

(A High Impact Factor, Monthly, Peer Reviewed Journal) Visit: <u>www.ijirset.com</u> Vol. 8, Issue 4, April 2019

# Modification on Tractor Mounted Axial Flow Blower Sprayer

Ramchandra Sutar<sup>1</sup>, Pravin Kashid<sup>2</sup>, Paras Patil<sup>3</sup>, Ghanshyam Kadate<sup>4</sup>, Ashish Kalekar<sup>5</sup>,

Miss Ashwini Lad<sup>6</sup>

Students, Department of Mechanical Engineering, PVPIT Budhgaon, Sangli, Maharashtra, India<sup>1,2,3,4,5</sup>

Assistant Professor, Department of Mechanical Engineering, PVPIT Budhgaon, Sangli, Maharashtra, India<sup>6</sup>

**ABSTRACT**: The design and operating procedures of air assisted axial flow blower sprayer has increased to a greater extent since last 10 years. It's overwhelming performance and efficiency has influenced farmers to adopt this technology for their crop enhancement. The main purpose of the study is to outline conditions under which air assisted axial flow sprayer would be beneficial to the farmers and thus helps to overcome the limitations. Air assisted axial flow sprayer uses power take off shaft to extract power from the tractor and transmits it to the axial fan. The mixture in the tank is pumped and sprayed through the nozzles which are then assisted by an axial fan to provide drift and penetration on the crops uniformly. The system can be attached with accessories for different spraying conditions. The paper deals with design and modification of axial flow tractor mounted blower sprayers considering the economic conditions of farmers with improved efficiency.

**KEYWORDS**: axial flow, velocity distribution, tractor mounted blower sprayer, pesticide spray

### I. INTRODUCTION

Now days, farmers all over the world are making almost efforts to increase food production to previously unreached levels in order to feed the millions utilizing most modern equipment and farming systems. Farmers are employing high yielding varieties of seeds, applying fertilizers and irrigation, and adopting proper plant protection measures for this purpose. India is no exception to this. However, Indian agriculture is characterized not only by its regular annual crops but also to a large extent, by its orchard and tree crops. Like any other crop, these plantation crops are susceptible to attack of pests and diseases. The Indian farmers usually control them using conventional methods and appliances which include spraying of pesticides to the affected crops up to the point of runoff with manually operated or power operated hydraulics prayers, such as rocking sprayer, foot sprayer and reciprocating pump supplying pressurized liquid to the spray guns.

To encounter and overcome all these and other problems, farmers and fruit growers of developed countries have been using air assisted spraying system for many years. In India, although air-assisted spraying technique has been employed in some of the hand operated and boom sprayers, air-carrier sprayers capable of spraying vast orchard and tree crops are still aliens to Indian agriculture .As the name implies, an air-carrier sprayer utilizes an airstream to carry the

spray droplets onto the target It employs a blower (which is basically a fan) to produce and deliver an air stream of sufficient discharge, velocity and pressure, and introduces the spray fluid into this air stream in the form of fine droplets at high pressures (from a reciprocating pump) at the air outlet The turbulence of the air stream causes thorough mixing of air and liquid, and this spray laden air proceeds from the sprayer to displace the original air inside the canopy action of t. The turbulent air stream along with the suspended pesticide solution in it causes ruffling he foliage and effect impingement of spray droplets on both sides of the leaves, including those in the inner most parts in the canopy.



(A High Impact Factor, Monthly, Peer Reviewed Journal) Visit: <u>www.ijirset.com</u>

#### Vol. 8, Issue 4, April 2019

### **II. LITERATURE SURVEY**

D.R. Menzies [1], stated that it is difficult to achieve insect and disease control in the top center of the tree canopy with many current sprayers, particularly when application rates are reduced. A study of the factors affecting sprayer performance is needed. Commercially available spray machines are not suited for such a study because they have large pesticide tanks, fans and nozzle manifolds fixed in position, and air volume and release angle fixed within relatively narrow limits. For these reasons, an experimental orchard sprayer was designed and fabricated as reported here.

Dennis G. Watson, Robert L. Wolff [2], studied that to focus on the problem of applying spray material to upper-plant, underside-leaf surfaces of corn and soybean plants. Aircraft and ground pressure atomizer applications of spray solution were quantified. Percent coverage values were generally less than 1 % on the sampling locations. Flat and hollow cone nozzle air carrier units were developed and evaluated for spray application to the upper-plant, bottom leaf surface. The air carrier method tested within a shroud improved spray deposition to the entire plant by 100% for corn and 234% for soybeans. Deposition to the upper-plant, bottom leaf surface was increased by 900% and 400% for corn and soybean plants, respectively. Deposition uniformity was also improved with the air carrier method.

