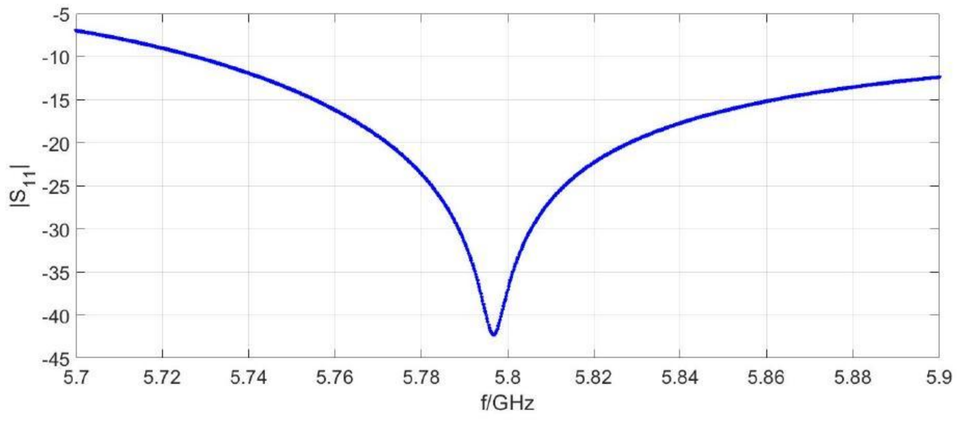

Fig. 3. Return loss in dB of the single SWA.

is 10 mm. Moreover, a Radom is considered in the design process to preserve the array against dust and drops. To do this, a PTFE layer with a thickness of 1 mm was chosen. A coaxial to waveguide transition is separately designed and unified with the SWA antenna. In this regard, a standard N-type is designed and integrated into the coaxial to waveguide transition for the high-power application purpose of the antenna. The simulated return loss of the designed SWA is depicted in Fig. 3 in the ISM frequency range.

IV. Simulation Results

A. Time-Reversal Concept and Ray Optic Comparison

A full wave simulation using commercial software CST Studio Suite is fulfilled to obtain the electromagnetic field distribution in the interested domain. Fig. 4 represents the comparison between the simulated electric field using the ray optic and the proposed TR method. As can be seen from this figure, the TR approach provides the same result as the ray optic technique. However, it's worth mentioning that these two methods' excitation phases of the phased array elements are different.

B. Comparison Between Far Field Phase Method and TR Concept

Figure 5 represents the electric field distribution when the far field assumption is used to shape the phase of the radiating elements. As can be understood from this figure, (i) the

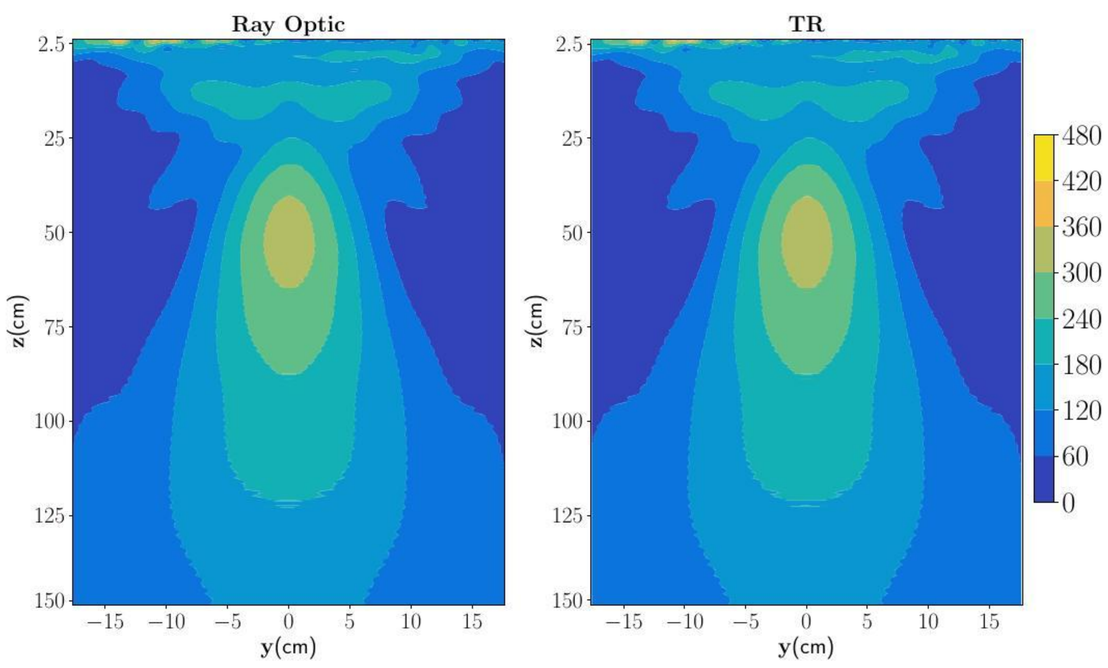

Fig. 4. Comparison between the ray optic and TR method.

