Impacts of post-sowing compaction on temporal variation of soil temperature for different wheat growth period in North China Plain

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Introduction

The reason of soil temperature variation has become a major concern considering the numerous impacts on soil physical properties, microbial process, nutrient movement, crop growth and yield. Many researches showed that soil temperature is influenced by soil management. Post-sowing compaction is one important part of soil management, which may influence soil temperature, other soil properties and crop growth. Appropriate post-sowing compaction can create suitable soil conditions for planted seeds by compacting soil particles to a proper density, providing better soil-seed contact and reducing the moisture loss rate for planting. However, excessive compaction can affect soil aeration, temperature and root growth, which due mostly to excessive mechanical impedance. Therefore, suitable post-sowing compaction device is necessary to guarantee appropriate compaction for soil and crop. The objective of this research is to evaluate the effects of three post-sowing compaction devices on temporal variation of soil temperature with different depth for different growth period of wheat in Beijing of North China Plain.

Materials and methods

A study was conducted in Beijing suburb of China, which has a mean annual temperature in the region is11℃, with a frost-free period of around 190 days. 75% of the annual precipitation occurs during summer with an annual average of 600 mm. Typically, winter wheat is sown in October and harvested in June. This study assessed three types of post-sowing compaction (Fig. 2): (1) compaction wheel of rubber (CW), (2) compaction roller consisting of welded steel bars (CR) and (3) two kinds of compaction rollers (traditional roller behind compaction roller consisting of welded steel bars, soil was compacted twice in this treatment) (TCR), which installed on planter with disc openers, were applied to the experimental plots. CW worked only on the intra-row soil surface; both CR and TCR worked on the whole soil surface, both intra- and inter-row. Rainfall, air and soil temperature were monitored by a public solar-powered automatic weather station. From each plot, five sensors were inserted into soil surface of intra-row and inter-row, 20cm, 40cm, and 60cm soil layers. The data of one day (October 5, 2015), one month (November 5, 2015), two months (December 5, 2015), three months (January 5, 2016) and four months (February 5, 2016) after post-sowing compaction were extracted and analyzed. Mean values were calculated for each of the measured variables, and ANOVA was used to assess the treatment effects.

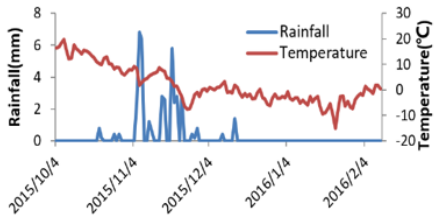
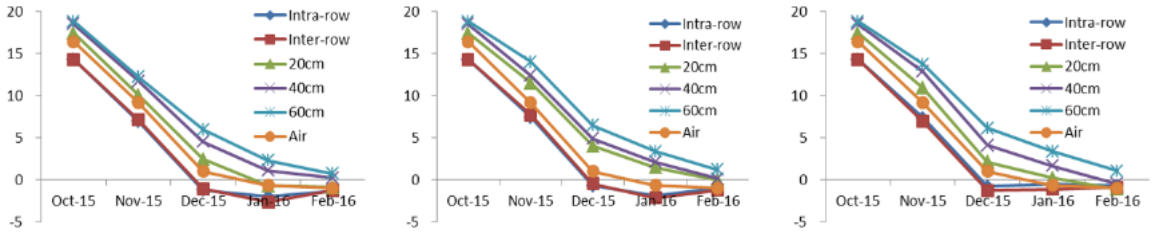


Figure 1. Distribution of rainfall and air temperature

Figure 2. Post-sowing compaction devices

Results and discussion

The average soil temperature had similar change regularity in the 20-60cm soil depth than that in the surface soil (Fig. 3). Under TCR treatments (Fig.3a), the differences for intra- and inter-row soil surface were existing seedlings. In the first two months after sowing, the average soil temperature on the intra-row soil surface was lower than inter-row surface, however, as the weather became colder in the three and four months after sowing, the soil temperature on the intra-row soil surface became higher than inter-row surface. This indicated that seedlings had the warm effect in colder weather since the sun's energy passes through the mulch and heats the air and soil beneath the mulch directly and then the heat is trapped by the ''greenhouse effect''. Under CR treatment (Fig.3b), the differences for intra- and inter-row soil surface were also existing seedlings; however, the soil temperature on the intra-row soil surface was lower than on the inter-row soil surface for all the extracted growth period. This discrepancy was probably due to less compaction than the TCR treatment. Under CW treatment (Fig.3c), the differences for intra- and inter-row soil surface were not only existing seedlings, but also existent compaction. And the soil temperature on the intra-row soil surface was higher than on the inter-row soil surface for all the extracted growth period. This was probably caused by the dual effect of seedlings and compaction.



(a) TCR treatment (b) CR treatment (c) CW treatment

Figure 3. Average soil temperature in different depth under different treatments in different growth period(℃)

Conclusions

The result of soil temperature in different soil depth showed that soil temperature on the soil surface has a similar variation rule with air temperature; and the deeper the soil depth, the higher the soil temperature. Soil temperature under TCR treatment on intra-row surface was lower than inter-row surface in the first two months after sowing, and higher than inter-row surface in three and four months after sowing, which indicated that seedlings had the warm effect in colder weather; but soil temperature under CR treatment on intra-row surface was lower than inter-row surface, and this discrepancy was probably due to less compaction than the TCR treatment. Soil temperature under CW treatment on the intra-row soil surface was higher than on the inter-row soil surface and this was probably caused by the dual effect of seedlings and compaction. Further work is required to confirm these results across a wider range of field soil conditions and to evaluate the impacts of ground cover.