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Management of leaf weevil, *Cyrtozemia dispar* Pascoe [Coleoptera: Curculionidae] infesting groundnut

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Abstract
Investigations on biology of groundnut leaf weevil, *Cyrtozemia dispar* Pascoe were carried out at Instructional farm, College of Agriculture, Junagadh Agricultural University, Junagadh during *Kharif*, 2018. For the management of leaf weevil, different combinations of soil application and foliar application of insecticides were evaluated. Among the different insecticide combinations, leaf weevil can be effectively managed by soil application of carbofuran 3G @ 1 kg a.i./ha at 30 DAS + foliar application of chlorpyriphos 20 EC @ 0.04% followed by carbofuran 3G @1 kg a.i./ha at 30 DAS + acephate 75 SP @ 0.075%. Carbofuran 3G @ 1 kg a.i./ha at 30 DAS + control and carbofuran 3G @ 1 kg a.i./ha at the time of sowing + control combinations performed less in giving satisfactory protection to groundnut crop against leaf weevil. The highest (2238.00 kg /ha) pod yield harvested in the plots treated with carbofuran 3G @ 1 kg a.i./ha at 30 DAS + chlorpyriphos 20 EC @ 0.04% followed by carbofuran 3G @ 1 kg a.i./ha at 30 DAS + acephate 75 SP @ 0.075% (2102.00 kg /ha).

Keywords: *Cyrtozemia dispar* Pascoe, foliar application, groundnut, leaf weevil, management, soil application

Introduction
Groundnut (*Arachis hypogea* Linnaeus) is a leguminous oilseed crop and In India, Gujarat is the largest producer of groundnut. Gujarat contributes about 33.12 per cent in area with 1.76 million hectares and about 41.71 per cent in production of 3.16 million tones (Anonymous, 2017).

The major factors which hamper the productivity of groundnut are insect pests and diseases. Besides the damage by defoliators and sucking pests, root and pod feeders, *Cyrtozemia dispar* Pascoe damage on foliage was recorded on rain-fed groundnut in Gujarat (Thirumalaisamy *et al.*, 2016).

A coleopteran insect, *C. dispar* was black to dark brown colored weevil with whitish stripes on both the lateral side of thorax as well as abdomen and having chewing and biting type of mouth parts. Adult feeds on young leaves of groundnut and cause notching on the margin of the leaflets and eating away of small patches of leaf lamina. As the immature grubs remain in the soil, they have strong mandibles and feed on the roots of the crop and also damage the flashy stem and rootlets of the plant. As adult of *C. dispar* is feeding on leaves and grubs found inside the soil, present investigation was help to determine the relationship between the soil applications along with foliar application of the chemical insecticide, which help in determining the effective combination for pest management.

Materials and Methods
In order to study the effect of different insecticides against leaf weevil, the experiment was laid out in a Randomized Block Design with factorial concept having three replications with the gross plot size of 5.0 m x 3.6 m and net plot size 4.8 m x 2.4 m during *Kharif*, 2018 at Instructional Farm, Junagadh Agricultural University, Junagadh. Groundnut variety GG-20 was sown at a spacing of 60 cm x 10 cm. All agronomical practices were adopted as per the recommendation in vogue. Details of insecticidal combinations are given in Table 1.

Table 1: Details of the insecticides used as soil and foliar application

	Technical name	Dose
S_1	Carbofuran 3G @ 1 kg a.i./ha at the time of sowing	33 kg /ha
S_2	Carbofuran 3G @ 1 kg a.i./ha at 30 DAS	
S_3	Control	-
F_1	Chlorpyriphos 20 EC @ 0.04%	20 ml/ 10 lit
F_2	Acephate 75 SP @ 0.075%	10 gm/10 lit
F_3	Control	-

As the immature stage of *C. dispar* is found in soil, the granular insecticide was applied for the control of this pest. Granular insecticide was mixed with the sand and broadcasted in furrow at the time of sowing and 30 DAS. According to the treatments, spraying of two different insecticides *viz.*, chlorpyriphos 20 EC @ 0.04% and acephate 75 SP @ 0.075% were carried out with the help of knapsack sprayer. The combination of soil application and foliar application *viz.*, S_1F_1, S_1F_2, S_1F_3, S_2F_1, S_2F_2, S_2F_3, S_3F_1, S_3F_2 and S_3F_3 were made in such manner that overall effect can be worked out. The necessary care was taken to prevent the drift of pesticides to reach the adjacent plots. As the population of *C. dispar* was starting after four week of sowing and the highest population was observed during first week of September, the first spray of insecticides was applied during first week of September.