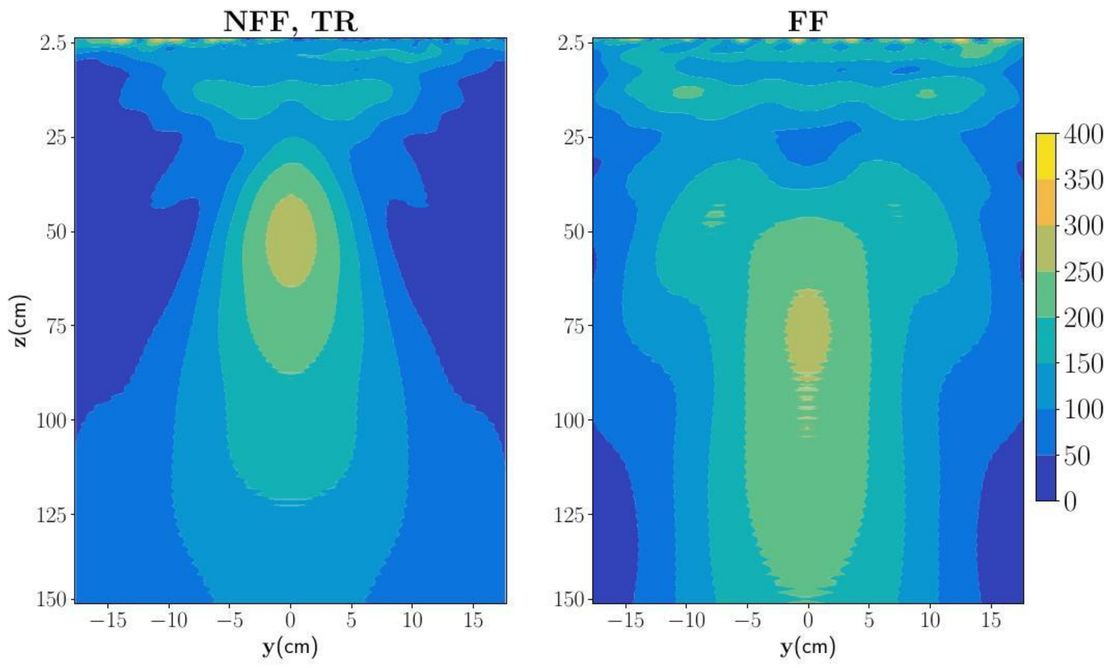

Fig. 5. Comparison between the TR method and far-field phase method.

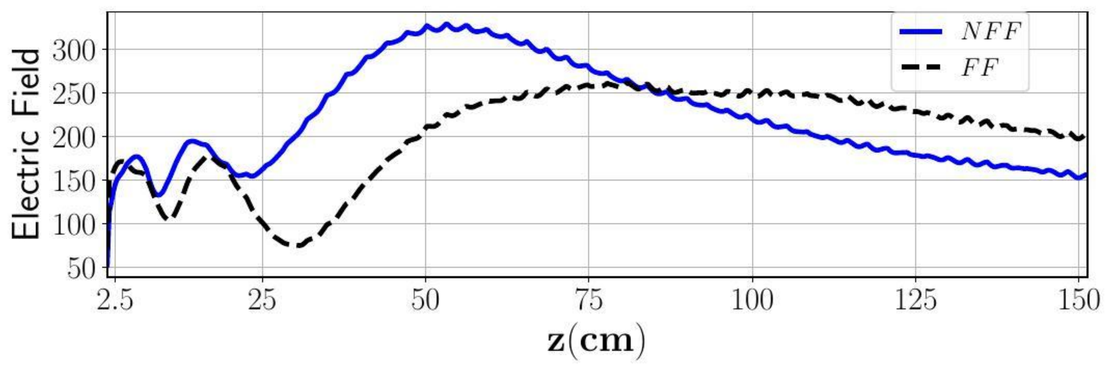

Fig. 6. Comparison of E-field profile in z-direction in the E-plane

focused point is occurring at a further distance from the phased array, and (ii) the maximum electric field of the focused point is less than the TR method. For a better comparison, the electric field distribution versus the axial distance of the antenna is plotted for two methods and compared in Fig. 6. As can be understood by this figure, compared to the FF assumption, employing the NFF phase provides a higher electromagnetic field strength at a shorter distance.

C. Steerability of the Phased Array

Different associated phase distributions are obtained using the TR concept to evaluate the steerability of the phased array. A dipole is inserted at the desired focused point, and the electric field is calculated at the position of the phased array elements. Then by conjugating the phase of the electric field, a new set of excitation is obtained for the phased array antenna.

V. Conclusion and Future Works

In this work, a 5.8 GHz SWA phased array antenna was designed for weed control purposes. A TR concept was used and investigated for NFF that can increase the concentrated power in the desired area. It was shown that the TR concept can provide the same results as the ray optic method in free space. The desired steerability for the NFF phased array can be achieved using the TR concept. However, in future work, by considering the air-soil interface near a phased array antenna, it will be shown that the performance of the ray optic method will be rendered while TR provides a proper phase distribution.