"Comparative study of chemicals with botanicals against spotted stem borer, *Chilopartellus*(Swinhoe) on Maize (*Zea mays* L.)"

ABSTRACT: *Chilo partellus*is regarded as one of the most significant and prevalent insect pests of maize and ~~the~~ itsmystic aspect of feeding makes itscontrol a challenging ~~to control~~task.~~hance~~ The current study ~~was conducted~~aims to evaluate ~~comparative study of~~ chemicals ~~with~~ andbotanicals against ~~*Chilo*~~ *C.partellus*. Eight treatments ~~were tested under field conditions~~ namely a~~A~~zadirachtin 10,000ppm, n~~N~~eem oil 3%, k~~K~~aranj oil 3%, n~~N~~eem oil 3% + i~~I~~midacloprid 17.5%SL, k~~K~~aranj oil 3% + i~~I~~midacloprid 17.5%SL,i~~I~~midacloprid 17.5%SL, s~~S~~pinosad 45%SC and untreated control ~~in~~ underrandomized block design with three replicationseach were tested in field condition. Among ~~all~~ the eight treatments, the lowest larval population of *C.~~hilo~~partellus*~~were~~ wasrecorded in k~~K~~aranj oil 3% + i~~I~~midacloprid 17.5%SL (1.99) followed by Karanj oil 3% + Imidacloprid 17.5%SL (2.42),i~~I~~midacloprid 17.5%SL (2.71), s~~S~~pinosad 45%SC (3.17), n~~N~~eem oil 3% (3.73), k~~K~~aranj oil 3% (3.95) and a~~A~~zadirachtin 10,000ppm (4.44) were superior over the ~~T~~$_0$ untreated control ~~which recorded~~ (7.24). The highest yield was recorded in k~~K~~aranj oil 3% + i~~I~~midacloprid 17.5%SL with 39.20 q/hectare and most economic treatment wasi~~I~~midacloprid 17.5%SL with highest cost benefit ratio ~~(~~1:2.2~~)~~.

Keywords: *Chilo partellus*, Maize stem borer, Maize, Management, Control, Insecticides, Biopesticides, Efficacy

1. INTRODUCTION: Maize (*Zea mays* L.) is the world's leading crop and is widely cultivated as cereal grain that was domesticated in Central America~~. It is one of the most versatile emerging crops having wider adaptability.~~ Globally, maize is known as queen of cereals because of its highest genetic yield potential(Directorate of Maize Research, ICAR).~~It is a crop that~~that the crop is used ~~to produce a~~for variety of purposes including foods and fodder using diverse plant parts, such as grain, leaves, stalks, tassels, and cobs(Singh *et al*., 2006).It is an important source of vitamins, minerals, lipids, protein, starch, and fiberand~~. It is~~ also highly nutritious for ~~use in~~ cattle and poultry ~~feed~~(Prasanna *et al*., 2001, Farnham *et al*., 2003).In terms of nutrition, maize grains include 4% oil, 70% carbohydrates, 2-3% crude fiber, and 10% protein in addition to vitamins A and E, riboflavin, and nicotinic acid. ~~Zein is~~

Comment [st1]: See if the family and order can be written

Comment [st2]: Mention order and family

Comment [st3]: What is it? Larvae per plant?

Comment [st4]: This is same as the previous treatment. Check for the correctness of the data

Comment [st5]: Don't capitalize unless it is a trade name. applies to whole document

Comment [st6]: Try to write the highest and the lowest values for yield and C:B ratio

Comment [st7]: According to title, the conclusion about botanical and chemicals in comparison must be drawn

Comment [st8]: Rephrase

Comment [st9]: Write the date of retrieval if actual date is not known

Comment [st10]: Either keep this sentence or the previous one

~~low in calcium and lacking in the necessary acids tryptophan and lysine~~(Joshi, 2015). Maize contributes over 20 per cent of food calories of Asian population~~InAsia, maize consumed as human food contributes over 20% of food calories~~(Shiferaw *et al.*, 2011).The global consumption pattern of maize is~~.:~~ feed-61%, food-17% and industry- 22%. It has attained a position of industrial crop globally as 83% of its production in the world is used in feed, starch and bio-fuel industries. Further, using maize directly or indirectly more than 3000 products are being made providing a wide opportunity for value addition. Because of its myriad uses, it is a prime driver of the global agricultural economy.With a yield of 1423 million ~~M~~T, it is grown on 188 million hactare of land in 170 countries across the globe. ~~Worldwide~~ China has maximum area under maize followed by the USA, both together representing 39% of world maize area. Since 2005, India ranks 4th in terms of area with 9.89 million he~~a~~ctare land under maize. (Indian Institute of Maize Research, ICAR 2024).Production of Maize in the country during 2023-24 is estimated at record 224.82 lakh tones.(PJTSAU, 2024).

