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Agricultural machinery – Granule Applicator – Methods of Test

BUREAU OF PRODUCT STANDARDS

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National Foreword

This Philippine Agricultural Engineering Standards PAES 166:2011, Agricultural machinery – Granule Applicator – Methods of Test was approved for adoption as Philippine National Standard by the Bureau of Product Standards upon the recommendation of the Agricultural Machinery Testing and Evaluation Center (AMTEC) and the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development of the Department of Science and Technology (PCARRD-DOST).

Foreword

The formulation of this national standard was initiated by the Agricultural Machinery Testing and Evaluation Center (AMTEC) under the project entitled "Development of Standards for Agricultural Production and Postharvest Machinery" funded by the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development - Department of Science and Technology (PCARRD-DOST).

This standard has been technically prepared in accordance with BPS Directives Part 3:2003 – Rules for the Structure and Drafting of International Standards.

The word "shall" is used to indicate mandatory requirements to conform to the standard.

The word "should" is used to indicate that among several possibilities one is recommended as particularly suitable without mentioning or excluding others.

In the preparation of this standard, the following documents/publications were considered:

ASAE S207.10 Operating requirement for tractors and power take-off driven implements

ASAE EP371 Preparing granular applicator calibration procedures

PAES 145:2005 Agricultural Machinery – Granular Fertilizer Applicator – Specifications

PAES 146:2005 Agricultural Machinery – Granular Fertilizer Applicator – Methods of Test

United States Patent US6810822. Agricultural and Gardening Fertilizer Applicator.

United States Patent US5860604. Motorized Fertilizer Spreader.

United States Patent US6610147. Shingle Granule Valve And Method Of Depositing Granules Onto A Moving Substrate.

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1 Scope

This standard specifies the methods of test and inspection for a granule applicator. Specifically, it shall be used to:

1.1 verify the mechanism, dimensions, materials, accessories of the granule applicator and the list of specifications submitted by the manufacturer;

1.2 determine the performance of the equipment; and,

1.3 report the results of the tests.

2 References

The following normative documents contain provisions, which through reference in this text constitute provisions of this National Standard:

PAES 165:2011 Agricultural Machinery – Granule Applicator – Specifications

3 Definitions

For the purpose of this standard, the definitions given in PAES 165:2011 and the following shall apply:

3.1
draft
total force parallel to the direction of travel required to move the implement

3.2
drawbar power
power available at the drawbar sustainable over a distance of at least 20 meters

3.3
effective field capacity
actual area covered per unit time

3.4
field efficiency
ratio between the productivity of a machine under field conditions and the theoretical maximum productivity

3.5
fuel consumption
volume of fuel consumed by the engine

3.6
transport height
overall height of the implement measured from the topmost point to its lowest point

3.7
transport length
overall length of the implement measured from the terminal point of the implement to the mounting point

3.8
wheel slip
reduction on the traveled distance by the tractor due to the attached implement

3.9
width of application
farthest distance of granule perpendicular to the direction of travel

4 General Conditions for Test and Inspection

4.1 Role of manufacturer or dealer

The manufacturer shall submit the operator's manual of the granule applicator and shall abide by the terms and conditions set forth by an official testing agency.

4.2 Role of the operator

An officially designated operator shall be skilled and shall be able to demonstrate, operate, adjust and repair matters related to the operation of the equipment.

4.3 Test site conditions

The granule applicator shall be tested in the laboratory and in the field for performance. The site shall have ample space, flat, and shall have wind breaks as much as possible.

4.4 Test equipment

The suggested list of minimum test equipment needed to carry out the granule applicator test is shown in Annex A.

4.5 Termination of test for granule applicator

If during the test, the granule applicator encounters major component breakdown or malfunction, the test engineer shall terminate the test.

5 Test and Inspection

5.1 Verification of the manufacturer's technical data and information

This inspection shall be carried out to verify the mechanism, dimensions, materials and accessories of the granule applicator in comparison with the list of manufacturer's technical data and information. All data shall be recorded in Annex B.

5.2 Performance test

This test shall be carried out to obtain actual data on overall performance of the equipment.

