DESIGN, FABRICATION AND TESTING OF A MOTORCYCLE MOUNTED HERBICIDE BOOM SPRAYER

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ABSTRACT

A motorcycle mounted herbicide boom sprayer with a capacity of 2 ha/hr was designed and fabricated in or overcome some of the challenges associated with the existing equipment for weed control such as knapsack sp tractor mounted boom sprayer etc. The machine was fabricated from locally available materials and comprises following parts: battery, spray pump, tank, hose, boom, nozzles and frame. Test results indicate that at 8, 10, 1 14 km/hr ground speeds, the spray application rates were 286, 270, 256 and 245L/ha respectively whi corresponding field capacities in ha/hr are 1.5, 1.8, 2.1 and 1.8 respectively. The field efficiencies obtained f four different speeds are 78.2, 76.1, 72.1 and 75.4% respectively. Maintenance and replacement of parts used i since all the components are available locally.

Keywords: *Weeds, sprayer, herbicide, crop, farm*

INTRODUCTION

Weeds are plants that are seen as hazardous or injurious to people, animals or crops. These undesirable plants different crops thereby reducing yield by as much as 95% due to shading and competition for light and nutrients (*et al.*, 1996). In an effort to reduce the activity of weeds on the farm, a lot of energy, time and resources are v which could have been invested in other farm operations. As a result of the manual method of weeds remova tedious and time consuming, various technical methods have been devised to control or eliminate weeds. So these methods include use of mechanical equipment, flooding, mulching and herbicide application using sp (Hamid *et al.*, 2011).

A sprayer is defined as a device that utilizes mechanical energy to atomize liquid chemical into a spray fog fo disease, insects or weed control in a given area of land (Prasad, 1994). Spray equipment vary in terms of mo scale of application, ranging from knapsack sprayers to tractor operated boom sprayers. However, the knapsack has their shortcomings of drudgery, limitation in application rate (200L/ha) and field efficiency (56%) depen the operator (Campbell and Altman, 1997). Also the tractor operated boom sprayer have their disadvantages high cost of the equipment and cost of operation and maintenance.

In view of the shortcomings associated with the existing methods of applying herbicides on the farm, this work " fabrication and testing of a motorcycle mounted herbicide boom sprayer" was conceived with a view of increa application rate limitation of the knapsack sprayer and at the same time solve the high cost problem of the drawn boom sprayers.

MATERIALS AND METHOD

Design Considerations

In carrying out this design work, the followings were put into consideration

i. Capacity of the chemical reservoir (plastic tank).
ii. The height of the boom and nozzle from the ground.
iii. The rate of herbicide discharge.
iv. Head losses.
v. Compactness and availability of construction materials.

Design Calculations

Determination of the Rate of Herbicide Discharge

The rate of herbicide discharge was determined as given by equation 1.

$Q = A.V$ (Rajput, 2006)

Where,
Q = discharge (m^3/sec)
A = Area of cross-section of the hose pipe (m^2)
V = Velocity of the liquid (m/sec) .

Determination of Head loss in the hosepipe
Due to friction in the hose pipe, head losses are inevitable. This was calculated from equation 2

(2)

$h_f = \frac{4fL}{D \times 2g} \times V^2$ (Rajput, 2006)

Where,
h_f = Head lost in the hosepipe
f = Friction factor
L = Length of the hosepipe (m)
D = Diameter of the hosepipe (m)
G = acceleration due to gravity (m/s^2)

Determination of power delivered by the pump
The power delivered by the pump was determined by equation 3. (3)
$P = wQH_p$ (Rajput, 2006)
P = Power delivered by the pump (W)
w = Fluid static weight (kg)
Q = Pump flow rate (m^3/s)
H_p = Head delivery by pump (m).

Determination of the Velocity of the liquid chemical in the Hose pipe
The velocity of liquid travelling in the hose was calculated using equation 4.