The insect pest complex that affects maize in India is an area that has not received extensive study. Notable insect pests of the crop are *Helicoverpa armigera* (Hubner) and *Mythimna separata* (Walker). *Spodoptera frugiperda, Atherigonasoccata* (Rondani), *Rhopalosiphummaidis* (Fitch), and*Chilo partellus* (Swinhoe)(Chouraddi*et al*.,2017).Scientists have undertaken numerous investigations and come to the conclusion that the maize stem borer, *C. partellus*is a significant pest of pearl millet (*Pennisetum typhoideum* (Rich), sorghum (*Sorghum bicolor* L.), and maize (*Zea maize* L.) across Asia and Africa~~.~~(Panwar,2005). ~~Similarly,~~ It was also noticed infesting Rice (*Oryza sativa*), Sugarcane (*Saccharum officinarum*) and several millets and~~,~~ ~~—~~grasses~~.~~(Kauma *et al*., 2008).*Chilo partellus*, a member of the Pyralidae family of insects, is a notable biotic barrier to maize cultivation worldwide.(Pingali.,2000). It is most significant pests in Asia and Africa~~-~~(Arabjafari and Jalali.,2007). Approximately 139 distinct insect pest species attack maize; among these, *C. partellus* is a major pest in various agroclimatic zones of India. (Shukla and Kumar, 2005).It is very difficult to control the stalk borer, because of cryptic and nocturnal habits of adult moths(Singh *et al.*, 2014).

Chilo partellus l~~a~~ey oval-shaped, creamy white eggs ~~having length~~ of around 0.8 mmlong~~. (Panchal and Kachole,2013).~~ It takes 4–8 days for the eggs to develop into larvae. ~~(Panchal and Kachole, 2013)~~and takes 28–35 days for the larvae to develop into pupa. Larvae in their final instar measure 25–30 mm long, and their bodies have rows of dark spots. Pupae

Comment [st11]: Rather write, more study is required

Comment [st12]: check

Comment [st13]: scientific name everywhere

are long, cylindrical and dark brown colored, males are smaller than females. The pupal period is 5-12 days~~ after pupation, adults emerge from pupae~~. The moths are pale brown colored with an approximate wingspan of 20-30 mm. These moths have 3–8 day lifespan.When they attain maturity, they mate and lay eggs.The life cycle of *C. partellus* takes 25–50 days to complete (Panchal and Kachole, 2013).~~Because~~ Since,maize has more sugars and amino acids than other gramineous hosts, it is more vulnerable to harm from stem borer infestation (Souza, 2002). It starts to infest the crop three to four weeks after sowing and continues to do so until the crop reaches maturity~~.~~(Sarup *et al*., 1978).The leaf-eating and stem-tuning activity of the larvae ~~are~~is the most common symptom of ~~*Chilo*~~ *C.partellus*damage to maize plants. In a natural field,~~ conditions.~~ the first signs of infestation are characteristic leaf lesions and scarification caused by the first and second instars of *C. partellus* (Sithole, 1990). After hatching, stem borer larvae move over the plant, gather in the funnel, and feed on the curled leaves for a few days before approaching the stalk and stem.(Mushore, 2005). When the infestation is severe, the larvae, either in the leaf whorl or in the stem, can cut through the meristematic tissues; the central leaves dry up to produce the 'dead heart' symptom**(**De Groote,2002~~).A dead heart is caused by the borers burrowing upward after entering the stem at the surface of the soil. (Kfir *et al*., 2002).~~Exit holes and tunnels in the main stem inhibit plant growth and promote bacterial and fungal diseases (Ndiritu 1999, Songa *et al*., 2001).Dead hearts reduce translocation, ear damage, lodging, initial leaf senescence and in severe cases complete crop failure (Naz *et al.*, 2003, Gupta *et al.*, 2010).The yield losses exhibit significant regional variations, with a range of 25-40% depending on the pest population density and crop phenological stage of infection(Khan *et al*.,2015).

2. MATERIALS AND METHODS

The current study was conducted in *Kharif*,~~season~~ 2023 at central research farm, SHUATS, Prayagraj, Uttar Pradesh, India. Experimental design em~~p~~oloyed was a Randomized Block Design (RBD) consisting of eight different treatments including untreated control, each ~~treatment was~~being replicated thrice with a~~. The p~~Plotsize ~~wa~~of~~s~~ 2m×1m~~. and treatments were assigned randomly.~~ The treatments included Azadirachtin 10,000ppm(1ml/l,) Neem oil 3% (30ml/l), Karanj oil 3% (30ml/l), Neem oil 3% + Imidacloprid 17.5%SL (30ml/l+0.25ml/l), Karanj oil 3% + Imidacloprid 17.5%SL (30ml/l+0.25ml/l),Imidacloprid 17.5%SL (0.5ml/l), Spinosad 45%SC (0.5ml/l) and untreated control. Two sprays were ~~carried out~~taken at an interval of 15 days~~. during the experimentation to assess the~~

Comment [st14]: Should not start sentences with numbers

Comment [st15]: Look into the necessity of mentioning details about biology

Comment [st16]: ????

Comment [st17]: Write about the purpose and importance of this work or article

Comment [st18]: Small case, applies to whole document

~~effectiveness of chemicals and botanicals on the *chilo partellus* larval population.~~ Five plants were randomly selected in each treatment and observations were taken one day before spraying~~, application and~~ three, seven and fourteen-days after spraying. Chemicals and Botanicals were applied at their recommended doses at economic threshold level (ETL = 10% infestation).

The Larval population observation of the maize stem borer was calculated according to the following equation:

$$Larval\ Population = \frac{Numberof Larvae}{Totalnumberof Plants}$$

The healthy marketable yield from different treatments were collected separately and weighed. ~~There were two sprays throughout the research period and T~~the treatment cost and common cost of cultivation per ~~hactere~~hectare was calculated. Total income was realized by multiplying the total yield per hectare by the prevailing market price; while the net benefit was obtained by subtracting the total cost of plant protection from total income. The C:B was calculated by following formula.

$$Cost\ Benefit\ Ratio = \frac{Grossreturn}{Totalcostofcultivation}$$

3. RESULTS AND DISUSSION

3.1 Comparative efficacy of chemicals with botanicals against spotted stem borer, *Chilopartellus*(Swinhoe) after first spray:

The data on the larval population of spotted stem borer on~~ mean (~~3^{rd}, 7^{th} and 14^{th}~~ DAS)~~ days after first spray revealed that all the treatments were significantly superior over control. Among ~~all~~ the treatments, the lowest larval population of spotted stem borer was recorded in T_5Karanj oil 3% + Imidacloprid 17.5%SL (2.48) followed by T_4 Neem oil 3% + Imidacloprid 17.5%SL (2.91), T_6 Imidacloprid 17.5%SL (3.13), T_7 Spinosad 45%SC (3.66), T_2 Neem oil 3% (4.20), T_3 Karanj oil 3% (4.44) and T_1 Azadirachtin 10,000ppm (5.00) is found to be least effective then all the treatments and is significantly superior over the control (6.93)~~. Among all the treatments (T_5 Karanj oil + Imidacloprid, T_4 Neem oil + Imidacloprid, T_6 Imidacloprid), (T_6 Imidacloprid, T_7 Spinosad), (T_7 Spinosad, T_2 Neem oil), (T_2 Neem oil, T_3~~

Comment [st19]: Mention the reference

Comment [st20]: Total number of plants observed?? Write the reference for the formula

Comment [st21]: reference

Comment [st22]: scientific name

Comment [st23]: Don't mention treatment number anywhere in the running text as the treatment itself is mentioned

Comment [st24]: Write properly about the significant difference between the treatments, applies to other subheadings also

~~Karanj oil) and (T_3 Karanj oil, T_1 Azadirachtin) were found statistically significant at par with each other.~~

3.2 Comparative efficacy of chemicals with botanicals against spotted stem borer, *Chilopartellus*(Swinhoe) after second spray:

The data on the larval population of spotted stem borer on ~~mean (~~3rd, 7th and 14th DAS~~)~~ days after the second spray revealed that all the treatments were significantly superior over control. Among all the treatments lowest larval population of spotted stem borer was recorded in T_5 Karanj oil 3% + Imidacloprid 17.5%SL (1.50) followed by T_4 Neem oil 3% + Imidacloprid 17.5%SL (1.93), T_6 Imidacloprid 17.5%SL (2.30), T_7 Spinosad 45%SC (2.68), T_2 Neem oil 3% (3.26), T_3 Karanj oil 3% (3.46) and T_1 Azadirachtin 10,000ppm (3.88) is found to be least effective then all the treatments and is significantly superior over the control (7.55). Among all the treatments (T_2 Neem oil, T_3 Karanj oil) were found statistically significant at par with each other.

Comment [st25]: Mention the table or figure or source from where the data is taken

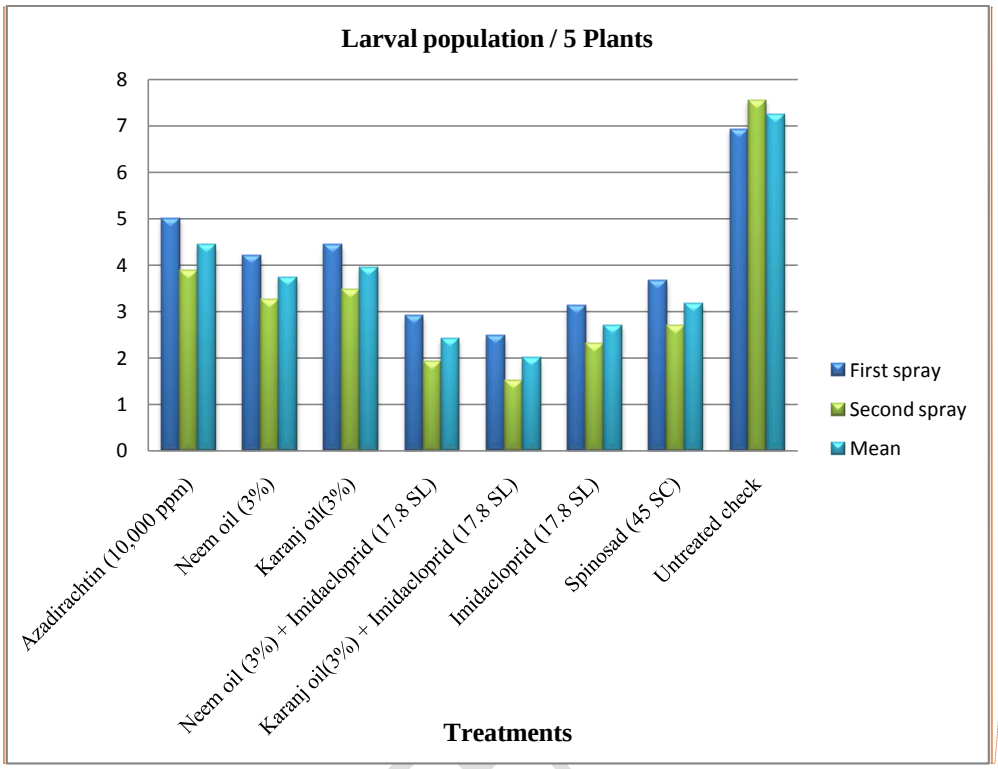
Comment [st26]: Not proper

3.3 Comparative efficacy of chemicals with botanicals against spotted stem borer, *Chilopartellus*(Swinhoe) after first and second spray (Overall mean).

The data on the larval population of spotted stem borer on mean (3rd, 7th and 14th DAS) days after first and second spray revealed that all the treatments were significantly superior over control. Among all the treatments lowest larval population of spotted stem borer was recorded in T_5 Karanj oil 3% + Imidacloprid 17.5%SL (1.99) followed by T_4 Neem oil 3% + Imidacloprid 17.5%SL (2.42), T_6 Imidacloprid 17.5%SL (2.71), T_7 Spinosad 45%SC (3.17), T_2 Neem oil 3% (3.73), T_3 Karanj oil 3% (3.95) and T_1 Azadirachtin 10,000ppm (4.44) is found to be least effective then all the treatments and is significantly superior over the control (7.24). Among all the treatments (T_5 Karanj oil + Imidacloprid, T_4 Neem oil + Imidacloprid, T_6 Imidacloprid), (T_4 Neem oil + Imidacloprid, T_6 Imidacloprid, T_7 Spinosad), (T_7 Spinosad, T_2 Neem oil, T_3 Karanj oil) and (T_2 Neem oil, T_3 Karanj oil T_1 Azadirachtin) were found statistically significant at par with each other.

Comment [st27]: Can write 3.1, 3.2 3.3 under single heading

Comment [st28]: No need to write everything when all the data is given in table or figure



Comment [st29]: See if the figure is required, table has all the data

Figure :Comparative efficacy of chemicals with botanicals against spotted stem borer, *Chilopartellus*(Swinhoe) after first and second spray

3.2??? The yields among all the treatments were significant. The highest yield was recorded in T_5 Karanj oil 3% + Imidacloprid 17.5%SL with 39.20 q/hac followed by T_4 Neem oil 3% + Imidacloprid 17.5%SL with 36.50 q/hac, T_6 Imidacloprid 17.5%SL with 34.40 q/hac, T_7 Spinosad 45%SC with 32.50 q/hac, T_2 Neem oil 3% with 30.70 q/hac, T_3 Karanj oil 3% with 29.85 q/hac, T_1 Azadirachtin 10,000ppm with 27.40 q/hac and T_0 untreated control 19.35 q/hac were recorded which was least yield.

Comment [st30]: What is the meaning?

Among all the treatments studied, the best and most economic treatment was T_6 Imidacloprid 17.5%SL with cost: benefit ratio of~~(~~1:2.2~~)~~, followed by T_5 Karanj oil 3% + Imidacloprid 17.5%SL (1:2.0), T_7 Spinosad 45%SC (1:1.9), T_4 Neem oil 3% + Imidacloprid 17.5%SL (1:1.7), T_1 Azadirachtin 10,000ppm (1:1.7), T_3 Karanj oil 3% (1:1.6), T_2 Neem oil 3% (1:1.5) and T_0 untreated control (1:1.4).

Table ????:Comparative efficacy of chemicals with botanicals against spotted stem borer, *Chilopartellus*(Swinhoe) on Maize (*Zea mays* L.)"

S. No.	Treatments	Dosage	LarvalPopulationof*chilopartellus*									Yield (q/ha)	C:B Ratio
			Firstspray					Secondspray				Overallmean		
			1DBS	3DAS	7DAS	14DAS	Mean	3DAS	7DAS	14DAS	Mean			
T_1	Azadirachtin (10,000 ppm)	1 ml/lit	5.80	5.60^{b}	4.40^{b}	5.00^{b}	5.00^{b}	4.13^{b}	3.60^{b}	3.93^{b}	3.88^{b}	4.44^{b}	27.40	1:1.7
T_2	Neem oil (3%)	30 ml/lit	5.93	5.06^{c}	3.26^{d}	4.26^{c}	4.20^{cd}	3.40^{d}	3.13^{c}	3.26^{c}	3.26^{c}	3.73^{bc}	30.70	1:1.5
T_3	Karanj oil (3%)	30 ml/lit	5.60	5.33^{bc}	3.66^{c}	4.33^{c}	4.44^{bc}	3.73^{c}	3.26^{bc}	3.40c	3.46^{c}	3.95^{bc}	29.85	1:1.6
T4	Neem oil (3%) + Imidacloprid (17.8SL)	30ml/lit + 0.25 ml/lit	5.80	3.86^{e}	2.13^{e}	2.73^{e}	2.91^{f}	2.20^{f}	1.66^{e}	1.93^{f}	1.93^{f}	2.42^{de}	36.50	1:1.7
T_5	Karanj oil (3%) + Imidacloprid (17.8SL)	30ml/lit + 0.25 ml/lit	6.06	3.40^{f}	1.73^{f}	2.33^{f}	2.48^{f}	1.66^{g}	1.33^{e}	1.53^{g}	1.50^{g}	1.99^{e}	39.20	1:2.0
T_6	Imidacloprid (17.8SL)	0.5 ml/lit	5.73	4.06^{e}	2.33^{e}	3.00^{e}	3.13^{ef}	2.46^{f}	2.13^{d}	2.33^{e}	2.30^{e}	2.71^{de}	34.40	1:2.2
T_7	Spinosad (45 SC)	0.5 ml/lit	5.73	4.46^{d}	3.00^{d}	3.53^{d}	3.66^{de}	2.86^{e}	2.46^{d}	2.73^{d}	2.68^{d}	3.17^{cd}	32.50	1:1.9
T_8	Control		6.06	6.60^{a}	6.93^{a}	7.26^{a}	6.93^{a}	7.40^{a}	7.60^{a}	7.66^{a}	7.55^{a}	7.24^{a}	19.35	1:1.4
F-Test			NS	S	S	S	S	S	S	S	S	S		
S.Ed.(±)			NS	0.15	0.18	0.13	0.32	0.13	0.13	0.16	0.13	0.81		
CD (0.05)			NS	0.32	0.38	0.28	0.67	0.28	0.28	0.33	0.28	0.95		

DBS-DaybeforeSpraying,DAS-DayafterSpraying,NS- Nonsignificant,S-Significant

4. CONCLUSION :*Chilo partellus*, a lepidopteran stem borer, damages the worldwide maize ecosystem economically. Due of its cryptic nature of feeding, it is challenging to control with chemical i~~I~~nsecticides. The excessive use of chemical insecticides and its associated detrimental effects have been widely criticized. Insects quickly develop resistance to chemical insecticides when they are frequently exposed to them but botanical insecticides contain a variety of naturally occurring active ingredients with unique modes of actions, such as antifeedant, repellent, oviposition deterrent, and synergistic effects, making resistance difficult to develop.Therefore, when chemical and botanical insecticides are used together, they have substantially greater efficacy than when they are applied separately because of their synergistic and complimentary effects.~~Keeping in the view present research was conducted and results shows that combinations of chemicals with botanical insecticides,~~In the present study, Karanj oil 3% + Imidacloprid 17.5%SL followed by Neem oil 3% + Imidacloprid 17.5%SL shows highest efficacy with highest yield 39.20 and 36.50 q/hacare respectively against spotted stem borer but economically best treatment was Imidacloprid (17.8SL) which shows highest cost benefit ratio (1:2.2). Combinations of chemicals with botanicals have lower cost benefit ratio to some extent compared to chemicalsbecause of the high dosages and expense of botanicals but it considered as a feasible alternative for~~of~~ chemicals and reduces adverse acute and chronic effects in environment along with bioaccumulation and biomagnifications.

Comment [st31]: rephrase

Comment [st32]: write about the larval number also

Comment [st33]: scientific name everywhere except in the beginning

REFERENCES

Agricultural market intelligence center, Professor Jayashankar Telangana State Agricultural University (PJTSAU) Maize outlook (2024).

Annual report, Department of Agriculture, Cooperation and farmers welfare, GOI; 2022-23,5

Arabjafari, K. H. and Jalali, S. K. (2007).Identification and analysis of host plant resistance in leading maize genotypes against spotted stem borer, *Chilo partellus* (Swinhoe) (Lepidoptera:Pyralidae). *Pakistan Journal of Biological sciences***10**(11): 1885-1895

Chouraddi, M., and Mallapur, C.P. (2017). Impacts of newer molecules of insecticides on management of maize stem borers. *Journal of Entomology and Zoology Studies***5**(4) 1424-1428

De, Groote, H. (2002). Maize yield losses from stem borers in Kenya. *International Journal of*

Tropical Insect Science.; **22**:89-96.

Directorate of Maize Research, ICAR. Follow the format, write the date when you last visited the website

Farnham, D.E., Benson, G.O. and Pearce, R.B. (2003). Corn perspective and culture. (In) Corn: Chemistry and Technology, 2nd, pp 1-33. White J P and Johnson L A (Eds.), American Association of Cereal Chemicals. *St. Paul, Minnesota, Publisher*, USA

Gupta, S., Handore, K. and Pandey, I.P. (2010). Effect of insecticides against *Chilo partellus* (Swinhoe) damaging *Zea mays* (maize). *International Journal of Parasitology Research*,**2**(2): 4-7.

Indian Institute of Maize Research (2024)

Joshi, M. Text Book of Field Crops. New Delhi: PHI Learning Private Limited, 2015.

Kauma, T.M., Schulthess, F., LeRu, B.P.,Mueke, J., Ogwang, J.A., and Omwega C.O (2008)"Abundance and diversity of lepidopteran stemborers and their parasitoids on selected grasses in Uganda". *Crop Portection*. **27**: 505-513.

Kfir, R., Overholt, W.A., Khan, Z.R., and Polaszek, A. (2002).Biology and management of economically important Lepidopteran cereal stem borers in Africa. *Annual Review of Entomology***47**: 701-731

Khan, I.A., Khan, M., Akbar, R., Saeed, M., Farid, A., Ali., Ijaz., and Alam, M. (2015).Assessment of different control methods for the control of Maize Stem Borer, *(Chilo partellus)*Swinhoe in Maize crop. *Journal of Entomology and Zoology Studies.* **3**(4):327-330.

Mushore , K. (2005). Assessment of suitability of different populations of stemborer species for the development of *Cotesia flavipes* (Hymenoptera: Braconidae) and the Establishment of the latter in Zimbabwe, Thesis, University of Zimbabwe, p 14

Naz, F., Faridullah, M. and Din, M. (2003). Insect pest of maize and their losses. *Asian Journal of Plant Sciences.* **2**(5): 412-4.

Ndiritu, C. G. (1999). Kenya: Biotechnology in Africa: Agricultural Biotechnology and the Poor, pp 109-14. Persley G.J. and Lantin M.M .,(eds.). *Consultative Group on International Agricultural Research.* Washington DC.

Panchal, B.M. and Kachole, M.S. (2013). Life cycle of *Chilo partellus* (Swinhoe) (Lepidoptera:

Pyralidae) on artificial diets. *Iternational Journal of Plant and Environmental Science* **3**(4), 19-22.

Panwar, V.P.S. (2005). Management of Maize stalk borer *Chilo partellus* (Swinhoe) in maize. *Stresses on Maize in Trepics.* pp. 324-375

Pingali, P.I. (2000). World Maize Facts and Trends. Meeting World Maize Need: Technological Opportunities and Priorities for the Public Sector. International Maize and Wheat Improvement Center, Mexico. D.F. 57p.

Prasanna, B.M., Vasal, S.K., Kassahun, B. and Singh, N. N. (2001). Quality protein maize. Current Science, **81**(10): 1308–18.

Sarup, P., Siddiqui, K.H., and Marwaha, K.K. (1978).Trends in maize pest management research in India together with bibliography. *Journal of Entomological Research.*; **111**:19-68.

Shiferaw, B., Prasanna, B., Hellin, J., and Banziger, M. (2011). Crops that feed the world 6. Past successes and future challenges to the role played by maize in global food security. Food Security, 3, 307–327.

Shukla, A and Kumar, A. (2005).Maize stem borer (*Chilo partellus* Swinhoe). A review of plant protection Bulletin, University of Agriculture and Technology, Udaipur, India

Singh, A., Yadav, U. (2023). Evaluate the Efficacy of Different Biopesticides with Imidacloprid against Maize Spotted Stem Borer (*Chilo partellus*swinhoe) on maize under field conditions. *International Journal of Plant & Soil Science*.**35**, (18), 1001-1006.

Singh, S.K., Chauhan, S.K., Singh, R.P., Singh, R.K., and Singh, R.B. (2006). Studies on abiotic factors related to yield gaps across the environment in tropical maize (*Zea mays* L.). Analysis of. Agricltural Research **;27**(4):373-376.

Sithole, S.Z. (1990).Status and control of *Chilo partellus*(Swinhoe) (Lepidoptera: Pyralidae) in southern Africa. *Insect Science and Its Application***11**: 481-488.

Souza, F.S., Rebeiro, R.H.E., Veloso, C.A.C., and Correan, L.A.(2002). Yielding and phenotypic stability of corn cultivars in three municipal districts of para State Brazil *Pesquisa-AgrepercuriaBrazileira*,**37**: 1269-1274