Assessing the Efficacy and Economics of Selected Insecticides against Pod Borer [*Helicoverpa armigera* (Hubner)] on Cowpea [*Vigna ungiculata* (L.) Walp]

ABSTRACT

The present field investigation was carried out in the Prayagraj district of Uttar Pradesh. The experiment was conducted in Kharif season 2023-2024 at Central Research Farm (CRF), SHUATS, Naini, Prayagraj district. The field layout chosen was RBD with seven treatments and controlled plot. To check the "Efficacy and economics of selected insecticides against pod borer, *Helicoverpa armigera* (Hubner) on cowpea *Vigna ungiculata* (L.) Walp". The result of the efficacy of the treatments after first spray showed that the Chlorantraniliprole (1.66) found out to be most effective. Followed by Spinosad (1.95) and Indoxacarb (2.22). Treatments Imidacloprid (2.33) and Fipronil (2.44) was found to be average. Bacillus thuringiensis (2.55) and Azadiractin (Neem Oil) (2.64) found to be less effective in managing the larval population of *Helicoverpa armigera*. According to the second spray of showed that Chlorantraniliprole (1.02) was found to be the most effective. Followed by Spinosad (1.42) and Indoxacarb (1.64). Treatments Imidacloprid (1.95) and Fipronil (2.1) was found to be average. *Bacillus thringiensis* (2.31) and Azadiractin (Neem oil) (2.44) found out to be less effective in managing the larval population of Helicoverpa armigera but comparatively superior over control. In another parameter higher yield was recorded in Chlorantraniliprole (24.08 q/ha) followed by Spinosad (22.50 q/ha), Indoxacarb (17.20 q/ha), Bacillus thuringiensis (13.70 q/ha) and Azadiractin (Neem oil) (12.60 q/ha) as compared to control (10.50 q/ha). The highest cost benefit ratio was obtained in treatment of Chlorantraniliprole (1:3.51), followed by Spinosad (1:2.85), respectively.

Keywords: Cost benefit ratio; Efficacy; Helicoverpa armigera; treatments.

1. INTRODUCTION

Cowpea (*Vigna unguiculata* (L).Walp.*)* (2n= 2x = 22) is a member ofthe Phaseoleae tribe ofthe leguminosae family. Members of the Phaseoleae include many of the economically important warm season and legumes, such as soybean (*Glycine max),* common bean (*Phaseolus vulgaris),* andmungbean(*Vignaradiata)*.Thenamecowpeaprobablyoriginatedfromthefactthattheplant wasanimportant sourceofhayforcowsinthesoutheasternUnitedStatesand inotherpartsofthe world. Some of the important local names for cowpea around the world include liebe," "wake" and "Ewa" in much ofWest Africa and "coup" in Brazil. In the United States, other names used to describe cowpea include "southern peas," "blackeyed peas," field peas" "pinkeyes" and crowders.Thesenameseffecttraditionalseedand market classesthat developedovertime inthe southern United States. (Fang *et al.*2007).

The grain contains 26.61 percent protein, 3.99 percent lipid, 56.24 percent carbohydrates, 8.60

percent moisture,3.84percentash,1.38percent crudefibre,1.51percent grossenergy,and54.85 percent nitrogen free extract. Rough estimates indicate that annualglobalproduction is around 2 mt from an area of 5m.ha. India accounts for about 0.5 mt production from around 1.5 m.ha. In India, the major area under grain cowpea is mainly confined to the states of Uttar Pradesh, Karnataka,TamilNadu,AndhraPradeshandKeralawhere,itismainlysownasamixedcropwith other pulses and cereals (Phani and Kumar 2023)

*Helicoverpa armigera*is a cosmopolitian and widely distributed insect pest in the world. It is a serious pest of all legumes.*Helicoverpa armigera* is found in Palearctic oriental Ethiopian and Australian Provinces, south of a line at approximately 52ºN. This range occupied by the species including tropical, dry, and temperate climates. The currently reported global distribution of *Helicoverpaarmigera*suggeststhatthepestmaybemostcloselyassociatedwithdesertsandxeric shrublands;Mediterraneanscrub;temperatebroadleafandmixedforests;tropicalandsub-tropical grasslands,savannasandshrublands;andtropicalandsub-tropicalbroadleafforest.(Wubneh*et al.,* 2016).