To evaluate the efficacy of different insecticides, observations on number of adult of *C. dispar* were counted visually from five randomly selected and tagged plants. Observation of adult population was recorded before foliar application and also after 3, 5, 7 and 9 days of spray.

With a view to evaluate the effect of different insecticides on the groundnut yield, crop was harvested from each net plot. The harvested yield was weighted and converted on hectare basis. The per cent increase in yield over control was calculated by using following formula (Pradhan, 1969).

Results and Discussion

The effect of various insecticides has been determined based on individual as well as pooled over period data. The data on mean leaf weevil count after application of insecticides presented in Table 2 and depicted in Figure 1. Data revealed that among three different soil applications, S_2 (carbofuran 1 kg a.i./ha at 30 DAS) was found superior in comparison to other treatments and showed lowest leaf weevil count *i.e.*, 0.75, 0.98, 1.79 and 2.07 per plant on third, fifth, seventh and ninth day after spraying, respectively. among sprayed insecticides, F_1 (chlorpyriphos 0.04%) was found most effective by recording lowest leaf weevil count *i.e.*, 0.53, 0.83, 1.56 and 1.96 per plant on third, fifth, seventh and ninth day after spraying, respectively. The next best treatment was F_2 (acephate 0.075%) showed leaf weevil population *viz.*, 0.94, 1.25, 2.16 and 2.40 per plant on third, fifth, seventh and ninth day after spraying, respectively (Table 2 and Figure 2).

The data present in Table 2 and depicted in Figure 3 regarding interaction effect of soil and foliar application (S x F) revealed that the effect was found significant among nine different combinations. The order of effective combinations on bases of leaf weevil population per plant on groundnut on third day after spraying (DAS) was: S_2F_1 (0.20) < S_2F_2 (0.59) ≤ S_3F_1 (0.72) ≤ S_1F_1 (0.79) < S_1F_2 (1.12) ≤ S_3F_2 (1.18) < S_2F_3 (1.93) ≤ S_1F_3 (2.34) ≤ S_3F_3 (2.92).

On fifth DAS, the order of effective combinations on bases of leaf weevil population per plant on groundnut on given in bracket was: S_2F_1 (0.43) < S_2F_2 (0.68) < S_1F_1 (1.02) ≤ S_3F_1 (1.08) < S_1F_2 (1.58) ≤ S_3F_2 (1.63) < S_2F_3 (2.19) < S_1F_3 (2.65) ≤ S_3F_3 (3.06).

After seven days of spraying, the chronological order of effectiveness is remained more or less same as it was found during previous periods. The order of effective combinations on bases of leaf weevil population per plant on groundnut given in brackets was: S_2F_1 (1.04) < S_2F_2 (1.46) ≤ S_1F_1 (1.79) ≤ S_3F_1 (1.98) < S_1F_2 (2.53) ≤ S_3F_2 (2.59) ≤ S_2F_3 (3.20) ≤ S_1F_3 (3.27) ≤ S_3F_3 (3.61).

The order of effective combinations [9 DAS] based on leaf weevil population per plant on groundnut given in bracket was: S_2F_1 (1.32) ≤ S_2F_2 (1.64) < S_3F_1 (2.25) ≤ S_1F_1 (2.37) ≤ S_1F_2 (2.72) ≤ S_3F_2 (2.99) ≤ S_2F_3 (3.61) ≤ S_1F_3 (3.72) ≤ S_3F_3 (3.88).

The data on mean leaf weevil count of pooled over periods presented in Table 3 and Figure 3. The order of effective combinations of soil with foliar application based on leaf weevil count on per groundnut plant given in bracket was: S_2F_1 (0.67) < S_2F_2 (1.04) < S_1F_1 (1.42) ≤ S_3F_1 (1.44) < S_1F_2 (1.93) ≤ S_3F_2 (2.04) < S_2F_3 (2.68) < S_1F_3 (2.96) < S_3F_3 (3.35).

