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Evaluation of Different Intercropping Systems and Organic Manures against Stem Borers in Maize

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ABSTRACT: *The experiment was carried out in College of Agriculture, Shivamogga to evaluate the effects of intercropping and organic manures on the infestation of maize stem borers,* Chilo partellus *(Swinhoe) and* Sesamia inferens *(Walker). The results revealed that maize + cowpea (M1) and neem cake (S3) recorded lowest per cent of plants showing pinholes and dead hearts. With regard to interaction effect maize + cowpea along with the application of neem cake (M1S3) was most effective by recording lowest damage.*

Keywords: *Maize, stem borers, intercropping, Chilo partellus, Sesamia inferens, neem cake*

INTRODUCTION

Chilo partellus (Swinhoe) (Lepidoptera:Pyralidae) and *Sesamia inferens* (Walker) (Noctuidae: Lepidoptera) are the most important insect pests inflicting greater loss to the crop. *Chilo partellus* as reported by Kumar [1] and Songa [2] is the most notorious insect pest attacking the maize crop in Asia and Africa. Damage occurs as a series of small holes in lines (pin holes) in younger leaves. Feeding and stem tunnelling by borer larvae on plants results in crop losses as a consequence of destruction of the growing point, early leaf senescence, interference with translocation of metabolites and nutrients that result in malformation of the grain, stem breakage, plant stunting, lodging and direct damage to ears [3], [4], [5]. Yield losses in different agro climatic regions of India due to *C. partellus* and *S. inferens* ranged from 26.7 to 80.4 and 25.7 to 78.9 per cent, respectively [6].

Sesamia inferens larvae cause wide damage to the crop by feeding on all parts of the plant except roots, preferably on first three leaf sheaths leading to gummy oozing with water soaked lesions. Whorl feeding of the larvae results in the formation of rows of oblong and elongated holes in unfolded leaves. The larvae bore into the central shoot resulting in drying up of the growing tissue/flag leaf and formation of dead hearts in young plants. The larvae also form circular or "S" shaped tunnels filled with excreta inside the stem and also show exit holes on the surface. Severe damage results in breaking of the stem. Larvae are found feeding on immature cobs, silks and tassel and severe infestation results in stunted plant growth and appearance of cob and tassel at one place [7]. The stem borers, being internal feeders, are difficult to manage only through insecticidal sprays. Hence, the present investigation is planned with the integrated approach using organic manures and intercrops which are ecofriendly in nature.

MATERIALS AND METHOD

Investigation was 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. 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 all 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 60X30cm in each treatment. There were four main plot treatments and four sub plot treatments.

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

Sub plot treatments: S1: Farm yard manure plus recommended dose of fertilizer (FYM + RDF), 7.5 t/ha plus 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, cow pea, 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 percentage of plants showing pinholes

At 20 DAS, maize + cowpea recorded minimum percentage of plants showing pinholes (5.23%) being significantly superior compared to other treatments. The other treatments in the order were maize + field bean (7.18%) and maize + coriander (11.33%). While, maize sole crop registered maximum percentage of plants showing pinholes (13.95%) being significantly inferior among various treatments. At 40 DAS, the minimum percentage of plants showing pinholes was observed in maize when intercropped with cowpea (15.76%) which was followed by maize + field bean (21.52%) and maize + coriander (33.15%). However, maize sole crop recorded maximum percentage of plants showing pinholes (42.56%) being inferior to all other treatments. Similar observations were recorded even at 60 DAS (Table 1).

The overall mean percentage of plants showing pinholes indicated that the minimum percentage of pinholes was recorded in maize intercropped with cowpea (12.80%). Next treatments to be followed were maize + field bean (18.16%) and maize + coriander (28.19%). Maize when grown as sole crop recorded maximum percentage of pinholes of 34.31 per cent which was least effective compared other various treatments (Table 1).

Effect of Organic manures on percentage of plants showing pinholes

At 20 DAS, soil application of neem cake @ 0.2 t/ha proved to be significantly superior by recording lowest of 6.11 percentage of plants showing pinholes compared to all other treatments. This was followed by poultry manure (9.43%) and rice hull ash (10.02%). Whereas, higher percentage of plants showing pinholes was recorded in FYM+RDF (12.14%) which was significantly inferior to all other treatments included in the study. At 40 DAS, significantly lowest percentage of plants showing pinholes was recorded in neem cake (20.25%). Other promising treatments were poultry manure (27.63%) and rice hull ash (28.31%). While, FYM+RDF registered highest percentage of plants showing pinholes (36.80%) being significantly inferior among all the treatments. Similar trend was observed at 60 DAS (Table 1).