2. MATERIALSAND METHODS

The experiment was conducted at experiment field of Department of Entomology , Central Research Farm , Sam HigginbottomUniversityof Agriculture Technology And Sciences, during the*rabi*seasonof2023-2024.Researchfield issituatedatPrayagrajatanelevationof78meters above sea level at 25.87 North latitude and 81.15ºE longitudes. This region has a sub-tropical climate prevailing in the South-East part of U.P. with both the extremes in the temperature, i.e., the winter and the summer. In cold winters, the temperature sometimes is low as 32ºF in December-Januaryand very hot summer with temperature reaching upto 115ºF in the months of May and June. The experimental design used was Randomized Block Design with 7 treatments andonecontrolPlotwiththreereplication.Withplotsizeof2m□1m.Thetreatmentstakenwere-Chlorantraniliprole18.5SC,Indoxacarb14.5SC,Azadiractin(Neemoil)5%,Imidacloprid17.8 SL, Spinosad 45 SC, Fiproniland *Bacillus thuringiensis* 4%WSP and Control.

TheLarvawerecalculatedon5randomlyselectedplantsineachplot.The larvawasoncecounted 1daybeforespray,andthenafterspraythedatawasrecordedon3^{rd},7^{th},14^{th}daysaftereachspray. The larval population of pod borer was determined after 3 mean observation of first and second spray recorded at 3^{rd},7^{th}, 14^{th} days after spray.

3. RESULTSAND DISCCUSION

3.1 EfficacyofDifferentInsecticidesandSomeBio-PesticidesonPodBorerafterFirstSpray

3.1.1 Third Days after First Spray

The data on larval population of gram pod borer on 3^{rd} day after 1^{st} spray revealed that all the treatmentsweresignificantlySuperiorovercontrol.Theminimumlarvalpopulationwasrecorded in Chlorantraniliprole(1.86) and it is followed by Spinosad (2.13). Both these treatments were significant to each other and superior over other treatments. The next treatments *viz.* Indoxacarb (2.33), Imidacloprid(2.53), Fipronil(2.6), *Bacillusthuringiensis*(2.73) andAzadiractin(Neem oil) (2.8)recorded larval populationrespectively. The treatment *Bacillus thuringiensis* (2.73) and Azadiractin(Neem oil)(2.8) recorded maximum among all treatments.

3.2 SevenDaysafterFirstSpray

The data on larval populationof gram pod borer on 7^{th} day after 1^{st} spray revealed that all the treatmentsweresignificantlysuperiorovercontrol.Theminimumlarvalpopulationwasrecorded in Chlorantraniliprole (1.46) and if followed by Spinosad (1.8), Indoxacarb (2.13), Imidacloprid (2.2),Fipronil(2.33), *Bacillusthuringiensis*(2.4),Azadiractin(Neemoil)(2.53)recordedlarval population respectively. The treaments*Bacillus thuringiensis* (2.4) and Azadiractin (Neem oil) (2.53) shows maximum larval population among all the treatments.

3.3 FourteenDaysafterFirstSpray

The data on larval population of gram pod borer on 14^{th} day after 1^{st} spray revealed that all the treatments are significantly superior over control. The minimum populationwas recorded in Chlorantraniliporle (1.66) and it is followed by Spinosad (1.93). Both the treatments were significant to each other and superior over other treatments. The next treatment *viz.* Indoxacarb (2.2), Imidacloprid (2.26), Fipronil (2.4), *Bacillus thuringiensis* (2.53) and Neem oil(2.6) recorded larval population respectively treatment *Bacillus thuringiensis* (2.53) and Azadiractin (Neem oil) (2.6) shows maximum larval population among all the treatments.

