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Slip-on-ring Spraying Devices for Spot Application of Chemicals to Control Eriophyid Mite in Coconut

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Abstract

Recently the coconut farmers were faced with harrowing times due to minute pest attack on coconut. The sudden outbreak of Eriophyid mite in coconut plantations has threatened the very survival of the copra industry in Southern India. To control the mite attack, spot application of pesticides is recommended as one of the remedial measures for which a slip on ring spraying device has been developed. The unit consists of a clamp, flexible hoses and nozzles. The unit is adjustable to suit any size of the coconut tree trunk. Flexible hoses with commercially available plastic (broad cone nozzles) nozzles are fixed to the delivery hoses surrounding the periphery of the clamp with the help of 'T' connectors. From the clamp all the flexible hoses are connected with main delivery line, which extends up to the bottom of the tree so that it can be attached with the commercially available rocker sprayer for spraying the chemical. Any number of flexible hoses with nozzle can be attached to the clamp. The cost of the unit for covering four to six bunches was Rs. 200 to 300 without the spraying unit. One set of clamp with required number of flexible hoses and nozzles, delievery pipe from the bottom of the tree have to be permanently fitted to each tree. Two persons are required to operate and move the sprayer unit in the coconut gardens. With rocker sprayer 20 to 25 trees can be sprayed per hour and with engine operated sprayer 25 to 30 trees can be sprayed in an hour. The discharge rate was measured at different pressure heads viz, 2.5, 5, 7.5 and 10 kg/cm^2 for different heights ranging from 3 to 15m by changing the nozzles from 1 to 4. The effect of spray height and operating pressure on the discharge of sprayer was investigated. The pressure coefficient is positive and significant indicating that if the pressure is increased by 1 kg/cm^2, the discharge is increased by 7.5 times at a given height for single nozzle, 15 times for two and four nozzles. The interaction coefficient between height and pressure is positive and significant indicating that increase in height increased the discharge by 0.15 times for one nozzle, decreased by 0.33 times for two, three and four nozzles. The height of spray has a negative correlation with discharge indicating that 1m increase in height reduced the discharge by 1.83 time at given operating pressure. The unit can be used for spraying 30 trees per hour. The slip-on-ring spraying device results in 80 and 75 per cent savings in cost and time when compared to conventional method of spraying.

Introduction

Coconut production in India has been increasing over the years. As a result, the country has emerged as the largest producer of coconuts in the world, though only third in area planted to the crop. Among the major coconut growing states, the share of Kerala in production was

42 per cent followed by Tamil Nadu with 31 per cent, Karnataka with 10 per cent and Andhra Pradesh with 8.8 per cent (Thampan, 1997). The present productivity level is the best in the world. Coconut products form a direct food source to a large section of people in the country.

Recently the coconut farmers were faced with harrowing times due to minute pest attack on coconut. The sudden outbreak of Eriophyid mite in coconut plantations has threatened the very survival of the copra industry in Southern India. The Eriophyid mite were present in the coconut groves throughout the year. But the peak populations were recorded during summer or dry periods. The mites attack 1 to 3 month old immatured nuts usually after pollination. By causing the immature button to fall, formation of abnormal buttons, poor development of butts, reduction in the nut size and kernel content and poor quality of husk associated with "gunmosis" discoloration and cracks, this mite has not only become a serious menace and but also has been inflicting heavy damage to coconut plantations in terms of yield reduction and economical return. To control the mite attack, spot application of pesticides is recommended as one of the remedial measures for which the following spraying device has been developed in the department of Farm machinery, College of Agricultural Engineering, TNAU, Coimbatore.

Fig. 1 Slip-on-ring spraying device.

Fig. 2 Slip-on-ring spraying device fitted in a coconut tree.

Table 1. Estimated Discharge at Various Levels of Height and Pressure for one Nozzle

Height of nozzle from ground level (m)	Discharge from one nozzle at different pressure heads (lit/hr)				
	2 kg/cm^2	4 kg/cm^2	6 kg/cm^2	8 kg/cm^2	10 kg/cm^2
3	51.14	67.15	83.17	99.19	115.21
6	40.57	57.52	74.47	91.42	108.37
9	30.01	47.89	65.77	83.65	101.53
12	19.45	38.26	57.07	75.87	94.68
15	8.89	28.63	48.37	68.11	87.84
18	0	19.00	39.67	60.33	81.00
21	0	9.37	30.96	52.56	74.16

