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Bio-efficacy of bullock drawn solar powered high clearance sprayer

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Abstract
The study was conducted to evaluate the bullock drawn solar powered high clearance sprayer for cotton (*Bt* cotton hybrid MRC 7351) and red gram (Maruthi ICP 8863) at the farmer's field, Raichur. The insecticide used was dinotefuran (Osheen) solution with a recommended dose of 200 g 1000 l^{-1}. The chemical used for spraying the red gram crop was chlorantriniprole with a recommended dose of 200 g 1000 l^{-1}. The insects were reduced from pre counting as the number of days increased after the spraying. The populations of aphids were 12, after 10 days reduced to 3.7 numbers. The percentage of pod damage significantly reduced in red gram crop. The results of present study conclude that bullock drawn solar powered high clearance sprayer is found to be superior when compared to conventional gun spraying.

Keywords: Pod borer, Bt cotton, Red gram, insects and pests, bullock drawn solar powered sprayer.

Introduction
Today the pest becomes major concern for the farmers across the world. In world food plant are damaged by more than 10,000 species of insects. Sometimes the yield loss by insects reaches as high as 60-70%. Indian agriculture is currently suffering an annual loss of about Rs. 8,63,884 million due to insects and pests. In spite of various control measures against pests farmers are mainly depend on chemical control which cause consistently increasein crop loss. This is due to misuse and overuse of insecticides which cause resistance and increase the survival rate of insect pests. Therefore, toward heavy crop loss, farmers resort to use the pesticides in large quantity, under the adage "if little is good, a lot more will be better". This causes harmful effect on nontarget living organism. Solar energy plays an important role in drying agriculture products and for pumping the well water for irrigation purpose in remote villages without electricity. This technology on solar energy can be extended for spraying pesticides, fungicides fertilizers, nutrients and weedicides using solar sprayers (Joshua *et al*., 2010) [5].

Cotton occupies 5% of the total cropped area distributed among three different agro climatic zones in India, and consumes 55% pesticide share accounting for 40% of total production costs. This fact signifies the impact of insect pests and the increased agrochemical use in cotton production. Nearly 130 species of insect pests occur on Indian cotton with a dozen of these arthropods requiring their management for realizing better cotton yields. Sucking pest's *viz.*, jassids (*Amrasca biguttula biguttula* Ishida), aphids (*Aphis gossypii Glover*), whiteflies (*Bemisia tabaci Gennadius*) and thrips, (*Thrips tabaci Lindeman*) are deleterious to the process of cotton growth and development with their ability to build up to serious proportions as a result of rapid and prolific breeding in cotton plant. The reproductive phase of cotton crop growth suffers damage inflicted by bollworm complex consisting three genera of bollworms *viz*., Earias, Helicoverpa and Pectinophora. The important foliage feeders are lepidopterans especially semilooper Anomis flava, Spodoptera litura and leaf roller Syllepte derogate. In Karnataka, cotton occupies an area of 5.65 lakh hectare with a production of 19.00 lakh bales and with a productivity of 572 kg lint per hectare (Anon., 2017).

Red gram (*Cajanus cajan* L) is a tropical grain legume mainly grown in India and ranks second in area and production which contributes about 90 % in the world's pulse production. In India, red gram is grown in 4.42 million ha with an annual production of 2.89 million tonnes and 655 kg ha-1 of productivity. In Karnataka, it is cultivated in an area of 6.38 lakh ha with production of 2.65 lakh tonnes1 and productivity is 415 kg ha-1

It is attacked by more than 250 species of insects, of which pod borer, *Helicoverpa armigera* Hubner is the most dreaded and polyphagous pest of red gram worldwide. Its preference for flowering and fruiting parts results in heavy loss upto 60 % or more under subsistence agriculture in the tropics (Japur *et al*., 2016) [4].

The efficacy of insecticides in the insect management is mainly influenced by the amount of chemical used in a unit area of target, deposit of the chemical on the area and percentage of the target area receiving the pesticides. The above three factors *viz.,* dose, distribution and coverage are dependent on the droplet size and density of the chemical (Kapasi *et al.,* 2013) [7]. Commonly used spray equipments are conventional tractor operated gun sprayer and bullock drawn solar powered high clearance sprayer. These sprayers were evaluated for their effectiveness in reducing pest and diseases.

The usage of pesticides to prevent pre-harvest and post-harvest losses has assumed a great significance during the last two decades, in an attempt to provide sufficient nutritive food for the ever growing population. Thus, application of pesticides is one of the most important operations in agricultural production. The most important and common method of applying pesticides in the modern agriculture is to apply with spraying machines. The efficient application of agricultural chemicals is a major social and economic concern in the present agricultural scenario. Inaccurate application of pesticides could result in more contaminated environment and higher farming cost (Khalid, 2010) [8].

More than 55 per cent of the total cultivated area is still being managed by using draught animals as against about 20 per cent by tractors. India possessed the finest breeds of draught animals. Bullocks, buffaloes and camels are the major draught animals for field operations. The small and marginal farmers are generally maintaining a pair of bullock for carrying out the field operations. To increase the utility of the animal power and proper selection of suitable spraying equipment, it is necessary to mechanize the spraying operation (Kalikar, 2012) [6].