3.4 OverallMeanofFirst Spray

Thedataofoverallmeananalysisonlarvalpopulationindicatedthatalltheinsecticidaltreatments were significantly effective in reducing the larval population of gram pod borer (*Helicoverpa armigera*)as compared to control plots. The minimum larval population was recorded in Chlorantraniliprole (1.66) and it was followed by Spinosad (1.95). Both these treatments were significant to each other and superior over other treatments. The next treatments *viz.* Indoxacarb (2.22), Imidacloprid (2.33), Fipronil (2.44), *Bacillus thuringiensis* (2.55) and Azadiractin (2.64) recorded larval population respectively. The treatments *Bacillus thuringiensis* (2.55) and Azadiractin (2.64) shows maximum larval population among all other treatments.

3.5 ThirdDaysafterSecond Spray

The data on larval population of gram pod borer on 3^{rd} day after 2^{nd} spray revealed that all the treatmentsweresignificantlysuperiorovercontrol.Theminimumlarvalpopulationwasrecorded in Chlorantraniliprole (1.26)and it was followed by Spinosad (1.6) . Both these treatments were significant to each other and Superior over other treatments.The next treatments *viz.* Indoxacarb (1.8),Imidacloprid(2.13),Fipronil(2.46),*Bacillusthuringiensis*(2.6)andAzadiractin(Neemoil)(2.66)recorde drespectively.Thetreatments *Bacillusthuringiensis*(2.6)andAzadiractin(Neem oil) (2.66) shows maximum larval population among all other treatments.

Table 1. Comparative efficacy of different insecticides against laraval populationofpodborer,*Helicoverpaarmigera*(Hubner)onCowpea(1^{st}Spray)

Treatments		LarvalPopulation/5Plants				
		1DBS	**3DAS**	**7DAS**	**14DAS**	**Mean**
T1	Chlorantraniliprole18.5%SC	2.66	1.86	1.46	1.66	1.66
T2	Indoxacarb14.5SC	2.8	2.33	2.13	2.2	2.22
T3	Azadiractin5%(Neemoil)	3.06	2.8	2.53	2.6	2.64
T4	Imidacloprid17.8%SL	2.86	2.53	2.2	2.26	2.33
T5	Spinosad45%SC	2.73	2.13	1.8	1.93	1.95
T6	Fipronil5%SC	2.93	2.6	2.33	2.4	2.44
T7	*Bacillusthuringiensis*4%WP	3	2.73	2.4	2.53	2.55
T_0	Untreated	3.13	3.33	3.26	3.53	3.37
F-test		NS	S	S	S	S
S.Ed.(±)			0.13	0.13	0.12	0.06
C. D.(P= 0.05)			0.29	0.38	0.25	0.14