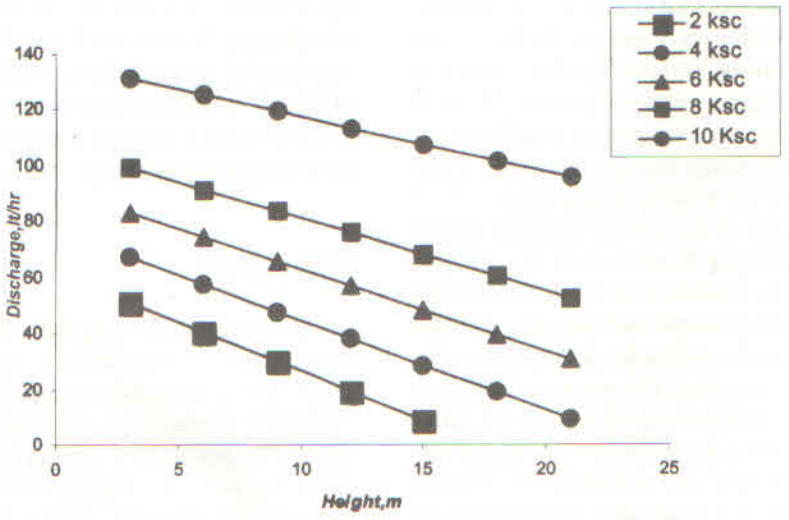

Fig.3. Estimated discharge at various levels of heighty and pressure for one nozzle.

Review of Literature

Occurrence of Mite

The first report of this Eriophyid mite in coconut was made in 196 in the state of Guerrero in Mexico. Later its occurrence was reported from several states in Africa and Central and South America. It is a notorious pest in the coconut groves in the Caribbean islands, Africa and America where it causes an estimated loss up to 25 % in yield of copra. In India, report on the infestation of this mite in coconut palm was also available.

A survey undertaken recently by the ICAR team from Delhi in Tamil Nadu revealed that the infestation was severe (> 40 %) in Coimbatore, Erode, Thanjavur and Theni districts. It was medium (10-40 %) in Madurai district and mild (0-10 %) in Cuddalore and Pudukkotai and other districts.

Control of Mite

Chemicals like dicrotophos, monocrotophos sprayed into bunches of developing fruits every 20 or 30 days significantly reduced the damage. For spraying the liquid pesticidal molecule in coconut palm, manually operated mist blowers and hydraulic sprayers and power operated hydraulic sprayers can be used.

Hand-operated Sprayers

The Micron sprayers Ltd., Three mills, Bromyard, U.K developed a hand-held sprayer which is ideal for spot–on application of pesticides without risk of drift. This hand-held and back-mounted system is avail-

Table 2. Estimated Discharge at Various Levels of Height and Pressure for Two Nozzles

Height of nozzle from ground level (m)	Discharge from two nozzles at different pressure heads (lit/hr)				
	2 kg/cm^2	4 kg/cm^2	6 kg/cm^2	8 kg/cm^2	10 kg/cm^2
3	59.50	87.98	116.47	144.95	173.44
6	52.49	78.99	105.49	132	158.5
9	45.48	70	94.53	119	143.57
12	38.47	61.01	83.553	106.09	128.63
15	31.46	52.02	72.58	93.14	113.69
18	24.45	43.03	61.60	80.18	98.76
21	17.43	34.03	50.63	67.23	83.82

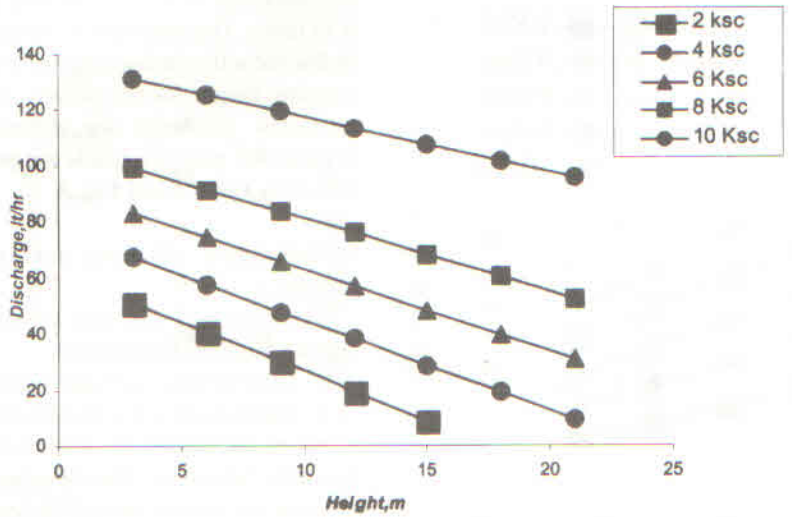

Fig.4 Estimated discharge at various levels of height and pressure for two nozzles.

able as the Accudos 25 which allows the operator to dispense and deliver a measured volume of spray liquid to a closely targeted and small area thus providing the high levels of accuracy, spatially and in dosage.

