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Evaluation of pre-harvest spray of insecticides for control of pulse beetle *Callosobruchus* sp. in green gram

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Abstract
Field-cum-laboratory experiment was conducted to study the effect of pre-harvest spray of insecticides for control of pulse beetle in green gram at Entomology farm and department, B. A. College of Agriculture, Anand Agricultural University, Anand during *Kharif* 2017-18 to 2018-2019. The experiment was laid out in the randomized block design (Factorial) consisted of 15 treatment combinations involving two factors with three replications. Adult emergence of pulse beetle differed significantly due to pre-harvest spray of insecticides and different spraying schedules. The lowest number of adult emergence was recorded in treatment indoxacarb 14.5 SC followed by profenofos 50 EC and emamectin benzoate 5 SG. In case of spraying scheduled lower number of adult emergence was recorded in spraying at maturity as compared to others. In interaction effect significantly lowest adult emergence as well as lower number of egg laying, seed damage and higher percentage of seed germination was recorded in pre-harvest spraying of indoxacarb 14.5 SC 0.012 per cent (8 ml/10 litre of water) at pod maturity stage to check the infestation of pulse beetle during storage up to two months.

Keywords: Pre-harvest spray, insecticides, green gram and pulse beetle

1. Introduction

Green gram (*Vigna radiata* (L) Wilczek) is under cultivation since prehistoric time in India. In storage, totally 25 species of insects have been recorded on pulses. Of these, coleopteran causes major damage to stored grains and its products. Among these, the pulse beetles *Callosobruchus* spp. is the major pests in stored pulse [2] and causes 40-50% losses in pulses storage [4]. The losses in pulses during post harvest handling and storing has been estimated about 8.5 per cent in India and recorded zero per cent germination due to *C. chinensis* infestation after six months in stored green gram. Among the eight legumes, the highest seed damage (79.59%) caused by *C. chinensis* was reported in green gram followed by black gram (59.30%), cow pea (51.04%), white gram (29.98%) and pea (1.70%) [6]. The beetle completes its life cycle within 25 to 34 days during summer, while 40 to 50 days in winter [4] but in the presence of grain protectants, life of the beetle found to be disturbed [1]. Infestation starts right from the field and continues to the store [3]. At last stage of maturation, seeds are infested by bruchids either from field or by the bruchids migrating from infested seeds of adjacent granaries or from seed godown which do not have expression at field [11]. As per the ancient adage, "Prevention is better than cure", controlling these pests in the field prevents them from entering godowns and spreading further to uninfected seeds. The marginal and sub-marginal farmers are unable to fumigate their godowns as most of the farmers used to store their produce in the gunny bags or in rooms where they are also receiving. It is very difficult to manage the pulse beetle which causes heavy losses during storage. Under such situation, it is necessary to find out such strategy which will be helpful to manage the pest. Accordingly to damaging pattern of this pest (Infestation starts right from the field) pre-harvest sanitation spray is a novel method to arrest these pathogens / insects in the field itself thereby delimiting the damage during storage. It involves the spraying of fungicides and / or insecticides during the formation and development of pod and seed at needy concentrations at suitable intervals [10].

2. Materials and Methods

In field

The field trials were conducted during *kharif* 2017 and 2018 at Entomology farm, B. A.

College of Agriculture, Anand Agricultural University, Anand with green gram (variety: GAM-5) adopting Randomized Block Design (Factorial) with two factors *i.e.* first factor was insecticides and second factor was spraying schedules with three replications. A seed crop was raised after following recommended agronomical practices in a plot size 4 x 5 m^2 under irrigated condition. Insecticidal spray was applied as per the three spraying schedules *i.e.* spraying at initiation of pod maturity (S_1), spraying at maturity (S_2) and spraying at initiation of pod maturity and maturity (S_3). The crop was imposed with pre-harvest spray using emamectin benzoate 5 SG 0.025% (I_1), chlorantraniliprole 18.5 SC 0.006% (I_2), profenofos 50 EC 0.1% (I_3) and indoxacarb 14.5 SC 0.012% (I_4) with knapsack sprayer as prophylactic measures against pulse beetle. The unsprayed plots served as control (I_5).

