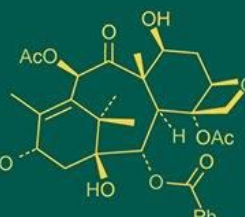


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Performance testing of developed small tractor operated raising platform for spraying orchard

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Abstract

Konkan region of Maharashtra is one of the largest mango growing belts in the country and Alphonso is highly demanded fruit in the region, which has got lot of export value as well as potential of export. There are several limitations for farm mechanization in Konkan region. Therefore, tractor (above 35 hp) operated machines and related technologies have got very limited scope for farm mechanization in the region. Considering the problems and limitations of Konkan region and farmers feedback, a small tractor operated raising platform was developed for harvesting, spraying and pruning operations. The basic components on machine consists of turntable, hydraulic tank, hydraulic pump, hydraulic motor, lifting arm, hydraulic cylinder, directional control valve, hydraulic oil flow pipeline and harvesting bucket. A small tractor (18.5 hp) was used to lift the platform up to 6 m height. The machine consists of two arms which rotates through 90° in both clockwise and anticlockwise direction. The developed raising platform was tested for spraying on mango orchard. The spraying was done with motorized knapsack mist blower. The spray droplets deposited on glossy papers were analyzed for determining volume median diameter (VMD), number mean diameter (NMD), uniformity coefficient (UC). The droplet size parameters were determined at six different locations of the tree canopy. From the table, it was found that the average value of volume median diameter (VMD) was 69.36 µm. The average values of number median diameter (NMD) was found to be 82.35 µm, The average value of uniformity coefficient (UC) was found to be 0.85. The maximum number of droplets occupies the size (VMD) in the range of 0-100 µm. In terms of percentage, it is 91.25%, 86.18%, 95.12%, 94.57%, 84.50% and 82.99 at TO, TI, MO, MI, BO and BI respectively. The developed tractor operated raising platform worked satisfactorily for spraying orchard.

Keywords: Raising platform, elevator, spraying, droplet size, VMD

Introduction

Mango (*Mangifera indica* Linn) is the most important fruit of India and is known as “King of fruits”. Mango (*Mangifera indica* L.), which belongs to the Anacardiaceae family, is the most important tropical fruit in the world. India is leading mango producer in the world, producing an estimated 24.7 million MT of mangoes annually which accounts for almost half of the entire global mango production. In Maharashtra, mango is occupying an area of 168.15 thousands ha with an annual production of 439.08 thousand MT (Anonymous, 2021) [1]. Konkan region of Maharashtra is one of the largest mango growing belts in the country and Alphonso is highly demanded fruit in the region, which has got lot of export value as well as potential of export. The growers in the region are using the traditional tools and methods for different operations for mango cultivation. Mechanization of the operations is the solution over the severe labour problem of mango growers. The mechanization has potential to complete the required horticultural operation in time, less time, saving in labours and labour cost, improving quality of work, reducing cost of production, increasing profit of margin and also reducing the drudgery involved in various farm operations.

There are several limitations for farm mechanization in Konkan region. The land is fragmented. In Konkan 71.96 per cent farmers are marginal. Because of poor economic conditions, small land holding and hilly terrains these conditions do not permit to adopt big machines on farm. Therefore, tractor (above 35 hp) operated machines and related technologies have got very limited scope for farm mechanization in the region. As harvesting, spraying and pruning are important operations in mango cultivation, remaining

with lack of mechanization. It is necessary to develop small machine for harvesting, pruning and spraying whose power source is a small tractor (mini tractor). Hence the study was undertaken to develop a elevator with platform for the operator having maneuverability, the important operations like harvesting of mango, pruning and spraying done in a better way, quick time, with saving of labours and growers can get the benefits of farm mechanization in the region.

Kathirve *et al.* (2002) ^[3] developed power tiller operated orchard sprayer. The drive for reciprocating pump transmitted from the clutch pulley of the power tiller through 'V' belt. The sprayer was operated at operating pressure of 17 to 25 kg/cm². Ramana and Jesudas (2009) ^[4] developed a parasol sprayer for efficient chemical application in dwarf and semi dwarf mango orchard based on physiological parameter of the mango tree. The sprayer was developed with a height of 4.5 m to accommodate trees up to a height of 3.75 m to 4 m.

Some of the agricultural universities, institutes and research organizations have also worked on development of raising platform for harvesting, pruning and sparying in India. A tractor mounted positioner was developed for harvesting of mango fruits at Gujarat Agricultural University, Junagad. The machine consisted of frame, three point linkage, hydraulic jack, supporting links, extension pipe and cage. A hydraulic jack of 2 tones capacity with two cylinders was mounted at the centre of the frame with the help of a pin of 40 mm passing through two plates welded to the frame and lower end of the hydraulic jack. The cage was mounted on top of the extension piece and its sides were folded. The machine was tested for mango harvesting (Gupta *et al* 2004).