5.2.1 Measurement of initial data

Dimensions and other measurements shall be noted. The area of the test site and the wind speed shall also be recorded in Annex C.

5.2.2 Laboratory performance test

5.2.2.1 Test for metering mechanism

This test shall be carried out to examine the performance of metering mechanism. This test should be conducted on the kind of granules for which the machine is suitable as specified by the manufacturer. The granules used shall be readily available and comply with the machine manufacturer's recommendations. If possible, this test shall be carried out at 1/4, 1/2 and 3/4 full of the granule applicator's hopper capacity at the recommended discharge rate setting.

5.2.2.2 Test for uniformity of distribution

This test shall be carried out to determine the uniformity of distribution. The machine shall be operated at the recommended discharge rate setting, with the hopper at 1/4, 1/2 and 3/4 full capacity. The granules shall be gathered in an array of granule collectors (Fig.1). All granule collectors used to measure distribution shall be identical. For each trial, collect and weigh the amount of granules in each collector. The result of the test shall be presented in a histogram and the variance shall be computed (Annex C).

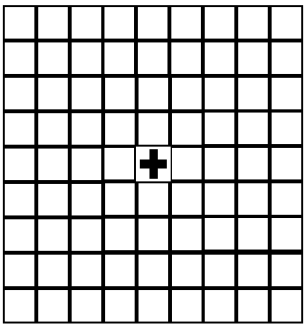

Figure 1. Measurement of uniformity of distribution

5.2.2.3 Test for width of application

The equipment shall be initially filled with granules. It shall be allowed to travel a distance of 10 meters. The width of application shall be determined by the distance of the farthest granule measured perpendicular to the direction of travel. Wind speed in the test site shall be measured and recorded.

5.2.2.4 Test for discharge rate

The discharge rate shall be obtained by determining the time required to empty the hopper or tank initially filled with a known weight of granules. This shall be computed using the formula in Annex D.

5.2.3 Field performance test

5.2.3.1 The fuel consumption of the granule applicator shall be obtained as described in Annex E.

5.2.3.2 The draft of the granule applicator shall be determined as described in Annex E.

5.2.3.3 The field efficiency, effective field capacity and drawbar power requirements of the implement shall be obtained using the formula in Annex D.

5.2.3.4 The noise level of the granule applicator shall be determined as described in Annex E.

5.2.3.5 The wheel slip shall be determined as described in Annex E.

5.2.3.6 The condition of granule applicator after test shall be compared to its initial condition.

5.2.3.7 Welded parts shall be inspected.

5.2.3.8 Loosened bolts shall be noted.

5.2.3.9 All data shall be recorded in Annex C.

5.3 Test trial

There shall be three (3) trials to conduct the test.

6 Test Report

The test report shall include the following information in the order given:

6.1 Title

6.2 Summary

6.3 Purpose and Scope of Test

6.4 Methods of Test

6.5 Description of the Machine

Table 1 – Machine Specifications

6.6 Results and Discussions

6.7 Observations (include pictures)

Table 2 –Performance test data

6.8 Name(s), signature(s) and designation(s) of test engineer(s)

Annex A

Suggested Minimum List of Test Equipment

Items	Quantity
A.1. timer accuracy: 0.10 s	1
A. 2 steel tape length: 5 m	1
A.3 weighing scale capacity, 1000 kg	1
A.4 fuel consumption	
graduated cylinder capacity, 1000 mL	1
A.5 four-wheel tractor	1 unit
A.6 marking pegs	4
A.7 marking tape	1
A.8 draft measurement	
spring, hydraulic or strain-gauge type dynamometer	1
A.9 collectors	as needed

Annex B
(informative)

Specifications of Granule applicator

Name of Applicant/ Distributor: _____
Address: _____
Tel No: _____

GENERAL INFORMATION
Name of Manufacturer: _____
Make: _____
Classification: _____
Serial No: _____ Brand/Model: _____
Production date of granule applicator to be tested: _____
Testing Agency: _____ Test Engineer: _____
Date of Test: _____ Location of Test: _____

