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MANAGEMENT OF *CHILO PARTELLUS* (SWINHOE) AND *SESAMIA INFERENS* (WALKER) THROUGH DIFFERENT INTERCROPPING SYSTEMS AND ORGANIC MANURES IN MAIZE ECOSYSTEM

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Abstract- To evaluate the effect of different intercropping systems and organic manures on maize stem borers, *Chilo partellus* (Swinhoe) and *Sesamia inferens,* experiment was carried out in college of Agriculture, Shivamogga. The results revealed that maize + cowpea (M1) recorded lowest number of pinholes per plant and least cob damage with reduced yield loss. With regard to interaction effect, maize + cowpea along with the application of neem cake (M1S3) was found to be most effective treatment in reducing pinholes and cob damage with reduced yield loss.

Keywords- Maize, Intercropping, *Chilo partellus*, *Sesamia inferens*, Neem cake.

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Introduction

Maize (*Zea Mays* L.) is one of the important crops in the world after wheat and rice. It is most widely distributed crop and ranks third in world crop production in India. It is regarded as an important food grain, feed and fodder crop. Presently, maize cultivation is gaining importance due to its increasing demand as animal feed and raw material for industry. Insect pests are major inflicting factor for the productivity of maize [1]. In India more than 39 species of insects have been reported to attack maize crop during its different stages of growth, of which only about a dozen are quite serious [2]. *Chilo partellus* (Swinhoe) (Lepidoptera: Pyralidae) and *Sesamia inferens* (Walker) (Noctuidae: Lepidoptera) are the major insect pests inflicting greater loss to the crop. *C. partellus* is notorious pest playing havoc role all over the world [3]. Injury to maize includes leaf feeding, tunnelling within the stalk, disruption of the flow of nutrients to the ear, and subsequent development of "deadhearts". The first symptom of *C. partellus* damage is the appearance of "shot-hole" injury to whorl leaves. "Deadhearts" result from larval feeding injury to the growth point of maize plants; this damage is most important during the first 2-3 weeks after seedling emergence [4, 5].

The pink stem borer, *S. inferens* a serious pest causing grain yield losses ranging from 18.0 to 49.0% [reference]. Losses due to *S. inferens* during post rainy season in South India varies from 25.7 to 78.9% [6]. Because of higher grain yield losses, research efforts are being initiated to develop a combination of intercropping system and organic manures which help in minimising pest load.

Materials and Method

Studies were carried out on the evaluation of intercropping systems and organic manures against stem borers in maize at College of Agriculture, Shivamogga during *kharif*, 2014-15. Shivamogga is geographically located at 13^0 27'- 14^o 39' N latitude and 74^o 37'- 75^o 52' E longitude with an altitude of 650 meters above the mean sea level. The place lying in Southern Transition Zone (Zone –7) receives an average annual rainfall of 842.33 mm distributed well over the *kharif* season. The field experiment was carried out using split plot design with three replications. The plot size was 3x3.6 m with 1.0 m replication border and 0.5 m treatment border between the plots. The experimental plots were separated by raising bunds of about 0.6 m height around each plot. The furrows were opened as per the spacing. The popular maize hybrid Pioneer 3501 was sown over a plot size of 3.6x3.0 m at spacing of 60x30 cm in each treatment. There were four main plot treatments and four sub plot treatments.

Main plot treatments: M1: Maize + Cowpea (1:1), M2: Maize + Field bean (1:1), M3: Maize + Coriander (1:1), M4: Maize

Sub plot treatments: S1: Farm yard manure + recommended dose of fertilizer (FYM + RDF), 7.5 t/ha + 100:50:25 NPK kg/ha S2: Poultry manure, 2 t/ha S3: Neem cake, 0.2 t/ha, S4: Rice hull ash, 1 t/ha

As per the main plot treatments, cowpea, field bean and coriander were intercropped with maize. In case of sub plot treatments farm yard manure, poultry manure, neem cake and rice hull ash were applied to respective plots at 15 days prior to sowing as a basal dose and recommended dose of fertilizers were applied as a basal dose at the time of sowing. Observations were made at 20, 40 and 60 DAS on percentage of plants showing pinhole symptoms and per cent dead hearts in all the treatments.

Result and Discussion

Effect of intercropping systems on number of pinholes per plant, percent cob damage and yield

Maize intercropped with cowpea registered lowest number of pinholes per plant (19.60) compared to maize + field bean (24.99) and maize + coriander (29.89). Maize grown as sole crop (34.70) was found to be less effective in controlling damage by stem borers [Table-1]. By considering per cent cob damage it can be concluded that maize + cowpea was superior treatment (4.33%) than maize + field bean (6.85%) and maize + coriander (8.92%). The maize sole crop was proved to be less effective (11.80%). It was found that maximum grain and fodder yields were registered in maize intercropped with cowpea (48.53q ha^{-1} and 93.97q ha^{-1}, respectively). Next best treatments were maize + field bean (43.82q ha^{-1} and 88.45q ha^{-1}) followed by maize + coriander (39.92q ha^{-1} and 75.83q ha^{-1}). Maize grown as sole crop recorded lowest grain and fodder yield (35.80q ha^{-1} and 65.45q ha^{-1}, respectively). Highest B:C ratio of 1:3.31 was recorded in maize +

cowpea, followed by maize + field bean(1:3.02), maize + coriander (1:2.81) compared to(1:2.42) in sole crop of maize [Table-2]. The present results are in line with the findings of Omolo and Seshu Reddy [7] in Kenya who identified sorghum and cowpea as the best crop combination in minimizing stem borer population, stabilizing productivity and reducing yield loss. Further, Chand and Sharma [8] found that growing maize in association with legumes reduced *C. partellus* damage on maize while Amoaka-Atta *et al*. [9] reported that cereals inter cropped with cowpea showed a significant delay in borer colonization. Likewise, intercropping of maize with beans at ratios of 1:1 to 2:1 significantly decrease borer densities compared to pure maize stands [10]. Mahadevan and Chelliah [11], Spurthi *et al.* [12] and Anonymous, [13] reported that sorghum inter cropped with cowpea reduced the incidence of *C. partellus* and increased the grain and fodder yield. Maize intercropped with cowpea (1:1) proved superior in reducing the stem borer damage by recording lowest percentage of plants showing pinholes followed by maize with field bean[14] All these reports are in line with the findings of present investigation.

Effect of organic manures on number of pinholes per plant, percent cob damage and yield

Considering the seriousness of wide spread use of chemicals in pest management and subsequently considerable insecticide residues in the consumable products, inducing the resistance through organic means have become more viable. Organic manures act like slow release fertilizers providing balanced nutrition to plants and facilitate balanced growth, finally making them less prone to pest incidence [15].

Table-1 *Effect of intercropping systems and organic manures on the number of pinholes per plant by stem borers in maize*

	Number of pinholes per plant at					
Treatments	20 DAS	30 DAS	40 DAS	50 DAS	60 DAS	Mean
M1	4.09^{a}	14.26^{a}	25.15^{a}	27.58^{a}	26.90^{a}	19.60^{a}
M2	9.40^{b}	20.58^{b}	31.65^{b}	32.77^{b}	30.54^{b}	24.99^{b}
M3	14.55^{c}	25.60^{c}	35.84^{c}	37.72^{c}	35.72^{c}	29.89^{c}
M4	19.46^{d}	29.77^{d}	40.61^{d}	42.24^{d}	41.42^{d}	34.70^{d}
SEm±	0.10	0.09	0.07	0.06	0.02	0.07
CD (p=0.05)	0.34	0.32	0.25	0.22	0.09	0.23
S1	14.80^{d}	28.99^{d}	39.93^{d}	43.06^{d}	41.42^{c}	33.64^{d}
S2	11.68^{b}	22.85^{c}	33.27^{b}	34.72^{b}	32.95^{b}	27.09^{b}
S3	8.98^{a}	15.66^{a}	26.41^{a}	27.67^{a}	27.26^{a}	21.19^{a}
S4	12.05^{c}	22.72^{b}	33.65^{c}	34.86^{c}	32.96^{b}	27.25^{c}
SEm±	0.08	0.04	0.03	0.03	0.04	0.02
CD (p=0.05)	0.22	0.11	0.09	0.07	0.11	0.06
M1S1	6.38^{d}	20.08^{f}	31.49^{f}	35.49^{g}	34.56^{f}	25.60^{g}
M1S2	3.97^{b}	15.15^{d}	25.47^{c}	27.73^{c}	27.35^{c}	19.94^{c}
M1S3	1.61^{a}	7.57^{a}	17.61^{a}	19.52^{a}	18.23^{a}	12.91^{a}
M1S4	4.42^{c}	14.25^{c}	26.01^{d}	27.58^{c}	27.46^{c}	19.94^{c}
M2S1	12.58^{h}	26.70^{k}	38.34^{l}	40.28^{j}	38.40^{h}	31.26^{k}
M2S2	8.94^{e}	20.91^{g}	31.78^{g}	32.44^{e}	29.81^{d}	24.77^{e}
M2S3	6.62^{d}	13.34^{b}	24.36^{b}	25.54^{b}	24.21^{b}	18.81^{b}
M2S4	9.48^{f}	21.36^{h}	32.12^{h}	32.82^{f}	29.75^{d}	25.11^{f}
M3S1	17.70^{k}	32.47^{m}	42.59^{o}	45.70^{l}	43.37^{j}	36.37^{m}
M3S2	14.53^{i}	25.67^{j}	35.46^{j}	37.50^{h}	34.57^{f}	29.55^{i}
M3S3	11.38^{g}	18.60^{e}	29.45^{c}	29.98^{d}	30.29^{e}	23.94^{d}
M3S4	14.60^{i}	25.66^{j}	35.87^{k}	37.69^{i}	34.66^{f}	29.70^{j}
M4S1	22.55^{m}	36.71^{n}	47.29^{p}	50.76^{m}	49.36^{k}	41.33^{n}
M4S2	19.28^{l}	29.66^{l}	40.38^{m}	41.21^{k}	40.07^{i}	34.12^{l}
M4S3	16.32^{j}	23.11^{i}	34.20^{i}	35.63^{g}	36.29^{g}	29.11^{h}
M4S4	19.68^{l}	29.60^{l}	40.58^{n}	41.35^{k}	39.95^{i}	34.23^{l}
SEm±	0.15^{j}	0.08	0.06	0.05	0.08	0.04
CD (p=0.05)	0.44	0.22	0.18	0.15	0.22	0.12

Values superscripted by same letter do not differ significantly, M: Main Plots, S: Subplots, MxS: Interaction, DAS: days afte r sowing

Main plot treatments	Sub plot treatments
M1: Maize + Cowpea (1:1)	**S1:** Soil application of Farm yard manure (FYM) plus Recommended dose of fertilizer (RDF)
M2: Maize + Field bean(1;1)	**S2:** Soil application of Poultry manure
M3: Maize + Coriander(1:1)	**S3:** Soil application of Neem cake
M4: Maize sole crop	**S4:** Soil application of Rice hull ash

With regard to number of pinholes per plant, neem cake showed lowest damage (21.19) compared to poultry manure (27.09) and rice hull ash (27.25). Highest damage was found in plots applied with FYM + RDF (33.64) [Table-1]. Neem cake application was proved to be superior treatment recorded lowest per cent cob damage (4.70%). The effectiveness of neem cake was followed by poultry manure (7.84%) and rice hull ash (8.17%). Application of FYM and RDF recorded highest per cent cob damage (11.19%). The effectiveness of different treatments was reflected on grain and fodder yield. Significantly higher grain yield (46.31q ha^{-1}) was recorded in neem cake. The other treatments to follow were rice hull ash (41.95q ha^{-1}) and poultry manure (41.63q ha^{-1}). FYM + RDF recorded lowest grain yield (38.19q ha^{-1}). Similarly, the highest fodder yield was in neem cake (85.45q ha^{-1}) followed by rice hull ash (81.11q ha^{-1}) and poultry manure (80.67q ha^{-1}). FYM + RDF registered lowest yield (76.46q ha^{-1}). Similar results were obtained with B:C ratio. Neem cake recorded higher B:C ratio (1:2.73), followed by rice hull ash (1:2.71) and poultry manure (1:2.55) and lowest B:C ratio (1:2.61) recorded in FYM + RDF [Table-2].

Neem cake @ 0.2 t ha^{-1} resulted in lowest percentage of plants showing pinholes compared to FYM + RDF, which was ineffective in reducing damage by stem borers [14]. Due to lacking of literature pertaining to effectiveness of neem cake against maize stem borers, related reviews of brinjal shoot and fruit borer are considered for the discussion. The efficacy of the neem cake in reducing the stem borer infestation was proved in the present study, which is in agreement with findings of Godase and Patel [16] who observed less brinjal shoot and fruit borer infestation in neem cake treated plots. The treatment combined with organic and inorganic showed very low percent reduction of shoot and fruit infestation compared to organic treatments. Laing *et al.*[17] revealed that application of rice

hull ash which is the source of silicon to corn reduced the incidence of Stalk borer *Chilo zonellus* and borer *Sesamia calamistis* and this is inconsonance with present investigation .
The effectiveness of the neem cake and poultry manure is attributed to presence of tri-terpenoids, which exhibit anti-feedant property and high content of potassium providing mechanical resistance against the boring larvae, respectively [18]. When rice hull ash is applied to soil, the silicon present is absorbed by the xylem vessels and deposited on the walls of plant tissue, forming a physical barrier, which might have prevented the feeding by insects [19].

Table-2 *Effect of intercropping systems and organic manures on the cob damage, grain and fodder yield of maize*

Treatments	Per cent cob damage	Grain Yield (q ha^{-1})	FodderYield (q ha^{-1})	B:C ratio
M1	4.33^{a}	48.53^{a}	93.97^{a}	3.31
M2	6.85^{b}	43.82^{b}	88.45^{b}	3.02
M3	8.92^{c}	39.92^{c}	75.83^{c}	2.81
M4	11.80^{d}	35.80^{d}	65.45^{d}	2.42
SEm±	0.04	0.04	0.04	-
CD (p=0.05)	0.12	0.12	0.11	-
S1	11.19^{d}	38.19^{d}	76.46^{d}	2.61
S2	7.84_{b}	41.63^{c}	80.67^{c}	2.55
S3	4.70^{a}	46.31^{a}	85.45_{a}	2.73
S4	8.17^{c}	41.95^{b}	81.11^{b}	2.71
SEm±	0.04	0.04	0.04	-
CD (p=0.05)	0.12	0.12	0.11	-
M1S1	5.88^{d}	43.61^{g}	90.10^{e}	3.02
M1S2	4.12^{c}	48.36^{c}	93.74^{c}	3.10
M1S3	2.98^{a}	53.40^{a}	97.86^{a}	3.26
M1S4	4.34^{c}	48.74^{b}	94.17^{b}	3.33
M2S1	9.29^{i}	39.71^{h}	83.27^{h}	2.77
M2S2	7.03^{e}	43.85^{f}	88.39^{g}	2.84
M2S3	3.72^{b}	47.78^{d}	93.24^{d}	2.95
M2S4	7.33^{f}	43.93^{f}	88.92^{f}	3.03
M3S1	13.03^{l}	36.74^{k}	71.69^{n}	2.61
M3S2	9.01^{h}	39.05^{j}	75.36^{k}	2.76
M3S3	4.21^{c}	44.49^{e}	80.63^{i}	3.02
M3S4	9.43^{i}	39.41^{p}	75.63^{j}	2.78
M4S1	16.55^{m}	32.71^{n}	60.79^{p}	2.21
M4S2	11.18^{j}	35.24^{m}	65.19^{o}	2.33
M4S3	7.89^{g}	39.54^{h}	70.08^{m}	2.39
M4S4	11.56^{k}	35.72^{l}	65.72^{n}	2.31
SEm±	0.09	0.08	0.07	-
CD (p=0.05)	0.24	0.23	0.21	-

Values superscripted by same letter do not differ significantly, M: Main Plots, S: Subplots, MxS: Interaction, DAS: days after sowing

Main plot treatments	Sub plot treatments
M1: Maize + Cowpea (1:1)	**S1:** Soil application Farm yard manure (FYM) plus Recommended dose of fertilizer (RDF)
M2: Maize + Field bean(1;1)	**S2:** Soil application Poultry manure
M3: Maize + Coriander(1:1)	**S3:** Soil application Neem cake
M4: Maize sole crop	**S4:** Soil application Rice hull ash

Interaction effect of intercropping systems and organic manures on number of pinholes per plant, percent cob damage and yield

Among the different treatment combinations, maize + cowpea with neem cake registered lowest number of pinholes per plant (12.91).This was followed by maize + field bean with neem cake (18.81), maize + cowpea with rice hull ash and maize + cow pea with poultry manure (19.94). Sole crop of maize with FYM + RDF recorded highest number of pinholes (41.33) [Table-1]. Maize + cowpea when integrated with neem was found to be superior, recording lowest per cent cob damage (2.98%). Next to this were maize + field bean integrated with neem cake (3.72%), maize + cowpea each mixed with poultry manure and rice hull ash (4.12% and 4.34%).Maize sole crop was found to be most susceptible by recording highest cob damage (16.55%). The results regarding superiority of treatment combination in terms of yield and cost economics revealed that maize + cowpea along with neem cake application recorded highest grain yield (53.40q ha^{-1}) and fodder yield (97.86q ha^{-1}). This was followed by maize + cowpea along with rice hull ash which recorded grain yield of 48.74q ha^{-1} and fodder yield of 88.39q $ha^{-1}$and maize + cowpea with application of poultry manure which recorded grain yield of 48.36q $ha^{-1}$and fodder yield of 93.74 q ha^{-1}. Maize sole crop applied with FYM + RDF registered lowest grain yield (32.71q ha^{-1}) and fodder yield (60.79q ha^{-1}). Maize intercropped with cowpea along with neem cake showed higher B:C ratio (1:3.33) followed by maize + cowpea with rice hull ash (1:3.26) and maize + cowpea with poultry manure (1:3.10). Interaction effect between different combinations of intercropping systems and organic manures showed that maize intercropped with cowpea along with application of neem cake found superior among the treatments by recording lowest percentage of plants showing pinholes [14].

Conclusion

Present findings showed that among different intercropping systems maize intercropped with cowpea recorded lowest pinholes, cob damage and highest yield. With regard to different organic manures, neem cake recorded lowest pinholes, cob damage and highest yield. This is the first report of interaction effect of maize intercropped with cowpea along with the application of neem cake.

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Conflict of Interest: None declared

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