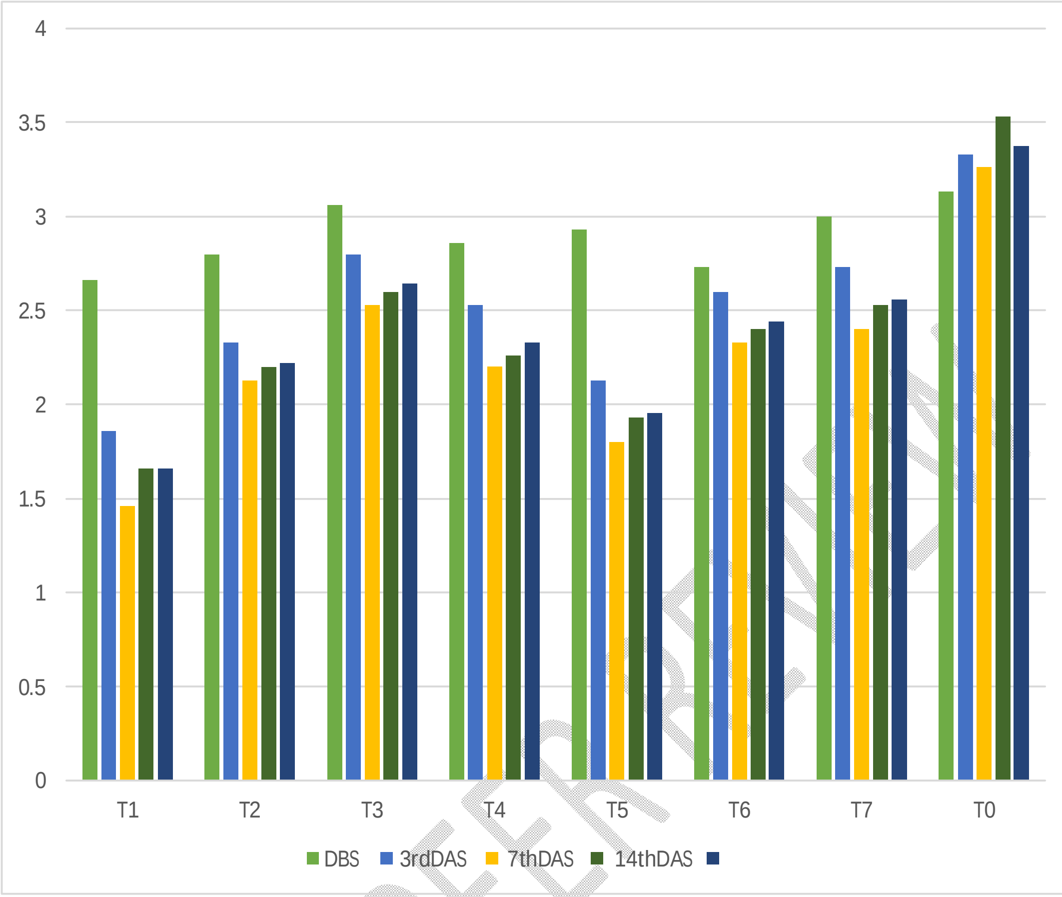

Fig. 1. Graphical representation of comparative efficacy of different insecticidesagainstpodborer, *Helicoverpaarmigera*(Hubner)onCowpea(1st Spray) (larval population)

3.6 SevenDaysafterSecond Spray

The data on larval population of gram pod borer on 7th day after 2nd spray revealed that all the treatmentsweresignificantlysuperiorovercontrol.The minimumlarvalpopulationwasrecorded in Chlorantraniliprole (0.8) and it was followed by Spinosad (1.13). Both the treatments were found significant to each oher and superior over other treatments . the next treatments *viz.* Indoxacarb (1.26), Imidacloprid (1.66) , Fipronil(1.73), *Bacillus thuringiensis* (1.93) and Azadiractin(Neemoil) (2.13)recordedlarvalpopulationrespectively. The treatments *Bacillus thuringiensis*(1.93)andAzadiractin(Neemoil) (2.13)showsmaximumlarvalpopulationamong all treatments.

3.7 FourteenDaysafterSecondSpray

The data on larval population of gram pod borer on 14th day after 2nd spray revealed that all the treatment weresignificantlysuperiorovercontrol.TheMinimumlarvalpopulationwasrecorded in Chlorantraniliprole (1) and it was followed by Spinosad (1.53). Both these treatments were significant to eachother and superiroroverothertreatments. The next treatments *viz.* Indoxacarb (1.86), Imidacloprid (2.06), Fipronil (2.13), *Bacillus thuringiensis* (2.4) and Neem oil (2.53) reductionwasrecorded.Thetreatments*Bacillusthuringiensis*(2.4)andNeemoil(2.53)showsthe maximum larval population among all other treatments.

