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A novel study on efficacy of animal urine against *Helicoverpa armigera* (Hubner) on chickpea at Pantnagar, Uttarakhand

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Abstract
A novel and preliminary field study was conducted on the efficacy of animal urine against gram pod borer, *H. armigera* (Hubner) on chickpea at experimental farm NEBCRC, GBPUA&T Pantnagar, Uttarakhand during *rabi* crop seasons of 2016-17 and 17-18. The pooled data for both the years clearly showed that all the treatments were found significantly superior over control. The data on mean larval population, pod damage and grain yield was obtained for Indoxacarb (14.5 SC) @ 0.9ml/l (3.34larvae/plant, 11.38% and 15.15q/ha) showed that the chemical was performed the best among the treatments followed by Desi cow urine (4.50larvae/plant, 13.00%, 12.92q/ha), Horse urine(4.33 larvae /plant), 13.97%, 12.55q/ha) and Goat urine (5.83larvae/plant,15.65%,12.25q/ha) in comparison to untreated control (19.34larvae/plant, 38.70%, 5.51q/ha). On the other hand, the mean population of pupae of parasitoid, *Campoletis chloridae* was recorded the least (0.78/plant) in Indoxacarb and significantly more per plant (2.42.2.42 and 2.00) in Desi cow urine, Horse urine and Goat urine treated plots, respectively. Thus, the present novel study clearly revealed that animal urine can safely and effectively be incorporated in integrated pest management schedule against *Helicoverpa armigera* on chickpea.

Keywords: Animal urine, cow urine, chickpea, *Helicoverpa armigera*, novel approach, pod damage

Introduction
Chickpea (*Cicer arietinum* Linn., Family- Leguminacae) is generally known as gram or bengal gram is the most important pulse crop in India and is considered as 'King of pulses' (Bhatt and Patel, 2001) [5].. Chickpea seed contains 1.17 percent protein, 5.3 percent fat, 61.2 percent carbohydrates, 3.9 percent fibres and 2.7 percent minerals (Singh *et al*., 2005) [19]. Globally, chickpea is grown over an area of 13.54 million hectares with a production of 13.10 million tonnes and productivity of 968 kg/ha. Chickpea was cultivated in an area of 8.19 million hectares with a production of 7.330 million tonnes and a productivity of 895 kg/ha in India. Uttarakhand consists of hilly tracts as well as *tarai* areas where chickpea is an important crop during *rabi*, which is cultivated in an area of 601 hectares with a production of 514 tonnes and a productivity of 810 kg/ha (DES, 2015) [3]. Even though, India occupies first position with respect to area and production, the productivity remained low due to biotic stresses of which the major limiting factor is gram pod borer, *Helicoverpa armigera* (Rummana *et al.,* 2010) [14].

H. armigera (Lepidoptera: Noctuidae) is a polyphagous, prolific and wide spread pest known to feed on several crops belonging to different families. This insect occurs as a major pest in many economically important crops such as pigeonpea, cotton, chickpea, blackgram and most of the vegetables (Subramanian and Mohankumar, 2006) [20]. It attacks over 200 crop species belonging to 45 families globally, thus leading to yield loss tune to US $ 2 billion annually. In India the loss tune to 200 million US $ on pigeon pea and chickpea (Rummana *et al.,* 2010) [14]. A single larva can damage several pods and eat always the developing grain resulting in substantial yield losses (Sarwar *et al.,* 2011) [16].

In the developing countries like India, pest management mainly depends on the use of chemical pesticides, as they are the most reliable and economical but indiscriminate use of pesticides resulted in development of resistance in *H. armigera against* organophosphorus, carbamates and pyrethroids (Kranthi *et al*., 2002, Bues *et al.*, 2005, Hossain *et al*., 2010) [12, 7, 9]. The failure of modern tactics has compelled the scientific community to go back to the traditional and indigenous products for tackling the pest problem.

