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Cow's Urine-Dung Extract Foliar Spraying as a Complementary Pest Control Method against Boll-Worm Complex on the Cotton Plant

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Abstract: ***A field experiment was conducted In the 2017 and 2018 cotton seasons to evaluate a novel approach as a complementary method to the chemical control against Lepidopteran larvae of both Pink bollworms, Pectinophora gossypiella (Saunders) (Fam.Gelechiidae) and Spiny bollworm, Earias insulana (Boisduval) (Fam. Noctuidae). Origin products such as cow`s urine- dung extract and crud neem oil had used in this study. Two different treatments of cow's urine-dung extract were prepared as manner, (1: 1) and (1: 4) (cow's urine-dung extract: water) (v: v), other two treatments were prepared with the addition 50 ml of neem oil to each to produce two treatments of (1:1:50) and (1:4:50) (cow's urine-dung extract: water: neem oil)(v:v:v). All treatments were applied to cotton plants by foliar spray. The evaluation of the foliar spraying of cow`s urine-dung extract and their combinations with neem oil treatments conducted over two consecutive periods each season from (mid-June) to (late-July), and from (early-Aug.) to (late-Sept.). The pooled data for both the seasons clearly showed that bollworm complexes density under all the treatments of the cow`s urine-dung extract and their combined with neem oil were found significantly superior lesser than that of the check, and there are no significant differences between each treatment than others in each season and over the two consecutive periods. Neem oil did not add an advantage to the cow's urine-dung extract treatments either (1: 1) or (1: 4) (cow's urine-dung extract: water). The results indicated that the cow`s urine-dung extract treatments were more effective during the period from mid-June to late-July on bollworm complexes vs. the period from early-Aug. to late-Sept. the results refer to the cow`s urine-dung extract has the ability to inhibit the bollworm complexes on cotton plants from the beginning of flowering to the boll maturity at a level that can delay apply the pesticides and reduce their use. The present study clearly revealed that cow`s urine-dung extract can safely and effectively be incorporated in an integrated pest management program against bollworm complex density on the cotton plant.***

Keywords: bollworm complex, cow urine, cow dung, neem oil

1. Introduction

Cotton, *Gossypium barbadense* L. is the most important fibre crop grown in Egypt. Many pests attack cotton plants causing real damage to the crop. *Lepidopteran larvae* of pink bollworm, *Pectinophtora gossypiella* (Saund.) (Fam.Gelechiidae) and spiny bollworm, *Earias insulana* (Boisd.) (Fam. Noctuidae) are two serious pests on cotton in Egypt, as well as in many parts of the world and very destructive if they exceed the injury threshold. A massive quantity of pesticides is applying to control bollworms. In Egypt, traditional pest control methods by using insecticides are the main means of reducing bollworm damage. The Egyptian Ministry of Agriculture recommends the use of different groups of pesticides to control the bollworms on the cotton at the level of 3% of an infestation (official recommendations of agricultural pest control, Egypt). This means that cotton fields receive from 4 to 5-time applications of pesticides spraying throughout a season against the bollworms. As well as the indiscriminate and widespread use of pesticides by farmers for their cotton plantation. The farmers use pesticides more frequently and increased doses than the recommended doses or procedures. Overzealous use of artificial pesticides has led to the problems of environmental pollution and their adverse effects on food and side effects on humans because of the residuals up taken by crops and later on incorporated in the food chain, and because of contaminated soil, water. These influences on the ecosystem have been mentioned in many studies and reports of relevant institutions [8]-[51]-[6]-[31]-[1]-[35]. The global concept of the health and environmental effects of synthetic pesticides had translated in the form of excessive restrictions and restrictions on the use of these products. In order to reduce the serious effects of these products. Integrated pest management (IPM) has been supported by governments across the world [36]. Several studies have been conducted to reduce the use of pesticides by using indigenous materials such as animal and plant origin products as natural and safe sources on the ecosystem. Of those sources, the animal origin products (cow urine and cow dung) can serve as a potential eco-friendly. Cow dung mixed with cow urine makes excellent manure and a natural pesticide [15]. It has long been known that both cow urine and cow dung have a valuable effect in agricultural processes and their use provides a source of many nutrients to plants. The cow dung as organic manure increase the vigour of the plant and reduce the disease incidence of root rots in cotton caused by *Phymatotrichum omnivorum* [20]. Cow dung contains undigested fibre, organic matter, various nutrients, and microorganisms [52]. Cow urine is rich in urea, minerals, and hormone [24]. In recent studies, many have shown that cow's urine and dung had a valuable impact on plant protection from pests and diseases. Several studies, particularly in India, have demonstrated the effectiveness of these wastes on many pathogens and insect pests and can be suitable alternatives to conventional chemical materials and play an important role in protecting many plants from harmful insect pests [43]. Many Literature review showed the positive effect of these waste on plant pathogens, growth and yield for several crops and vegetable such as reported on Cucumber [3]-[4], Mustard ([22]-[11], Maize [30], Wheat [37] , rice [23], Sweet corn