In storage

After threshing, 500 g seed was collected from each treatment, replication-wise. Such quantity of seed was kept in cloth bag ensuring protection from cross infestation during the storage period. The observations on adult emergence were recorded at weekly interval up to two month. Number of seeds having exit hole (damaged seed) were counted at the end of the two months. For the purpose, 100 seeds were randomly selected from each treatment replication-wise and seeds having exit hole were counted. In addition, 10 seeds were also selected randomly to record the number of egg(s) on each seed at the end of two months. The data recorded on adult emergence, seed damage (based on exit hole) and egg population was subjected to ANOVA.

3. Results and Discussion

During the first year data on adult emergence in pre-harvest spraying of different insecticides, spraying schedules and interaction effect of pre-harvest spraying and spraying scheduled was showed no adult emergence up to two week of storage, whereas after three week adult emergence was recorded in control only. However, the results of pre-harvest spray and spraying scheduled alone were recorded significant at 4, 5, 6, 7 and 8 weeks of storage while in interaction 4^{th} and 5^{th} week data showed significant but thereafter results was non-significant. Lowest number of adult emergence (4.70) was recorded in treatment indoxacarb 14.5 SC (I_4) followed by profenofos 50 EC (I_3) and emamectin benzoate 5 SG (I_1). In case of spraying scheduled lower number of adult emergence was recorded in spraying at maturity (S_2) as compared to others. The results of interaction effect were found significant and lowest adult emergence was recorded in treatment combination indoxacarb 14.5 SC spraying at maturity stage (I_4S_2) in green gram.

Minimum seed damage as well as eggs and maximum seed germination was recorded in pre- harvest spraying of indoxacarb 14.5 SC and it was at par with profenofos 50 EC. However, non-significant effect of spraying schedule alone and combination with pre-harvest spraying on seed damage and eggs laid by pulse beetle were found in green gram, whereas spraying of insecticides at maturity gave significantly higher seed germination as compared to other spraying schedule. Combination with pre-harvest spraying effect was non-significant.

As per the second year data on adult emergence in pre-harvest spraying of different insecticides, spraying schedules and interaction effect of pre-harvest spraying and spraying scheduled was showed no adult emergence up to two weeks of storage, whereas after three weeks adult emergence were recorded in control only. The results of pre-harvest spray and spraying schedules alone were recorded significant at 4, 5, 6, 7 and 8 weeks of storage while in interaction 4, 5, 6 and 7 week data showed significant but in last week of storage (8week) results was non-significant. Pooled over periods showed significantly lowest number of adult emergence (3.87) in treatment indoxacarb 14.5 SC (I_4) followed by profenofos 50 EC (I_3) and emamectin benzoate 5 SG (I_1). In case of spraying schedule lower number of adult emergence was recorded in spraying at maturity (S_2) as compared to others. The results of interaction effect were found significant and lowest adult emergence (1.57) was recorded in treatment combination indoxacarb 14.5 SC spraying at maturity stage (I_4S_2) in green gram.

Looking to the insecticides and spraying schedule alone, significantly lower number of egg laying, seed damage and higher percentage of seed germination was recorded in pre-harvest spraying of indoxacarb 14.5 SC followed by profenofos 50 EC at maturity stage as compared to other spraying schedules. Combination with pre-harvest spraying and schedules effect were found non-significant.

