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Field studies on Bio efficacy and Phytotoxicity of Indoxacarb 14.5% SC against pod borer of chickpea

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Abstract
Field experiment was carried out during rabi 2015 and 2016 to evaluate the bio efficacy of indoxacarb 14.5% SC against chickpea podborer. The plots sprayed with Indoxacarb 14.5% SC @ 75 g.a.i /ha were best treatments in reducing the pod borer larval load, their damage to pods and registering good seed yield of chickpea. Indoxacarb 14.5% SC was on par with all other standard check treatments used in the experiment for Chrysoperla and coccinellids activity. This product does not cause any phytotoxicity symptoms on chickpea. Hence, Indoxacarb 14.5% SC @ 75 g a.i. / ha is the optimum and effective dose to manage the pod borer of chick pea.

Keywords: Chickpea, Indoxacarb 14.5% SC, podborer

Introduction
Gram commonly known as a 'chickpea' is a very important pulse crop that grows as a seed of a plant named *Cicer arietinum* in the Leguminosae family. India is the largest chickpea producer contributing 65 % of world's annual production as well as consumer in the world. Chickpea is the world's third most important food legume. It contains 25% proteins, which is the maximum provided by any pulse and 61.1% carbohydrates (Singh and Yadav 2007) [2]. However, high yield is limited by the insect pests attacking chickpea. The major insect pests *i.e.* termites (*Odontotermes obesus*), cutworms (*Agrotis ipsilon, A. segetum, A. spinifera and Mythimna separata)* appear during seedling stage in certain areas, while *Helicoverpa armigera* appear in great number during vegetative growth and at pod formation stage of chickpea (Lal 1996) [5]. A single larva may destroy several pods before reaching to maturity and this pest is reported to damage 5 to 40 per cent pods of chickpea crop.

Material and Methods
The experiment was conducted at Krishi Vigyan Kendra, Gangavathi University of Agricultural Sciences, Raichur during rabi seasons of 2015 and 2016 in a Randomized Block Design (R.B.D.) with six treatments, each consisting of four replicates. The total number of plots was 24. The chickpea seeds of variety 'JG-11' were sown in plots of size 4 x 3 m2 with row spacing 30 cm and plant to plant distance 10 cm.
All the insecticides under study were applied as foliar spray using Knapsack sprayer. To determine the efficacy of chemicals, two sprays were conducted on chickpea. First spray was done at pod initiation stage and second spray after 15 days of first spray. The details of treatments with respective dose and method of application has been given in Table 1.

Table 1: Treatment details along with checks

Sl. No.	Treatments	Dosage (g.ai/ha)	Formulation dose (ml)	Water volume (l/ha)
T1	Indoxacarb 14.5% SC	40	270	500
T2	Indoxacarb 14.5% SC	50	333	
T3	Indoxacarb 14.5% SC	60	400	
T4	Indoxacarb 14.5% SC	75	500	
T5	Indoxacarb 14.5% SC	150	1000	
T6	Indoxacarb 15.8% EC	50	333	
T7	Lambda-cyhalothrin 5% EC	25	500	400
T8	Untreated Control	-	-	500

Method of observation

1. Pod borer larval count on randomly selected 10 plants in each plot was made on one day before spray and 3, 7,10 & 15 days after spray each spray
2. Pod damage data at harvest was taken and per cent pod damage was worked out
3. Yield data at harvest was taken in each plot and converted to hectare basis
4. 10 plants were selected at random from each plot and the total number leaves of those showing phytotoxicity if any were counted & observations were made for symptoms like yellowing, leaf injury, vein clearing, wilting, , necrosis, epinasty & hyponasty before spray, 3, 7 & 14 days after spray on 0-10 scales as, 0= no phytotoxicity, 1= 1 – 10%, 2= 11-20%, 3= 21 – 30%, 4= 31 – 40%, 5= 41 – 50%, 6= 51 – 60%, 7= 61 – 70%, 8= 71 – 80%, 9= 81 – 90% and 10= 91 – 100% phytotoxicity.

Results

Bioefficacy of Indoxacarb 14.5% SCagainst pod borer (*Helicoverpaarmigera*)

First Season

The bioefficacy data on Indoxacarb 14.5% SC on *Helicoverpa* larval population count in chickpea is presented in table 2.