The lowest leaf weevil population [0.67 weevils /plant] over the periods was recorded in the combination of S_2F_1 (carbofuran 1 kg a.i./ha at 30 DAS + chlorpyriphos 0.04%) was found significantly superior to the rest of the combinations. The next best combination was S_2F_2 (carbofuran 1 kg a.i./ha at 30 DAS + acephate 0.075%). S_1F_1 (carbofuran 1 kg a.i./ha at the time of sowing + chlorpyriphos 0.04%) and S_3F_1 (Control + chlorpyriphos 0.04%) found moderate in their effectiveness which were at par with each other. Less effective combinations was S_1F_2 (carbofuran 1 kg a.i./ha at the time of sowing + acephate 0.075%) which was at par with S_3F_2 (control + acephate 0.075%). The next effective combination was S_2F_3 (carbofuran 1 kg a.i./ha at 30 DAS + control) followed by S_1F_3 (carbofuran 1 kg a.i./ha at the time of sowing + control).

The data on pod yield harvested from the different combinations are summarized in Table 4 and depicted in Figure 4 revealed that all insecticidal formulations recorded significantly higher pod yield than control. The chronological order of yield kg/ha given in bracket was: S_2F_1 (2238) ≥ S_2F_2 (2102) > S_1F_1 (1844) ≥ S_1F_2 (1692) > S_3F_1 (1478) ≥ S_3F_2 (1422) ≥ S_2F_3 (1382) ≥ S_1F_3 (1317) > S_3F_3 (1211).

The chronological order of effective combinations based on the per cent increase in yield over control given in bracket was: S_2F_1 (84.81) > S_2F_2 (73.58) > S_1F_1 (52.27) > S_1F_2 (39.72) > S_3F_1 (22.05) > S_3F_2 (17.42) > S_2F_3 (14.12) > S_1F_3 (8.75).

Table 2: Effectiveness of soil and foliar application of insecticides against leaf weevil after spray

Treatments		No. of weevils per plant				
		3 DAS	5 DAS	7 DAS	9 DAS	Pooled over periods
Soil application (S)						
S_1	Carbofuran 3 G @ 1 kg a.i./ha at the time of sowing	1.16*b* (1.34)	1.30*b* (1.69)	1.58*b* (2.49)	1.71*b* (2.92)	1.44*b* (2.07)
S_2	Carbofuran 3 G @ 1 kg a.i./ha at 30 DAS	0.87*a* (0.75)	0.99*a* (0.98)	1.34*a* (1.79)	1.44*a* (2.07)	1.16*a* (1.34)
S_3	Control	1.22*b* (1.48)	1.36*b* (1.85)	1.64*b* (2.68)	1.73*b* (2.99)	1.49*b* (2.22)
ANOVA						
S. Em. ±		0.03	0.02	0.03	0.03	0.03

C. D. at 5%		0.08	0.07	0.10	0.10	0.07
Foliar application (F)						
F_1	Chlorpyriphos 20 EC @ 0.04%	0.73*a* (0.53)	0.91*a* (0.83)	1.25*a* (1.56)	1.40*a* (1.96)	1.07*a* (1.14)
F_2	Acephate 75 SP @ 0.075%	0.97*b* (0.94)	1.12*b* (1.25)	1.47*b* (2.16)	1.55*b* (2.40)	1.28*b* (1.64)
F_3	Control	1.54*c* (2.37)	1.62*c* (2.62)	1.83*c* (3.35)	1.93*c* (3.72)	1.73*c* (2.99)
ANOVA						
S. Em. ±		0.03	0.02	0.03	0.03	0.03
C. D. at 5%		0.08	0.07	0.10	0.10	0.07
C. V. %		7.21	5.90	6.29	6.09	6.64

Notes:
1. Figures in parentheses ( ) are retransformed values; those outside are √ x transformed value.
2. Treatment mean with letter(s) in common are not significant at 5 % level of significance within a column.