Pooled over years results showed significantly lowest number of adult emergence (4.25) were recorded in treatment indoxacarb 14.5 SC (I_4) followed by profenofos 50 EC (I_3) and emamectin benzoate 5 SG (I_1). In case of spraying scheduled lower number of adult emergence (10.46) was recorded in spraying at maturity (S_2) as compared to others. The results of interaction effect were found significant and lowest adult emergence (1.96) was recorded in treatment combination indoxacarb 14.5 SC spraying at maturity stage (I_4S_2) in green gram. In case of the treatments and spraying schedule alone, significantly lower number of egg laying, seed damage and higher percentage of seed germination were recorded in pre-harvest spraying of indoxacarb 14.5 SC (I_4) followed by profenofos 50 EC at maturity stage (S_2) as compared to other spraying schedules.

The interaction effect between insecticides and spraying schedules (I x S) did not show significant differences for most of the seed damage, eggs and germination parameters. However, significantly higher (89%) infested seeds and number of eggs/seed (7.9) were recorded in untreated control and its combination and minimum 19 per cent seed damage and 1.14 eggs/seed in treatment indoxacarb 14.5 SC (I_4) at maturity stage (S_2) I_4S_2. These findings are in agreement with pre-harvest spray of different insecticides malathion [8] and endosulfan [5] in green gram. The reduction of damaged seed percentage in the sprayed plots due to their insecticidal property was also supported by in mungbean [9] and in peas [7].

Table 1: Effect of pre-harvest sprays of insecticides on adult emergence of pulse beetle in green gram

Treatments		No. of pulse beetle emerged/ 500 g seeds #		
		2017	2018	Pooled
Insecticides (I)				
I_1	Emamectin benzoate 5 SG, 0.025 %	3.47*(11.54)	3.29(10.32)	3.38(10.92)
I_2	Chlorantraniliprole 18.5 SC, 0.006%	4.66(21.22)	4.35(18.42)	4.50(19.75)

I_3	Profenofos 50 EC, 0.1%	3.40(11.06)	3.14(9.36)	3.27(10.19)
I_4	Indoxacarb 14.5 SC, 0.012%	2.28(4.70)	2.09(3.87)	2.18(4.25)
I_5	Untreated control	4.90(23.51)	4.49(19.66)	4.70(21.59)
S. Em. ±		0.03	0.03	0.10
C. D. at 5%		0.11	0.07	0.41
Spraying Schedules (S)				
S_1	Spraying at initiation of pod maturity	3.96(15.18)	3.74(13.49)	3.85(14.32)
S_2	Spraying at maturity	3.46(11.47)	3.16(9.49)	3.31(10.46)
S_3	Spraying at initiation of pod maturity and maturity	3.80(13.94)	3.51(11.82)	3.66(12.89)
S. Em. ±		0.03	0.02	0.04
C. D. at 5%		0.08	0.06	0.26
Interaction (I x S)				
I1S1		3.72(13.34)	3.53(11.96)	3.63(12.68)
I1S2		3.19(9.68)	3.01(8.56)	3.10(9.11)
I1S3		3.50(11.75)	3.32(10.52)	3.41(11.13)
I2S1		4.82(22.73)	4.59(20.57)	4.70(21.59)
I2S2		4.42(19.04)	4.11(16.39)	4.27(17.73)
I2S3		4.74(21.46)	4.35(18.42)	4.54(20.11)
I3S1		3.63(12.68)	3.44(11.33)	3.73(13.41)
I3S2		3.15(9.42)	2.82(7.45)	2.99(8.44)
I3S3		3.42(11.19)	3.15(9.42)	3.29(10.32)
I4S1		2.72(6.90)	2.56(6.05)	2.64(6.47)
I4S2		1.71(2.42)	1.44(1.57)	1.57(1.96)
I4S3		2.41(5.31)	2.27(4.65)	2.34(4.98)
I5S1		4.93(23.80)	4.59(20.57)	4.76(22.16)
I5S2		4.82(22.73)	4.40(18.86)	4.61(20.75)
I5S3		4.95(24.00)	4.49(19.66)	4.72(21.78)
S.Em. ±	I x S	0.06	0.04	0.06
	P	0.03	0.02	0.26
	P x I	0.08	0.06	0.12
	P x S	0.07	0.04	0.04
	P x I x S	0.15	0.10	0.09
	Y x I x S	-	-	0.05
	Y x P x I x S	-	-	0.13
C. D. at 5%	I x S	0.08	0.06	0.20
	P	0.10	0.07	NS
	P x I	0.24	0.17	NS
	P x S	NS	NS	NS
	P x I x S	NS	NS	NS
	Y x I x S	-	-	0.16
	Y x P x I x S	-	-	0.40
CV %		7.01	5.15	6.36