There is a vast potential in the traditional methods practiced in rural India that can be included for combating the pest problems. Cow urine and cow dung were reported to be effective for insect control as reported by Rankin (1986) [13]. The plant extracts prepared in cow urine were found very effective against *H. armigera* (Gupta, 2007, and Singh *et al.*, 2012, Arora *et al.* 2014) [8, 17, 4]. According to the literature searched so far, there is no any research work conducted on the efficacy of different types of animal urine for the management of this noxious insect pest. Thus, the present field study is preliminary and novel in context of use of animal urine against gram pod borer, *H. armigera* on chickpea.

Material and Methods

The field experiments, on the bio efficacy of. animal urine against *H. armigera* on Chickpea were conducted during *rabi* crop seasons, 2016-17 and 2017-18 at experimental farm NEBCRC, GBPUA&T Pantnagar, Uttarakhand. The trials were laid in Randomized Block Design (RBD) on chickpea variety PG-186 with a plot size of 3x3 m = $9m^2$ and distance from row to row and plant to plant was maintained at 30 cm and 10 cm, respectively. The crop was sown in the mid November 2016 and 2017. There were 09 treatments which were replicated thrice. The treatments included the urine of selected domestic animals *i.e*. Desi, Jersy and Holstein breed cows, Ox, Buffalo, Goat and Horse which was collected from university campus dairy farm of GBPUA&T, Pantnagar and used @ 20 percent in comparison to Insecticide, Indoxacarb 14.5SC @0.9ml/l against *H. armigera* on chickpea. The 20 percent solution of animal urine was prepared and left for 3 days for fermentation. The 50 ml solution of detergent powder was added to these animal urine formulations just before spray to serve as sticker. These animal urine formulations @20% were sprayed twice on chickpea crop starting from the initiation of pest incidence (ETL) at fortnightly intervals during evening hours (Tiwari *et al.*, 2016) [21]. The observations were recorded by randomly selecting ten plants from each plot and larval population was recorded 1 day before spraying, 3, 7, 14 days after spraying (DAS) on the mean population of larvae. The observations on percent pod damage and grain yield were recorded at the end of second spraying and after threshing the crop, respectively. Mean population of pupae of Ichneumonid wasp, *Campoletis chloridae*, a natural enemy associated with larvae of *H. armigera* were also recorded at 15 DAS of first and second sprayings.

Percent pod damage was calculated by using the following formulae (Hussain, 2007)

$$\text{Percent pod damage} = \frac{\text{No. of damage pods}}{\text{Total number of pods}} \times 100$$

$$\text{Percent reduction in pod damage} = \frac{\text{Pod damage in control- pod damage in treatment}}{\text{Pod damage in control}} \times 100$$

$$\text{Percent increase in yield} = \frac{\text{Grain yield in treatment- Grain yield in control}}{\text{Grain yield in control}} \times 100$$

The data so obtained were transformed to Arc sin, square root, percentage and analyzed statistically. After harvesting the crop, the data on the grain yield were recorded from each plot and analyzed statistically.

Efficacy of animal urine against *H. armigera* on chickpea

The results presented in Table-1 revealed that 3 days after first spray, Indoxacarb was most effective showing minimum larval population of 0.34, followed by Desi cow urine 0.50, HF cow urine 0.67, and Ox urine 1.00. The next best treatments were Jersy cow urine and Horse urine (1.17 each) followed by Buffalo urine (1.34), Goat urine (1.50). Seven days after first spray, Indoxacarb, Desi cow urine and Ox urine were the best treatments with 1.34, 2.00 and 2.00, respectively. The next best treatments were HF cow urine, Goat urine (2.34 each) followed by Jersy cow urine and Horse urine (2.50 each) with significantly higher larval counts in Buffalo urine (2.84) treated plots. Fourteen days after first spray, Indoxacarb recorded with lowest larval population of 3.84, followed by Desi cow urine (4.34) and Horse urine (4.33). The next best series of treatments were Goat urine, Ox urine, Jersy cow urine with 6.34, 6.50 and 6.67 larvae, respectively. However, HF cow urine (7.00) and Buffalo urine (7.67) observed with higher number of larvae. Three, seven and fourteen days after first spray untreated control were recorded with highest number of larvae respectively as 5.83, 7.84 and 8.84. The results revealed 3 days after second spray; Indoxacarb was most effective showing minimum larval population 2.50, followed by Horse urine (3.34), Desi cow urine (3.67) and Buffalo urine (3.84). HF cow urine (4.50), Jersy cow urine (4.83) and Goat urine (5.00) recorded with higher larval counts. Seven days after second spray also similar trend was followed with lowest larval population in Indoxacarb (4.17), followed by Goat urine (4.17), Desi cow urine (5.34), Ox urine (5.83) and Horse urine (5.84). Fourteen days after second spray also revealed, Indoxacarb was best treatment with 3.34 larval populations, followed by Horse urine (4.33), Desi cow urine (4.50) and Ox urine (5.00). As in the case of after first spray, three, seven and fourteen days after second spray also untreated control were recorded with highest number of larvae respectively as 13.00, 15.80 and 19.34. Overall mean larval population of *H. armigera* after two sprays showed significantly less number 2.59larvae/plant in Chemical, Indoxacarb treated chickpea plots followed by Desi cow urine (3.39larvae/plant), Horse urine (3.59larvae/plant) and Goat urine (4.06 larvae/palnt) with more number 5.41larvae/plant was recorded in Jersy Cow urine whereas the mean larval population (11.78/plant) was recorded in untreated control.