The overall mean percentage of plants showing pinholes indicated that the application of neem cake proved to be superior by recording lowest of 16.74 per cent followed by poultry manure (23.31%) and rice hull ash (23.61%). Significantly, highest percentage of plants showing pinholes was recorded in FYM+RDF (29.79%) (Table 1).

Interaction effect of intercropping systems and organic manures on percentage of plants showing pinholes

At 20 DAS, among the different combinations of intercropping systems with organic manures, the results indicated that M1S3: maize + cowpea with neem cake (2.33%), M2S3: maize + field bean with neem cake (4.23%) and M1S2: maize + cowpea with poultry manure (5.12%) recorded lower percentage of plants showing pinholes which ranged from 2.33 to 5.12 per cent. The treatment combinations of M4S2: maize sole crop with poultry manure (14.27%), M4S4: maize sole crop with rice hull ash (14.62%) and M4S1: maize sole crop with FYM+RDF (17.46%) recorded higher percentage of plants showing pinhole damage which ranged from 14.27 to 17.46 per cent (Table 1).

At 40 DAS, perusal of the data on various combinations of intercropping systems with organic manures revealed lower percentage of plants showing pinhole damage in M1S3: maize + cowpea with neem cake (8.57%) M2S3: maize + field bean with neem cake (14.17%) and M1S2: maize + cowpea with poultry manure (15.88%) which ranged from 8.57 to 15.88 per cent. The treatment combinations of M4S4: maize sole crop with rice hull ash (41.96%), M3S1: maize + coriander with FYM+RDF (43.36%) and M4S1: maize sole crop with FYM+RDF (52.62%) registered higher percentage of plants showing pinhole damage which ranged from 41.96 to 52.62 per cent. Similar trend was observed during 60 DAS (Table 1).

Table 1
Effect of intercropping systems and organic manures on the percentage of plants showing pinholes by stem borers in maize

Treatments	*20 DAS*	*40 DAS*	*60 DAS*	*Mean*
M1	5.23[a]	15.76[a]	16.47[a]	12.80[a]
M2	7.18[b]	21.52[b]	23.79[b]	18.16[b]
M3	11.33[c]	33.15[c]	37.96[c]	28.19[c]
M4	13.95[d]	42.56[d]	43.16[d]	34.31[d]
SEm+	0.07	0.03	0.02	0.05
CD (p=0.05)	0.23	0.09	0.07	0.16
S1	12.14[d]	36.80[d]	38.77[d]	29.79[d]
S2	9.43[b]	27.63[b]	29.95[b]	23.31[b]
S3	6.11[a]	20.25[a]	22.65[a]	16.74[a]
S4	10.02[c]	28.31[c]	30.01[c]	23.61[c]
SEm+	0.04	0.03	0.04	0.02
CD (p=0.05)	0.11	0.09	0.12	0.06
M1S1	7.53[e]	22.52[f]	23.81[e]	18.32[f]
M1S2	5.12[c]	15.88[c]	16.33[b]	12.93[c]
M1S3	2.33[a]	8.57[a]	8.92[a]	6.71[a]
M1S4	5.93[d]	16.07[d]	16.82[c]	13.25[d]
M2S1	9.46[g]	28.69[h]	30.86[h]	23.74[h]
M2S2	7.39[e]	20.64[e]	24.05[f]	18.18[e]
M2S3	4.23[b]	14.17[b]	17.01[c]	12.28[b]
M2S4	7.64[e]	22.57[f]	23.22[d]	18.43[f]
M3S1	14.13[j]	43.36[n]	47.05[m]	35.04[n]
M3S2	10.94[h]	32.42[i]	37.15[j]	28.07[j]
M3S3	8.39[f]	24.18[g]	29.75[g]	21.22[g]
M3S4	11.87[i]	32.64[j]	37.89[k]	28.41[k]
M4S1	17.46[l]	52.62[o]	53.34[n]	42.07[o]
M4S2	14.27[j]	41.59[l]	42.26[l]	34.06[l]
M4S3	9.47[g]	34.07[k]	34.92[i]	26.75[i]
M4S4	14.62[k]	41.96[m]	42.09[l]	34.33[m]
SEm+	0.08	0.06	0.08	0.04
CD (p=0.05)	0.22	0.18	0.23	0.11