H. Zhu, R. D. Brazee, R. C. Derksen, R. D. Fox, C. R. Krause, H. E. Ozkan, K. Losely[3], noticed that "New sprayers are needed to deliver droplets uniformly within dense nursery crops to obtain healthy and marketable plants in the nursery industry. An air-assisted sprayer with five-port nozzles was developed and investigated to improve spray penetration into dense nursery canopies Dynamic air velocities corresponding to the deposit sampling locations inside and outside the canopy were measured at the time when the sprayer passed over the canopies. The measured air jet velocity decreased from 40.1 to 19.4 m/s when the distance from the orifice increased from 0.33 to 0.79 m. The peak velocities at the top and middle elevations for both inside and outside the canopy decreased as the nozzle height above the ground increased, but the peak velocities at the bottom elevation for both situations were not significantly decreased as the nozzle height increased."

M.P. Tekade, G.S. Kadam, K.G. Dhande and A.G. Powar [4], shown that "In orchard, it is difficult to spray the pesticide uniformly throughout the tree by conventional methods. Air carrier sprayer is a viable alternative to hydraulic sprayer especially when sprayer has to deposit chemical on target, which are far from sprayer. An air carrier sprayer was evaluated for pesticide application in Mango orchard. The flow rate of spray nozzle was measured by operating sprayer at a speed of 7, 8.5 and 10 km/hr. with four different dosage discs. The flow rate of air carrier sprayer varies from 0.6 lit/m in to 2.42 lit/m in. with different dosage discs. The spray swath and horizontal throw of air carrier sprayer increases with increase of speed. The air velocity increase in distance from blower outlet from 3 m to 15 m. The air carrier sprayer deposit spray uniformly on inner and outer side of tree at different locations and hence recommended for orchard spraying."

D.D. Tekale, A.R. Mantri and S.C. Kawade [5], were conducted experiments in laboratory to study the performance of three centrifugal flow mist blowers based on air velocity, air discharge, efficiency and power requirement. These blowers B1,B2 and B3,gave more air velocity, air discharge and efficiency at 2450, 2000 and 1600 rpm, respectively and power required to run these blowers was 28.4 kW, 19.9 kW and 4.4 kW, respectively. The suitable tractors to operate these blowers in the field were 45 hp, 35 hp and 18 hp, respective

### III. PROBLEM STATEMENT

We have tested the current axial flow mist blower sprayer in the laboratory and this show that air velocity of the current model of blower sprayer is not blow air uniformly on all side. The industry faces more problem that the supportive frame can't attach to every model of the tractor. There is one more problem in current model that the velocity (rpm) of the blower fan is low and if tried to increase speed the engine load is increases.

#### **OBJECTIVES**

1. To test the performance of existing blowers in industry.

2. To modify axial flow blower suitable for grape vineyard and pomegranate orchards operated by small tractors.

3. To modify the blower sprayer of uniform distribution of air to all the side.

4. To manufacture the frame for assembly of the blower sprayer that can suitably attach for any model of tractor.



(A High Impact Factor, Monthly, Peer Reviewed Journal) Visit: <u>www.ijirset.com</u> Vol. 8, Issue 4, April 2019

5. To Increase air velocity of the blower sprayer

### IV. METHDOLOGY

### • CONSTRUCTION



Air assisted axial type blower sprayer is an assembly of different type of component which is mounted on the frame and connected to tractor.

The sprayer consist of following components

- 1. Axial blower
- 2. Frame for mounting blower
- 3. Distributer line
- 4. Sprayer Nozzles
- 5. Pesticide tank
- 6. Strainers
- 7. Power transmission units
- 8. Hydraulic pump

### V. DESIGN AND MODIFICATION CALCULATION

For uniform distribution of air we have modify and design following components **6.1 Power Transmission Distribution** Total power at PTO = 13.7 HP = 10.1kw Power to pump = 5HP = 3.7285kw Power to Fan = 7.7 HP = 6.3715 kw



(A High Impact Factor, Monthly, Peer Reviewed Journal) Visit: <u>www.ijirset.com</u> Vol. 8, Issue 4, April 2019