Notes: *Figures in parenthesis are retransform values; those outside are $\sqrt{X + 0.5}$ transformed values
Up to two months of storage

Table 2: Effect of pre-harvest spray of insecticides on seed damage, germination and eggs of pulse beetle in green gram after 2 month of storage

Treatments		Seed damage (%)			Seed germination (%)			No. of eggs/seed		
		2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled
I_1	Emamectin benzoate 5 SG, 0.025%	42.08 (44.91)**	40.15 (41.58)	41.11(43.23)	76.22 (94.33)	73.33 (91.77)	74.77(93.10)	2.33 (4.93)*	2.29 (4.74)	2.31 (4.84)
I_2	Chlorantraniliprole 18.5 SC, 0.006%	50.99 (60.38)	49.35 (57.56)	50.17 (58.97)	69.66(87.92)	68.11 (86.10)	68.88 (87.02)	2.57 (6.10)	2.53 (5.90)	2.55 (6.0)
I_3	Profenofos 50 EC, 0.1%	33.41(30.32)	32.48 (28.84)	32.94 (29.57)	79.00 (96.36)	77.55 (95.35)	78.27(95.87)	1.59 (2.03)	1.56 (1.93)	1.58 (2.0)
I_4	Indoxacarb 14.8 SC, 0.012%	29.96 (29.94)	27.27 (20.99)	28.61 (22.93)	82.55(98.32)	83.00 (98.51)	82.77(98.42)	1.45 (1.60)	1.37 (1.38)	1.41 (1.49)
I_5	Untreated control	66.43 (84.01)	66.24 (83.77)	66.33 (83.88)	55.77 (68.36)	46.22 (52.13	51.00(60.40)	2.86 (7.68)	2.83 (7.51)	2.85 (7.62)
S. Em. ±		2.28	0.45	1.16	0.84	0.60	1.93	0.03	0.03	0.02
C. D. at 5%		6.62	1.29	3.30	2.42	1.76	7.56	0.10	0.08	0.06
S_1	Spraying at initiation of pod maturity	48.10 (55.40)	45.77 (51.34)	46.93(53.37)	70.93 (89.33)	67.13 (84.90)	69.03(87.19)	2.26 (4.61)	2.22 (4.43)	2.24 (4.52)
S_2	Spraying at maturity	42.28 (45.26)	40.20 (41.66)	41.24 (43.46)	74.73(93.06)	72.06 (90.51)	73.40(91.84)	2.05 (3.70)	1.99 (3.46)	2.02 (3.58)
S_3	Spraying at initiation of pod	43.34 (47.10)	43.32	43.33	72.26	69.73	71.00	2.17	2.14	2.16