[42], Watermelon [48], Sugarcane [18] and Lablab bean [47]. Also, many works of literature review showed similar studies were done [21]-[45]. Other beneficial effects of cow urine and cow dung for protecting European honeybee, *Apis mellifera* colonies were reported [38]-[39]. They mentioned that the animal origin products could serve as a potential eco-friendly measure for management of honey bee mite, *Varroa destructor* and European foulbrood disease caused by the bacteria, *Melissococcus plutonius*. On the other hand, cow urine and cow dung are the two of the ingredients of "Panchgavya",(an organic blend of the five products of cow: urine, dung, milk, curd, and ghee) [16]-[17]. Panchgavya has many beneficial implications in agriculture, organic farming as good quality natural manure and bio-pesticides [46]-[32].The use of non-chemical methods for pest control and crop protection is already gaining importance in several countries. Use insecticides against bollworms are rarely recommended over the early duration of cotton grown in Egypt because during this period the populations of bollworms are bellowing level that causes economic damage and the infestation is not significant value. The current study conducted to evaluate naturalistic materials, e.g. cow's urine-dung extract, and neem oil as a complementary method to the chemical control against the bollworm complex (Pink and Spiny bollworm). Such as these materials were applied as a foliar spray on the cotton plants in the experimental area at the beginning of flowering and continued in successive sprays with the aim of assessing their effect on reducing the population density of the bollworm complex.

2. Materials and Methods

In the 2017 and 2018 cotton seasons at (Mahalet-Deiay village; Disuq district; Kafr al-Shaykh Province; Egypt), a field experiment was conducted to evaluate a novel approach as a complementary method to the chemical control against both Pink bollworms, *Pectinophora gossypiella* (Saunders) and Spiny bollworm, *Earias insulana* (Boisduval). Animal and plant products such as cow`s urine- dung extract and crud neem oil had used in this study. The experiment was carried out in randomized complete block design, four treatments of cow`s urine-dung extract alone or combined with neem oil and untreated check each replicated thrice. There were 15 plots (12 plots/treatments and 3 plots/check) measuring 7 X 6 m each separated by 20 cm pathway. Cotton variety "Giza 82" was sown in the mid-April in both the two seasons.

Experimental procedures

The experimental procedures were similar in both seasons.

Collection of cow urine and cow dung:

Before 24 hrs off application, 10 liters of cow urine and 10 kg. cow dung collected from local nearby houses domesticating cows in the experiment area. The animal origin products mixed in a container and then filter by using a muslin cloth to produce cow's urine-dung extract.

Prepare the treatments of cow's urine-dung extract:

Two different treatments of cow's urine-dung extract were prepared, (1: 1) and (1: 4) (cow's urine-dung extract: water) (v: v), each treatment was applied at 5 liters/3replicates**.**

Prepare the combination of cow's urine-dung extract with neem oil treatments:

The crude neem oil purchased from Genius Nature Herbs Pvt Ltd, India. By the same manner preparation of the previous two treatments, other two treatments were prepared with the addition 50 ml of neem oil / 5 litres to each to produce two treatments of (1:1:50) and (1:4:50) (cow's urine-dung extract: water: neem oil)(v:v:v). Each treatment was applied at 5 litres/ 3 replicates with add 2.5 ml of Triton X100 as emulsifier agent/treatment

Field application and evaluation:

Pink and spiny bollworm resides on cotton plants in synchronous timing most of the season and this is a key reason for the severity of harming these pests. In the present study, the insect data (population density of both pests, in addition to their exit holes) had grouped together and recorded in term of "bollworm Complexes". In Egypt, there are no recommendations for use of insecticides against pink and spiny bollworms during the early stages of fruiting formations of cotton because at this time the level of injury is non-significant value. Chemical control against bollworms usually starts from early-July. Since at this time begins the level of harm of these pests grows. Pesticide control begins at the level of injury 3 % according to the Ministry`s recommendations (official recommendations of agricultural pest control, Egypt). The present study had designed to follow the progression of bollworm complexes density under the effect of the foliar spraying of cow`s urine-dung extract treatments from (mid-June) to (late Sept.) during the 2017 and 2018 cotton seasons. The spray timing in both seasons was identical (mid-June, early-July, mid-July, early-Aug., mid-Aug., early-Sept. and mid-Sept.) (Table1). The spray was applied by using a backpack motor sprayer. Usually, during this period, the density of worms gradually increases causing significant economic damage. Therefore, the evaluation of the foliar spraying of cow`s urine-dung extract treatments conducted over two consecutive periods:

- From (mid-June) to (late-July), the treatments repeated every two weeks and the cotton plant receives three foliar sprays beginning in mid-June.
- From (early-Aug.) to (late-Sept.), the treatments repeated every two weeks and the cotton plant receives four foliar sprays beginning on early-Aug. (Table1).

First bollworm Complexes data:

Visual field inspection for the pink and spiny bollworm larvae did perform after two weeks off first applying treatments to record the first data of the bollworm complexes. The pink bollworm larval count was recorded

on the flowers of 25 randomly selected plants in each replicate (five plants in each quadrant and centre/replicate resulting in a sample of 25 plants that representing the replicate). The terminal buds of the selected plants also had inspected to record the population of the spiny bollworm larvae. The same procedure had done in untreated replicates (check).

The following bollworm Complexes data:

The following foliar sprays for the first time have been assessed by taking samples of green boll and laboratory examined. After two weeks of each application, five balls had taken from each quadrant and centre/replicate resulting in a sample of 25 green bolls representing the replicate. The inspection timing of repeated sampling shown in table 2. Insect data (bollworm complex) had expressed/replicate by recording the total number of pink and spiny bollworms and exit holes. The same procedure had done in untreated replicates (check). All data of bollworm complexes in different treatments and check for both the two seasons were analyzed using analysis of variance (ANOVA) and means were separated by using Tukey's Honestly Significant Difference (HSD) test. All analyses were done by *VassarStats website* for Statistical Computation. Effect of the tested treatments recorded in terms of (percentage) reduction and was calculated using Abbott's formula [50]:

$$reduction\ of\ \% = \left(1 - \frac{n\ @\ T\ after\ treatment}{n\ @\ Co\ after\ treatment}\right) * 100$$

Where: n = Insect population, T = treated, Co = control (check).

Table 1: Shows the tested treatments of cow`s urine-dung extract and their application timing as a foliar spray during the 2017 and 2018 cotton seasons. The spray timing in both seasons was identical.

Treatments						
(1: 1) (cow's urine-dung extract : water)						
(1: 4) (cow's urine-dung extract: water)						
(1:1: 50ml neem oil) (cow's urine-dung extract : water:50ml neem oil)						
(1:4: 50ml neem oil) (cow's urine dung extract : water:50ml neem oil)						
Application timing of the treatments as foliar spraying / 2017 & 2018 cotton seasons						
mid-June	early-July	mid-July	early-Aug.	mid-Aug.	early-Sept.	mid-Sept.
1st spray	**2nd spray**	**3rd spray**	**4th spray**	**5th spray**	**6th spray**	**7th spray**

Table 2: Shows the inspection timing of repeated sampling after two weeks of each applying treatments in both 2017 & 2018 cotton seasons

Field inspection timing/blooms & terminal buds	**Laboratory inspection timing / green boll samples**					
1st visually inspection	**2nd inspection**	**3rd inspection**	**4th inspection**	**5th inspection**	**6th inspection**	**7th inspection**
Late-June	mid-July	late-July	Mid-Aug.	late-Aug.	mid-Sept.	Late-Sept.