After the first spray results revealed that, untreated control was recorded with highest mean number of *C. chloridae* population (3.84) followed by Horse urine (2.34), Desi cow urine, Buffalo urine (2.17 each), HF cow urine and Goat urine (1.50 each). Again untreated control was recorded with highest mean number *C. chloridae* population (4.00) even after second spray. The next best treatment series after second spray were Horse urine (2.67), Jersy cow urine, Ox urine and Buffalo urine (2.50 each). After the both sprays, the highest overall mean *Campoletis* pupae (2.42pupae /plant) was recorded in Desi cow urine treated chickpea plots which was at par with Horse urine (2.41pupae/plant), Buffalo urine (2.26pupae/plant) and Goat urine (2..00pupae/plant) with significantly different from Chemical, Indoxacarb where the least (0.76pupae/plant) was observed in comparison to the highest *Campoletis* population (3.12pupae/plant) was recorded in untreated control.

The data presented in Table-2 showed that after two sprays, Indoxacarb 14.5 SC@ 0.9 ml/l gave the least pod damage (11.38%) followed by Desi cow urine (13.00%) and Horse urine (13.97%). The next best treatments with lower percent pod damage were Goat urine (15.65%), Ox urine (22.57%), Buffalo urine (22.60%), cow urine HF (23.43%) and Jersy cow urine (23.18%). All the treatments were found to be significantly superior over control with pod damage (38.70%) percent. In terms of yield of chickpea, highest yield (15.15 q/ha) was recorded in Indoxacarb treated plot whereas lowest (5.51 q/ha) yield was recorded in untreated control plot. Among the different animal urine formulations evaluated Desi cow urine (12.92 q/ha), Horse urine (12.55 q/ha) and Goat urine (12.25 q/ha) were recorded with significantly higher grain yield. The next best treatments were HF cow urine (9.76 q/ha), Buffalo urine (8.68 q/ha) and Jersy cow urine (8.55 q/ha).

Two sprays of Indoxacarb 14.5 SC @ 0.9 ml/l was found to be more effective than other animal urine formulations where percent pod damage reduction was recorded the highest (70.59%) followed by Desi cow urine, Horse urine, Goat urine, Ox urine, Buffalo urine, Jersy Cow urine and HF Cow urine which were recorded the percent pod damage reduction by, 66.41, 63.90, 59.56.41.68.41.60, 40.10 and 39.46, respectively. Cow urine HF @20% was recorded least effective among the treatments but significant and superior over control. All the treatments were found to be significantly superior over control. Similarly, increase in grain yield over control was also significantly more for insecticide treatment, Indoxacarb (63.63%) followed by desi cow urine (57.35%), horse urine (56.0%) which was at par with goat urine (55.02%) with the least value recorded in Jersy cow urine (35.56%).

