Food and Agriculture Organization of the United Nations

Ministry of Agriculture

Department of Agricultural Research Services

SUSTAINABLE FALL ARMY WORM MANAGEMENT IN MALAWI

Authors:

H. B Dambolachepa, E.D.L Mazuma, R.S Banda, B. Chisama

Chitedze Agricultural Research Station, P.O Box 158, Lilongwe.

September, 2023

1.0 Introduction

1.1.Background information

Fall armyworm (FAW) (*Spodoptera frugiperda)* is an insect pest, which has wide host range encompassing over 80 crop species including maize (*Zea mays*), sorghum, millet, sugarcane, cotton and some vegetables crops. It is a migratory pest and can fly over 100 km in a single night in search of food and suitable breeding areas. This attribute explains the rapid spread of FAW to many countries within a short period, reaching epidemic proportions, and causing significant crop losses to farmers. Additionally, it negatively impacts local biodiversity and the environment. The pest is therefore a food security threat and needs to be managed.

It is estimated that 8.3 to 20.6 million metric tons of maize, an equivalent of USD 2.5 billion to USD 6.2 billion, is annually lost to FAW in 12 African countries alone. The lost quantity is estimated to have been adequate to feed 40 million to 100 million people. Africa has therefore experienced its own share of food security threat and reality from FAW. It is for this reason that efforts have been made by various stakeholders to identify measures that can be used to sustainably manage FAW in the region. These measures include Good agriculture practices, physical control, botanicals, low risk pesticides and use of other substances identified as effective and sustainable control options for FAW that can be systematically use in combination in an integrated pest management (IPM) strategy.

The Food and Agriculture Organization of the United Nations (FAO) developed a three-year (2019-2022) Global Action for Fall Armyworm Control (GA). The GA ensured that there is coordinated approach to the FAW management at country, regional and global levels. Under the GA, Malawi was one of the eight countries, selected to run sustainable FAW management demonstrations in Southern Africa. Ministry of Agriculture through Departments of Agricultural Research Services (DARS), Crop Development (DCD) and Agricultural Extension Services (DAES) is running the demonstrations with financial and material support from FAO.

The goal of the programme was to reduce maize yield and production loss to FAW by scaling up the adoption of sustainable and effective FAW management technologies in Malawi and Southern

Africa through demonstrations. It was expected that the programme would produce various outputs such as hunger and poverty reduction that will lead to the following outcomes: first, global, regional, national and farmer-level coordination and collaboration on FAW control would be enhanced, which will result in implementation of ecosystem friendly IPM practices and policies. Second, the reduction in crop yield losses caused by FAW. Third, prevention of spread of FAW to new areas.

The Department of Agricultural Research Services through the Plant Protection Commodity Team at Chitedze Agricultural Research Station was entrusted to implement the national demonstrations on a 10-hectare land in 2021/2022 cropping season. Use of local plant botanicals, good agricultural practices (maize-legumes intercrop and mulching) and use of low risk pesticide were the technologies demonstrated. During 2022/2023 season the demonstrations were planted for both winter at Kandiyani irrigation site and as rainfed at Chitedze sites respectively on 5-ha land.

1.2.Objectives:

i. To demonstrate a scale-up use of effective and sustainable FAW management technologies in Malawi and Southern Africa for control of FAW;
ii. To effectively disseminate information on best practices on FAW-IPM to farmers and other stakeholders; and
iii. To demonstrate performances side-by-side comparison of best bet technologies versus conventional practice (control) in FAW management.

1.2.1. Field lay out

5 ha of land was demarcated based on the number of treatments and the two maize varieties to be used. There were 9 treatments (see list below) and each was allocated half a hectare portion of land. A 2-meter separation distance was left between the treatments and the varieties. Each of the 0.5 ha was further split into two equal portions (0.25 ha) and were allocated to the two maize varieties; DK 777 and SC 719. The exercise was carried from 22nd to 25th December 2021.

1. Crop treated with Neem based on scouting results

2. Crop treated with *Tephrosia vogelli* (ombwe) based on scouting results
3. Crop treated with *Neorautanemia mitis* (mphanjobvu) based on scouting results
4. Crop treated with synthetic pesticide, *flubendiamibe* based on scouting results
5. Crop with a mulch and regularly scouted
6. Crop without any form of treatment but regularly scouted (control)
7. Plot with maize/cowpea intercrop and regularly scouted
8. Plot with maize/soy bean intercrop and regularly scouted
9. Plot with maize pigeon pea intercrop and regularly scouted

10. Figure 1: Collection of plant botanicals on Namangungu hill, Kandeu, Ntcheu district

1.2.2. Planting

Maize was planted on ridges spaced at 75cm apart, at 25 cm intra-row spacing, 1 seed per station. Cowpea was planted at 10 cm intra-row spacing, 2 seeds per station. Soybean was planted at 5 cm intra-row spacing, 2 seeds per station. Pigeon pea was planted 60 cm intra-row spacing, 3 seeds per station. For the intercrop plots, maize-legumes were planted as stipulated in the protocol; 2 rows for maize, 1 row for the legume. Supplying and thinning were carried out immediately after seed germination.