The pod borer larval population one day before 1st spray in the experimental field did not differ significantly among the plots indicating uniform distribution of larvae and it was above the economic threshold level. The larval load after spray varied among the treatments and it was lowest (5.0/10 plants) in Indoxacarb 14.5%SC @ 150 g.a.i/ha and highest in untreated control (12.47/10 plants) on 15th day of 1st spray. Among the Indoxacarb 14.5%SC dosages tested, the Indoxacarb 14.5% SCsprayed @ 150g.a.i/ha recorded significantly less number of larvae and was on par with Indoxacarb 14.5% SC @ 75g.a.i/ha (5.18/10 plants), Indoxacarb 14.5% SC60g.a.i/ha (5.55/10 plants) andIndoxacarb 15.8% SC @ 50g.a.i/ha(5.49/10 plants)on 15 days after I spray. The efficacy trend of Indoxacarb 14.5% SC remained same even after II spray.

Second season

The pod borer larval population one day before 1st spray in the experimental field did not differ significantly among the plots indicating uniform distribution of larvae and it was above the economic threshold level. The larval load after spray varied among the treatments and it was lowest (5.01/10 plants) in Indoxacarb 14.5%SC @ 150 g.a.i/ha and highest in untreated control (12.43/10 plants) on 15th day of 1st spray. Among the Indoxacarb 14.5% SC dosages tested, the Indoxacarb 14.5% SC sprayed @ 150 g.a.i/ha recorded significantly less number of larvae and was on par with Indoxacarb 14.5% SC @ 75g.a.i/ha (5.65/10 plants), Indoxacarb 14.5% SC 60 g.a.i/ha (5.74/10 plants) and Indoxacarb 15.8% SC @ 50 g.a.i/ha(5.65/10 plants) on 15 days after I spray. The efficacy trend of Indoxacarb 14.5% SC remained same even after II spray (Table 2a).

Pod damage by gram pod borer

First season

Significantly lesser pod damage was found in plots received Indoxacarb 14.5% SC @ 150 g.a.i/ha (5.22%) which were on par with standard checks viz., Indoxacarb 15.8% SC @ 50 g.a.i/ha (6.84%). The pod damage by pod borers was maximum (23.38%) in untreated control (Table 3).

Second season

Significantly lesser pod damage was found in plots received Indoxacarb 14.5% SC @ 150 g.a.i/ha (5.63 %) which were on par with standard checks viz., Indoxacarb 15.8% SC @ 50 g.a.i/ha (6.96 %). The pod damage by pod borers was maximum (21.43 %) in untreated control (Table 3a).

Yield

First season

The significantly highest yield of chickpea was registered in Indoxacarb 14.5% SC @ 150 g.a.i/ha treated plot (16.12 q/ha) which was at par with Indoxacarb 14.5% SC treated @ 75 g.a.i/ha (15.75 q/ha) and standard checks Indoxacarb 15.8%SC @ 50 g.a.i/ha sprayed plot (15.38/ha). The lowest seed yield of 9.68 q/ha recorded from untreated control (Table 3).

Second season

The significantly highest yield of chickpea was registered in Indoxacarb 14.5% SC @ 150 g.a.i/ha treated plot (19.10 q/ha) which was at par with Indoxacarb 14.5% SC treated @ 75 g.a.i/ha (17.70 q/ha) and standard checks Indoxacarb 15.8%SC @ 50 g.a.i/ha sprayed plot (14.10 q/ha). The lowest seed yield of 10.72 q/ha recorded from untreated control (Table 3).

Safety of Indoxacarb 14.5% SC to Natural enemies

First season

Indoxacarb 14.5% SC has recorded the on par population of natural enemies after 15 days after second spray as that of all other standard check treatments used in the experiment. However the population of Chrysoperla and recorded in untreated check was significantly higher than all the treatments. The similar trend was seen against coccinellids population in all the treatments (Table 4).

Phytotoxicity of Indoxacarb 14.5% SC

There was no phytotoxic effect on plant as it was evidenced by not causing any of the phytotoxic symptoms at the dose indicated in table 5.

Discussion

Chickpea yield is decreasing day by day due to many factors among which the major factor is direct damage caused by larvae of *H. armigera*.