A tractor mounted hydraulic operated ladder was developed at TNAU, Coimbatore to reduce the harvesting /pruning cost, increase the harvesting/pruning efficiency and enhance the overall productivity of mango orchards. The developed system was attached to the rear of a minimum 45 hp agricultural tractor. The power was taken from tractor hydraulic system. The hydraulic ladder had the capability to lift a service worker and the required tools to the crown zone as high as 10 m. It was able to rotate from 0 to 360° both in clockwise and anticlockwise direction so that minimum 4 coconut/mango tress could covered by simply operating the directional valve (Thiyagarajan and Tajiddin, 2018) ^[8]. The self propelled hydraulically operated multi-utility platform for orchard management system was developed at CIAE, Bhopal to increase the accessibility of pickers to fruit on tress and to carry out orchard management practices like spraying and pruning. The platform was designed for vertical reach of 6 m and load carrying capacity of 200 kg (Roul and Bhargav, 2020) ^[7].

Kolhe and Jadhav (2011) ^[6] tested tractor mounted hydraulic elevator for mango orchard. The average harvesting capacity for Alphonso mango fruits was observed 192 kg/h (675 fruits/h). The average field capacity of the machine was 0.08 ha/h (10x10 m spacing). The average lifting time required for harvesting bucket to reach up to height of 10.04 m was 38 sec. The average lowering time required for harvesting bucket to lower down from height of 10.04 m was 28 sec. The hydraulic elevator was suitable for harvesting of mango and coconut orchard up to 12 m and pruning of tree up to 10 m height comfortably.

Materials and Methods

The small tractor operated raising platform was developed for spraying. (Fig. 1). The basic components on machine consists of turntable, hydraulic tank, hydraulic pump, hydraulic motor, lifting arm, hydraulic cylinder, directional control valve, hydraulic oil flow pipeline and platform. The control of the elevator works on the principle of hydraulic system and Pascal's law. The power required for hydraulic pump operation was taken from tractor PTO shaft. The hydraulic oil flows from the hydraulic tank to hydraulic pump and from pump to the multi position multi-way directional control valve. The directional control valves with control lever is attached on harvesting bucket. The operator controls movement of fruit elevator. One single operator controls the motion of the cylinder, hydraulic motor and the platform through control panel. In forward stroke, the oil flow from the tank to hydraulic pump and pump to cylinder. While in reverse stroke, the hydraulic oil returns to the hydraulic tank and arm moves downward. The hydraulic motor rotation is controlled clockwise or anticlockwise to control the movement of turn table.

The testing of developed small tractor operated raising platform was carried out for spraying on mango trees (Kesar). The motorized knapsack mist blower was used for spraying on mango trees. Glossy photo paper of 44 ×44 mm size were used for spray deposition purpose on different canopy positions (Fig. 2) and placed at six different locations in the tree on the upper leaf surface as shown in the sketch (Fig. 3). These locations were top outer (TO), Top inner (TI), Middle outer (MO), middle inner (MI), bottom outer (BO) and bottom inner (BI).

The measurement of tree canopy diameter (m) and tree canopy height (m) were done. The spraying was done from a distance of 1.25 m from the outermost points of the tree canopy. The operator was standing inside the raising platform (Fig 3) of the elevator and the motorized knapsack mist blower was mounted on the back of operator. The raising platform was lifted as per the height of the tree up to 6 m. The hose pipe with nozzles is in the hand of the operator standing in harvesting platform spraying the entire circumference of the tree. For spraying the mango trees, blue dye was mixed with water at a ratio of 1:10 (100 mL of dye per liter of water) to produce a colored spray solution.

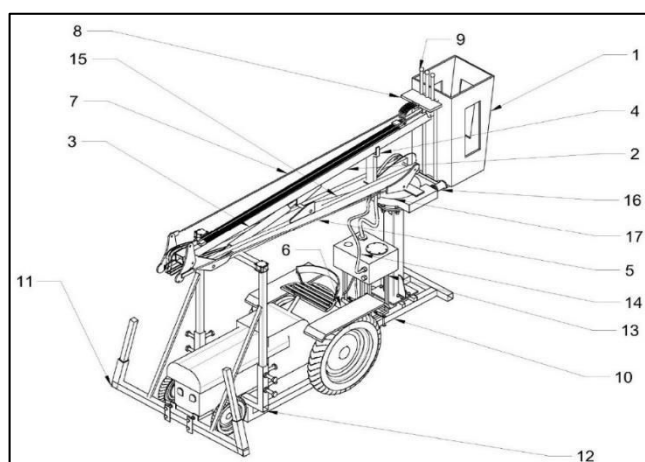


Fig 1: Developed small tractor operated raising platform

1	Harvesting bucket (Platform)	10	Main frame
2	Upper arm	11	Front support arms
3	Upper cylinder	12	Support for resting of lower arm
4	Upper arm resting support	13	Hydraulic tank
5	Lower arm	14	Seamless hydraulic hose pipes
6	hydraulic pump	15	Lower cylinder
7	Extension pipes for support	16	Hydraulic motor
8	Bucket platform	17	Turn Table
9	Directional control levers		



