NOVEL SENSOR-BASED METHOD (QUICK TEST) FOR THE IN-SEASON RAPID EVALUATION OF HERBICIDE EFFICACY UNDER REAL FIELD CONDITIONS IN MAIZE

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Introduction

Optimum herbicide use is a key factor affecting the success of any Integrated Weed Management (IWM) strategy. Research has highlighted the role of the Normalized Difference Vegetation Index (NDVI) and sensor-based methods in the evaluation of herbicide efficacy in a short time after application and also the prevention of herbicide-resistance [1,2,3]. The main objective of the current study was to implement a novel method for the *in-situ* evaluation of herbicide efficacy in maize (*Zea mays* L.), and also validate the reliability of the method in pot experiments.

Materials and methods

Field trial

A field trial was conducted during 2020-2021 in a maize field located in Pirgos, Elis, Greece. A randomized complete block design was implemented with four replications. Plot size was 2.5 m wide and 4 m long. An untreated control along with six different herbicide treatments were included. The herbicide treatments were: nicosulfuron + rimsulfuron + mesotrione (39.6 + 9.9 + 118.8 g ai ha^{-1}), florasulam + mesotrione (5.01 + 80.1 g ai ha^{-1}), nicosulfuron + rimsulfuron + dicamba (40.48 + 10.12 + 242 g ai ha^{-1}), 2,4-D ester (600 g ai ha^{-1}). Herbicides were applied when weeds were between the 4- and 6- leaf growth stages. Black nightshade (Solanum nigrum L.) was the dominant species. Patches of barnyardgrass [*Echinochloa crus-galli* (L.) P.Beauv.] were also present; in lower densities, though. NDVI and weed density were evaluated in four 0.25 m^2 quadrats before treatment and also at 1, and 2 weeks after treatment (WAT). The NDVI measurements were performed with aa Trimble® GreenSeeker® handheld crop sensor. The sensor unit has self-contained illumination in both red and NIR bands and measures reflectance in the red and NIR regions of the electro magnetic spectrum according to Equation:

