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Effect of Moisture Content on the Performance of A Motorized Weeding Machine

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Abstract: - *A Motorized weeding machine developed at the Department of Agricultural Engineering Technology, Rufus Giwa Polytechnic Owo was evaluated for the machine performance parameters. Studies were conducted on the effect of moisture content (10%, 13% and 16%) and the type of cutting blades (Flat blade, spike tooth blade and curved blade) on the machine efficiency, quality performance efficiency, percentage of uprooted weeds and percentage of partially uprooted weeds. Soil moisture content and type of cutting blades statistically affected the machine performance at 5% level of significance using Duncan Multiple Range Test (DMRT). The machine was found to be influenced by the soil moisture content and type of cutting blades; however the machine gave the best machine efficiency of 94%, quality performance efficiency of 84%, and 2.8% percentage of uprooted weeds and least percentage of partially uprooted weeds of 1.8% using the spike tooth blade at 16% soil moisture content.*
Keywords: - *Effect, soil, moisture content, weeding machine, performance.*

I. Introduction

Weeds have been a great problem in farms. Lots of control methods have been introduced to get rid of weeds namely; manual, biological, chemical and mechanical. The manual method is useful but of much drudgery for the farmers and city gardeners. The chemical method has adverse effects on the farmers and the environment. Though, foreign machines may be suitable for other farm operations but not for soil engaging operations as soil varies from place to place. Weeds left uncontrolled may harbour insects and diseases and produce seeds which infect and affect future crops. Weeds infestation on Nigeria soil is quite high particularly during the raining seasons when soil moisture is high and plant growth conditions are optimum (Olukunle, 1995). Weeds were said to have been the potential carriers of infections like fungus and other diseases which can contaminate crops (Manuwa and Olofinkua, 2009).

The power requirement for soil engaging equipments is generally high as reported by Olukunle (1995), yet the manual power available on the farm is limited to 0.075kw (0.1hp) (Kaul and Egbo, 1985; Olunkunle and Oguntunde, 2006).

Ademosun et al (2003) reported the development of various machines for weeding and harvesting; among these are finger type weeder, a peg type dry land weeder, ox-drawn straddle rotary weeder, sickle-combine harvester, etc. Previous efforts in this area are quite appreciable, but the research efforts are yet to be adopted by farmers in Nigeria. One of the major problems with existing designs is that the manual power required to move the machines and propel the operational components of these machines is high. This is probably making these designs un-adoptable by farmers.

The losses incurred to weeds as mentioned earlier can be ascribed as one of the factors responsible for food shortage which has been responsible for most of the social vices in Nigeria .The use of traditional methods of clearing weeds is characterized with much drudgery, time wastage and low productivity. The only way of solving this all important problem is by the development of mechanical weeding machines using local materials available and adaptable to our soil type and features. The use of chemicals for clearing weeds is now being campaigned against by government and some other non-governmental organizations because of absorption of the chemical composition through the soil to the crops.

Many factors are responsible for variation in the efficiency of weeding machine. Among them are the weed densities, soil moisture, nature of weeds, machine speed and soil type. Therefore, this paper examines the effect of soil moisture content and type of cutting blades on the performance of a locally developed motorized weeder.

II. Materials and Methods

2.1 Machine Description and Operation

The machine was designed to suite the convenience of the operator. This is to provide comfort and enhances safety. These were therefore achieved by designing for the provision of an adjustable handle to suit variability in height of the operator. A ground wheel is provided to minimize the force required to push the machine on the field during operation.

The frame is the unit of the machine on which all other components are mounted. It is made of square pipe of 30mmx30mm. The coverage area of the frame is 32000mm^2. The handle is attached to the main frame. This is made of hollow pipe with brackets. The hollow pipe is 25mm diameter and1200mm in length. It enables the operator to push the machine during operation within the crop rows.

There are three types of cutting blades fabricated for the purpose of evaluation. The cutting blades were made of flat bar beveled at an angle of 50^o to form an L-shape in order to minimize the effort required in cutting the soil. The weight of the blade is 3.8Kg

A 2hp petrol engine is suitable as the prime mover while belt and pulley are the power transmission components. As the shaft rotates, the cutting blades do the weeding by cutting the weeds from the root level. The direction of operation is controlled by the operator via the handles of the machine.