Fig 2: Placement of glossy photo papers on leaves of tree canopy sections

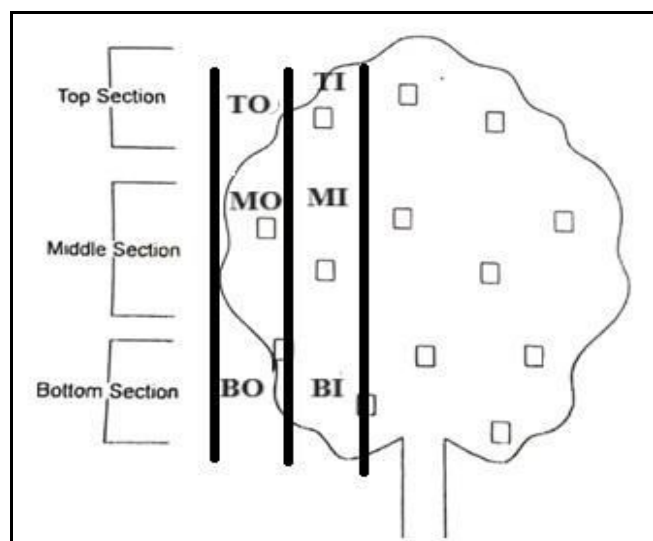


Fig 3: Schematic view of different positions of tree

Before starting the experiment, it was ensured that the tractor was set to the specified forward speed. After all adjustment were made, the constant travel speed of the tractor was maintained along the mango tree canopy during spray application. It was also ensured that, the sprayer was allowed to run for about 1 minute before the actual start of the experiment to maintain a constant flow pressure. After confirming all the required settings, the actual spraying was carried out over the entire canopy of the mango tree. The sprayer was turned off immediately after completing the spraying of the tree canopy. The spray deposited glossy paper (Fig. 4) were dried for 15 minutes on the tree for

better impression of blue dye. After that all the glossy papers were removed from tree and labelled separately.



Fig 3: Testing of developed tractor operated raising platform for spraying on mango trees



Fig 4: Spray deposition on glossy paper

Results and Discussion

Biovis PSA 2000 software was used for droplet size analysis. The samples selected for analysis were scanned with the digital microscope camera. The spray droplets deposited on glossy papers were analyzed for determining volume median diameter (VMD), number mean diameter (NMD), uniformity coefficient (UC). From the Table 1, it was found that the average value of volume median diameter (VMD) was 69.36 μm . The average values of number median diameter (NMD) was found to be 82.35 μm . The average value of uniformity coefficient (UC) was found to be 0.85. As per the ASABE droplet size classification, the smaller value of VMD spray quality is termed as fine and the finer droplets gives good coverage on the target (Anonymous, 2021b) [2]. The maximum number of droplets occupies the size (VMD) in the range of 0-100 μm . In terms of percentage, it is 91.25%, 86.18%, 95.12%, 94.57%, 84.50% and 82.99 at TO, TI, MO, MI, BO and BI respectively (Table 2).

Table 1: Droplet size (μm) and uniformity coefficient on various positions of tree canopy

Sr. No.	Position of leaf	Average values of T1, T2, T3		
		Parameters		
		VMD	NMD	UC
1	Top outer (TO)	65.24	71.69	0.91
2	Top inner (TI)	53.62	61.63	0.87
3	Middle outer (MO)	74.98	84.25	0.89
4	Middle inner (MI)	59.51	61.38	0.97
5	Bottom outer (BO)	82.47	90.63	0.91
6	Bottom inner (BI)	73.48	93.01	0.79
	Average	69.36	82.35	0.85

Table 2: Droplet size (μm) range and percentage

Sr. No.	Droplet range, μm	Number of droplets, %					
		TO	TI	MO	MI	BO	BI
1	0 - 100	91.25	86.18	95.12	94.57	84.50	82.99
2	101 - 200	7.96	11.44	4.38	4.74	12.48	13.64
3	201 - 300	0.72	1.70	0.31	0.40	2.04	2.00
4	301 - 400	0.02	0.51	0.14	0.13	0.74	0.64
5	401 - 500	0.05	0.12	0	0.11	0.19	0.39
6	501 - 600	0	0	0	0	0	0
7	601 - 700	0	0	0	0	0	0
8	701 - 800	0	0	0	0	0	0
9	801-900	0	0	0	0	0	0
10	901 – 1000 and above	0	0	0	0	0	0

Conclusions

The developed small tractor operated raising platform worked satisfactorily for spraying operation in mango orchard up to 6 m height.

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