#### 6.2 Design and selection of Fan 1. Area of fan Diameter of fan = 635mmArea of fan (A) = $\pi/4(635*10^{-3})^2$ A=0.3166 m<sup>2</sup> 2. Discharge of Air Air Velocity (V)=28 m/s Volume of air=A\*v = 0.3166\*28 $O = 8.867 \text{ m}^3/\text{s}$ Power to Fan = 6.3715 kwTotal pressure \* Discharge of air 3. Total power = $P = P_T * Q$ $6.371.5*10^3 = P_{T*}8.867$ $P_{\rm T} = 718.56 \text{ N/m}^2$ $P_V = \frac{1}{2} * \rho v^2$ =1/2\*102\*28 $P_V = 470.4 \text{ N/m}^2$ 4. Total pressure = Static pressure + Velocity pressure $P_T = P_s + P_v$ $P_{\rm S} = 718.56-470.4$ $P_s = 248.16 \text{ N/m}^2$ $P_{s} = 25.30 \text{ mm of WG}$ $P_{\rm S} = 0.99$ inch of WG 5. RPM at fan shaft = 2060 rpmMinimum Diameter Of Hub Of Fan $d_{\min} = 19000/rpm\sqrt{Ps}$ (P<sub>s</sub> in inch of WG) $= 19000/2060\sqrt{0.99}$ $d_{min} = 9.27$ inch d<sub>min</sub>=235.45 mm $d_{min}\,{\cong}240~mm$ r = Hub Dia/Fan Dia =240/635 = 0.38No. Of Blades = 10 Sr.No Specification 1. Number of blade

Specifications of existing Specifications of New axial flow axial flow blower blower 9 10 2. Width of blade, mm 140 140 3. Diameter of tip, mm 600 635 265 240 4. Hub diameter, mm 5. 0.44 0.38 Boss ratio 6. Casing diameter, mm 620 660 7. Spacing between two blades at hub 200 90 (mm)8. Spacing between two blades at tip(mm) 105 190 9. Total weight of impeller, kg 4.09 2.59



(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 8, Issue 4, April 2019

### **Calculation of parameter**

Mean Axial Velocity: It depends on air discharge rate, fan radius and boss ratio.

$$V_{a} = \frac{\varrho}{\frac{(1-r^{2})*\pi*r_{t}^{2}}{(1-0.38^{2})*\pi*0.317^{2}}} = \frac{8.867}{32.82 \text{ m/s}}$$

r = Boss ratio

 $r_t = Tip radius in m$ 

 $Q = Air discharge m^3/s$ 

### Local flow coefficient:

It is the ratio of axial velocity (va) to the rotational speed of rotor at a given radius(r) it is given by, At hub

 $\lambda_h = \frac{V_a * 60}{2\pi * N_2 * r_h}$ 

$$=\frac{32*60}{2\pi*2160*0.12}$$

$$= 1.17$$
  
Va = Mean axial velocity. m/s

N = Impeller speed, rpm

 $r_h = Impeller radius, m$ 

At tip

 $\lambda_t = \frac{V_a * 60}{2\pi * N_2 * r_t} \\ = \frac{32 * 60}{2\pi * 2160 * 0.317}$ = 0.44

 $r_t =$  Impeller radius, m

**Blower efficiency** 

Blower efficiency is the ratio of output power blower to the input power, is given by,

 $\Pi = \frac{Output \ to \ blower}{Input} * 100$ 

$$=\frac{6.37}{10.1}*100$$

$$= 63\%$$
  
= 0.63

Max. pressure (P) can be attained at blower exit at maximum blower efficiency

 $P = \frac{total \ power \ available}{air \ discharge} * blower \ efficiency$  $= 717.60 \text{ N/m}^2$ 

Total theoretical( H<sub>th</sub>) pressure required at impeller  $H_{th} = P * \left(\frac{AC}{As}\right)^2 = P * \left(\frac{0.31}{0.345}\right)^2$  $H_{th} = 596.55 \text{ N/m}^2$  $A_c = area of impeller, m^2$  $A_s = area of casing, m^2$ Total pressure loss flow coefficient (K<sub>th</sub>)

$$K_{th} = \frac{H_{th}}{0.5* \text{ density of air*mean axial velocity}}$$
$$= \frac{596.55}{0.5*1.2*32^2}$$
$$= 0.97$$



(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: <u>www.ijirset.com</u>

### Vol. 8, Issue 4, April 2019

### Local swirl coefficient ( $\varepsilon_s$ ):

It is the ratio between the swirl velocity and the axial velocity component, downstream the rotor at a given radius.

$$\varepsilon_{s} \text{ (at hub)} = \frac{K_{th} * \lambda_{h}}{2}$$
$$= \frac{0.97 * 1.17}{2}$$
$$= 0.57$$
$$\varepsilon_{s} \text{ (at tip)} = \frac{K_{th} * \lambda_{t}}{2}$$
$$= \frac{0.97 * 0.44}{2}$$
$$= 0.22$$

### Mean Blade angle:

• Blade inlet angle: It is the angle made by the vector mean of the relative velocities at the inlet and outlet.  $\beta_{m}$  at hub = tan<sup>-</sup> ( $\frac{1-0.5*0.57*1.17}{1.17}$ )

$$= 30^{\circ}$$

• Blade outlet angle: It is the angle made by the inlet velocity to the axis of rotation.

 $\beta_{\rm m}$  at tip = tan<sup>-</sup>  $\left(\frac{1-0.5*0.57*0.44}{0.44}\right)$ = 65.13°

• ASSEMBLY OF MODIFIED BLOWER



Fig:assembly of modified components

The fig shows the assembly of modified components of blower sprayer. The components are casing, doom, blower guide vanes. The doom is modified as flat. The casing diameter is increases for more air suction. The blower guide vanes are convert the air velocity to pressure.



(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: <u>www.ijirset.com</u>

#### Vol. 8, Issue 4, April 2019

### VI. RESULTS AND OBSERVATIONS

We were tested the velocity distribution of air of old as well as new model of tractor mounted blower sprayer in the industry.

The test results are as following:

Side of the blower	Velocity distribution in	Velocity distribution in
	old model (m/s)	new model (m/s)
Left side of blower	16	28
Middle side of blower	18	30
Right side of blower	22	31

#### VII. CONCLUSION

The problem of air velocity distribution in the blower sprayer on all side is partially solved. According to the test, velocity of air is little more on left side of blower sprayer. As per industries requirement we are also successfully increases the velocity of air. We are manufacture the metal frame that can suitably attach to the every model of the tractor. The cost of this blower sprayer is low as compare to the other company's blower sprayer as the performance of our blower sprayer is same.

#### REFERENCES

[1] Menzies, D.R "Design of an experimental sprayer for pesticide application studies in orchards",. Eng. 20: 87-89(29 May 1978)

[2]Dennis G. Watson, Robert L. Wolff, "Air Carrier Technique for Row Crop Spraying Applications", Transactions of the ASABE 28, No. 5 (Sep 1985)

[3].H. Zhu, R. D. Brazee, R. C. Derksen, R. D. Fox, C. R. Krause, H. E. Ozkan, K. Losely. "A specially designed air-assisted sprayer to improve spray penetration and air jet velocity distribution inside dense nursery crops", Manuscript number PM 5991.(August 2005)

[4].M.P. Tekade, G.S. Kadam, K.G. Dhande Anda.G. Powar "Performance evaluation of tractor mounted tall tree air carrier sprayer for

Spraying on mango orchard", International journal of agricultural engineering, Volume 1 no.2: 30-34 (July, 2008)

[5]D.D. Tekale, A.R. Mantri And S.C. Kawade, "Performance evaluation of centrifugal flow mist blowers in laboratory", International journal of agricultural engineering, Volume1 no.2 : 197-201 (May 2009)

[6].Best Practices in Air blast Spraying Jason Deveausince 2008

[7]V.B.BHANDARI, "Design of Machine Elements", Tata McGraw-Hill Education, 2010.

[8]Bache, D. H., and D. R. Johnstone.. Microclimate and Spray Dispersion. New York, N.Y.: Ellis Horwood.1992

[9]Derksen, R. C., C. R. Krause, R. D. Fox, R. D. Brazee, and R. Zondag J. Environ. Hort "Spray delivery to nursery trees by air curtain and axial fan orchard sprayer". 22(1): 17-22. 2004.

[10]Randall, J. M.: "The relationship between air volume and pressure on spray distribution on fruit trees." J. Agric. Res. 16(1): 1-31.1971

[11]. Zucker A. and N. Zamir. "Air carrier sprayers for cotton." Journal of Agricultural Engineering Research 9(2): 188-193.1964.

[12]Watson, D. G. The construction and evaluation of two air stream assisted, hydraulic nozzle spraying units. Unpublished Master's Thesis, Southern Illinois University.1984.