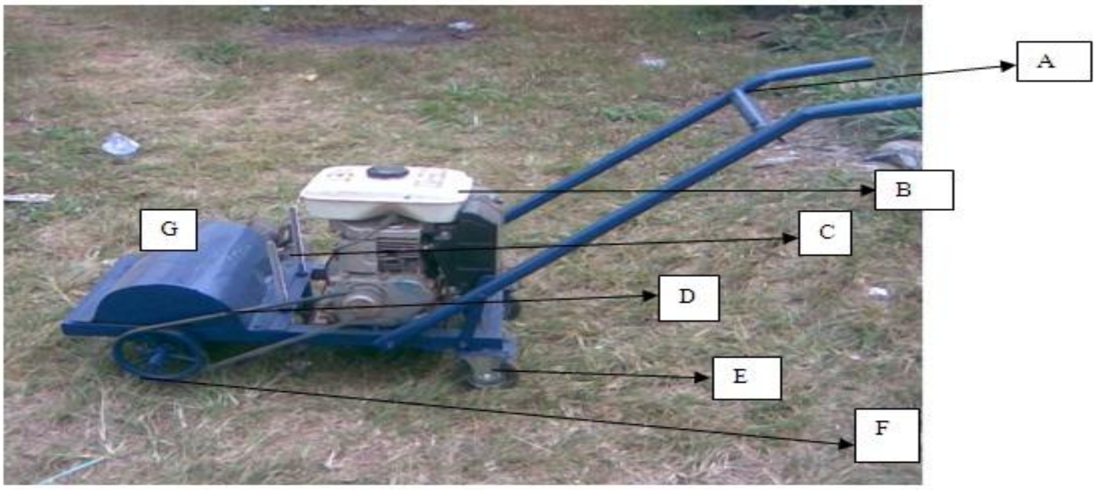

Fig.1: Motorised Row Weeder

A = Operating handle
B = 5hp petrol engine
C = Bolt for depth control
D = Belt
E = Land wheel
F = Pulley
G = Blade Shield
H= Frame

Fig 2, The flat blade

Fig. 3, The spike-tooth blade.

Fig 4, The curved blade

2.2 Test and Performance Evaluation

30m^2 of land was measured out from the demonstration farm of Rufus Giwa Polytechnic, Owo, Ondo State Nigeria. 2m by 4m land was measured and demarcated with rope into five places, this is then replicated into three different plots (i.e. plots I, II & III). The preparation of the plots involves removal of debris, wood stumps and stones for easy operation of the machine. Each plot was wetted with varying and predetermined amount of water to vary the soil moisture content .The plots were conditioned to moisture content of 10%, 13% and 16% w.b. The soil moisture
content was determined using the method described by ASAE (1983).

The machine efficiency, quality performance efficiency, percentage of partially uprooted weeds and percentage of weeds not uprooted were determined by the following equations.

Machine efficiency

$$E = \frac{W_u}{W_T} \times 100\% \quad \ldots 1$$

Percentage of un-uprooted weeds

$$-\frac{W_{un}}{W_T} \times 100\% \quad \ldots 2$$

Percentage of partially uprooted weeds

$$\frac{W_{pu}}{W_T} \times 100\% \quad \ldots 3$$

Quality performance efficiency,

$$\frac{W_{tu}}{W_T} \times 100\% \quad \ldots 4$$

Where;
E = machine efficiency
W_u = uprooted weeds
W_T = total weeds
W_{un} = un-uprooted weeds
W_{pu} = partially uprooted weeds
W_{tu} = total uprooted weeds

III. Results and Discussion

The results of the performance test analysis are presented in tables 1, 2, 3 and 4. Table I shows that the moisture content, types of cutting blade and the interaction between moisture contents and types of cutting blades significantly affected the machine efficiency, quality performance efficiency, percentage of partially uprooted weeds and percentage of un-uprooted weeds at 5% level of significance

Table 2 shows the result of applying Duncan Multiple Range Test (DMRT) to the means of moisture content on the performance parameters of the powered weeder, it can be seen from table 2 that the machine efficiency and quality performance efficiency increased with increase in moisture content while the percentage of partially uprooted weeds and percentage of un-uprooted weeds decreased with increase in moisture content. This is because at high moisture content weeds are turgid, which makes them susceptible to mechanical shear easily.
Table 3 shows the results of applying DMRT to the means of types of cutting blade on the performance parameters. It can be seen from this table that the spike tooth blade gives highest average machine efficiency (76.62%) followed by the curved blade (71.84%) and the flat blade (68.56%) respectively.

