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Interactive comment on "Estimating hydraulic conductivity of a crusted loamy soil from beerkan experiments in a Mediterranean vineyard" *by* Vincenzo Alagna et al.

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Dear Prof. Gerd Wessolek,

First of all, we wish to thank You for Your comments, Your encouraging words and Your suggestion to improve the manuscript.
The specific objective of our investigation was to check the ability of the BEST method to yield plausible estimates of saturated hydraulic conductivity of crusted and non-crusted soils because the potential of the beerkan runs to detect the effect of the crust layer on flow is still largely unknown. There are some encouraging signs at this purpose but only a few investigations have been carried out. In a stratified

porous medium, the crusted layer may control the infiltration process and, following Lassabatere et al. (2010), the hypothesis was that BEST parameters may be assigned to the less permeable layer.
Two different approaches were applied in this investigation to check the ability of the BEST procedure to yield a different information between crusted and non-crusted soil. The first approach considered temporal changes of K_s values obtained between the rows before and after the intense storms fallen in September 2015 that led to the development of a weak but clearly detectable surface crust. With this approach, the third field campaign allowed us to detect the restoring of higher K_s values because tillage removed the crust. **Figure 1a** depicts the soil hydraulic conductivity functions obtained from averaged parameters for the different sampling dates at the vine inter-row area. While the curves of the first and the third sampling dates are close to one another, the curve of the second campaign departs for them rather clearly. Indeed, this result could be viewed as a suggestion that this latter curve might represent a crust layer characteristic curve. The second approach considered the spatial variation (i.e., rows vs. inter-rows) of conductivity, i.e. taking into account the protective role of the vegetation. A shift between the hydraulic conductivity functions for the row and inter-row areas was also detected, with the soil of the latter area denoting a reduced ability to conduct water for a given soil water content value (**Figure 1b**). Therefore, both approaches suggested that the BEST procedure was appropriate to show the impact of crusting on soil hydraulic conductivity.
However, we agree with You that the interest for our investigation could increase if we were able to show what are the hydrological implications of different soil hydraulic properties between the surface and the subsurface layers (Roth, 1997). At this purpose, we carried out some numerical simulations during the review of the manuscript with the objective to check the plausibility of our assumption that a beerkan infiltration run on the crusted soil layer is appropriate to hydraulically characterize this layer.
Numerical simulations were carried out using the graphical software packageVS2DI (Healy, 1990; Healy and Ronan, 1996), developed by the U.S. Geological Survey

for simulating the movement of water and transport of solute or heat in variably saturated porous media. In particular, the finite-difference method was used to solve the Richards equation for water flow. According to Nasta et al. (2012), a zero pressure head boundary condition was imposed on the soil surface delimited by the ring, while free drainage was set at the bottom of the modeled domain. The BEST derived parameters were used in VS2DI to obtain the simulated cumulative infiltration curves. In particular, the parameters estimated along the rows and on the bare inter-rows area during the second field campaign were used to define the hydraulic properties of the underlying soil and the crust layer (thickness of 4 mm), respectively. Moreover, with the aim to assess the impact of the hydraulic conductivity of the crust layer on the simulated curves, different K_s values of the crust layer (from 93.6 to 165.6 mm h^{-1}) were considered. Then, the simulated cumulative infiltration curves ($I_{SIMULATION}$) were compared with the experimental BEST curve obtained on the crusted soil during the second field campaign (I_{BEST} for N data points at time t_k using the root mean squared errors ($RMSE$s):

$$RMSE = \sqrt{\frac{\sum_{k=1}^{N}[I_{SIMULATION}(t_k)-I_{BEST}(t_k)]^2}{N}} \quad (1)$$

Figure 2 shows the relationship between $RMSE$ and K_s values of the surface crust. The smallest deviation was obtained for a crust layer having K_s = 133.2 mm h^{-1}. This value differed by a negligible factor of 1.03 from the in situ K_s value obtained on the layered system (crust layer, underlying soil). This result supported our hypothesis that the experimental K_s value was representative of the hydraulic behavior of the least permeable layer (i.e., the crust layer). Therefore, the derived BEST parameters could be properly assigned to this layer, which controlled the flow and consequently cumulative infiltration of the stratified medium.

