ten replicates. Error bars represent ± standard deviation.

CONCLUSION

Soil management plays an important role in designing sustainable farming systems. Utilizing this approach requires more detailed study and careful experimental design than the traditional comparison between conventional and reduced tillage. A more precise analysis that takes into account soil characteristics and weed management Therefore, it is important to implement integrated weed management programs for weeds with evolutionary resistance to any weed control method. Tillage strategy as part of agricultural control is an interesting way to reduce the use of herbicides.

Our results focused on two main parts, the first one is the of influence agricultural practices on soil physical properties, soil humidity, porosity and penetrometry, and the second one is the influence of chemical and mechanical processes in weed infestation, and its consequences on the crop.

The humidity value is high in the NT and NT+G (of 25.6% and 23.4%) technique compared and to CT (22.2 and 21.4), as the plant cover frequently favors water conservation in the upper soil layer. Reduced evapotranspiration leads to lower humidity losses in the SD system; water penetrates the NT soil about three times faster than CT in ploughed soil (Chervet et al., 2016).

Nevertheless, soil porosity is better in CT than in NT tillering the soil significantly increases the porosity, a of 66.7% has been obtained with CT and 60.3% with CT+G; which is explained by the turning of the soil which favors its restructuring by rearranging the aggregates, contrary to NT where the soil is less disturbed. In general, in NT, weed control by herbicide was partial and reappearance was faster compared to CT where the seed stock was buried deep by the ploughing operation, which slowed down the germination of weed seeds.

The combination of mechanical tillage and chemical control (CT+G) allows the eradication of weeds with a significant reduction in the quantity of herbicide, this combination seems to be the most efficient to face one of the constraints of the yield decrease which are weeds and to preserve the environment. The results obtained confirm that yield is directly influenced by weed competition; this is less important in NT than in CT and more precisely in relation to the chemical treatment (yield is high in CT, NT+G and TC+G, while it is low in NT). Traditional tillage, with its deeper action on the soil, resulted in a high yield. The highest values 351.3 heads per m^2 and 252 heads per m^2 were recorded with CT+G and CT treatments respectively, while the lowest value was obtained by NT (28.6 heads per m^2), which explains the effect of weeds and competition on wheat yields.

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