

PERFORMANCE OF SELF PROPELLER LIQUID AND ORGANIC FERTILIZERS MACHINE FOR SMALL HOLDING

By

MAHMOUD AHMED IBRAHIM EL-ATTAR

A thesis submitted in partial fulfillment

of

the requirement for the degree of

DOCTOR OF PHILOSOPHY

In

Agricultural Science

(Agricultural Mechanization)

Department of Agricultural Mechanization

Faculty of Agriculture

Ain-Shams University

1995

631-33
M.A



50855



236

PERFORMANCE OF SELF PROPELLER LIQUID AND ORGANIC FERTILIZERS MACHINE FOR SMALL HOLDING

By

MAHMOUD AHMED IBRAHIM EL-ATTAR

A thesis submitted in partial fulfillment

of

the requirement for the degree of

DOCTOR OF PHILOSOPHY

In

Agricultural Science

(Agricultural Mechanization)

Department of Agricultural Mechanization

Faculty of Agriculture

Ain-Shams University

1995



PERFORMANCE OF SELF PROPELLER LIQUID AND ORGANIC FERTILIZERS MACHINE FOR SMALL HOLDING

By

MAHMOUD AHMED IBRAHIM EL-ATTAR

B.Sc. Agric. (Agricultural Mechanization)

Ain-Shams University, 1982

M.Sc. Agric. (Agricultural Mechanization)

Ain-Shams University, 1988

This thesis for

Approved by :

Prof. Dr. S.A. Hamad *S. A. Hamad*

Prof. of Agric. Eng. Dept., Fac. Agric., El -Mansoura Univ.,
Egypt.

Prof. Dr. A.E. El-Leboudi *A. El-Leboudi*

Prof. of soils Sci. Dept., Fac. Agric., Ain-Shams Univ., Cairo,
Egypt.

Prof. Dr. M.M. Moustafa *M. Moustafa*

Prof. of Agric. Eng. and Head of Agric. Mechanization Dept.,
Fac. Agric., - Ain-Shams Univ., Cairo, Egypt.

Date of examination : 22 / 12 / 1994

PERFORMANCE OF SELF PROPELLER LIQUID AND ORGANIC FERTILIZERS MACHINE FOR SMALL HOLDING

By

MAHMOUD AHMED IBRAHIM EL-ATTAR

B.Sc. Agric. (Agricultural Mechanization)

Ain-Shams University, 1982

M.Sc. Agric. (Agricultural Mechanization)

Ain-Shams University, 1988

Under the Supervision of : Prof. Dr. M. Moustafa
Professor of Agricultural Engineering and Head of Agricultural
Mechanization Department

ABSTRACT

The study was run on designed and built self propeller liquid and organic fertilizers machine for small holding. It included measurements on; weight and its distribution, field capacity, fuel consumption, nitrogen distribution in soil, energy, rolling resistance and traction. The primary components of this machine were :1) power tiller (14 Hp-diesel fuel). 2) a one-axial compost spreader. 3) device mix the compost with the soil. 4) injection unit. The performance of this machine was evaluated in the field by carrying out a comparative study of the under-surface application (10 cm below soil surface) versus on-surface application method. Nitrogen

sources used were liquid urea, liquid ammonium nitrate, solid urea, solid ammonium nitrate and compost. Nitrogen rates used 50, 100, 150 kg N/ feddan.

The results of field experiments showed that the injecting liquid urea and liquid ammonium nitrate using the machine increased the grain and stover yields of maize by about 14% and 10% over the surface application of solid urea and solid ammonium nitrate. The results also revealed that there was an increase in maize grains and stover with increasing nitrogen level. The maximum grain and stover yields of maize was obtained with nitrogen rate 100 kg N/feddan.

KEY WORDS

Mechanical application	: Infection pressure N/Cm ² .
	Machine speed Km/h.
	Discharge liquid fertilizer Lit/min.
	Discharge Compost m ³ /min.
Fertilizer application	: Liquid Urea.
	Liquid ammonium nitrate.
	Solid urea.
	Solid ammonium nitrate.
	Compost.

ACKNOWLEDGMENT

The author wishes to express his appreciation to all who contributed directly or indirectly to make this research possible.