3. Results

The efficacy of different treatments of cow's urine - dung extract (1:1) and (1:4) (cow`s urine extract: water)(v:v) and their combinations with neem oil (1:1:50), (1:4:50) (cow`s urine extract: water: neem oil) (v:v:v) on bollworm complexes density for both seasons 2017 & 2018 is presented in Table 3, 4, 5 and 6.

1- Effect of the tested treatments on bollworm complexes intensity on cotton plants from (mid-June) – (late-July)

By using analysis of variance (ANOVA) the pooled data of a periodic counting data of pink and spiny bollworms larvae and their exit holes (bollworm complexes) on cotton plants (table 1&3) showed significant ($P > 0.01$) differences in each season. By using Tukey's Honestly Significant Difference (HSD) test data showed that bollworm complexes under cow`s urine-dung extract treatments and their combined with neem oil were significantly lesser than that of check and there are no significant differences between each treatment than other in each season. ($F = 11.3$; $df = 4$; $P < .0001$ / 2017) and ($F = 9.74$; $df = 4$; $P < .0001$ / 2018).

A- The check

Table 3 and 5 show the average data for periodic counting of bollworm complexes either by visual field examination or by laboratory screening green bolls. The numerical values of bollworm complexes ranged from 1 - 4.3 with an average of 2.4 / 2017 (Table 1) and from 1.7 - 6.3 with an average of 4.1 / 2018 (Table 3).

B- Treatment of (1:1) (cow`s urine-dung extract: water)(v:v) & (1:1:50) (cow`s urine- dung extract :water: neem oil)(v:v:v) vs. check

Data shows no bollworm complexes were recorded, on cotton plants under the influence of treatment (1:1) (cow`s urine dung extract: water) (v: v). which means a reduction of 100% vs. check / 2017was occurred in bollworm population (Table 3). The recorded data of bollworm complexes under applied the same treatment / 2018 ranged from (0 – 2) with average of reduction (68%) vs. check (Table 5). At the same time treatment (1:1:50) (cow`s

urine- dung extract: water: neem oil) (v: v: v) was evaluated. Data showed that the average numerical values throughout the periodic counting for bollworm complexes were ranged from (0 - 1) with an average reduction rate of (86%) vs. check / 2017 (Table 3) and, was ranged from (0 - 2) /2018 which led to a (76%) decrease vs. check (Table 5).

C- Treatment of (1:4) (cow`s urine-dung extract: water)(v:v) & (1:4:50) (cow`s urine- dung extract :water: neem oil) (v:v:v) vs. check

On the other hand, the bollworm complex values for the periodic inspection under treatment (1:4) (cow`s urine-dung extract: water) (v: v) ranged from (0 - 1) with a decrease of (72%) vs. check / 2017, while the values ranged (0 – 0.7) with an average reduction of (95%) vs. check / 2018. Under the application treatment of (1:4:50) (cow`s urine- dung extract: water: neem oil) (v: v: v), bollworm complex values ranged from (0 - 1) with a level of (86%) reduction vs. check / 2017, while these values were in range (0 - 2) with reduction at a (68%) vs. check / 2018.

As there were no significant differences between treatments, can say that the average reduction of bollworm complexes intensity under all treatments during (mid-June – late-July) ranged from (100-72 %) vs. check /2017 and ranged from (95-68%) vs. check / 2018.

2- Effect of the tested treatments on bollworm complexes intensity on cotton plants from (early Aug.) – (late Sept.)

By using analysis of variance (ANOVA) the pooled data of pink and spiny bollworms larvae and their exit holes(bollworms complex) (table 2 &4)during August and September in both seasons showed significantly ($P > 0.01$) differences between the treatments for each season. By using Turkey's Honestly Significant Difference (HSD) test data showed that (bollworms complex) under cow`s urine-dung extract treatments and their combined with neem oil were significantly lesser than that of check and there are no significant differences between each treatment than other for both seasons. (F 14.5; $df = 4$; $P < .0001$ / 2017) and ($F = 20.3$; $df = 4$; $P < .0001$ / 2018).

A -The check

The pooled data of a periodic counting data of (bollworm complexes) by inspection the green bolls over the period from (August)–(Late-stomper) showed that the numerical values of untreated plant (check) ranged from(7 – 14) with an average 9.9 / 2017 and from 8.7–15.7 with an average of 13.3 / 2018 (Table 4 and 6).