The plots sprayed with Indoxacarb 14.5% SC @40 to 150 g.a.i /ha were best treatments in reducing the pod borerlarval load, their damage to pods and registering good seed yield of chickpea. The present experimental findings are supported by (Anis-ur-Rahman *et al*. 2006) [1] who reported that indoxacarb as the most effective in reducing the larval population in chickpea crop results are also in agreement with Wakil *et al.* (2006) [6] who reported that indoxacarb was the most effective in reducing the larval population of *H. armigera* in sunflower. Singh *et al*. (2007) [2] and Deshmukh *et al*. (2010) [3] reported that indoxacarb caused minimum larval population in chickpea. Karar *et al.,* (2002) [4] reported that minimum larval population was recorded for lambda cyhalothrin in cotton crop, thus supporting our findings.

Table 2: Effect of Indoxacarb 14.5% SC on pod borer, *Helicoverpaarmigera armigera* larval population (2015)

Treatments	Mean larva / 10 plant								
	I spray					II spray			
	1 DBS	3DAS	7DAS	10 DAS	15 DAS	3DAS	7DAS	10 DAS	15 DAS
Indoxacarb 14.5% SC @40 g a.i/ha	11.41 (3.42)	4.38 (2.20)	4.03 (2.12)	6.38 (2.62)	9.39 (3.13)	2.19 (1.64)	3.67 (2.03)	5.18 (2.36)	6.02 (2.53)
Indoxacarb 14.5% SC@50 g a.i/ha	10.51 (3.32)	2.63 (1.75)	1.33 (1.35)	4.11 (2.14)	5.98 (2.54)	0.93 (1.20)	0.53 (1.01)	1.48 (1.41)	1.93 (1.56)
Indoxacarb 14.5% SC@60 g a.i/ha	11.13 (3.41)	2.03 (1.59)	0.99 (1.22)	3.78 (2.06)	5.55 (2.45)	0.48 (0.99)	0.08 (0.76)	1.08 (1.26)	1.48 (1.41)
Indoxacarb 14.5% SC@75 g a.i/ha	10.97 (3.39)	1.98 (1.57)	1.03 (1.21)	3.88 (2.08)	5.18 (2.38)	0.34 (0.92)	0.06 (0.75)	1.03 (1.24)	1.33 (1.35)
Indoxacarb 14.5% SC@150 g a.i/ha	11.08 (3.40)	1.48 (1.41)	0.85 (1.19)	3.14 (1.90)	5.00 (2.34)	0.11 (0.78)	0.00 (0.71)	0.74 (1.11)	1.20 (1.31)
Indoxacarb 15.8% SC@50 g a.i/ha	10.78 (3.36)	2.48 (1.71)	1.39 (1.37)	3.98 (2.11)	5.49 (2.44)	0.38 (0.94)	0.03 (0.73)	0.98 (1.22)	1.42 (1.38)
Lambda-cyhalothrin 5% EC@25 g a.i/ha	11.39 (3.45)	3.03 (1.87)	2.78 (1.80)	5.93 (2.53)	8.39 (2.97)	1.48 (1.40)	1.98 (1.57)	2.22 (1.63)	2.32 (1.66)
UTC	10.78 (3.36)	12.38 (3.59)	13.38 (3.76)	14.38 (3.85)	12.47 (3.59)	13.38 (3.71)	12.69 (3.62)	13.38 (3.73)	11.78 (3.50)
SEM+	0.12	0.12	0.11	0.14	0.17	0.09	0.1	0.11	0.12
CD at 5%	0.36	0.36	0.33	0.44	0.51	0.26	0.32	0.34	0.35

Values in paranthsis are square root transformed
Note: DBS= Days Before Spray, DAS= Days After Spray

Table 2a: Effect of Indoxacarb 14.5% SC on pod borer, *Helicoverpa armigera* larval population (2016)