$V_o = \frac{Q}{A}$ (Nakayama and Boucher, 2000)

(4)

V_o = Velocity of the fluid (m/s)

Q = the pump flow rate (m^3/s)

$A = \frac{\pi D^2}{4}$

$D = Internal\ diameter\ of\ the\ hose\ (m)$

Determination of the Tank Capacity
The tank was considered as a cuboid and as such, the capacity was calculated using equation 5.
$V_t = L \times W \times H$ (Omeni *et al.*, 1997) (5)
Where,
V_t = Volumetric capacity of the tank (m^3)
L = Length of the tank (m)
W = Width of the tank (m)
H = Height of the tank (m)

Machine Description
The followings are the component of the motorcycle herbicides sprayer.

Tank: This is a rectangular 25 litres capacity plastic tank. It holds the liquid chemical temporarily before delivery on the farm.
Hose: These are fluid pathways provided to connect the bottom and top openings of the tank so as to release the herbicide and to return excess herbicide to the tank.
Strainer: This is a mesh made of very fine silk of 0.05mm diameter provided in the nozzle to prevent dirt from clogging the tip or orifices of the nozzle. The meshes are loosely inserted in the nozzles so that they can easily be cleaned occasionally when they are dirty or clogged.

Spray pump: This is a 12 volt DC pump. It sucks the liquid from the tank at low pressure by means of a hose and releases it to the nozzles through the boom at a very high pressure.

Battery: This is the source of power for the pump. It is a 12 volt, 7 amps rechargeable battery.

Nozzles: The nozzles help to atomize the chemical solution into droplets and deliver the liquid in a desirable spray pattern to the target object.

Boom: This is a 1.75 mm diameter PVC pipe used in connecting the four nozzles with the aid of screw extensions. A hose is used to link the center of the boom to the tank. .

Machine frame: The machine frame is made of 2 inches rectangular light pipe with dimensions, 35mm x 25mm x 55mm (length, breadth and height) and a 2mm thick bottom mild steel plate on which the tank seats.

Principle Of Operation

The various parts of the machine were coupled together and the tank was filled with liquid chemical. The strainer was placed at the inlet of the tank to remove impurities that may likely block the nozzles. With the motorcycle set in motion and the switch connecting the pump and the battery turned on, spraying was actuated and continuously spraying was maintained by the constant motion of the motorcycle

MACHINE EVALUATION

The machine was tested as shown in plates 1 and 2 at four different ground speeds of 8, 10, 12 and 14 km/hr with a view of determining the spray application rate, field capacity, and field efficiency. Each of the experiment was done in triplicate and the results obtained are tabulated in table 1

Plate 1: Spraying proces

Plate 2: Spray overlap from adjacent nozzles

Spray application rate (L/ha)

The spray application rate was calculated using equation 6 in order to know how many litres of chemical that will be needed per hectare.

$$\text{Application rate (L/ha)} = \frac{600 * Total\ sprayer\ output\ (L/min)}{Swath\ width\ (m) * travel\ speed\ (km/h)} \quad (6)$$

Field capacity

The field capacity is the number of hectare that can be sprayed per unit time. It was evaluated by equation 7.

$$\text{Field capacity (FC)} = \frac{Width\ (ft) * Speed\ (mph)}{8.25} \quad (7)$$

Field efficiency (FE%)

Field efficiency is defined as the percentage of time the machine operates at its full rated speed and width while in the field and it was calculated using equation 8.

$$\text{Efficiency (E\%)} = \frac{A_c}{A_t} \times 100 \quad (8)$$

Where,

A_c = Area covered with chemical

A_t = Total area of field travelled

RESULTS AND DISCUSSIONS

Table 1: Average Machine performance at varied motorcycle speeds

Motorcycle speed (km/h)	Spray application rate (L/ha)	Field capacity (ha/h)	Field efficiency (%)
8.0	286	1.5	78.2
10.0	270	1.8	76.1
12.0	256	2.1	72.1

Spray Application Rate

From table 1, the result shows that the spray application rate depends on the speed of the motorcycle such that the lowest speed 8 km/hr had the highest application rate of 286 L/hr while the highest speed recorded the lowest application rate of 245 L/hr. This means that the slower the motorcycle speed, the higher the application rate and vice versa.