Prof. Dr. MOUBARK MOHAMED MOUSTAFA, head of the Agricultural Mechanization Dep., Faculty of Agriculture, Ain Shams University, for his valuable scientific assistance and advices throughout the research, and also for his supervision during the execution of this work.

Prof. Dr. ABDEL GHANI MOHAMED EL-GINDY, director of the Agricultural Engineering Research Institute, for offering facilities and for his help during this investigation.

Dr. MAHMOUD AHMED EL-NONI, Lecture of Agricultural Mechanization, Faculty of Agricultural, Ain Shams University, for his helpful efforts during the present work.

Dr. EL-ESSAWY ALI EL-KABBANY, Researcher, Plant nutrition Dept., the Soils Research Institute, for his help during this investigation.

I wish to also express my thanks to all staff members of the Agricultural Engineering Research Institute. Also to the staff members of the Gemmiza Research Station for this continuous help.

Many thanks are extended to my mother and to all who have helped in carrying out this work.

CONTENTS

	Page
1- INTRODUCTION	1
2- REVIEW OF LITERATURE	3
2.1 Liquid and Solid fertilizers applied with special machines and methods of their application	4
2.2 The parameters affecting mechanical injection of liquid fertilizers	10
2.2.1 Machine speed	10
2.2.2 Injection depth	11
2.2.3 Injection pressure.....	14
2.2.4 The space between injection rows	16
2.3 Organic and inorganic N sources and application rates....	18
2.3.1 The comparative effect of liquid and solid fertilizers on maize	18
2.3.2 The comparative effect of inorganic and organic fertilizer on maize	22
2.4 Nitrogen distribution in the soil profile after applied nitrogenous fertilizers	26
2.5 Rolling resistance and power requirement.....	29
3 MATERIALS AND METHODS	34
3.1 Characteristics of the machine	34
3.1.1 The power tiller	34
3.1.2 An one-axial compost spreader	38
3.1.2.1 Drawbar	40

-II-

	Page
3.1.2.2 Trailer	40
3.1.2.3 Conveyer	42
3.1.2.4 Spreader	42
3.1.2.5 Device for uphold and downhill the injection unit	42
3.1.3 Device mix compost with the soil	45
3.1.4 Injection unit	45
3.1.4.1 Roller pump	45
3.1.4.2 Pressure regulator	46
3.1.4.3 Injection blades	46
3.2 Machine calibration with spreading compost.....	49
3.3 Machine calibration with liquid fertilizer	51
3.4 Evaluation of rolling resistance force	54
3.5 Characteristics of concerned soil	54
3.6 The field experiment	57
3.7 Evaluation of nitrogen distribution in soil after fertilization	58
3.8 Estimating machinery costs	58
4 RESULTS AND DISCUSSION	62
4.1 Design parameter	62
4.1.1 Strength calculation of the applicators	62
4.1.2 Strength calculation of the machine frame	65
4.2 The machine evaluation	68
4.2.1 The forward speed	68
4.2.2 Turning time	68

-III-

	Page
4.2.3 The filling time	69
4.2.4 The machine calibration the field capacity.....	69
4.3 Balance and weight transfer	74
4.3.1 The forces required for pulling the machine	75
4.3.2 Center of weight	75
4.3.3. The rolling resistances	79
4.3.4 The coefficient of the rolling resistances	82
4.4 Fuel and energy requirements.....	85
4.4.1 Fuel and specific fuel consumption	85
4.4.2 Energy requirements	85
4.5 Fertilizer Distribution in the soil	89
4.6 Effect of different fertilization treatments on grain and stover yieldsof maize	89
4.6.1 Effect of different nitrogen sources on grain yield....	89
4.6.2 Effect of nitrogen levels on grain yield	91
4.6.3 Effect of different nitrogen sources on stover yield..	91
4.6.4 Effect of nitrogen levels on stover yield	92
4.6.5 The interaction effect between nitrogen source and nitrogen levels on grain yield	92
4.6.6 The interaction effect between nitrogen source and nitrogen levels on stover yield	95
4.7 Nitrogen content in grain and stover yield as effected by sources and the rates of nitrogen fertilizers.....	98