3.8 OverallMean afterSecondSpray

Thedataofoverallmeanindicatedthat allthe insecticidaltreatmentsweresignificantlyeffective in managing the larval population of gram pod borer (*Helicoverpa armigera*) as compared to control plots. The minimum larval population was recorded in Chlorantraniliprole (1.02) and it was followed by Spinosad (1.42). Both the treatments are significant to each other and superior over other treatments. The next treatments *viz.*Application of Indoxacarb (1.64), Imidacloprid (1.95), Fipronil (2.10),*Bacillus thuringiensis* (2.31) and Azadiractin (Neem oil) (2.44) recorded maximum larval population respectively. The treatments *Bacillus thuringiensis* (2.31) and Azadiractin (Neem Oil) (2.44) shows least effectiveness among all other treatments

Table 2. Comparative efficacy of different insecticides against larval populationofpodborer,*Helicoverpaarmigera*(Hubner)onCowpea(2ndspray)

Treatments		LarvaPopulation /5 Plants			
		3DAS	**7DAS**	**14DAS**	**Mean**
T1	Chlorantraniliprole18.5%SC	1.26	0.8	1	1.02
T2	Indoxacarb14.5SC	1.8	1.26	1.86	1.64
T3	Azadiractin5%(Neemoil)	2.66	2.13	2.53	2.44
T4	Imidacloprid17.8%SL	2.13	1.66	2.06	1.95
T5	Spinosad45%SC	1.6	1.13	1.53	1.42
T6	Fipronil5%SC	2.46	1.73	2.13	2.10
T7	*Bacillusthuringiensis*4%WP	2.6	1.93	2.4	2.31
T0	Untreated	3.66	4.13	4.4	4.06
F-test		S	S	S	S
S.Ed.(±)		0.11	0.14	0.14	0.17
C. D.(P= 0.05)		0.23	0.29	0.29	0.37

Table 3.Comparativeefficacyofdifferentinsecticidesagainstgram podborer, *Helicoverpa armigera* (Hubner) on Cowpea (*Vigna ungiculata)* Overall larval population)

Treatments		LarvalPopulation/5 Plants		
		1stSpray	2ndSpray	Mean
T1	Chlorantraniliprole18.5%SC	1.66	1.02	1.34
T2	Indoxacarb14.5SC	2.22	1.64	1.93
T3	Azadiractin5%(Neemoil)	2.64	2.44	2.54
T4	Imidacloprid17.8%SL	2.33	1.95	2.14
T5	Spinosad45%SC	1.94	1.42	1.68
T6	Fipronil5%SC	2.44	2.10	2.27
T7	*Bacillusthuringiensis*4%WP	2.55	2.31	2.43
T0	Control	3.53	4.06	3.71
F-test		S	S	S

3.9 OverallMean afterFirst and Second Spray

Theoverallmeandataonthelarvalpopulationofpodborerafterbothspraysrevealedthat allthe treatments are found significantly superior over control. Among all the treatments the minimum larvalpopulationwasrecordedinChlorantraniliprole(1.34)andit isfollowedbySpinosad(1.68). Both the treatments are significant to each other and superior over other treatments. The next treatments *viz.* Indoxacarb (1.93), Imidacloprid (2.141), Fipronil (2.27), *Bacillus thuringiensis* (2.43) and Azadiractin (Neem oil) (2.54) recorded maximum population (). The treatments *Bacillus thuringiensis* (2.43)and Azadiractin(Neemoil) (2.54)shows least effectiveness among all other treatments.

4. DISCUSSION

Inthe experiment seventreatmentsweretaken*viz.* Chlorantraniliprole 18.5SC,Indoxacarb14.5 SC, Azadiractin(Neemoil) 5%, Imidacloprid 17.8 SL, Spinosad 45 SC, Fiproniland Bacillus thuringiensis 4%WSPand a control plot, to check the comparative efficacy of different insecticides and bio pesticides against pod borer Helicoverpaarmigra larval population and the yield of Cowpea.