Table 3: Interaction effect between soil and foliar application of insecticides against leaf weevil after spray

Treatments	**No. of weevils per plant**									
	3 DAS		**5 DAS**		**7 DAS**		**9 DAS**		**Pooled over periods**	
S_1F_1	0.89*b* (0.79)		1.01*c* (1.02)		1.34*bc* (1.79)		1.54*b* (2.37)		1.19*c* (1.42)	
S_1F_2	1.06*c* (1.12)		1.26*d* (1.58)		1.59*d* (2.53)		1.65*bc* (2.72)		1.39*d* (1.93)	
S_1F_3	1.*53de*(2.34)		1.63*f* (2.65)		1.81*e* (3.27)		1.93*e* (3.72)		1.72*f* (2.96)	
S_2F_1	0.45*a* (0.20)		0.66*a* (0.43)		1.02*a* (1.04)		1.15*a* (1.32)		0.82*a* (0.67)	
S_2F_2	0.77*b* (0.59)		0.83*b* (0.68)		1.21*b* (1.46)		1.28*a* (1.64)		1.02*b* (1.04)	
S_2F_3	1.39*d* (1.93)		1.48*e* (2.19)		1.79*e* (3.20)		1.90*de* (3.61)		1.64*e* (2.68)	
S_3F_1	0.85*b* (0.72)		1.04*c* (1.08)		1.41*c* (1.98)		1.50*b* (2.25)		1.20*c* (1.44)	
S_3F_2	1.09*c* (1.18)		1.28*d* (1.63)		1.61*d* (2.59)		1.73*cd* (2.99)		1.43*d* (2.04)	
S_3F_3	1.71*e* (2.92)		1.75*f* (3.06)		1.90*e* (3.61)		1.97*e* (3.88)		1.83*g* (3.35)	
Mean	1.08 (1.16)		1.22 (1.48)		1.52 (2.31)		1.63 (2.65)		1.31 (1.72)	
	S. Em. ±	C.D. at 5%	S. Em. ±	C. D. at 5%	S. Em. ±	C. D. at 5%	S. Em. ±	C. D. at 5%	S. Em. ±	C. D. at 5%
Soil application (S)	0.03	0.08	0.02	0.07	0.03	0.10	0.03	0.10	0.01	0.04
Foliar application (F)	0.03	0.08	0.02	0.07	0.03	0.10	0.03	0.10	0.03	0.12
Periods (P)	-	-	-	-	-	-	-	-	0.01	0.05
S X P	-	-	-	-	-	-	-	-	0.03	NS
F X P	-	-	-	-	-	-	-	-	0.03	0.08
S X F	0.05	0.14	0.04	0.12	0.06	0.17	0.06	0.17	0.03	0.07
S X F X P	-	-	-	-	-	-	-	-	0.05	NS
C. V. %	7.21		5.90		6.29		6.09		6.64	

Notes:
1. NS: Non significant and S: Significant. Figures in parentheses are retransformed values; those outside are √ x transformed value.
2. Soil application: carbofuran 1 kg a.i./ha at the time of sowing (S_1), carbofuran 1 kg a.i./ha at 30 DAS (S_2) & control (S_3). Foliar application: chlorpyriphos 0.04% (F_1), acephate 0.075% (F_2) & control (F_3).
3. Treatment mean with letter(s) in common are not significant at 5 % level of significance within a column.

Table 3: Impact of combination of soil and foliar application of insecticides on groundnut pod yield

Treatments	**Pod Yield (kg/ha)**	**Yield increase over control (kg /ha)**	**Per cent increase in yield over control**
S_1F_1	1844*b*	633	52.27
S_1F_2	1692*b*	481	39.72
S_1F_3	1317*c*	106	8.75
S_2F_1	2238*a*	1027	84.81
S_2F_2	2102*a*	891	73.58
S_2F_3	1382*c*	171	14.12
S_3F_1	1478*c*	267	22.05
S_3F_2	1422*c*	211	17.42
S_3F_3	1211*d*	-	-
Mean	1631.78	-	-
ANOVA			
S. Em. ±	70.20	-	-
C. D. at 5%	210.46	-	-
C. V. %	7.45	-	-

Notes:
1. Soil application: Carbofuran 1 kg a.i./ha at the time of sowing (S_1), Carbofuran 1 kg a.i./ha at 30 DAS (S_2) & Control (S_3). Foliar application: Chlorpyriphos 0.04% (F_1), Acephate 0.075% (F_2) & Control (F_3).