The result of applying DMRT to the means of interaction between moisture content and the types of cutting blade is presented in table 4. These results show that the interaction between moisture content and types of cutting blade statistically affected all the performance parameters of the machine at 5% level of significance. The spike tooth blade gave the best machine efficiency at the three investigated moisture contents with the highest of

94% at moisture content of 16% (w.b).

However, the quality performance efficiency, percentage of partially uprooted weeds and percentage of un-uprooted weeds were 84.0%, 2.8% and 1.8% respectively at this moisture content. Flat blade gave the lowest machine efficiency at all the three investigated moisture contents with the least of 62.2% at moisture content of 15.8% (w.b).

The high percentage of quality performance efficiency (84%) and percentage of partially uprooted weeds (2.8%) and the least percentage of un-uprooted weeds (1.8%) were recorded at 16% moisture content.

Table 1: F-ratio for the Results of the Performance Tests

Sources of variation	Machine efficiency	Quality performance efficiency	Partially uprooted weeds	Un-uprooted weeds
Moisture content (m)	1856.82*	1469.94*	75.68*	566.87*
Types of cutting blade (T)	192.26*	148.66*	8.43*	62.70*
Two – factor interaction (MxT)	15.33*	12.48*	4.72*	3.68*

Denotes statistically significant difference at 5% level

Table 2: Effect of Moisture Content on Performance Parameters

Moisture content (%) (Wb)	Machine efficiency	Quality performance effieicency	Percentage	
			Partially uprooted weeds	Un-uprooted weeds
8.4	58.3	51.2	14.02	21.4
12.7	76.8	68.4	8.65	13.32
15.8	89.2	71.6	3.88	5.8

Values in the same vertical column with the same superscripts letters are not significant

Table 3: effect of types of cutting blades on performance parameters

Types of cutting blades	Machine Effeiciency	Quality performance efficiency	Percentage	
			Partially uprooted weeds	Un-uprooted weeds
Spike tooth	76.6	70.08	8.28	16.73
Curved blade	71.84	67.56	16.55	15.22
Flat blade	68.56	53.28	11.62	20.20

Values in the same vertical column with the same superscript are not significant

Table 4: Effect of interaction between moisture content and types of cutting blades

Moisture Content/Type of Cutting Blade	Machine efficiency (¬µ)	Quality Performance Efficiency(¬Q)	Percentages	
			Partially prooted Weeds	Un-uprooted Weeds
M_1.S	64.0g	58.6g	10.6a	12.0a
M_1.C	8.3h	54.3h	12.4a	15.6b
M_1.F	50.8l	48.3l	11.8a	18.3a
M_2.S	74.6d	67.6d	7.6c	4.6c
M_2.C	68.7c	60.3c	8.1b	7.7d
M_2.F	60.2f	56,4f	9.6bc	8.4e
M_3.S	94.0a	84.0a	2.8c	1.8b
M_3.C	80.6b	76.5b	5.6d	2.5c
M_3.F	70.0c	62.2c	6.3d	3.8f

Explanation as in Table 3

IV. Conclusions

Moisture content of weeds statistically affects the performance parameters of the weeding machine at 5% level or significance.

Types of cutting blades significantly affect the performance parameters at 5% levels of significance. Machine efficiency and quality performance efficiency of the machine increased with increase in moisture content.

Percentage of partially uprooted weeds and percentage of un-uprooted weeds decreased with increase of moisture content. The spike tooth cutting blade gave the best machine efficiency, followed by the curve blade and the flat bar blade, respectively.

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