$$NDVI = \frac{NIR-Red}{NIR+Red} \quad [1]$$

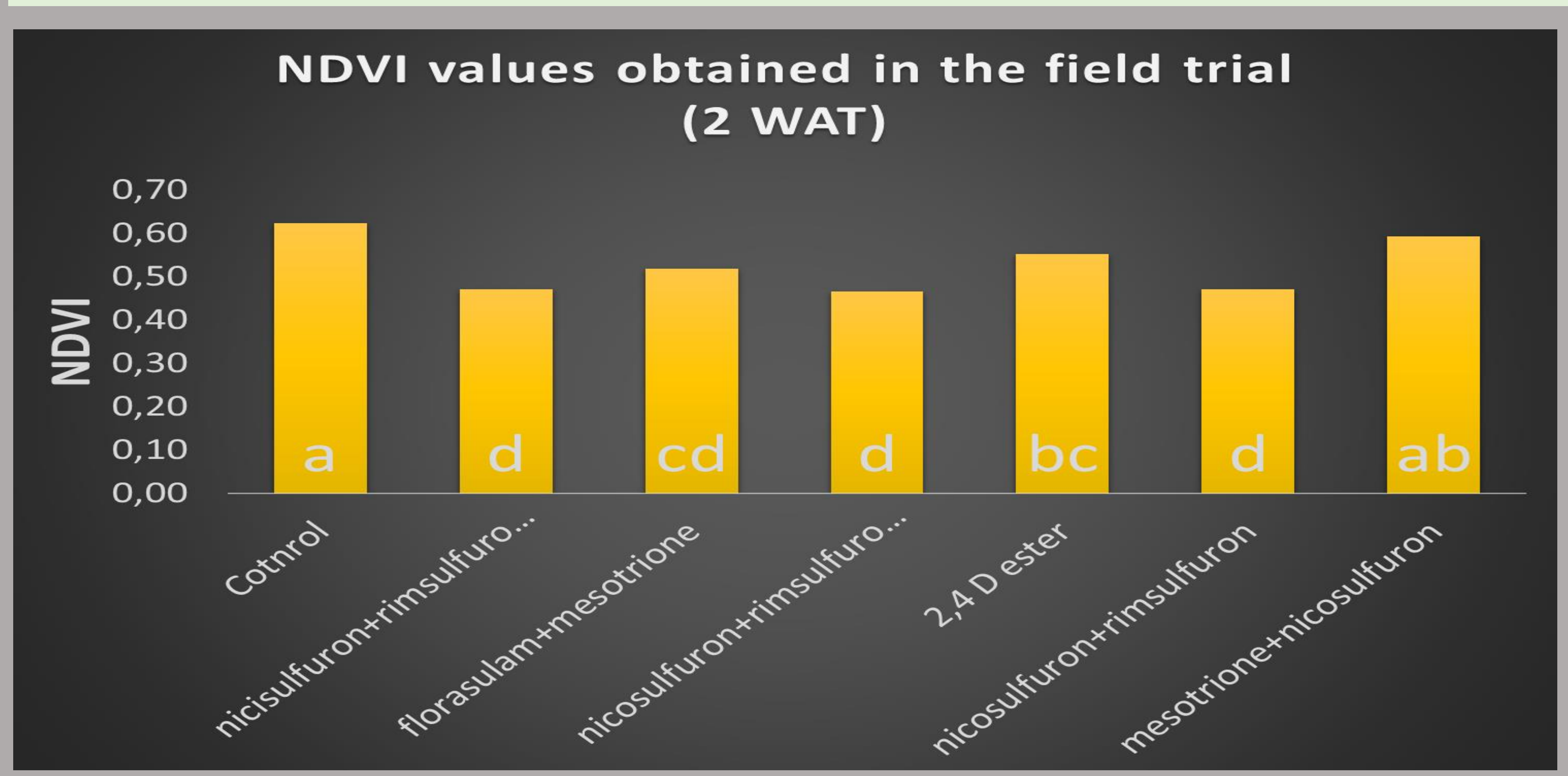
Pot experiments

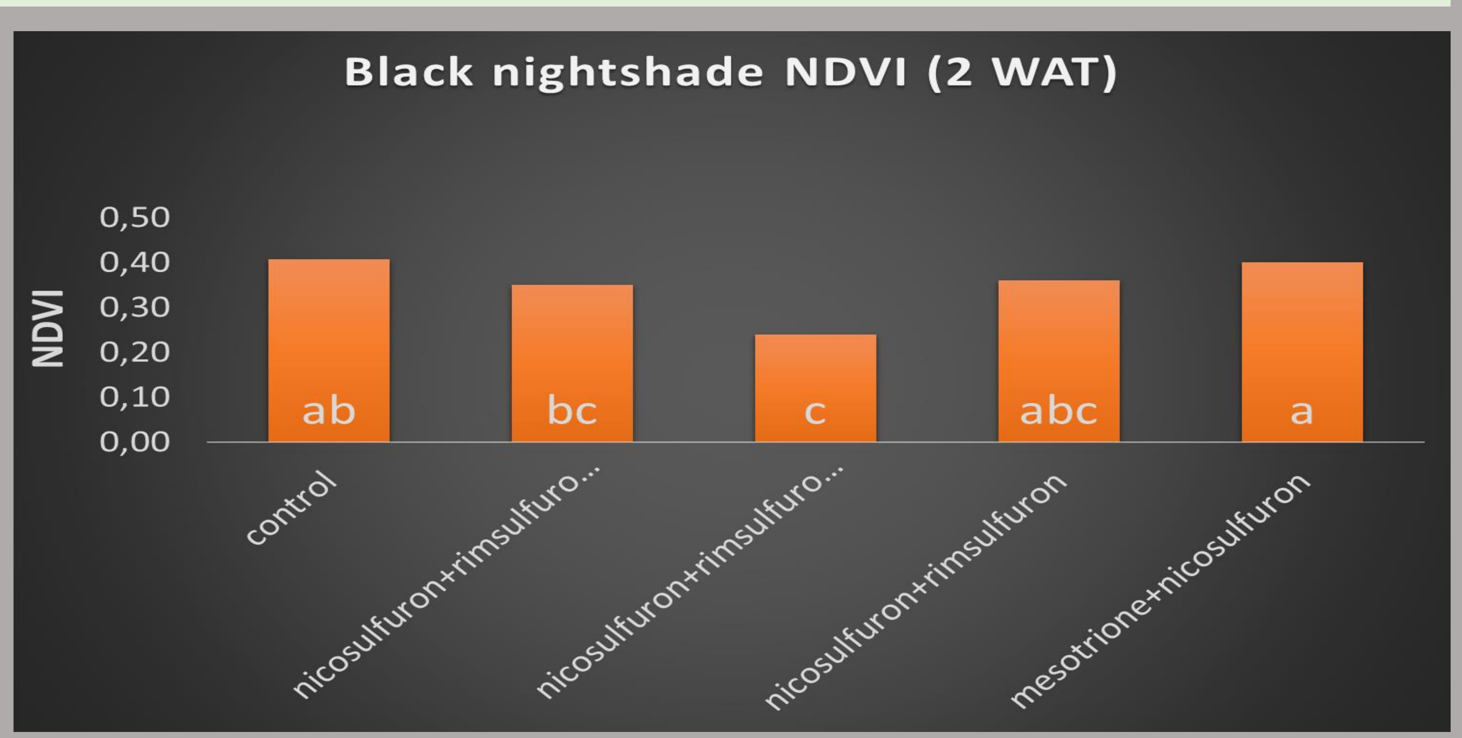
During experimental setup, seedlings of the dominant species were sampled to be transplanted into 12 × 13 × 15 cm^3 plastic pots. The accession of black nightshade was evaluated regarding their response to nicosulfuron + rimsulfuron + mesotrione, florasulam + mesotrione, nicosulfuron + rimsulfuron + dicamba, nicosulfuron + rimsulfuron and mesotrione + nicosulfuron. An untreated control was included yielding a total of 5 treatments. A completely randomized design was implemented with 4 replications per treatment. The experiment was repeated twice. At 1 and 2 WAT NDVI values, and dry weight per seedling were measured. All herbicides were applied with a Gloria® 405 T sprayer equipped with five flat spray nozzles delivering 300 L ha^{-1} of spray solution at 200 kPa constant pressure.