Field capacity

The result presented in table 1, shows that the field capacity is directly proportional to the motorcycle speed. The highest motorcycle speed, 14 km/hr recorded the highest field capacity of 2.8ha/hr and the least field capacity of 1.5 ha/hr was observed for the lowest speed of 8km/hr.

Field efficiency

The field efficiency as shown in table 1 reduces with increase in the motorcycle speed. The major reason for this reduction is due to wind effect. As the speed increases, the higher the chance of the spray to be prone to wind drift.

CONCLUSION

The motorcycle mounted herbicide boom sprayer was designed, fabricated, and tested. From the test result on the fabrication and testing of the machine, the following conclusions were made:

i) The optimum application rate of the motorcycle mounted sprayer was found to be 270 L/ha with an average field efficiency of 76.1%. This indicates a 35 % increase in application rate and 34 % increase in efficiency compared to conventional knapsack sprayer (200L/ha application rate and 56% efficiency).
ii) Field capacity of the machine increased with speed.
iii) The motorcycle mounted sprayer reduced the risk of chemical exposure to man since it is sprayed behind the operator.
iv) Also, the cost of maintaining the machine is low compared to tractor mounted sprayer

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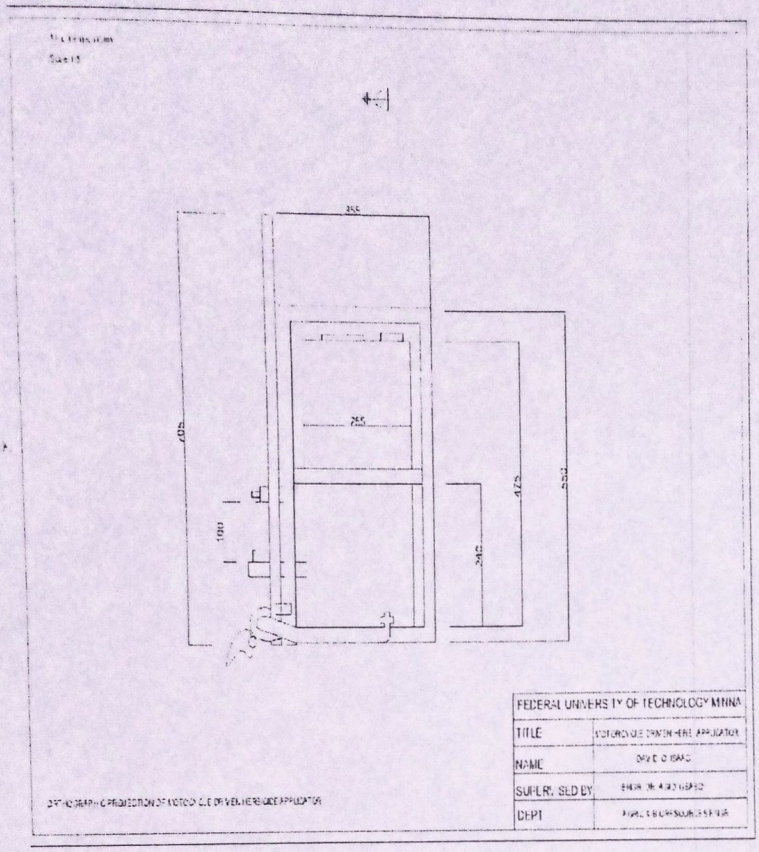
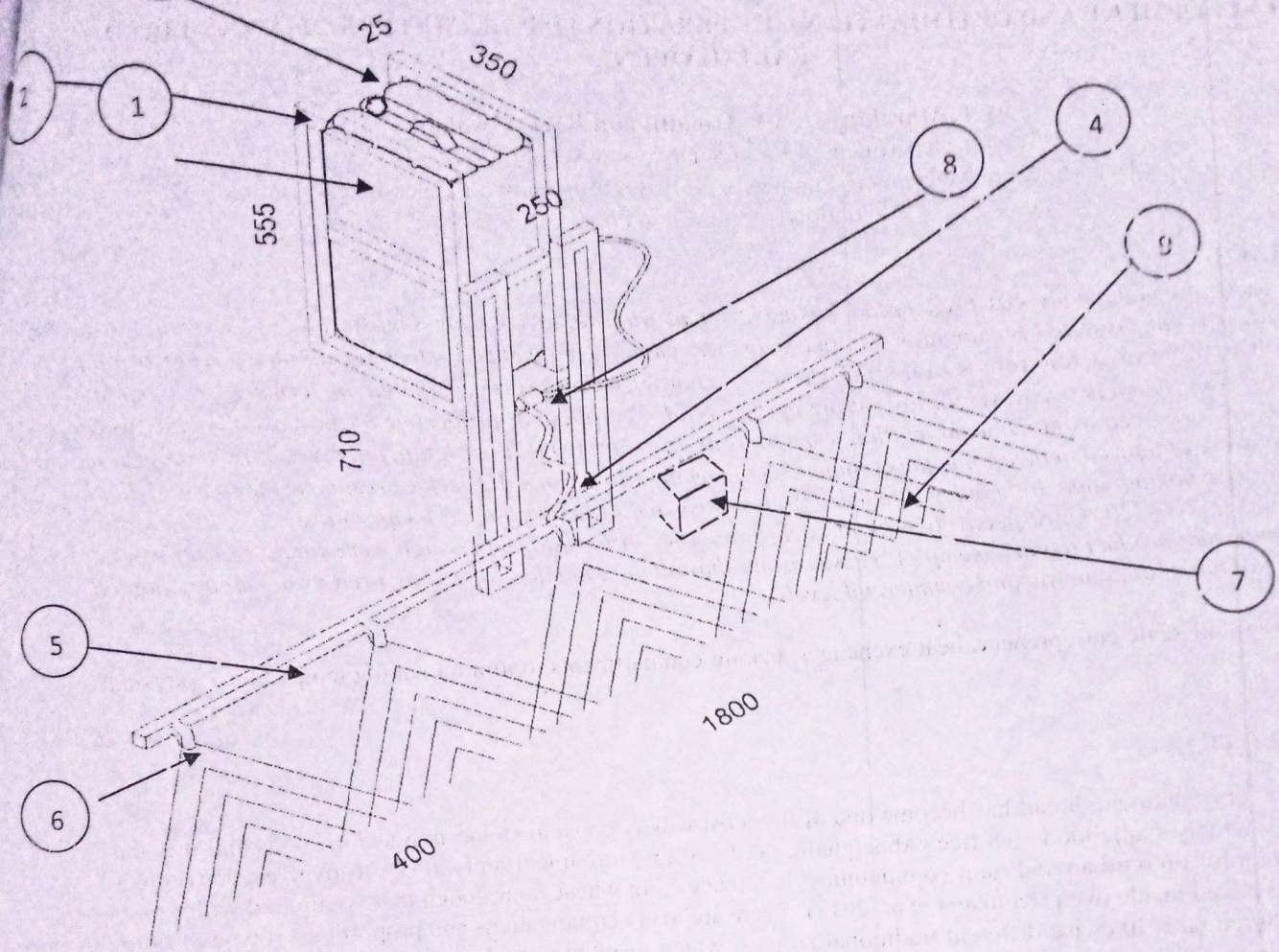


Isometric view of motorcycle mounted herbicide boom sprayer



1	TANK
2	FRAME
3	ADJUSTABLE ARM
4	HOSE
5	BOOM
6	NOZZLE
7	BATTERY
8	PUMP
9	SPRAY (OVERLAP)