Finally the results pertaining to overall mean population of larvae of *H. armigera*, pod damage and yield data as shown in Tables 1 and 2, clearly revealed that minimum larval population (2.59/plant), pod damage (11.38%) and higher yield (15.15q/ha) was obtained from insecticide, Indoxacarb treated plots. Though Indoxacarb was found effective, it showed deleterious effect against natural enemy of *H. armigera*, a parasitoid wasp, *Campoletis chloridae* as only 0.76 pupae/plant of it were recorded. Whereas in animal urine treated chickpea plots where mean population of *Campoletis* pupae were recorded in Desi cow urine (2.42pupae/plant) followed by Horse urine (2.41pupae/plant), Buffalo urine (2.26pupae/plant) and Goat urine (2.00pupae/plant).

All the treatments were found significantly superior over control and Indoxacrb (14.5 SC) @ 0.9ml/l was performed the best among the treatments followed by Desi cow urine, Horse urine and Goat urine. The present finding are also according with the finding of Jayshri *et al.* (2008) [10] and Anandhi *et al.* (2011) [1] who reported that the, indoxacarb recorded the highest reduction of pod borer population and grain damage in first and second spray in comparison to biopestoicides. On the other hand, Sadawarte and Sarode (1997) [15] reported that a mixture of cow urine, NSKE (5%) and cow dung (5%) acts as an oviposition deterrent to moths and antifeedant to caterpillars and thereby the damage to maturing pods is minimized. Boomathi *et al.* (2006) [6] tested the combined action of neem seed kernel extract and cow excreta on biological activities of *H. armigera*. NSKE 5% + cow urine + cow dung extract 5% treatment was found to be the best exhibiting toxic effect on eggs and larvae of *H. armigera*. Katuwal *et al.* (2012) [11] evaluated the efficacy of using the urine of four animals (cow, buffalo, goat, sheep), a urine-mix (cow urine and plant leaves) against the diamondback moth, *Plutella xylostella* under field conditions. The plot treated by the urine-mix had the least number of cabbage leaves damaged, followed by the plot treated with cow urine and then the plot treated with goat urine. Singh *et al.* (2012) [17] evaluated that neem seed kernel extract in cow urine @5% recorded highest reduction of pod borer population (73.9%). Arora *et al.* (2014) [4] studied about the efficacy of the indigenous biopesticide formulation (BPF) comprising of botanicals along with cow urine, and evaluated that BPF controlled 70 to 80 percent of fruit borers resulting in enhanced tomato fruit yield of 35 tons per ha as compared to 15 tons per ha in the check plots.

Thus the present novel study clearly demonstrated the potential and possibilities of using animal urine against larval population of *H. armigera* with less pod damage, high grain yield, and with no any adverse effect on natural enemy population. Thus, it can be concluded from this present field study that animal urine can open new avenues for eco-friendly management of this noxious pest of international importance and can easily be incorporated in Integrated Pest management programme against *H. armigera* on chickpea crop as it is eco-friendly, cost effective easily available at farmers' level, but as being novel and preliminary study, further in depth study is essentially required to come to the final conclusions

Table 1: Effect of Animal urine on mean population of larvae of *H. armigera* and its natural enemy *Campoletis chloridae* during 2016-17 and 2017-18 at Pantnagar Uttarakhand (Pooled Data)

Sl. No.	Treatments	Conc. (%)	Mean Number of larvae/plant						Overall mean No. of larvae/ plant	Mean no. of *Campoletis* pupae		Overall mean No. of *Campoletes* pupae/plant
			Before Spray	Days After First Spray			Days After Second Spray			After 1st spray	After 2nd spray	
				3	7	14	3	7	14			
1	Cow urine- Desi	20	3.17 (1.91)	0.50 (0.97)	2.00 (1.57)	4.34 (2.19)	3.67 (2.03)	5.34 (2.41)	4.50 (2.23)	3.39	2.17 (1.63)	2.67 (1.78)	2.42
2	Cow urine- HF	20	2.17 (1.63)	0.67 (1.03)	2.34 (1.67)	7.00 (2.74)	4.50 (2.22)	7.50 (2.81)	8.50 (2.99)	5.09	1.50 (1.41)	2.17 (1.63)	1.84
3	Cow urine- Jersy	20	3.00 (1.87)	1.17 (1.25)	2.50 (1.67)	6.67 (2.68)	4.83 (2.29)	8.34 (2.96)	9.00 (3.08)	5.41	1.33 (1.35)	1.50 (1.41)	1.42
4	Ox urine	20	2.84 (1.83)	1.00 (1.19)	2.00 (1.57)	6.50 (2.65)	3.84 (2.07)	5.83 (2.51)	6.50 (2.64)	5.31	1.34 (1.35)	2.34 (1.68)	1.84
5	Buffalo urine	20	2.50 (1.73)	1.34 (1.33)	2.84 (1.79)	7.67 (2.86)	3.84 (2.08)	6.50 (2.64)	6.00 (2.55)	4.70	2.17 (1.63)	2.34 (1.68)	2.26
6	Goat urine	20	3.00 (1.87)	1.50 (1.35)	2.34 (1.63)	6.34 (2.59)	5.00 (2.35)	4.17 (2.16)	5.00 (2.34)	4.06	1.50 (1.41)	2.50 (1.73)	2.00