B- Treatment of (1:1) (cow`s urine-dung extract: water) (v: v) & (1:1:50) (cow`s urine- dung extract: water: neem oil) (v: v: v) vs. check

Under the influence of treatment (1:1) (cow`s urine dung extract: water) (v: v), the periodic numerical values of the bollworm complexes intensity ranged from (1 – 5.7) Leading to a decrease by (71%) vs. check / 2017 (table 4) and were ranged from (1.3 – 7.7) resulting (64%) decrease in bollworm complexes vs. check / 2018 (table 6). Under the influence of treatment (1:1:50) (cow`s urine- dung extract: water: neem oil) (v: v: v) the numerical values of periodic counting of Bollworm complexes ranged from (0 - 6) which led to a decrease by (80%) vs. check / 2017 (table 4) and was ranged from (2.3 – 7.3) led to a (64%) decrease compared to the check / 2018 (table 6).

C- Treatment of (1:4) (cow`s urine-dung extract: water)(v:v) & (1:4:50) (cow`s urine- dung extract :water: neem oil) (v:v:v) vs. check

The values of the periodic examination data for the bollworm complexes under treatment (1: 4) (cow`s urine dung extract: water) (v: v) were ranged from (1-10), leading to (64%) lesser vs. check / 2017 (table 4) and, were ranged from (3- 10) leading to a decrease (59%) vs. check / 2018 (Table 6). The treatment (1:4:50) (cow`s urine- dung extract: water: neem oil) (v: v: v) showed periodic values that ranged from (0 – 5) which led reduction at (72 %) vs. check / 2017 (Table 4). and ranged from (5.3 - 9) at a level lower by (41%) vs. check / 2018 (Table 6).

As there were no significant differences between treatments, can say that the average reduction of bollworm complexes intensity under all treatments during (August-late September) ranged from (80-64 %) vs. check /2017 and ranged from (64-41%) vs. check / 2018.

4. Discussion

In the present investigation, results showed that in highly significant vs. non-treated, both cow`s urine-dung extract treatments alone or in combination with neem oil reduced bollworm complexes on cotton plants in both experimental seasons. Our finding showed that the application neem oil (50 ml), which was added to the cow`s urine-dung extract either (1: 1) or (1: 4) (cow`s urine-dung extract: water) (v: v) did not add an advantage to the treatments as evidenced by no significant differences between the efficiency of each treatment on bollworm complexes intensity and the other. Although all application treatments have resulted in similar effects by alleviating the bollworm complexes damage, it may be concluded that the treatment of (cow`s urine-dung extract: water) (1:4) is the advisable treatment Because it is less concentrated and less expensive than other treatments. It has been known for a long time that both cow dung and cow urine have a significant impact on agricultural processes. Cow urine is rich in urea, minerals, and hormone [24]. As per the review article of Dahma et al. [16], cow urine contains 24 types of salts. Its main contents are water 95%, urea 2.5%, minerals, salt, hormones, and enzymes-2.5%. It contains iron, calcium, phosphorus, carbonic acid, potash, nitrogen, ammonia, manganese, iron, sulphur, phosphates, potassium, urea, uric acid, amino acids, enzymes, cytokine and lactose etc. Cow dung can be defined as the undigested residue of consumed food material being excreted by herbivorous bovine animal species[19]. It mainly consists of lignin, cellulose, and hemicelluloses and contains 24 different