	Page
4.8 The interaction effect between nitrogen sources and nitrogen levels on nitrogen content in grains and stover yield	100
4.9 The cost analysis	100
5 SUMMARY AND CONCLUSIONS	105
6 REFERENCES	111
7 ARABIC SUMMARY	

-VI-
LIST OF TABLES

No	Page
1- Some physical and chemical characteristics of soil under investigation	56
2- Levels and amounts of nitrogen fertilizer given to grown maize crop	76
3- The effect of machine weight with different load of fertilizer on pulling force (N) at different soil and forward speed 2.5 Km/hr.	76
4- The relationship between the rolling resistance (N), and ground conditions at different speeds	80
5- The relation between the coefficient of rolling resistance and ground conditions at different speeds.....	80
6- The effect of forward speed and load of fertilizer on power, fuel consumption and specific fuel consumption at plowed surface.....	86
7- The mean values of available nitrogen (p.p.m.), after 48 hr. from application of fertilizers under furrow irrigation system	90
8- Effect of used nitrogen fertilizer on grains and stover yield of maize in 1991 and 1992 seasons	93
9- Effect of used nitrogen levels on grains and stover yield of maize in 1991 and 1992 seasons	93

-VII-
LIST OF TABLES (Cont's)

No	Page
10- Grain yeidl (ton/feddan) of maize as affected by interaction between applied nitrogen fertilizers and nitrogen levels in 1991 and 1992 seasons	96
11- Stover yield (ton/feddan) of maize as affected by interaction between nitrogen fertilizers applied and nitrogen levels in 1991 and 1992 seasons	96
12- Effect of applied nitrogen fertilizers on total nitrogen in dry grains and dry stovers (kg/feddan) of maize in 1991 and 1992 seasons	99
13- Effect of applied nitrogen levels on total nitrogen in dry grains and dry stovers (kg/feddan) of maize in 1991 and 1992 seasons.....	99
14- Total nitrogen in dry grains (kg/feddan) of maize as affected by interaction between nitrogen fertilizers applied and nitrogen levels in 1991 and 1992 seasons	101
15- Total nitrogen in dry stovers (kg/feddan) of maize as affected by interaction between nitrogen fertilizers applied and nitrogen levels in 1991 and 1992 seasons	101
16- The costs price for application of different nitrogenous fertilizers using the machine and the labours of production maize crop	104

-VIII-
LIST OF FIGURES

No	Page
1- The broadcast machine of compost	35
2- The applicator machine of liquid fertilizer	35
3- Diagram representing the machine used for application of liquid fertilizer and solid, Dimension in Cm.	36
4- The power tiller used in traction (Side view)	37
5- The power tiller used in traction (Elevation view).....	37
6- Diagram representing the trailer spreader of compost and injector liquid fertilizers. Dimension in Cm.	39
7- A one -axial compost spreader (Elevation view).....	41
8- A one - axial compos spreader (Sid view)	41
9- The mosion system of the conveyer	43
10- Device mix the compost with the soil	43
11- The spreader for broadcast the compost	44
12- The mosion system of the spreader	44
13- The roller pump and two applicator blades	47
14- Injection liquid fertilizer of maize crop	47
15- Diagram representing mechanism of pressure control for the machine used in injection (After Artobolevsky, 1986)	48

-IX-
LIST OF FIGURES (Cont's)

No	Page
16- Determine the rolling resistance by dynamometer	55
17- Dynamometer designed by M.M.Mostafa 1980.....	55
18- a) The forces acting in the vertical plan, b) the changes in the values of static bending moment acting on the longitudinal beams of the fram trailer	63
19- Diagram showing forces acting on the machine under operating conditions.....	77
20- Application of the weighing methods in locating center of gravity	78
21- The effect of forward speed on the rolling resistance at different soil surface	81
22- The run-way curve of the rolling resistance of forward speed 2.5 km/hr., at different soil surfaces	83
23- The run- way curve of the rolling resistance on plowed soil surface at different speeds	84
24- The effect of forward speed and load of compost on the specific fuel consumption and drawbar power at broadcasting compost	87
25- The effect of forward speed and load of fertilizer on the specific fuel consumption and drawbar power at injection liquid fertilizer...	88