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

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

The overall mean percentage of plants showing pinholes indicated that the combinations of different intercropping systems with organic manures differed significantly. The treatment combinations of M1S3: maize + cowpea with neem cake (6.71%), M2S3: maize + field bean with neem cake (12.28%) and M1S2: maize + cowpea with poultry manure (12.93%) proved to be significantly superior by recording lower percentage of plants showing pinholes which ranged from 6.71 to 12.93 per cent. The higher percentage of plants showing pinholes was recorded in treatment combinations viz. M4S4: maize sole crop with rice hull ash (34.33%), M3S1: maize + coriander with FYM+RDF (35.04%) and M4S1: maize sole crop with FYM+RDF (42.07%) ranging from 34.33 to 42.07 per cent which were found to be ineffective compared to all other treatment combinations (Table 1).

Effect of intercropping systems on per cent dead hearts

The data on the per cent dead hearts at 20 DAS varied significantly among the main plot treatments. Maize + cowpea recorded lowest of 3.22 per cent dead hearts being statistically superior to rest of the treatments. Next to this treatment were maize + field bean (6.86%) and maize + coriander (7.94%). While, highest percentage of dead hearts (11.06%) was recorded in maize sole crop which was found to be significantly inferior to various other treatments. At 40 DAS, the per cent dead hearts in main plot treatments differed significantly ranging from 6.73 to 14.54 per cent. Maize + cowpea intercropping recorded lowest of 6.73 per cent dead hearts. This was followed by maize + field bean (8.95%) and maize + coriander (10.19%). Wherein, maximum percentage of dead hearts was observed in maize sole crop (14.54%) being significantly inferior to rest of the treatments. Similar trend was observed during 60 DAS (Table 2).

The overall mean per cent dead hearts showed that the treatments differed significantly among themselves. Maize intercropped with cowpea proved to be the best treatment by registering lowest of 5.65 per cent dead hearts, other promising treatments were maize + field bean (8.22%) and maize + coriander (9.69%) and maize grown as sole crop was found to be least effective treatment by recording highest percentage of dead hearts (13.53%) (Table 2).

Effect of organic manures on per cent dead hearts

At 20 DAS, Soil application of neem cake had minimum percentage of dead hearts (4.70%) being statistically superior to rest of the treatments. Next to this treatment were poultry manure (7.05%) and rice hull ash (7.38%). FYM+RDF differed significantly by recording maximum of 9.95 percentage of dead hearts which was found to be statistically inferior among the various treatments. At 40 DAS, neem cake registered minimum of 6.95 per cent dead hearts which was the best among all the treatments, followed by poultry manure (9.79%) and rice hull ash (10.25%). Wherein, FYM+RDF recorded maximum percentage of dead heart (13.43%) being significantly inferior to all other treatments. Almost similar trend was recorded with respect to 60 DAS (Table 2).

Table 2
Effect of intercropping systems and organic manures on the per cent dead hearts by stem borers in maize

Treatments	*20 DAS*	*40 DAS*	*60 DAS*	*Mean*
M1	3.22[a]	6.73[a]	6.44[a]	5.65[a]
M2	6.86[b]	8.95[b]	9.03[b]	8.22[b]
M3	7.94[c]	10.19[c]	10.45[c]	9.69[c]
M4	11.06[d]	14.54[d]	14.32[d]	13.53[d]
SEm+	0.03	0.02	0.04	0.03
CD (p=0.05)	0.12	0.08	0.13	0.10
S1	9.95[d]	13.43[d]	13.37[d]	12.39[d]
S2	7.05[b]	9.79[b]	9.78[b]	9.01[b]
S3	4.70[a]	6.95[a]	6.95[a]	6.32[a]
S4	7.38[c]	10.25[c]	10.14[c]	9.38[c]
SEm+	0.04	0.04	0.04	0.02
CD (p=0.05)	0.12	0.13	0.10	0.06
M1S1	4.83[e]	9.35[h]	9.02[f]	8.00[f]
M1S2	3.12[b]	6.33[c]	6.12[b]	5.47[b]
M1S3	1.56[a]	4.29[a]	3.96[a]	3.34[a]
M1S4	3.37[c]	6.95[d]	6.68[c]	5.80[c]
M2S1	9.84[k]	12.56[k]	12.51[j]	11.67[i]
M2S2	6.58[g]	8.51[f]	8.48[e]	7.72[e]
M2S3	4.09[d]	5.96[b]	6.31[b]	5.45[b]
M2S4	6.93[h]	8.76[g]	8.81[f]	8.03[f]
M3S1	10.98[l]	12.82[l]	13.08[k]	12.34[j]
M3S2	7.41[i]	9.98[i]	10.42[h]	9.48[g]
M3S3	5.55[f]	7.46[e]	7.59[d]	7.01[d]
M3S4	7.82[j]	10.51[j]	10.71[i]	9.93[h]
M4S1	14.16[n]	18.99[o]	18.88[n]	17.54[m]
M4S2	11.09[l]	14.31[m]	14.08[l]	13.36[k]
M4S3	7.58[i]	10.08[i]	9.95[g]	9.47[g]
M4S4	11.40[m]	14.78[n]	14.37[m]	13.77[l]
SEm+	0.08	0.09	0.07	0.04
CD (p=0.05)	0.23	0.25	0.21	0.11