Materials and Methods

Slip-on-Ring Spraying Device

To control the mite attack, spot application of chemicals is recommended as one of the remedial measures for which slip-on ring spraying device was developed at the Department of Farm Machinery. The unit can be easily clamped and fitted to the top of the tree trunk. The unit consists of three parts, viz., clamp, flexible hoses and nozzles.

The clamp is made of mild steel flat and can be fitted at the top portion, just below the crown of the tree with the help of a ratchet type locking arrangement (**Fig.1**). It is adjustable to suit any size of the coconut trees. Flexible hoses with commercially available plastic (broad cone nozzles) nozzles are fixed to the delivery hoses surrounding the periphery of the clamp with the help of 'T' connectors and the position of the nozzles can be adjusted to suit the bunch position. Because of flexibility of line hoses, the nozzles can be fixed directly on the top of bunches (**Fig.2**) using the iron hooks provided at the end of the flexible hoses. From the clamp all the flexible hoses are connected with main delivery line, which extends up to the bottom of the tree so that it can be attached with the commercially available rocker sprayer for spraying the chemical. Any number of flexible hoses with nozzle can be attached to the clamp.

Evaluation of Slip-on-Ring Spraying Device

The device was fitted to the coconut tree and the spraying performance was evaluated. The discharge rate was measured at different pressure heads viz, 2.5, 5, 7.5 and 10 kg/cm^2 by collecting the liquid from the nozzle. At each pressure setting, the test was replicated thrice and the mean value was recorded. The spray was collected for a time period using stopwatch into a measuring cylinder. The measuring period should be at least 60 seconds and for convenience it is limited to 30 seconds. The test was repeated for different heights ranging from 3 to 15m by changing the nozzles from 1 to 4.

Results and Discussion

The results of the experiments conducted to study the performance of existing and developed models for spot application of chemicals are discussed below.

Performance Characteristics of Slip-on-Ring Spraying Device

The existing model of sprayer was tested for performance. Various functional forms were tried to study the effect of spray height and operating pressure on the discharge of sprayer. Based on the R^2 value and the predicting ability of the functional forms, a suitable function was selected. The suitable function is of the form,

$Q = \beta_0 + \beta_1 H + \beta_2 P + \beta_3 H P$

Where

Q = Discharge, lt/hr

H = Height from the ground, m

P = Operating pressure, Kg/cm^2

β_0, β_1, β_2 & β_3 = Functional coefficients

For different number of nozzles, different functions were estimated by the method of OLS (Ordinary least square method).

a.Discharging efficiency for one nozzle

The estimated function for one nozzle is given **Equation a**.

Here the R^2 value is very high and

Table 3. Estimated Discharge at Various Levels of Heighyt and Pressure for 3 Nozzles

Height of nozzle from ground level (m)	Discharge from three nozzles at different pressure heads (lit/hr)				
	2 kg/cm^2	4 kg/cm^2	6 kg/cm^2	8 kg/cm^2	10 kg/cm^2
3	81.4	114.85	148.29	181.73	215.17
6	73.26	104.07	134.89	165.69	196.51
9	65.12	93.3	121.48	149.66	177.84
12	56.98	85.53	108.07	133.63	159.17
15	48.83	71.75	94.67	117.59	140.51
18	40.69	60.98	81.27	101.55	121.84
21	32.55	50.21	67.86	85.52	103.18