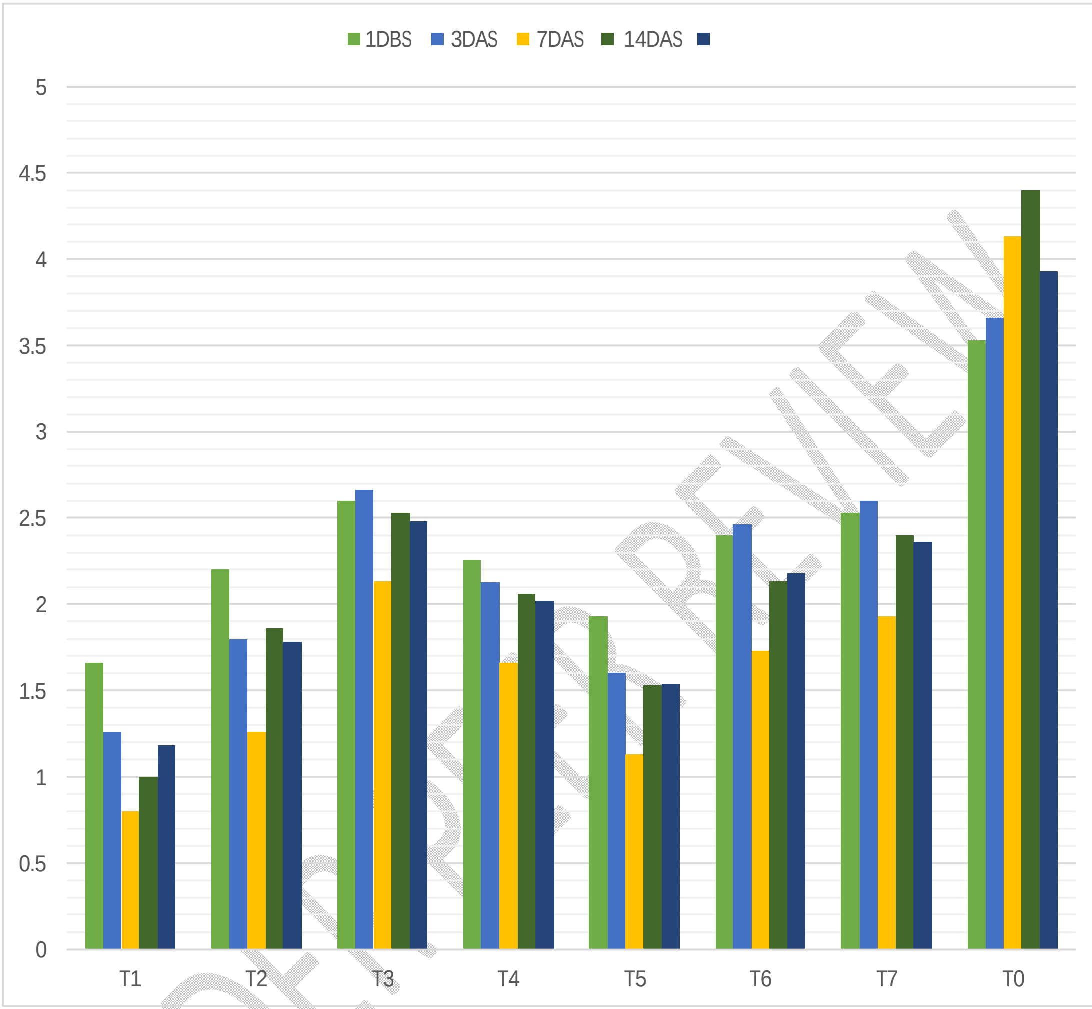

Fig.2.Graphicalrepresentationof(2nd spray)(Larvalpopulation)

Table4.Economicsofcultivation

T.No	Treatment	Yieldof q/ha	Cost ofyield ₹`/h	Totalcost of yield (₹`)	Common cost (₹)	Treat ment cost (₹)	Total cost (₹)	C:B ratio
T1	Chlorantraniliprole 18.5SC	24.08	6000	1,44,480	32,810	8280	41,090	1:3.51
T2	Indoxacarb14.5SC	17.20	6000	1,03,200	32,810	4400	37,210	1:2.77
T3	Azadiractin5%	12.60	6000	75,600	32,810	2900	35,710	1:2.11
T4	Imdiacloprid 17.8%SL	17.10	6000	98,400	32,810	3200	36,010	1:2.73
T5	Spinosad45 %SC	22.50	6000	1,23,000	32,810	14400	47,210	1:2.85
T6	Fipronil5%SC	14.50	6000	87,000	32,810	3200	36,010	1:2.41
T7	*Bacillusthrungiensis 4%* WSP	13.70	6000	82,200	32,810	3200	36,010	1:2.28
T0	Control	10.50	6000	63000	32,810	------	32,810	1:1.92