Regarding your second suggestion, intensity and kinetic energy of the rainfall

were found to play a major role in determining mechanical changes of the soil surface (Baumhardt et al., 1990; Eigel and Moore, 1983). In the subsection 2.2. of the manuscript we reported some characteristics of the rainfalls occurred between the first and second sampling campaigns, which led the development of the surface crust.

Lastly, we agree that **Table 3** and **Figure 5** show redundant information and we will delete **Figure 5**.

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Best regards

Dr Simone Di Prima

On behalf of the authors

Fig. 1. Soil hydraulic conductivity functions obtained from averaged parameters for **(a)** different sampling dates and **(b)** along and between the vine-rows.

Fig. 2. **(a)** Root mean square errors ($RMSE$s) between the simulated and the experimental BEST curves vs. the saturated soil hydraulic conductivity, K_s, values of the surface crust. **(b)** Infiltration curve simulated considering a K_s value of the surface crust equal to 133.2 mm h^{-1} (line) compared with the measured BEST curve at the second field campaign in the inter-row area (dashed line). **(c)** Soil water content profile simulated with K_s = 133.2 mm h^{-1}.

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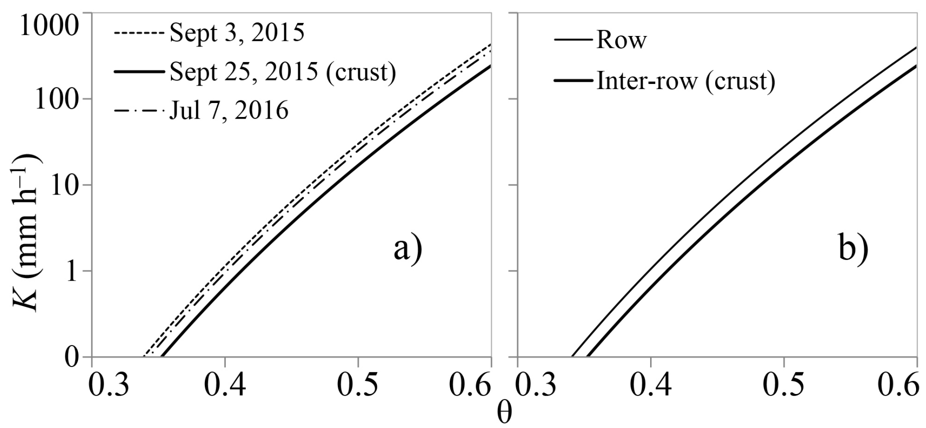
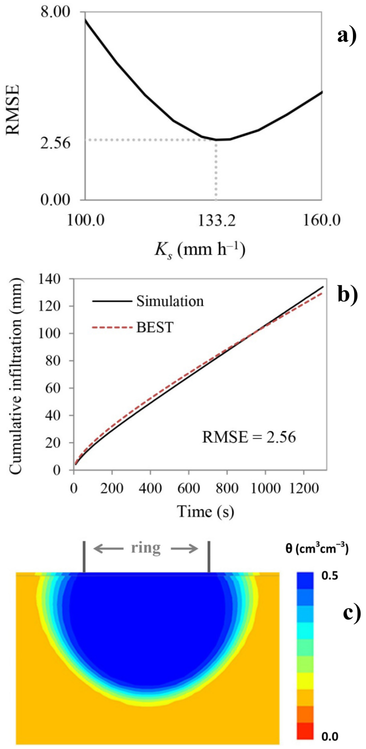


Fig. 1.



8.00
2.56
0.00
RMSE
100.0
133.2
160.0
K_s (mm h^{-1})
a)
140
120
100
80
60
40
20
0
Cumulative infiltration (mm)
Simulation
BEST
RMSE = 2.56
0
200
400
600
800
1000
1200
Time (s)
b)
ring
θ (cm^{3}cm^{-3})
0.5
0.0
c)

Fig. 2.