



TEST REPORT

of the
Julius Kühn-Institut

Federal Research Institute
for Cultivated Plants, Braunschweig



Electronic nozzle control with pulse width modulation

TeeJet „DynaJet“

Approved for the use with sprayers for field crops

Applicant

TeeJet Technologies GmbH
Paul-Strähle-Straße 10
73614 Schorndorf

Manufacturer

Spraying Systems Co.
North Ave at Schmale Rd.
Wheaton, IL (USA)

Approved on

6 February 2019

Equipment and dimensions

Electronic nozzle control with pulse width modulation TeeJet "DynaJet" consisting of the solenoid valves mounted on the respective spray boom (solenoid valve instead of the normal diaphragm valve), the connection lines and the nozzle control "DynaJet Flex" for setting the pulse width modulation "PWM".

Method of operation: The nozzle control system controls the injection times and the closing times of the nozzle via the "DynaJet Flex" terminal, the so-called "Duty Cycle" ("DC" on the monitor). The switching cycles are designed for 20 Hz. By means of pulse width modulation and the setting of the "duty cycle", the application rate of the nozzles used is thus regulated between 30% and 100%, without the pressure in front of the nozzles and thus also the droplet spectrum changing. The pulse width can also be set very easily via the terminal with touchscreen from 0 to 100% (0% = nozzles completely closed, 100% nozzle completely open). In the case

of a duty cycle of less than 50%, care must be taken because gaps in the longitudinal direction can be produced by switching the nozzles on and off.

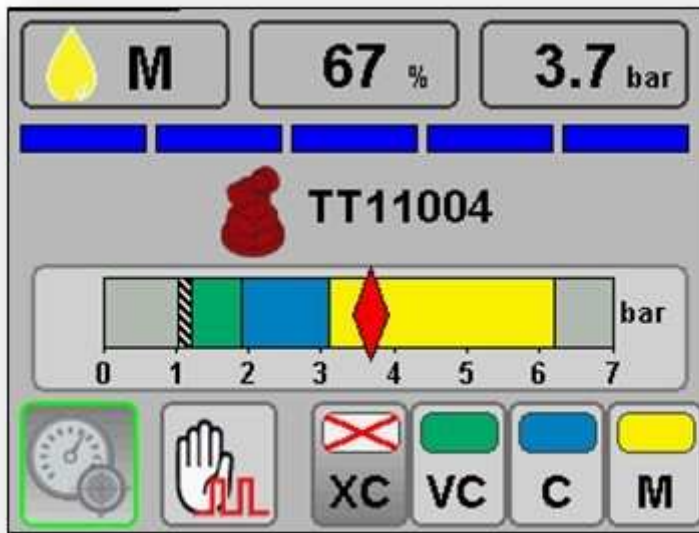


Fig. 3: The monitor display shows information about the „duty cycle“, the droplet size spectrum and the spray pressure.

In order to effectively prevent such gaps, adjacent nozzles are always alternately switched through the system. With a double overlap of the nozzle spray thus gaps in the direction of travel are reduced.

The optimal choice of the nozzle size - based on the usual operating ranges for application rate and driving speeds - in almost completely open state („DC“ about 85 to 100%), requires that a DC of less than 50% can occur only at reduced travel speed. A „DC“ of less than 50% associated with high speeds (e.g., 12 km / h) therefore does not occur under normal circumstances.

Assessment

During the technical inspection and also in practical use the system worked without errors or failures. The cross distribution results on the test bench with different nozzles and different pulse width modulations were in the range of the permissible tolerances (maximum 7% coefficient of variation, see table 1 and 2). The deviations of the individual nozzle volume flows from the common average were within the permissible range (+/- 5%) both before and after practical use.

In 2018, a sprayer (Lemken Primus) was equipped with the system. The distribution uniformity in the cross distribution is both before and after the practical application in the required range.

The longitudinal distribution of the system was tested on the laboratory spraying track at different pressures, duty cycle („DC“) and travel speeds. The results of the longitudinal distribution determined under dynamic conditions show with coefficients of variation of max. 10% comparable results in relation to the static cross distribution measurements. The accuracy of the longitudinal distribution is rated as good on the basis of the measured values.