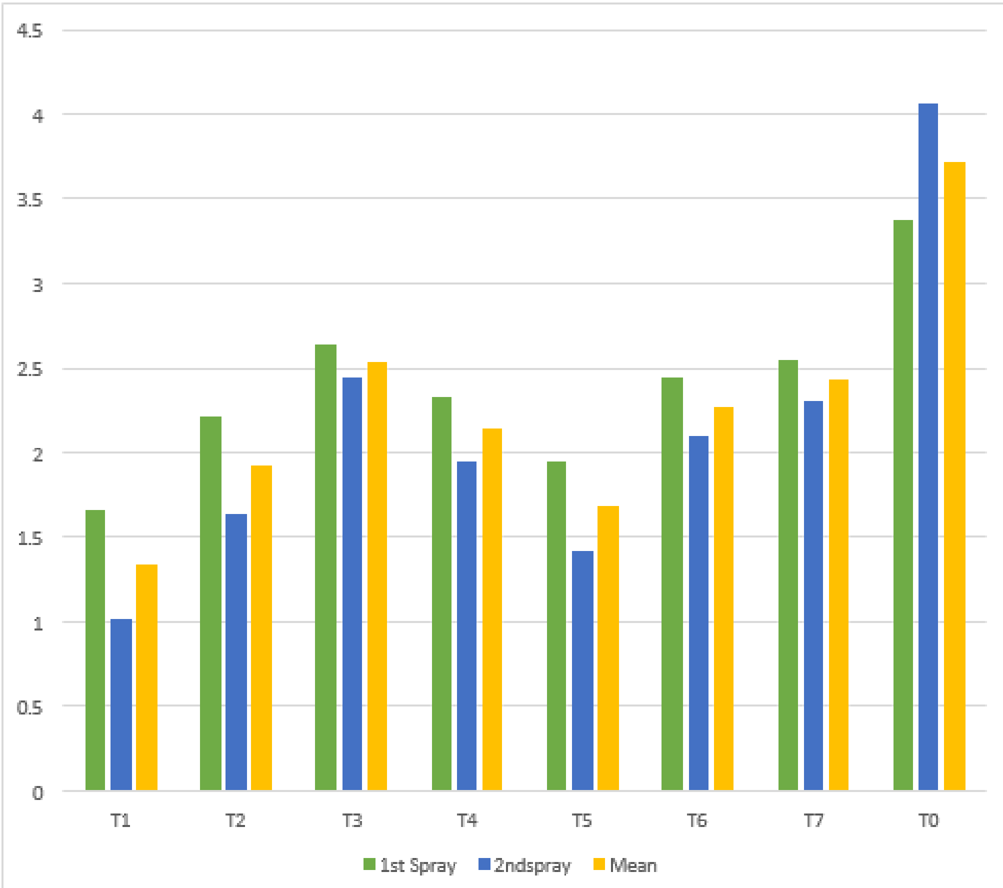

Fig.3.Graphicalrepresentationof(Overalllarvalpopulation)

The ove all mean data onthe larvalpopulation ofpod borer after both sprays revealed that allthe treatments are found significantlysuperior over control. Among allthe treatments the minimum larval population was recorded in Chlorantraniliprole (1.34) and it is followed by Spinosad (1.68). Both the treatments are significant to each other and superior over other treatments. The next treatments viz. Indoxacarb (1.93), Imidacloprid (2.141), Fipronil (2.27), Bacillusthuringiensis(2.43)andAzadiractin(Neemoil)(2.54)recordedmaximumpopulation(). The treatments Bacillus thuringiensis (2.43) and Azadiractin (Neem oil) (2.54) shows least effectiveness among all other treatments.