Items to be inspected

ITEMS	Manufacturer's Specification	Verification by the Testing agency
B.1 type of granule applicator		
B.2 overall dimensions		
B.2.1 transport height, mm		
B.2.2 transport length, mm		
B.2.3 weight, kg		
B.2.4 material		
B.3 chain and sprocket assembly (if present)		
B.3.1 material		
B.3.2 length, mm		
B.3.3 diameter of sprocket, mm		
B.4 metering system		
B.4.1 type		
B.4.2 material		
B.5 spinner plate (if present)		
B.5.1 diameter, mm		
B.5.2 thickness, mm		
B.5.3 material		
B.6 hopper or tank		
B.6.1 material		
B.6.2 capacity, m^3		
B.6.3 thickness, mm		
B.6.4 dimension		
B.7 engagement assembly (if present)		
B.7.1 type		
B.7.2 material		
B.8 lever arm (if present)		
B.8.1 length, mm		
B.8.2 thickness, mm		

ITEMS	Manufacturer's Specification	Verification by the Testing agency
B.8.3 material		
B.9 handle (if present)		
B.9.1 length, mm		
B.9.2 thickness, mm		
B.9.3 material		
B.10 wand (if present)		
B.10.1 length, mm		
B.10.2 diameter, mm		
B.10.3 material		
B.11 engine (if present)		
B.11.1 power rating, kW		
B.11.2 type		
B.12 wheels (if present)		
B.12.1 diameter, mm		
B.12.2 material		
B.13 orifice		
B.13.1 area, mm^2		

ANNEX C

Performance Test Data Sheet

Items to be measured and Inspected

C.1 Test field conditions	Remarks
C.1.1 area, m^2	
C.1.2 wind speed, kph	

C.2 Performance Test				
Items	**Trials**			**Ave.**
C.2.1 Noise level, dB	**I**	**II**	**III**	
C.2.2 Fuel consumption, Lps				
C.2.3 Discharge rate, kg/s				
C.2.4 Width of application, m				

C.2.5 Operating time, h	**Trials**								
	I		**II**		**III**		**Ave.**		
	Test time	Non-productive	Test time	Non-prod.	Test time	Non-prod.	Test time	Non-prod.	Productive time

C.2.6 Field efficiency, %				
C.2.7 Effective field capacity, ha/h				
C.2.8 Draft, N				
C.2.9 Drawbar power, kW				

C.2.10 Uniformity of distribution
Trial I
Variance:

Trial II
Variance:
Trial III
Variance:
Average variance:

C.2.11 Wheel slip analysis									
Trials									**Ave. %W.S. (%)**
I			**II**			**III**			
A(m)	**B(m)**	**%W.S.**	**A(m)**	**B(m)**	**%W.S.**	**A(m)**	**B(m)**	**%W.S.**	

C.3 Other observations	**Remarks**
C.3.1 accessibility of grease points *	
C.3.2 cracks on welded parts	
C.3.3 detached welded parts	
C.3.4 loosened bolts	
C.3.5 miscellaneous:	

* rating: 1 – very good
2 – good
3 – satisfactory
4 – poor
5 – very poor

ANNEX D

Formula Used During Calculation and Testing

D.1 Drawbar power

$$P = \frac{D \times S}{3.6}$$

where:

P drawbar power required for the implement, kW

D draft force required to move the implement, kN

S speed of tractor, kph

D.2 Discharge rate

$$Q = \frac{W_g}{t}$$

where:

Q discharge rate, kg/s

t total time of application, s

W_g weight of granules applied, kg

$$W_g = W_i - W_f$$

where:

W_i initial weight of granules in tank or hopper, kg

W_f final weight in tank or hopper, kg

D.3 Effective field capacity

$$C = \frac{E}{T}$$

where:

C effective field capacity, m^2/h

T operating time, h

E effective area accomplished, m^2

$$E - wD$$

where:

w actual working width, m

D total distance traveled, m

$$D = \frac{A}{s}$$

where:

A area of plot, m^2

s average swath or width of cut, m

$$S = \frac{W}{2N}$$

where:

W width of plot, m

N number of trips per round

D.4 Field efficiency

$$Eff = \frac{C}{C_o} \; x \; 100$$

where:

Eff field efficiency, %

C effective field capacity, m^2/h

C_o theoretical field capacity, m^2/h

D.5 Uniformity of distribution

$$\sigma^2 = \frac{\sum(x-m)^2}{n-1}$$

where:

σ^2	variance for distribution
x	weight of granules in collector, g
m	mean weight of granules in collector, g
n	total number of collectors

D.6 Wheel slip

$$\%\ W.S. = \frac{A - B}{A} \times 100$$

where:

% *W.S.*	wheel slip, %
A	distance traveled by the tractor under no load after a given number of wheel revolution, m
B	distance traveled by the tractor with implement attached after a given number of wheel revolution, m

D.7 Theoretical field capacity

$$C_o = w\ x\ S$$

where:

C_o	theoretical field capacity, ha/h
w	actual working width, m
S	speed of tractor, m/h

D.8 Fuel consumption

$$E_f = \frac{V_i - V_f}{t}$$

where:

E_f	fuel consumption, Lps

V_i initial volume of fuel in tank, L

V_f final volume of fuel in tank, L

t time of operation

ANNEX E

Field Performance Test

E.1 Fuel consumption

This shall be done by filling the tank with a known volume of fuel. After the test, the tank shall be emptied by draining the fuel through the carburetor. The drained fuel shall be measured using a graduated cylinder. The difference between the initial volume of fuel and the final volume shall be divided by the time of operation to determine the fuel consumption of the equipment.

Fuel consumption can also be measured by filling the tank to full capacity before and after the each test trial. The amount of fuel refilled shall be measured using a graduated cylinder. The difference in the volume of the fuel shall be divided by the time of operation to yield the fuel consumption of the equipment.

E.2 Draft of the implement

A spring, hydraulic or strain-gauge type dynamometer shall be attached to the front of the tractor on which the implement is mounted. Another auxiliary tractor shall pull the implement-mounted tractor through the dynamometer in neutral gear but with the implement in the operating position. The draft in the measured distance of 20m as well as the time it takes to traverse it shall be read and recorded. On the same field, the draft in the same distance shall be read and recorded but with the implement lifted above the ground. The difference in the readings shall be obtained as the draft of the implement

E.3 Wheel slip analysis

The percentage of wheel slip shall be obtained by recording the difference of the traveled distance without load and the traveled distance with the implement attached. A mark shall be placed on the wheel of the tractor (Fig.2). The tractor shall be allowed to move forward up to 10 revolutions of the marked wheel under no load (A). The distance shall be measured and recorded. On the same surface, the tractor shall be allowed to move forward with the implement attached. After same number of revolutions, the distance traveled shall be measured and recorded (B). The percentage of wheel slip shall then be computed using the formula in Annex D.

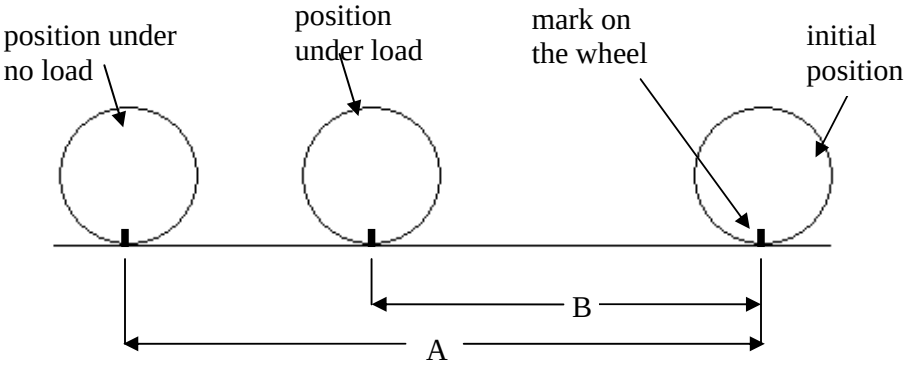

Figure 2. Measurement of wheel slip

Philippine Agricultural Engineering Standards

AMTEC-UPLB – PCARRD Project: "Development of Standards for Agricultural Production and Postharvest Machinery"

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