Practical application: The electronic nozzle control system was used in 2018 on 633 hectares with the nozzles TeeJet AITTJ60 110 06 and TeeJet AIC 110 05 VP. A sufficient effect of the plant protection measures was confirmed. Phytotoxic damage did not occur.

Basics for testing

The tests were carried out on basis of the Regulations for Testing Plant Protection Equipment (JKI-Guideline 2-1.1:2013) and of ISO 5682-1:1999. The requirements of ISO 16119-2:2013 and of JKI-Guideline 1-2.1:2013 were fulfilled.

Work safety

The device part has been safety-checked by the Testing and Certification Body of the Social Insurance for Agriculture, Forestry and Horticulture (PZ.LSV) and meets the safety requirements applicable at the time of the assessment.

Table 1: Results in cross distribution with nozzle AIC 110 05 VP

Pressure (bar)	Puls width modulation Duty Cycle (%)	Max. deviation of the single nozzle flows from the mean value (%)	Evenness of cross distribution at (cm) 40 / 50 / 60 (CV %)	Droplet spectrum (BCPC-Standard)
2.0	30	- 4.7	5.3 / 7.5 / 5.5	
4.0	30	- 6.1	- / 4.9 / -	
4.0	50	- 5.0	- / 5.0 / -	
4.0	100	- 3.0	- / 6.2 / -	
6.0	30	-	- / 4.4 / -	
6.0	50	-	- / 4.9 / -	
6.0	100	-	- / 5.0 / -	

Table 2: Results in cross distribution with nozzle AITTJ60 110 06

Pressure (bar)	Puls width modulation Duty Cycle (%)	Max. deviation of the single nozzle flows from the mean value (%)	Evenness of cross distribution at (cm) 40 / 50 / 60 (CV %)	Droplet spectrum (BCPC-Standard)
1.5	30	-	6.0 / 6.3 / -	
1.5	100	-	- / 5.5 / -	
2.0	30	- 6.2	7.0 / 4.6 / 4.6	
3.0	30	-	- / 4.4 / -	
3.0	50	-	- / 4.7 / -	
3.0	100	-	- / 5.2 / -	
4.0	30	- 8.3	- / 3.8 / -	
4.0	50	6.4	- / 4.5 / -	
4.0	100	5.7	- / 4.9 / -	
5.0	30	-	- / 4.3 / -	
5.0	50	-	- / 4.5 / -	

Table 3: Dynamic longitudinal distribution with different puls width modulation „Duty Cycle“ (DC)

Nozzle	Puls width modulation Duty Cycle (%)	Pressure (bar)	Driving speed (km/h)	Evenness of cross distribution - mean value from 4 repetitions - (CV %)
AIC110 05 VP	30	5	8	6.04
AIC 110 05 VP	50	5	8	4.18
AIC 110 05 VP	75	5	8	4.30
AIC 110 05 VP	100	5	8	2.94
AIC 110 05 VP	30	5	12	11.0
AIC 110 05 VP	50	5	12	7.77
AIC 110 05 VP	75	5	12	6.55
AIC 110 05 VP	100	5	12	4.75
AITTJ60 110 06	30	5	8	3.81
AITTJ60 110 06	50	5	8	2.55
AITTJ60 110 06	75	5	8	2.44
AITTJ60 110 06	100	5	8	1.78
AITTJ60 110 06	30	5	12	8.27
AITTJ60 110 06	50	5	12	5.01
AITTJ60 110 06	75	5	12	5.63
AITTJ60 110 06	100	5	12	5.23
XR 110 05 VS	30	3	8	4.25
XR 110 05 VS	50	3	8	3.84
XR 110 05 VS	75	3	8	4.10
XR 110 05 VS	100	3	8	4.18
XR 110 05 VS	30	3	12	5.55
XR 110 05 VS	50	3	12	4.90
XR 110 05 VS	75	3	12	3.99
XR 110 05 VS	100	3	12	4.54

Field testing:

Landwirtschaftskammer Niedersachsen
Pflanzenschutzamt
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30453 Hannover

Technical testing:

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