minerals like nitrogen, potassium, in addition to this trace amount of sulfur, iron, and magnesium. Several studies have shown that cow manure contains and hosts a wide variety of microorganisms varying in individual properties and act as antibiotic for many plant pathogens [52]-[33]-[2]-[9]-[44]. Thus, the application of cow urine and cow dung is an effective tool to improve the physical and chemical properties of soil and provides a source of many nutrients to plants. The use of cattle litters (urine and dung) not only enrich the soil fertility but also reduce the insect-pests of the crops significantly. In this context, many studies evaluated Cow-urine and cow dung against many insect pests and found encouraging results and have highlighted the effectiveness of bovine waste on the protection of many crops from a wide range of pests. There are Several investigations are support our finding, where they found that application of botanical and cow urine and in combination effectively reduced the insect pest damage viz mustard aphid [22], soybean stem fly [7], sorghum shoot fly [41], melon aphids and pickle worms [48]), Spilarctia oblique [10] and pod borer [5]. Also, cow urine is saving to insect predators [22]. In view of these, insect pests and diseases are reduced with organic manure and it is clear that cows' waste protects the plant from a wide variety of pests varying biologically, taxonomically and environmentally. The lower pest levels widely reported in organic-farming systems and soil organic matter can lead to better plant resistance against insect pests [40]-[26]-[25]. Several studies have indicated with evidence that high levels of chemical fertilizer applications can cause nutrient imbalances in crops, making them more susceptible to insect pest pressure. Since plants are a source of nutrients for herbivorous insects, it may be said that increasing the plant's nutritional content increases its susceptibility as a source of food for the population pests [34]-[13]-[29]-[14]-[25]-[27]. On the other hand, many studies comparing pest populations on plants treated with synthetic vs. organic fertilizers and have documented that chemical fertilizers has increased the potential of certain insects and diseases to cause economic losses and the lower foliar content of ammonium nitrate NO3-N of organically grown crops may be a key factor in determining lower insect damage on crops fertilized with organic amendments and preservation of beneficial insects in the absence of pesticides [49]-[28]. Soils with high organic matter and active soil biology generally exhibit good soil fertility [25]. Crops grown in such soils generally exhibit a lower abundance of several insect herbivores, reductions that may be attributed to lower nitrogen content in organically farmed crops. Soil applications and foliar spraying are the two principal methods of applying the nutrients to plants. Turkey and Wittwer [12], measured the absorption, movement, and utilization of plant nutrients within plants to comparing the efficiency of plant use foliar fed by spraying vs. dry soil-applied nutrients. They found feeding by the foliar-spray application provided about 95% efficiency of use compared to about 10% of use from soil application. it may be concluded from our finding that the significant decrease of bollworm complexes on the cotton plant may be justified by enhancing the absorb for the organic source of nutrients and bring the greatest benefit to the plants by foliar spray applications of cow`s urine-dung extract. We believe that the results of the current study indicate that the use of foliar spraying of cow`s urine-dung extract treatment led to the healthy growth of treated cotton plants and with the absence of pesticides, natural enemies were present, which created an environment not convenient for increasing the bollworm complex.

Table 3: The efficacy of different treatments of cow's urine - dung extract (1:1) and (1:4) (cow`s urine extract: water)(v:v) and their combinations with neem oil (1:1:50) and (1:4:50) (cow`s urine extract: water: neem oil) (v:v:v) on intensity of bollworm complexes on cotton plants from (mid-June) to (late-July) during 2017

Application timing	Inspection timing	Check	treatments							
			(1:1)		(1:1:50)		(1:4)		(1:4:50)	
		bollworm complex *	bollworm complex	% reduction	bollworm complex	% reduction	bollworm complex	% reduction	bollworm complex	% reduction
mid -June	**late-June**	**1**	**0**		**1**		**0**		**0**	
early-.July	**mid-July.**	**2**	**0**		**0**		**1**		**0**	
mid-July	**ate -July.**	**4.3**	**0**	**100**	**0**	**86**	**1**	**72.0**	**1**	**86.3**
****mean ±SE**		**2.4[a] ±0.6**	**0[b]**		**0.3[b] ±0.2**		**0.7[b] ±0.2**		**0. 3[b] ±0.2**	
F		**11.3**								
P		**<.0001**								
HSD[.01]		**1.43**								

* Mean number/3 replicates
**Means followed by the same letter are not significantly different

The present results indicated that the cow`s urine-dung extract treatments were more effective during the period from mid-June to late-July on bollworm complexes vas. the period from early-Aug. to late-Sept. Integrated Pest Management (IPM) means the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human and animal health and the environment.

Table 4: The efficacy of different treatments of cow's urine - dung extract (1:1) and (1:4) (cow`s urine extract: water)(v:v) and their combinations with neem oil (1:1:50) and (1:4:50) (cow`s urine extract: water: neem oil) (v:v:v) on intensity of bollworm complexes on cotton plants from (Early-Aug.) to (Late-Sept.) during 2017.