Generally, the engine powered sprayers are more of tenly used in India which require fuels like petrol, diesel, kerosine, *etc*. As the fuel prices are increasing day by day, these sprayers have become uneconomic and need to be replaced by solar powered sprayers. Renewable energy source like solar energy is available abundantly therefore by utilizing solar energy using solar panels sprayer can be powered. This solar sprayer can be drawn by bullocks because of availability of animal power in the villages, cost of operation will be less so it will be economically feasible than the diesel powered sprayers. This sprayer has an advantage that, it has a high clearance so that taller field crops can be sprayed. Therefore the present study was carried out to develop and evaluate the bullock drawn solar powered high clearance sprayer.

Materials and methods

The bullock drawn solar powered high clearance sprayer was evaluated its effectiveness against some of the insects and pests present in the cotton and red gram. Evaluation of bullock drawn solar powered high clearance sprayer was carried out in cotton (*Bt* cotton hybrid MRC 7351) and red gram (Maruthi ICP 8863) at the farmer's field, Raichur. The efficacy of bullock drawn solar powered high clearance sprayer was carried out at the parameters which are optimized in the field studies.

The biological efficacy was measured for the cotton and red gram crops. The main sucking pests for cotton were aphids and leafhopper. The main insect present in the red gram crop was *Helicoverpa armigera*. The efficacy was measured by taking the number of insects present before the spraying and number of insects present after the 3 days, 5 days and 10 days.

Cotton

The biological efficacy was measured for cotton. The chemical used for spraying cotton crop was dinotefuran (osheen). The chemical was mixed with water at a proportion of 200 g 1000 l^{-1}. The main sucking pests for cotton were *aphids* and leaf *hopper*. The efficacy was measured by taking the number of insects present before spraying and after 3 days, 5 days and 10 days of spraying.

Red gram

The efficacy of red gram crop was also measured during the field test. The chemical used for spraying the red gram crop was chlorantriniprole. The chemical was mixed with water at a proportion of 200 g 1000 l^{-1}. The main insect present in the crop was *Pod borer* and *Helicoverpa armigera*. The efficacy was measured by taking the number of insects present 1 day before spraying and number of insects present after 5 days and 10 days of spraying.

Results and discussion

The data representing the efficacy of insecticides and pesticide against insects and pests is given in the Table 1 and 2. The insects were reduced from pre counting as the number of days increased after the spraying. This is because of the toxic effect of insecticide on insects.

The leaf hoppers were 5.7 before spraying reduced to 1.4. In case of T2 (conventional tractor operated sprayer) pre count leaf hoppers were 8.4 reduced to 3.5 after 10 days of spraying. The populations of aphids were 12, after 10 days reduced to 3.7 numbers. Pre counts of aphids were 15 before spraying in conventional tractor operated sprayer reduced to 5.3 numbers. This shows that bullock drawn solar powered high clearance sprayer were effective against cotton sucking pest.

Bio-efficacy of spraying against *Helicoverpa armigera* in red gram crop is presented in Table 3. It shows that population of *Helicoverpa armigera* was 8.7 numbers reduced to 0.6 numbers after 10 days whereas in conventional method it was 14 number reduced to 1.8 numbers.

Table 1: Bio-efficacy of spraying against leafhopper in cotton

Treatment	Population of leaf hopper (No. of hoppers/leaf)			
	Pre count	3 DAS	5 DAS	10 DAS
T1	5.7	4.5	3.7	1.4
T2	8.4	6.4	2.6	3.5

DAS: Days after spraying

Table 2: Bio-efficacy of spraying against aphids in cotton

Treatment	Population of aphids (No. of aphids /leaf)			
	Pre count	3 DAS	5 DAS	10 DAS
T1	12	9.6	7.4	3.7
T2	15	12.1	9.8	5.3

DAS: Days after spraying

Table 3: Bio-efficacy of spraying against *Helicoverpa armigera* in red gram

Treatment	Population of *Helicoverpa armigera* (No. of *Helicoverpa armigera* /plant)			
	% pod damage	1 DBS	5 DAS	10 DAS
T1	11	8.7	2.2	0.6
T2	14	7.9	3.4	1.8

T1: Bullock drawn solar powered high clearance sprayer
T2: Conventional tractor operated sprayer
DAS: Days after spraying
DBS: Days before spraying

The pod damage by *Helicoverpa armigera* for bullock drawn solar powered high clearance sprayer and conventional tractor operated sprayer was 11 and 14 per cent. Conventional method of tractor operated spraying recorded higher pod borer population. The overall, present study concluded that bullock drawn solar powered high clearance sprayer is found to be superior when compared to conventional spraying for the management of pod borer.

Field capacity of the bullock drawn solar powered high clearance sprayer was found to be 0.945 ha/h for cotton crop and 1.012 ha/h for red gram crop. The field efficiency of the sprayer unit was found to be 80 per cent and the results are in agreement with the findings of Hunt (1983) [3].

For spraying operation, the bullock drawn sprayer is operated at an average travel speed of 2.7 km/h for cotton and 3.0 km/h for red gram crop. Similar results were reported by Veerangouda *et al*. (2010) [9]. The average draft for spraying operation was found to be 802.65 N for cotton and 804.38 N for red gram crop. The average power output was found to be 0.65 kW for cotton crop and 0.68 kW for red gram crop. This is the power to operate the sprayer in the field, which was within the range (0.61 to 1.1 kW) of a pair of bullocks as reported by Gupta *et al*. (2003) [2].

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