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

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

Overall mean value indicated that neem cake recorded minimum of 6.32 per cent dead hearts which was significantly superior to all other treatments, followed by poultry manure (9.01%) and rice hull ash (9.38%). FYM+RDF recorded highest percentage of dead hearts (12.39%) which was found to be least effective among the various treatments (Table 2).

Interaction effect of intercropping systems and organic manures on per cent dead hearts

At 20 DAS, among the interactions of different intercropping systems with organic manures, lower percentage of dead hearts was recorded in M1S3: maize + cowpea with neem cake (1.56%), M1S2: maize + cowpea with poultry manure (3.12%) and M1S4: maize + cowpea with rice hull ash (3.37%) being statistically superior to all other interactions. Whereas, M3S1: maize + coriander with FYM+RDF (10.98%), M4S2: maize sole crop with poultry manure (11.09%), M4S4: maize sole crop with rice hull ash (11.40%) and M4S1: maize sole crop with FYM+RDF (14.16%) combinations registered higher percentage of dead hearts being statistically inferior to all other treatments (Table 2).

At 40 DAS, among the combinations of intercropping systems with organic manures, the results indicated that M1S3: maize +cowpea with neem cake (4.29%) and M2S3: maize+ field bean with neem cake (5.96%) recorded lower percentage of dead hearts which were most effective treatment combinations. The treatment combinations of M3S1: maize + coriander with FYM+RDF (12.82%), M4S2: maize sole crop with poultry manure (14.31%), M4S4: maize sole crop with rice hull ash (14.78%) and M4S1: maize sole crop with FYM+RDF (18.99%) recorded higher percentage of dead hearts damage which ranged from 12.82 to 16.58 per cent being ineffective compared to rest of the treatment combinations (Table 2).

The overall mean per cent dead hearts indicated that among the combinations of intercropping systems with organic manures lower percentage of dead hearts was recorded in M1S3: maize +cowpea with neem cake (3.34%). While, treatment combinations with higher per cent dead hearts were noticed in M3S1: maize + coriander with FYM+RDF (12.34%), M4S2: maize sole crop with poultry manure (13.36%), M4S4: maize sole crop with rice hull ash (13.77%) and M4S1: maize sole crop with FYM+RDF (17.54%) ranging from 12.34 to 17.54 per cent being ineffective compared to rest of the treatments (Table 2).

The present results are in line with the findings of Omolo and Seshu Reddy [8] in Kenya who identified sorghum and cowpea as the best crop combination in minimizing stem borer population, stabilizing productivity and reducing yield loss. The maize and sorghum as intercrop was found to be inferior. With regard to dead heart formation, lowest per cent dead hearts were formed in maize intercropped with cowpea in 2:1 ratio. Mahadevan and Chelliah [9], Spurthi [10] and Anonymous [11] reported that sorghum inter cropped with cowpea reduced the incidence of *C. partellus* and other borers.

All these reports are in support of the present investigation.

In the absence of the literatures pertaining to the superiority of neem cake against maize stem borers, related reviews of brinjal shoot and fruit bores was 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 [12] who observed less brinjal shoot and fruit borer infestation in neem cake treated plots as against NPK as inorganic form. The treatment combined with organic and inorganic showed very low per cent reduction of shoot and fruit infestation compared to organic treatments. The application of neem cake can be attributed to the presence of triterpenoids which exhibited high antifeedant property due to which hardening of the plant tissue takes place which will provide mechanical resistance to the boring larvae, respectively [13].

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