The data after over all mean analysis of 3rd, 7th and 14th days after 1st insecticidal application indicated that all the insecticidal treatments were significantly effective in managing the larval population of Helicoverpa armigeraas compared to untreated plots. Chlorantraniliprole (1.66) was found significantly superior these findings are supported by Sharma and Tayde (2022) followed bySpinosad (1.95) similar findings also reported in Cowpea by Naraynaet al.,(2015). Thenext besttreatment formanagingthelarvalpopulationwasIndoxacarb (2.22)whichwasalso supported by Naraynaet al.,(2015). The treatment Imidacloprid (2.33) found to be effective controllinggrampodborersimilar findingswerereportedby Farooqetal.,(2023).Thetreatment Fipronil (2.44) was also effective in controlling the larval population as supported by Satish et al.,(2018) . Bacillus thuringiensis(2.55)is the next best treatment in managingthe larval populationofpodborerwhichisreportedbySatish etal.,(2018)followedbyAzadiractin(Neem oil) (2.64) whichis lesseffectiveagainst grampodborer similar resultsarerecordedby Sharma and Tayde(2022).

Coming to 2nd spray overall mean analysis of 3rd ,7th and 14th days after insecticidal application indicatedthatalltheinsecticidaltreatmentsweresignificantlyeffectiveinmanagingthelarval populationofHelicoverpaarmigeraascomparedtocontrolplots. Chlorantraniliprole(1.02)was foundsignificantlysuperiorthesefindingsaresupportedbySharmaandTayde(2022)Followed by Spinosad(1.42) similar findings are also reported in cowpea by Narayna et al., (2015) Indoxacarb(1.64)isthenextbesttreatmentformanagingthepopulationofgrampodborersimilar findingswerefound intheNaraynaetal.,(2015).ThetreatmentImidacloprid(1.95)foundtobe effectiveincontrollingthepodborerwhichisalsoreportedbyFarooqetal.,(2023),thenextbest treatment Fipronil (2.10) which is in line findings of Satish et al.,(2018) Bacillus thuringiensis (2.31)isthenexteffectivetreatmentsupportedbySatishetal.,(2018)followedbyNeemoil(2.44) in controlling gram pod borersimilar results are recorded by Sharma and Tayde (2020).

Whenthecostbenefit ratio wasworkedoutthehighest andcost benefit ratio wasrecorded inChlorantraniliprole(24.08q/ha)and(1:3.51)asrespectively.Thisresult issupportedbyBarwa and Kumar (2022) ,followed by Spinosad (22.50 q/ha) and (1:2.85)this result is supported by Barwa and Kumar (2022); followed by Indoxacarb (17.20) and (1:2.77) this findings is supported byLavanya and Kumar (2022), Followed by Imidacloprid (17.10) and (1:2.73) this result is supported by,followed by Fipronil (14.50) and (1:2.41) supported by Narayna et al.,(2015), followed by Bacillus thuringiensis (13.70) and (1:2.28) this result is supported by Mohenty and Tayde (2022) , Followed by Neem oil (12.60) and (1:2.11) similar findings are supported by Yerrabala et al., (2021).

5. CONCLUSION

From the analysis of the present findings it is evaluated that among all the treatments ChlorantraniliprolewasfoundtobemosteffectiveagainstGrampodborerfollowedbySpinosad. Indoxacarb resulted higher yield. While Imidacloprid , Fipronil ranked middle in order of their efficacy, then *Bacillus thuringiensis* and Neem oil found to be least effective in managing *Helicovepraarmigera*and it can be a part of Integrated pest management in order to avoid indiscriminate use of pesticide causing pollution in the environment and not much harmful to beneficial insects.
Among thetreatments studied T_1- Chlorantraniliprole gave the highest cost benefit ratio (1:3.51) and marketing yield (24.08q/ha) followed by T_5 Spinosad which gave the cost benefit ratio of (1:2.85) and marketing yield of (22.50 q/ha).

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