Application timing	Inspection timing	Check	treatments							
			(1:1)		(1:1:50)		(1:4)		(1:4:50)	
		bollworm complex *	bollworm complex	% reduction	bollworm complex	% reduction	bollworm complex	% reduction	bollworm complex	% reduction
Early-Aug.	Mid-Aug.	**7**	**1**	70.7	**0**	80	**1**	63.6	**0**	71.7
Mid-Aug.	Late-Aug.	**8**	**2**		**0**		**1**		**2**	
Early-Sept.	Mid-Sept.	**10.7**	**3**		**2**		**2.4**		**4**	
Mid-Sept.	Late-Sept.	**14**	**5.7**		**6**		**10**		**5.3**	
****mean ±SE**		**9.9^{a} ±0.9**	**2.9^{b} ±0.6**		**2.0^{b} ±0.7**		**3.6^{b} ±1.2**		**2.8^{b} ±0.6**	
F		**14.5**								
P		**<.0001**								
HSD[.01]		**4.09**								

* Mean number/3 replicates
**Means followed by the same letter are not significantly different

Table 5: The efficacy of different treatments of cow's urine - dung extract (1:1) and (1:4) (cow`s urine extract: water)(v:v) and their combinations with neem oil (1:1:50) and (1:4:50) (cow`s urine extract: water: neem oil) (v:v:v) on intensity of bollworm complexes on cotton plants from (mid-June) to (late-July) during 2018.

Application timing	Inspection timing	Check	treatments							
			(1:1)		(1:1:50)		(1:4)		(1:4:50)	
		bollworm complex *	bollworm complex	% reduction	bollworm complex	% reduction	bollworm complex	% reduction	bollworm complex	% reduction
Mid -June	Late-June	**1.7**	**0**	**68**	**1**	**76**	**0**	**95.0**	**0**	68.3
Early-.July	Mid-July.	**6.3**	**2**		**2**		**0**		**2**	
mid-July	Late-July.	**4.3**	**2**		**0**		**0.7**		**2**	
****mean ±SE**		**4.1^{a} ±0.7**	**1.3^{b} ±0.4**		**1^{b} ±0.4**		**0.2^{b} ±0.1**		**1.3^{b} ±0.5**	
F		**9.74**								
P		**<.0001**								
HSD[.01]		**2.33**								

* Mean number/3 replicates
**Means followed by the same letter are not significantly different

Table 6: The efficacy of different treatments of cow's urine - dung extract (1:1) and (1:4) (cow`s urine extract: water)(v:v) and their combinations with neem oil (1:1:50) and (1:4:50) (cow`s urine extract: water: neem oil) (v:v:v) on intensity of bollworm complexes on cotton plants from (early-Aug.) to (late-Sept.) during 2018.

Application timing	Inspection timing	Check	treatments							
			(1:1)		(1:1:50)		(1:4)		(1:4:50)	
		bollworm complex *	bollworm complex	% reduction	bollworm complex	% reduction	bollworm complex	% reduction	bollworm complex	% reduction
Early-Aug.	Mid-Aug.	**8.7**	**1.3**	63.9	**2.3**	63.9	**4**	58.7	**5.3**	41.4
Mid-Aug.	Late-Aug.	**13.7**	**3**		**6**		**3**		**7.7**	
Early-Sept.	Mid-Sept.	**15**	**7**		**3.7**		**4.7**		**9**	
Mid-Sept.	Late-Sept.	**15.7**	**7.7**		**7.3**		**10.3**		**9**	
****mean ±SE**		**13.3^{a} ±0.9**	**4.8^{b} ±0.8**		**4.8^{b} ±0.7**		**5.5^{b} ±0.9**		**7.8^{b} ±0.5**	
F		**20.3**								
P		**<.0001**								
HSD[.01]		**3.85**								

* Mean number/3 replicates
**Means followed by the same letter are not significantly different

IPM emphasizes the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms (FAO). With consideration the critical economic threshold, our finding suggests that the cow`s urine-dung extract has the ability to inhibit the bollworm complexes on cotton plants from the beginning of flowering to the boll maturity at a level that can delay apply the pesticides and, reduce their use. Thus, the present study clearly revealed that cow`s urine-dung extract can safely and effectively be incorporated in the integrated pest management program against bollworm complex density on the cotton plant.

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