maturity and maturity		(47.07)	(47.09)	(90.72)	(88.00)	(89.40)	(4.21)	(4.08)	(4.17)
S. Em. ±	1.77	0.35	0.90	0.65	0.47	0.40	0.02	0.02	0.01
C. D. at 5%	5.13	1.00	2.55	1.87	1.36	1.13	0.07	0.06	0.05
I1S1	45.55 (50.96)	43.64 (47.63)	44.59 (49.28)	74.33(92.70)	71.33 (89.75)	72.83 (91.29)	2.43 (5.40)	2.41 (5.31)	2.42 (5.36)
I1S2	39.17 (39.89)	36.45 (35.30)	37.81(37.58)	78.66 (96.13)	75.33 (93.59)	77.00 (94.94)	2.19 (4.30)	2.12 (3.99)	2.15 (4.12)
I1S3	41.52 (43.94)	40.37 (41.95)	40.94 (42.94)	75.66 (93.87)	73.33 (91.77)	74.50 (92.86)	2.38 (5.16)	2.34 (4.98)	2.36 (5.04)
I2S1	56.09 (68.88)	52.91(63.63)	54.50(66.28)	67.66(85.55)	65.66 (83.01)	66.66 (84.30)	2.66 (6.58)	2.61 (6.31)	2.63 (6.42)
I2S2	47.08 (53.63)	45.93 (51.62)	46.51(52.63)	72.33(90.79)	70.33 (88.67)	71.33(89.75)	2.48 (5.65)	2.45 (5.50)	2.46 (5.55)
I2S3	49.78 (58.30)	49.20 (57.30)	49.49(57.80)	69.00 (87.16)	68.33 (86.36)	68.66(86.76)	2.57 (6.10)	2.54 (5.95)	2.56 (6.05)
I3S1	33.59 (30.61)	34.23 (31.64)	33.91(31.12)	77.66(65.43)	75.00 (93.30)	76.33(94.41)	1.76 (2.60)	1.72 (2.46)	1.74 (2.53)
I3S2	31.86 (27.86)	30.64 (25.97)	31.25(26.91)	80.66(97.37)	80.33 (97.30)	80.50(97.28)	1.43 (1.54)	1.38 (1.40)	1.41 (1.49)
I3S3	34.77 (32.52)	32.48 (28.84)	33.67 (30.74)	78.66(96.13)	77.33 (97.18)	78.00(95.68)	1.60 (2.06)	1.58 (2.0)	1.59 (2.03)
I4S1	31.62 (27.49)	29.76 (24.64)	30.69(26.05)	81.00(97.55)	80.00 (96.98)	80.50 (97.28)	1.53 (1.84)	1.49 (1.72)	1.51 (1.78)
I4S2	28.14 (22.24)	24.33 (16.97)	26.24(19.55)	84.33(99.02)	85.66 (99.43)	85.00(99.24)	1.35 (1.32)	1.22 (0.99)	1.28 (1.14)
I4S3	30.12 (25.18)	27.71 (21.62)	28.91(23.37)	82.33 (98.22)	83.33 (98.65)	82.83(98.44)	1.46 (1.63)	1.40 (1.46)	1.43 (1.54)
I5S1	73.66 (92.08)	68.29 (86.32)	70.97 (89.37)	54.00(65.45)	43.66 (47.66)	48.83(56.66)	2.93 (8.08)	2.89 (7.85)	2.91 (7.97)
I5S2	65.17(82.37)	63.65 (80.30)	64.41(81.34)	57.66(71.38)	48.66 (56.37)	53.16(64.05)	2.59 (6.21)	2.77 (7.17)	2.78 (7.23)
I5S3	60.47(75.71)	66.76 (84.43)	63.62 (80.26)	55.66 (68.18)	46.33 (52.32)	51.00(60.40)	2.86 (7.68)	2.84 (7.57)	2.85 (7.62)
S. Em. ±	3.96	0.78	2.02	1.45	1.05	0.89	0.06	0.05	0.04
C. D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS
C. V. %	15.39	3.12	11.28	3.45	2.62	3.08	4.82	4.20	4.53

Notes: * Figures in parenthesis are retransform values; those outside are arc sine transformed values, **Figures in parenthesis are retransform values; those outside are $\sqrt{X + 0.5}$ transformed values

4. Conclusion

Among the different treatments, spraying of indoxacarb 14.5 SC 0.012 per cent at maturity stage were found more effective in checking cross infestation of pulse beetle in green gram and also recorded higher seed germination with lowest seed damage. In contrast to this, spraying of chlorantraniliprole 18.5 SC, 0.06 per cent at initiation of pod maturity was less effective in checking cross infestation.

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