7	Horse urine	20	3.00 (1.85)	1.17 (1.28)	2.50 (1.72)	4.33 (2.19)	3.34 (1.96)	5.84 (2.51)	4.33 (2.19)	3.59	2.34 (1.67)	2.50 (1.75)	2.41
8	Indoxacarb 14.5 SC	0.9ml/l	3.17 (1.91)	0.34 (0.89)	1.34 (1.35)	3.84 (2.06)	2.50 (1.64)	4.17 (2.12)	3.34 (1.96)	2.59	1.02 (1.28)	0.50 (0.99)	0.76
9	Untreated Control		3.50 (1.99)	5.83 (2.51)	7.84 (2.89)	8.84 (3.05)	13.00 (3.67)	15.80 (34.04)	19.34 (4.45)	11.78	3.34 (1.96)	3.00 (1.85)	3.17
	SEM±			0.45 (0.15)	0.45 (0.15)	0.71 (0.15)	0.54 (0.14)	0.74 (0.14)	0.63 (0.14)			0.38 (0.11)	
	CD @5%		NS	1.48 (0.48)	1.49 (0.48)	2.31 (0.48)	1.76 (0.46)	2.41 (0.46)	2.07 (0.48)		NS	1.23 (0.35)	
	CV			42.93 (15.99)	22.62 (10.94)	16.29 (8.18)	15.46 (8.94)	14.86 (7.67)	12.23 (6..87)			22.40 (8.93)	

Table 2: Effect of Animal urine on overall mean population of larvae of *H. armigera* and its natural enemy *Campoletis chloridae*, pod damage and grain yield during 2016-17 and 2017-18 at Pantnagar Uttarakhand (Pooled Data)

Sl. No.	Treatments	Conc. (%)	Overall mean No. of larvae/plant	Overall mean No. of *Campoletes* pupae/plant	Pod damage (%)	Reduction in pod damage over control (%)	Pooled grain yield (q/ha)	Increase in yield over control (%)
1	Cow urine- Desi	20	3.39	2.42	13.00 (21.08)	66.41	12.92 (3.66)	57.35
2	Cow urine- HF	20	5.09	1.84	23.43 (28.90)	39.46	9.76 (3.20)	43.55
3	Cow urine- Jersy	20	5.41	1.42	23.18 (28.74)	40.10	8.55 (3.61)	35.56
4	Ox urine	20	5.31	1.84	22.57 (28.33)	41.68	10.89 (3.37)	49.40
5	Buffalo urine	20	4.70	2.26	22.60 (28.32)	41.60	8.68 (3.03)	36.52
6	Goat urine	20	4.06	2.00	15.65 (23.26)	59.56	12.25 (3.57)	55.02
7	Horse urine	20	3.59	2.41	13.97 (21.90)	63.90	12.55 (3.61)	56.09
8	Indoxacarb 14.5 SC	0.9ml/l	2.59	0.76	11.38 (19.67)	70.59	15.15 (3.96)	63.63
9	Untreated Control	-	11.78	3.17	38.70 (38.47)	-	5.51 (2.45)	-
	SEM±				1.09 (0.72)		0.53 (0.08)	
					3.56 (2.34)		1.74 (0.26)	
					7.53 (3.82)		7.19 (3.41)	

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