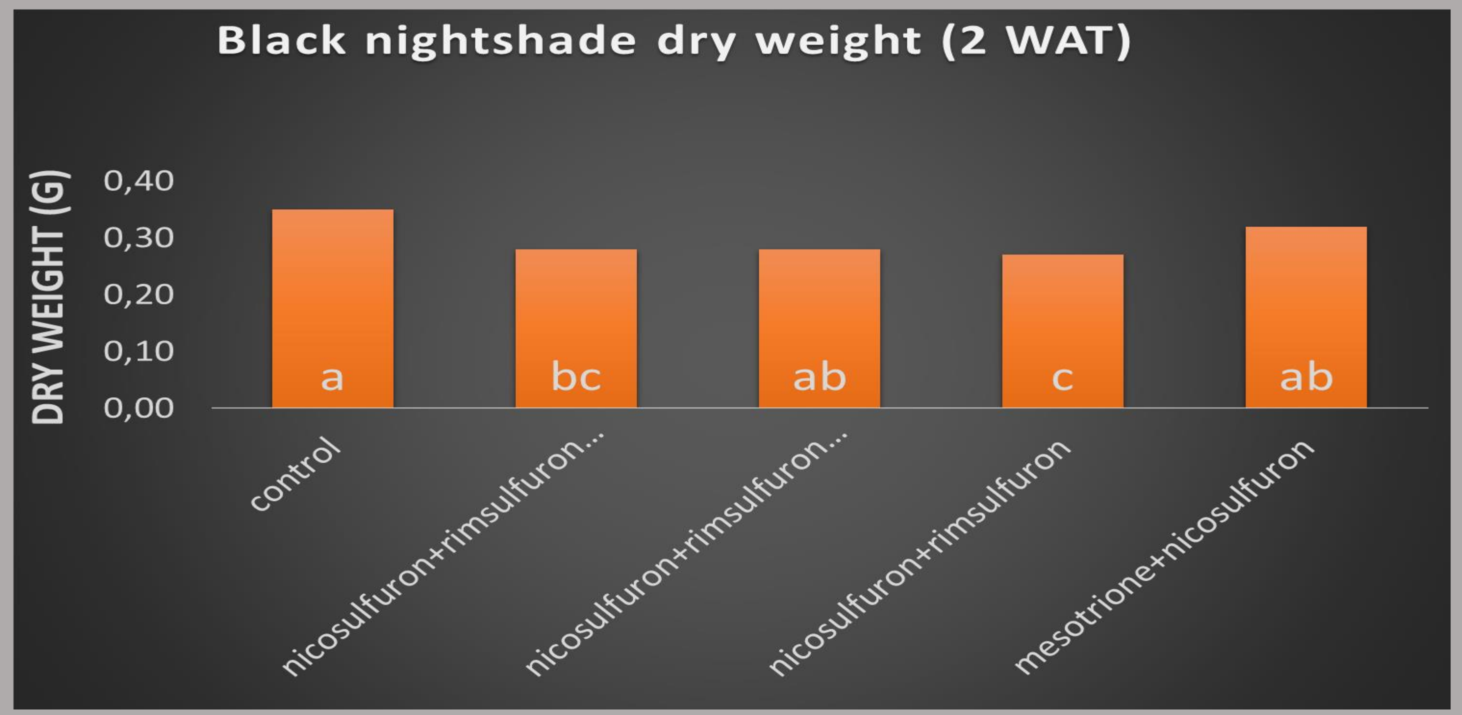
Statistical analysis

Data from field and pot experiments were subjected to Analysis of Variance (ANOVA) conducted at α = 0.05 significance level. Mean separation was conducted according to Fischer's LSD test. Concerning pot experiments, no significant interactions were detected between experimental runs; therefore pooled data across runs are presented.

Results and discussion







In the field trial, the high NDVI values recorded (0.59) indicate the low efficacy of mesotrione + nicosulfuron. The measurements of weed density (10 barnyardgrass plants m^{-2}, 20 black nightshade plants m^{-2}) were in accordance with NDVI values (R^2 = 0.8286; data not shown). However, nicosulfuron + rimsulfuron + mesotrione caused significant NDVI and weed density reductions. These findings are in accordance with other studies where NDVI was a reliable estimate of herbicide efficacy under real field conditions [3,4].

Under greenhouse conditions, nicosulfuron + rimsulfuron + mesotrione resulted in the lowest NDVI values for black nightshade and suggesting the high efficacy of this particular prepackage herbicide mixture. On the contrary, the application of mesotrione + nicosulfuron did not result in lower NDVI and weed biomass values compared to the untreated. Such results indicate the presence of a potentially herbicide-resistant population of black nightshade. Previous research in winter cereals has shown that NDVI is a valuable tool for the *in-situ* detection of potentially herbicide-resistant populations inside the current growing season [3]. The findings of the present study indicate that spectrometer measurements might prevent the spread of potentially herbicide-resistant populations, as also suggested from other relative studies [1,2,3].

Conclusions

To conclude, the findings of the pot experiments were in line with the corresponding of field trials suggesting that NDVI is a reliable estimate of herbicide efficacy under both field and greenhouse conditions. The present study targeted to establish cause-effect relationships and showed that spectrometer measurements can be a useful tool for the optimization of herbicide efficacy. Further research is required to optimize this novel method in more crops and under different soil and climatic conditions.

References & Acknowledgements

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