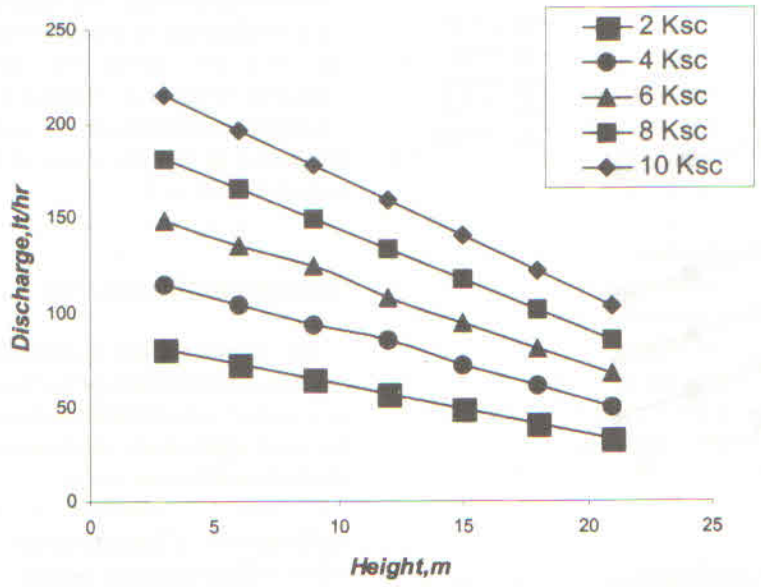

Fig.5. Estimated discharge at various levels of height and pressure for three nozzles.

significant, indicating that the discharge is 97.81 % accounted by height and pressure. Moreover, the chi-square value for the above function is not significant at 5 % level indicating its goodness. The figure in parenthesis shows the T value indicating that the parameters, operating pressure and height have a significant effect on discharge.

The sign of the height coefficient is negative and significant indication that in the case of one nozzle, if height increases, the discharge will decrease significantly at a given pressure level. The pressure coefficient is positive and significant indicating that if the pressure is increased by 1kg/cm^2, the discharge will be increased by times at a given height. The interaction coefficient between height and pressure is positive and significant indicating that as the height increases the discharge will also increase 0.15 times. This may due to the negligible reduction in discharge with increasing height for the nozzle. The estimated discharge for different heights and pressure heads are presented in **Table 1** and **Fig. 3**.

$$Q^{\wedge} = 46.6085 - 3.830095H^{\wedge} + 7.544541P^{\wedge} + 0.154947HP \quad (R^2=0.9781)$$
$$(-9.660069) \quad (14.003180) \quad (2.675620)$$
Equation a

$$Q^{\wedge} = 36.0574 - 1.677218\,H^{\wedge} + 15.231315\,P^{\wedge} - 0.330091\,HP \quad (R^2=0.9788)$$
$$(-3.059718) \quad (20.448082) \quad (-4.122837)$$
Equation b

$$Q^{\wedge} = 53.4790 - 1.837482\,H^{\wedge} + 18.036069\,P^{\wedge} - 0.438458\,HP \quad (R^2=0.9902)$$
$$(-4.243750) \quad (30.654319) \quad (-6.933062)$$
Equation c

$$Q^{\wedge} = 56.6167 - 1.244804\,H^{\wedge} + 22.713737\,P^{\wedge} - 0.645748\,H^{\wedge}P^{\wedge} \quad (R^2=0.9742)$$
$$(-1.462949) \quad (19.644459) \quad (-5.195918)$$
Equation d

b.Discharging efficiency for two nozzles

The estimated function for two nozzles is given **Equation b**.

R^2 value is very high and significant indicating that the discharge is 97.88 % accounted by height and pressure. Moreover, the chi-square value is not significant at 5 % level and T value shown in parenthesis significant at 5% level indicates the goodness of the result. From the model, the operating pressure has a positive correlation with discharge indicating that if the pressure is increased by 1kg/cm^2,the discharge will be increased by 15 times at a given height.

The sign of the height coefficient is negative and significant indicating that the discharge will decrease significantly at a given pressure level. The interaction coefficient between height and pressure is negative and significant indicating that as the height increases, the discharge will be decreased by 0.33 time. The estimated discharge for different heights and pressure heads are presented in **Table 2** and **Fig.4**.

c.Discharging efficiency for three nozzles

The regression model for three nozzles is given **Equation c**.

Here the R^2 value is very high and significant showing that discharge is 99% accounted for by height and op-

Table 4. Estimated discharge at various levels of height and pressure for four nozzles

Height of nozzle from ground level (m)	Discharge from four nozzles at different pressure heads (lit/hr)				
	2 kg/cm^2	4 kg/cm^2	6 kg/cm^2	8 kg/cm^2	10 kg/cm^2
3	94.43	135.98	177.54	219.09	260.65
6	88.83	124.5	162.18	199.86	237.54
9	79.22	113.02	146.83	180.63	214.43
12	71.61	101.54	131.47	161.39	191.32
15	63.99	90.05	116.11	142.16	168.22
18	56.39	78.57	100.75	122.93	145.11
21	48.78	67.08	85.39	103.7	122.00

