ABSTRACT: The application of herbicides allows producers to have an efficient control of weeds population. However, due to the ecological impact which herbicide produces, its use should be minimized. Moreover, a reduction of that amount would represent important economic savings. Uniform spraying is widely used in herbicide applications in Argentina. On the other hand, the distribution of weeds is often “patchy”, rather than even or random. Consequently, the efficiency of weed control can be improved if herbicides are applied only over the weed infested areas. Many approaches have been proposed for weed detection in the world. A red and near-infra-red range (RR/NIR) weed detector was designed and made by researchers of INTA. The objective of the present study was to establish the range of the day at which the device was capable of working, as well as to determine the stability of the readings registered throughout the day. The test was made statically for two different surfaces, the first one with a complete cover of weed (cynodon dactylon) and the other without weed simulating strubble. The device was set to save the NDVI value every minute into its internal memory for later analysis. The data was analyzed and the device showed a stable behavior through the day even with presence of cloudiness. The range of the day at which the sensor was able to operate was from 9:15 to 17:33Hs.

KEYWORDS: herbicide application, machine vision, spot spraying, weed detection

INTRODUCTION: The application of herbicides allows producers to have an efficient control of weeds population. However, due to the ecological impact which herbicide produces, its use should be minimized. Moreover, a reduction of that amount would represent important economic savings. Uniform spraying is widely used in herbicide applications in Argentina. On the other hand, the distribution of weeds is often “patchy”, rather than even or random (Cardina et al. 1995, Gerhards et al. 1997, Wang et al. 2001). Different studies have demonstrated that weed patches can cover from 80% to as little as a few percent of arable fields (Brown et al. 1990, Thompson et al. 1991, Johnson et al 1995, Rew et al. 1996). Consequently, the efficiency of weed control can be improved if herbicides are applied only over the weed infested areas (Wang et al. 2001), reducing the waste which produces the application on those areas where it is not necessary. With the aim of reducing ecological impact and costs many approaches have been proposed for weed detection in the world by using methods of artificial vision (Shearer and Colmes 1990, Woebbecke et al. 1992, Zhang and Chaisattapagon 1995, Tian et al. 1997, 1999). In other research done by the authors, it was determined that the method of detection of red and near infrared (RR/NIR) is the most appropriate to be developed in Argentina. With the application of this technology, savings of 67 million dollars a year would be obtain and farmer’s profit might be increased in 9% (Moltoni and Moltoni 2005). This system distinguishes between green plants and soil but it does not make a distinction between weeds and crop. Despite being only useful for weed control on fallow sites, the amount of herbicides used in this stage is 29% of the total applied yearly. A red and near-infra-red range (RR/NIR) weed detector was designed and made by researchers of INTA. The device was tested under different surfaces and probing a correct
operation for different weeds and in different hours of the day (Moltoni et al. 2006). The objective of the present study was to establish the range of the day at which the device was capable of working, as well as to determine the stability of the readings registered throughout the day.

METHODOLOGY: The test was made with the objective to simulate the real conditions in which the agricultural pulverizations are done and two different surfaces were employed. For the first surface a complete coverage of weed (cynodon dactylon) was used and for the second surface ground without weed (Figure 1). The measurements were carried out in the months of October and November statically. The device was placed at a distance of 80 centimeters from the surface and NDVI values were saved at intervals of a minute during the whole day. Three repetitions for each surface were employed and days with variable conditions of cloudiness were chosen in order to verify the incidence of clouds in the readings and the general behavior of the weed sensor.

![Tested surfaces](image)

FIGURE 1. Tested surfaces: (a) weed (cynodon dactylon), (b) ground without weed

Saved data for each surface was downloaded to a computer for analysis.

RESULTS AND DISCUSSION: In the following Figures we can observe the graphical representation of the values obtained for both surfaces. Near infrared range (NIR), red range (RR), NIR/RR ratio and the value of NDVI were plotted.

![Graphical representation of readings](image)

FIGURE 2. Graphical representation of readings on surface with weeds

In Figure 2 is possible to identify a few zones where the readings on NIR and RR decrease considerably. This change represents the obstruction of the sun by the passage of clouds and despite the decrease in NIR and RR values it does not represent a significant change in NDVI value which could jeopardize the detection of weeds present on the surface. At the right corner of Figure 2 we can appreciate an abrupt ascent of the registered values, which is product of an intentional change in gain
of the first stage of the sensor and it was intended to improve resolution of the instrument. The change in gain allowed the use of the device for approximately one more hour.

In order to determine the range of the day at which the sensor was able to operate we accepted a deflection of +/- 5% of the NDVI value registered which in this case is 0.4061. The upper and lower NDVI limits were 0.4264 and 0.3858. For the surface without weeds we observe similar results, changes in NIR and RR values does not represent a significant change in NDVI value which in this case is 0.2445 and the upper and lower limits are 0.2567 and 0.2322.

Figure 3 is a graphical representation of weed and ground NDVI together. It is also marked +/- 5% deflection accepted for each surface which was used to determine the device daily range of use. The period of time was from 9:15 to 17:33Hs, which is a total of 8 hours with 18 minutes.

For the surface without weeds in Figure 4 which is one of the repetitions made, we observe that changes in NIR and RR values does not represent a significant change in NDVI value at lease before 15Hs. After this hour, NIR and RR decrease their value not because of the presence of cloudiness, but because of the presence of shadows projected by trees.
Shadows projected by trees modified the NDVI value increasing it. If the NDVI value is high enough, the device could detect weeds on a surface without them and applied herbicide on areas that do not need it. This situation is not as bad as having weeds and not detects them which would leave weeds without treatment.

CONCLUSION: The range of the day at which the sensor was able to operate was from 9:15 to 17:33Hs, which is a total of 8 hours with 18 minutes. The NDVI readings stayed stable throughout the day even with presence of clouds. The shadows projected by trees alter the measured values of NDVI.

REFERENCES: