PRECISION AGRICULTURE: ITS APPLICATION IN SPRAYERS

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1- INTRODUCTION

The precision agriculture, using collecting systems, its integration and data processing, and microprocessors incorporation, sensorial and actuators, allow the environmental diminishing impact and cost production and increase the yield and its quality and improve the operator work conditions. The increase using of this technicians in the agricultural equipments has improve the technological level of the several agrarian production steps, mainly the ploughs, fertilisation, sowing and harvesting.

2- MATERIAL AND METHODS

In the trial tests it was used a 4 RM tractor, a nine tine cultivator, a sprayer where was installed the debit electronic calculator - regulator (CRED). The measure speed system is a Doppler effect radar, mounted in front tractor.

The CRED, using an electric valve mounted in the pressure system, control the debit maintaining it in a value previous established. This system use continuously the tractor speed and pressure sprayer, measured by a captor, to control the debit; the values of these parameters and the debit hectare chosen by the operator permit to determine the debit hectare applied at each moment.

Besides these elements, its connections and a circuit breaker, which permit to interrupt the spraying, this equipment has:
- a Custom Monitoring System (CMS), that function using a pressure transducer, consists of a console, ground speed sensor, pressure transducer, implement lift switch and main harness, woks either in operate or setup mode. When in operating mode the display gives information about speed (kph), field area, total area, area per hour, distance, in meters, travelled between the counter start and stop, field product (litres applied), etc, and, in setup mode, it permits to introduce the parameters indicated in table I.
- a Custom Calculator - Regulator System (CCS), that consists of a console, a command module, monitored valve, pressure transducer and a speed sensor, can woks to in either operate or setup mode (table I). During the operating mode, used during the spraying operation, is displayed in the console the pressure work and the instantaneous debit / hectare. After switch it is displayed the spray debit programmed and the lower and upper speed allowed to maintain the debit chosen (figure I).

The methodology used in these tests consisted in the previous determination of necessary data to equipment characterisation, mainly the nozzles debit at different pressure which allow the CMS and CCS programming. After the characterisation tests it were done some field essays witch the CRED system installed and not installed in the sprayer, measuring the debit/ha in the following conditions:

- soil conditions (ploughed - mb and not ploughed - nmb);
- slope (- 18, -8, 0, 8, 18);
- nozzles size (1.0 and 1.2 mm);
- spray pressure (3 and 5 bar).

Notice that all trials were done with PTO normalised regime (540 rpm) and the selected gear that allow ± 4 km/h; for the tests done in ploughed soils it was previous done a mobilisation with 6 - 8 cm depth.

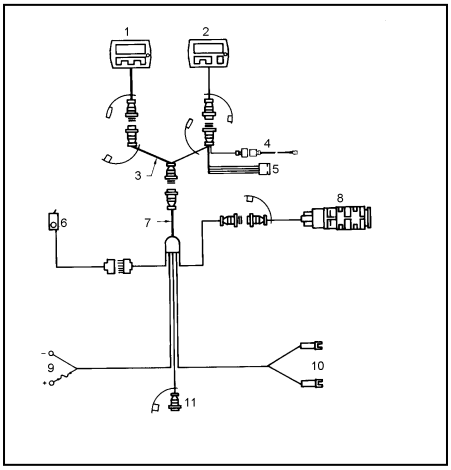

Figure 1- Pressure monitoring system (Dickey-JONH, 1995)
1- Calculator - regulator console; 2- Monitoring console 3- Main harness 4- Harness from ignition 5- Boom section 6- Switch 7- Main harness 8- Radar ground speed; 9- Battery 10- Optional connections 11- Auxiliary harness.

Table 1.- Parameters programmed in CCS e CMS

Setup Pos.	Constants	Valuesr	Setup Pos.	Constants	Values
A	Pressure	P	C0	Pressure	P
B	Applocation rate (l/ha)	500,0	C1	Conversion factor	1,0
C	Application rate +/-(l/ha)	+/- 50	C2	Sum of nozzle capacities	Variable
D	Nozzles saping (m)	0,250	C4	Nozzle capacity pressure (bar)	3 or 5
E	Nozzle capacity pressure	3 or 5	C5	Pressure sensor offset (bar)	0,5
F	Nozzle flow capacity	Variable	C6	Tank level (/10)	30,0
G	Flush pressure (bar)	1,0	C7	Tank alarm level (/10)	5,0
H	Convertion factor	1,0	U6	Ground speed calibration	6096
I	Zero pressure (bar)	0,5	E0	Boom switch sense	0,0
J	System response (s)	2,0			
A	Nozzles control set	0,0			
B	Ground speed calibartion	6096			
C	Pressure limits set	Variable			

3- RESULTS

In "se" situation, the slope, nozzles and spray pressure changes, let to different debit as shown:

- varying the slopes from -18 to + 18 %, the debits vary positively from 8.51% to 2.49 %
- changing the nozzles from 1.0 mm to 2.0 mm increase de debit scope from 21.90 to 33.48 %;
- changing the pressure from 3 to 5 bar there is a increase the debit from 15.10 to 41.20 %.

In "cm" situation the presented factors do not change significantly the debit, as its variations are minor than 1 %.

With CRED programmed to give 500 L/ha it was got, in "cm" situation, debits from 494.7 to 510.7 L/ha (average - 501.6 L/ha, **(δ**= ± 5.6) and in "se" situation debits from 405.3 to 793.1 l/ha (average - 567.9 L/ha; **(δ**= ± 108.3). See table 2.

Table 2- Debits (L/ha) with 3 and 5 bar

	-18%		-8%		0%		8%		18%	
	1,0	1,2	1,0	1,2	1,0	1,2	1,0	1,2	1,0	1,2
se e nmb	418,00	517,33	406,76	536,00	442,50	550,67	436,78	577,33	490,00	594,67
se e mb	405,33	550,40	424,50	537,33	466,00	558,66	446,50	568,00	472,67	593,33
cm e nmb	498,67	493,33	493,33	494,67	504,00	500,00	502,67	508,00	504,00	509,33
cm e mb	496,00	494,67	497,33	494,67	502,67	501,33	509,33	504,00	508,00	505,33

	-18%		-8%		0%		8%		18%	
	1,0	1,2	1,0	1,2	1,0	1,2	1,0	1,2	1,0	1,2
se e nmb	512,67	-	523,93	701,33	569,50	724,00	567,14	762,67	564,00	732,67
se e mb	552,67	717,33	554,00	708,00	589,50	728,00	595,00	752,00	606,00	793,07
cm e nmb	497,33	498,67	501,33	497,33	500,00	501,33	504,00	506,67	506,67	504,00
cm e mb	500,00	494,67	497,33	497,33	505,33	502,67	509,33	509,33	504,00	510,67

4- CONCLUSIONS

As conclusions it can be stated that::

- the CRED use permits to get, since it was respected the programmed conditions that are indicated in Custom Calculator - Regulator System (CCS), debits close to that chosen by the operator;
- the CRED use makes easy the spray operation as the equipment regulation is almost operator independent and this one has access to important information about application spray conditions;
- the CRED use in not important when the tractor - sprayer speed is almost constant

The CRED system used in these trials reduce the rate application spraying variations but it was important to know the influence in the droplet size resulting from the pressure changes.

5. REFERENCES

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