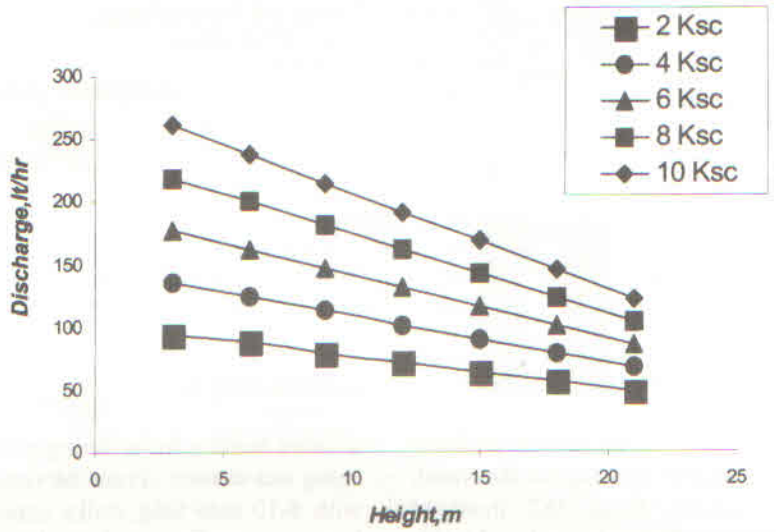

Fig.6. Estimated discharge at various levels of height and pressure for four nozzles.

erating pressure. Moreover, the chi-square value for the above function is not significant to indicate its goodness. The values shown in parenthesis indicate that the pressure and spray height have a significant effect on discharge at 5% level. The height of spray has a negative correlation with discharge indicating that as the height increased by 1m, the discharge will be reduced by 1.83 times at a given operating pressure. The pressure coefficient is positive and significant indicating that if the pressure increases, the discharge will increase significantly at a given height. The interaction coefficient between height and pressure is positive and significant similar to the case of two nozzles. The estimated discharge for different heights and pressure heads are presented in **Table 3** and **Fig.5**.

d.Discharging efficiency for four nozzles

The estimated function for four nozzles is given **Equation d**.

Here also the R^2 value is very high and significant (R^2=0.9781). It indicates that the discharge is 97.81% accounted for by the height and pressure. Besides, the value of chi-square is not significant at 5% level and the T value (shown in parenthesis) is significant at 5% level supporting the result.

The sign of the height coefficient is negative and significant indicating that in the case of four nozzles, if the height is increased by one unit, the discharge is decreased by 1.24 times at a given operating pressure. Similarly, the pressure coefficient is positive and significant indicating that if the pressure is increased by 1kg/cm^2, the discharge will be increased by 22.7 times at a given height. The interaction coefficient has a similar effect on the discharge as in the case of two and three nozzles. The estimated discharge at various levels of height and pressure for four nozzles are shown in **Table 4** and **Fig.6.**

Cost of spraying

Number of tress sprayed per hour with slip-on-ring device, 30;

Number of trees sprayed per hour in manual spraying, 8; and

Savings in time by using slip-on-ring device, 73%.

Total cost of operation of slip-on-ring spraying device, 33Rs/hr;

Cost of operation per tree, 1.00Rs/tree;

Cost of operation for manual spraying, 12.50Rs/hr;

Cost of manual spraying, 5.00Rs/tree;

Saving in cost with slip-on-ring spraying device when

compared with manual spraying, 80%.

Conclusions

From the laboratory trials, it was concluded that the pressure coefficient is positive and significant indicating that if the pressure is increased by 1 kg/cm^2, the discharge will be increased by 7.5 times at a given height for single nozzle, 15.2, 18.0 and 22.7 times at a given height for two nozzles, three nozzles and four, respectively. The interaction coefficient between height and pressure is positive and significant indicating that as the height increases, the discharge will also be increased by 0.15 times for one nozzle. For all the nozzles tested, the height of spray has a negative correlation with discharge indicating that as the height increased the discharge will be reduced at given operating pressure. On the other hand, the pressure coefficient is positive and significant indicating that if the pressure increases, the discharge will increase significantly at a given height. The slip-on-ring spraying device results in 80 and 75 per cent savings in cost and time when compared to the conventional method of spraying.

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REFERENCES

Carpenter, T.G.; D.L.Reichard, S.M.Wilson. (1985). Design and feasibility of a permanent pesticide application system for orchards. Transactions of the ASAE. 350-355.

Thampan, P.K. (1997). Gains from organic farming. The Hindu Survey of Indian agriculture. 89-93.

Thangavelu, S.; K.R.Swaminathan, M.Balasubramaniyam. (1985). Spray characteristics of spray booms for Rocker sprayer. J.Agric.Engng. ISAE.22(2): 19-26.