Treatments	Mean larva / 10 plant								
	I spray					II spray			
	1 DBS	3DAS	7DAS	10 DAS	15 DAS	3DAS	7DAS	10 DAS	15 DAS
Indoxacarb 14.5% SC @40 g a.i/ha	10.56 (3.32)	5.33 (2.41)	4.83 (2.31)	6.02 (2.54)	8.24 (2.93)	2.62 (1.74)	3.47 (1.98)	2.61 (2.45)	5.72 (2.45)
Indoxacarb 14.5% SC@50 g a.i/ha	11.23 (3.42)	4.31 (2.18)	2.59 (1.74)	4.76 (2.26)	4.69 (2.25)	1.02 (1.23)	0.58 (1.02)	0.94 (0.96)	1.93 (1.51)
Indoxacarb 14.5% SC@60 g a.i/ha	12.56 (3.61)	3.33 (1.95)	1.89 (1.52)	3.23 (1.91)	5.07 (2.36)	0.56 (1.03)	0.01 (0.71)	0.53 (0.58)	1.74 (1.50)
Indoxacarb 14.5% SC@75 g a.i/ha	12.43 (3.59)	2.65 (1.77)	1.68 (1.46)	2.63 (1.77)	4.63 (2.27)	0.37 (0.93)	0.09 (0.77)	0.46 (0.54)	1.26 (1.33)
Indoxacarb 14.5% SC@150 g a.i/ha	11.23 (3.42)	1.56 (1.43)	0.88 (1.17)	2.39 (1.67)	3.91 (2.09)	0.55 (1.02)	0.12 (0.79)	0.56 (0.62)	1.10 (1.26)
Indoxacarb 15.8% SC@50 g a.i/ha	10.89 (3.37)	2.65 (1.77)	1.46 (1.40)	3.84 (2.08)	5.65 (2.47)	0.41 (0.95)	0.08 (0.76)	0.48 (0.55)	1.62 (1.44)
Lambda-cyhalothrin 5% EC@25 g a.i/ha	12.64 (3.62)	3.42 (1.97)	2.41 (1.71)	5.87 (2.52)	8.41 (2.98)	1.64 (1.46)	1.89 (1.54)	1.66 (1.63)	2.43 (1.70)
UTC	10.01 (3.24)	9.26 (3.12)	12.96 (3.67)	13.52 (3.74)	12.43 (3.59)	13.96 (3.79)	12.98 (3.67)	10.24 (8.60)	11.54 (3.47)
SEM+	0.11	0.12	0.12	0.16	0.15	0.11	0.10	0.12	0.12
CD at 5%	0.33	0.38	0.36	0.49	046	0.33	0.29	0.36	0.35

Values in paranthsis are square root transformed
Note: DBS= Days Before Spray, DAS= Days After Spray

Table 3: Effect of Indoxacarb 14.5% SC on pod damage by gram pod borer (2015)

Treatments	% pod damage	Yield (g/ha)
Indoxacarb 14.5% SC @40 g a.i/ha	10.65 (18.99)	11.55
Indoxacarb 14.5% SC@50 g a.i/ha	9.63 (18.02)	12.65
Indoxacarb 14.5% SC@60 g a.i/ha	8.78 (17.17)	13.13
Indoxacarb 14.5% SC@75 g a.i/ha	6.16 (14.34)	15.75
Indoxacarb 14.5% SC@150 g a.i/ha	5.22 (13.17)	16.12
Indoxacarb 15.8% SC@50 g a.i/ha	6.84 (15.16)	15.38
Lambda-cyhalothrin 5% EC@25 g a.i/ha	11.32 (19.61)	11.79

UTC	23.38 (28.83)	9.68
SEM+	1.17	0.57
CD at 5%	3.55	1.72

Values in paranthsis are arcsin transformed**.**

Table 3a: Effect of Indoxacarb 14.5% SC on pod damage by gram pod borer (2016)

Treatments	% pod damage	Yield (g/ha)
Indoxacarb 14.5% SC @40 g a.i/ha	11.26 (19.57)	13.50
Indoxacarb 14.5% SC@50 g a.i/ha	10.35 (18.76)	14.75
Indoxacarb 14.5% SC@60 g a.i/ha	9.56 (18.00)	15.23
Indoxacarb 14.5% SC@75 g a.i/ha	7.06 (15.36)	17.70
Indoxacarb 14.5% SC@150 g a.i/ha	5.63 (13.70)	19.10
Indoxacarb 15.8% SC@50 g a.i/ha	6.96 (15.30)	17.55
Lambda-cyhalothrin 5% EC@25 g a.i/ha	10.84 (19.22)	14.10
UTC	21.43 (27.56)	10.72
SEM+	0.64	0.63
CD at 5%	1.94	1.89

Values in paranthsis are arcsin transformed.