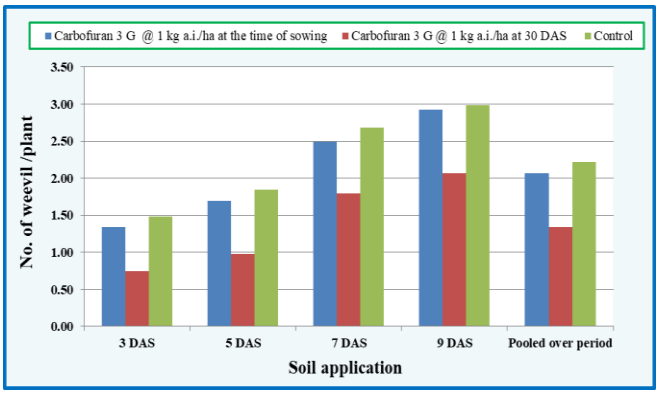

Fig 1: Effect of soil application of insecticides against leaf weevil infesting groundnut

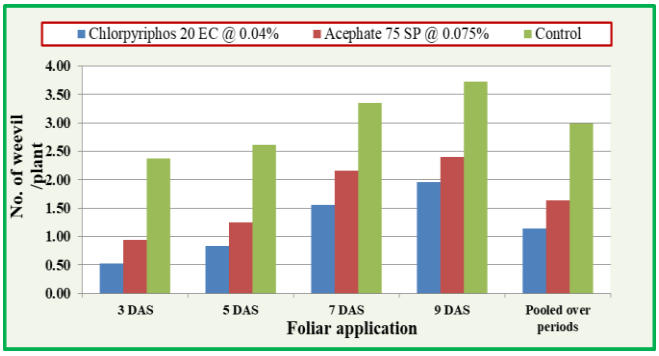

Fig 2: Effect of foliar application of insecticides against leaf weevil infesting groundnut

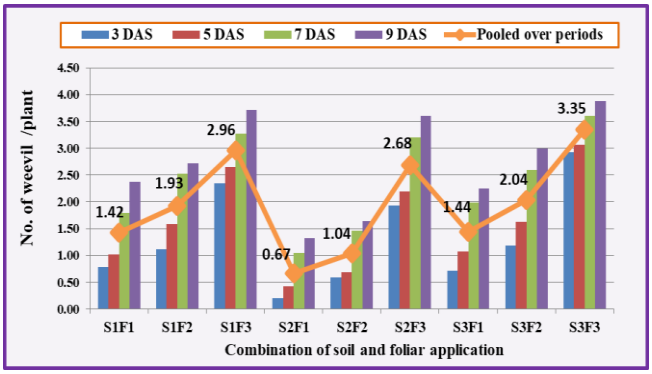

Fig 4: Interaction effect between soil and foliar application of insecticides against leaf weevil infesting groundnut

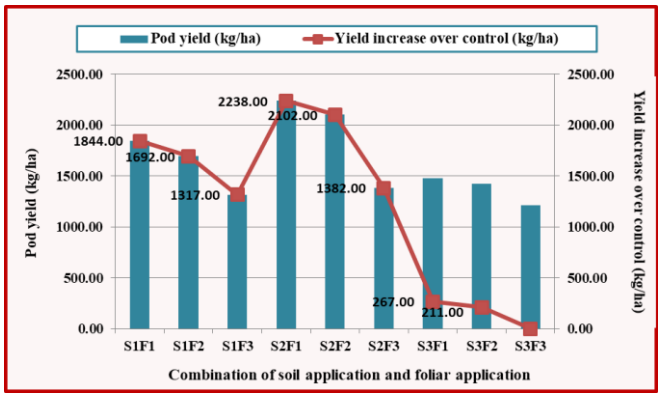

Fig 4: Effectiveness of different combinations on groundnut pod yield due to leaf weevil

Conclusion

Among the different insecticide combinations, leaf weevil can be effectively managed by soil application of carbofuran 3G @ 1 kg a.i./ha at 30 DAS + foliar application of chlorpyriphos 20 EC @ 0.04% followed by carbofuran 3G @1 kg a.i./ha at 30 DAS + acephate 75 SP @ 0.075%, carbofuran 3G @ 1 kg a.i./ha at the time of sowing + chlorpyriphos 20 EC @ 0.04% and control + chlorpyriphos 20 EC @ 0.04%. While, carbofuran 3G @ 1 kg a.i./ha at the time of sowing + acephate 75 SP @ 0.075% and control + acephate 75 SP @ 0.075% were moderately effective. Carbofuran 3G @ 1 kg a.i./ha at 30 DAS + control and carbofuran 3G @ 1 kg a.i./ha at the time of sowing + control combinations performed less in giving satisfactory protection to groundnut crop against leaf weevil.

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