Table 4: Effect of Indoxacarb 14.5% SC on natural enemies population of pod borer

Treatment	Natural enemies (Population/10 plants) after 15 days after second spray	
	Chrysoperla	***Coccinella spp.***
Indoxacarb 14.5% SC @40 g a.i/ha	0.34	0.32
	(0.91)	(0.91)
Indoxacarb 14.5% SC@50 g a.i/ha	0.26	0.31
	(0.86)	(0.9)
Indoxacarb 14.5% SC@60 g a.i/ha	0.22	0.25
	(0.85)	(0.87)
Indoxacarb 14.5% SC@75 g a.i/ha	0.15	0.22
	(0.78)	(0.85)
Indoxacarb 14.5% SC@150 g a.i/ha	0.12	0.16
	(0.79)	(0.81)
Indoxacarb 15.8% SC@50 g a.i/ha	0.13	0.18
	(0.79)	(0.82)
Lambda-cyhalothrin 5% EC@25 g a.i/ha	0.14	0.16
	(0.78)	(0.81)
UTC	0.78	0.68
	(1.13)	(1.07)
SEM+	0.06	0.05
CD at 5%	0.18	0.16

Values in paranthsis are square root transformed

Table: 4a: Effect of Indoxacarb 14.5% SC on natural enemies population of pod borer

Treatment	Natural enemies (Population/10 plants)	
	Chrysoperla	***Coccinella spp.***
Indoxacarb 14.5% SC @40 g a.i/ha	0.35	0.47
	(0.92)	(0.98)
Indoxacarb 14.5% SC@50 g a.i/ha	0.27	0.30
	(0.87)	(0.89)
Indoxacarb 14.5% SC@60 g a.i/ha	0.20	0.16
	(0.84)	(0.81)
Indoxacarb 14.5% SC@75 g a.i/ha	0.16	0.14
	(0.81)	(0.80)
Indoxacarb 14.5% SC@150 g a.i/ha	0.14	0.10
	(0.80)	(0.77)
Indoxacarb 15.8% SC@50 g a.i/ha	0.20	0.37
	(0.83)	(0.92)
Lambda-cyhalothrin 5% EC@25 g a.i/ha	0.25	0.18
	(0.86)	(0.82)
UTC	0.63	0.67
	(1.06)	(1.08)
SEM+	0.05	0.05
CD at 5%	0.16	0.16

Table 5: Phytotoxicityeffect of Indoxacarb14.5% SC on chick pea

Treatment (g.a.i./ha)	Phytotoxicity parameters						
	Yellowing	Leaf injury	Vein clearing	Wilting	Necrosis	Epinasty	hyponasty
DBS							
Indoxacarb 14.5% SC@60 g a.i/ha	*0.0	0.0	0.0	0.0	0.0	0.0	0.0
Indoxacarb 14.5% SC@75 g a.i/ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Indoxacarb 14.5% SC@ 150 g a.i/ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0
UTC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3 DAS							
Indoxacarb 14.5% SC@60 g a.i/ha	*0.0	0.0	0.0	0.0	0.0	0.0	0.0
Indoxacarb 14.5% SC@75 g a.i/ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Indoxacarb 14.5% SC@ 150 g a.i/ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0
UTC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7 DAS							
Indoxacarb 14.5% SC@60 g a.i/ha	*0.0	0.0	0.0	0.0	0.0	0.0	0.0
Indoxacarb 14.5% SC@75 g a.i/ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Indoxacarb 14.5% SC@ 150 g a.i/ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0
UTC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10 DAS							
Indoxacarb 14.5% SC@60 g a.i/ha	*0.0	0.0	0.0	0.0	0.0	0.0	0.0
Indoxacarb 14.5% SC@75 g a.i/ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Indoxacarb 14.5% SC@ 150 g a.i/ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0
UTC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14 DAS							
Indoxacarb 14.5% SC@60 g a.i/ha	*0.0	0.0	0.0	0.0	0.0	0.0	0.0
Indoxacarb 14.5% SC@75 g a.i/ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Indoxacarb 14.5% SC@ 150 g a.i/ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0
UTC	0.0	0.0	0.0	0.0	0.0	0.0	0.0

*No phytotoxicity symptoms were observed on sprayed crops. DBS: Day before Spray
UTC: Untreated Control

Conclusion

The plots sprayed with Indoxacarb 14.5% SC @ 75 g.a.i /ha were best treatments in reducing the pod borer larval load, their damage to pods and registering good seed yield of chickpea. Indoxacarb 14.5% SC was on par with all other standard check treatments used in the experiment for Chrysoperla and coccinellids activity. This product does not cause any phytotoxicity symptoms on chickpea. Indoxacarb 14.5% SC @ 75 g a.i. / ha is the optimum and effective dose to manage the pod borer of chick pea.

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