1.2.3. Staff orientation

Staff trainings were conducted on pest scouting and data collection at harvest. The trainings were facilitated by FAO and comprised of theory as well practical's which were conducted at Kandiyani.

1.2.4. Weed management and mulching

In order to maintain the fields free of weeds, harness, a pre-emergence herbicide was applied. The herbicide was applied at the rate of 300ml in 16 liters of water as stipulated on the instruction manual. According to the protocol, mulching is one of the treatments and maize stovers were used as mulch.

Figure 2: One hectare of land under the mulch as management practices being demonstrated at the site.

1.2.5. Fertilizer application

Timely application of both basal and top-dressing fertilizers which is recommended for a good crop response and yield was followed. The fertilizer application was done on time. For instance, basal dressing fertilizer was applied just after 10 days of planting, followed by the application of top-dressing fertilizer after 21 days of basal fertilizer application.

1.2.6. Hand weeding

Soon after the weeds appeared in the field, hand weeding was carried out. This was to ensure that the demonstration plots remained weed free.

1.2.7. Pest scouting, data collection and pesticides application

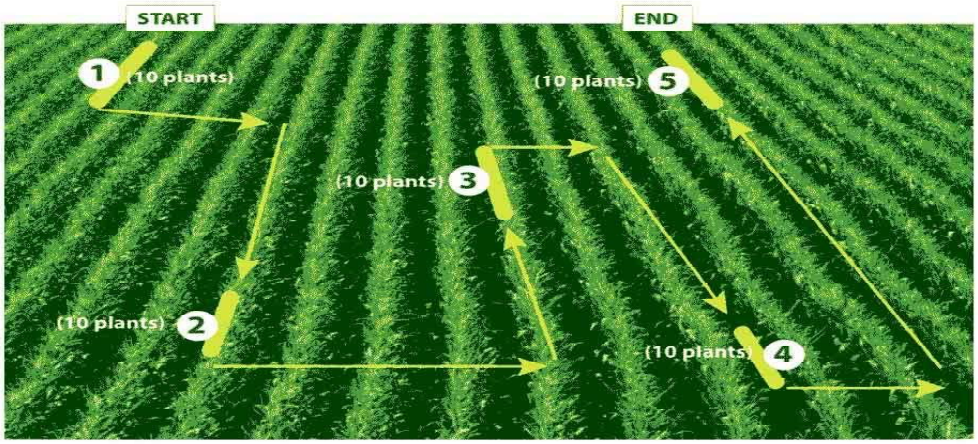
Pest scouting started from 7th November, 2022 exactly 7 days after planting. Scouting is key to pest management informs determination of threshold levels foe decision making on whether or not to apply treatments in maize fields. The main focus of scouting was for early detection of fall armyworm damage symptoms and infestation. In general, scouts focused on fresh signs of FAW egg-hatch and larval feeding, rather than looking for the FAW larvae themselves as it is non-

destructive. The signs that were checked during scouting included characteristics such as leaf damage, holes in the ear, and frass.

Figure 3: Plant Protection Officers carrying out pest scouting

Scouting procedure

Figure 4: The scouting procedure the used the Walk a letter "W", covering the entire field



Source: FAW Guidance note number 2

- At the start, at every turn, and at the end, 10 plants were inspected in a row. These ten plants were named a "station".
- The scouting process checked carefully in the whorl of each plant for signs of recent leaf damage or fresh frass in the whorl. These could indicate a live larva feeding activity, FAW.
- Signs of FAW presence (fresh leaf damage or frass in whorl-proxy for the presence of larvae) were checked. So the sampling was fast, non-destructive and it was always carried out on every 7 days from the previous scouting. whorls were checked (3-5 young leaves) and cob damage where they had started to form or had formed.
- During scouting, an overall assessment of the fields, the crops, and for FAW, was made and recorded.
- Naturally-occurring "farmers' friends" that help control FAW – predators (ants, earwigs, pirate bugs, birds, etc.), parasitoids (wasps that kill eggs and larvae), and pathogens (bacteria, fungi, and virus) were also recorded during scouting.
- Uneven darkened eggs and any larvae killed by parasitoids (white silken cocoons) or pathogens (hard or soft larval cadavers) were also assessed and recorded.
- Information collected during field scouting was carefully recorded in order to determine the threshold level for determining when to treat the maize crop.
- The botanical pesticides were applied on the whorl of the maize plant when the FAW infestation levels had reached 20%.
- Scouting, data collection and pesticides application were carried out for about 13 weeks.

Figure 5: Preparation of botanical pesticides at Chitedze

Figure 6: First application of botanical pesticides in the field

1.2.8. Preparation and application process of aqueous treatments

The botanical pesticides preparation, processing and application were done as prescribed in the tables 1 and 2 below. Botanicals were applied starting from week number 4 and continued on week 7, 10 and 12 (Table 2)

Table 1: Description of botanical pesticides preparation

Neem leaf extract:	30 kg plant powder per hectare which had been shade dried and pounded was used with 2 kg soaked in 20 liter of water and let it stand under shed for 12hrs, then filtered the mixture was used within 24 hrs. The filtrate was applied into leaf whorls during the afternoon when the FAW infestation level reached 20%. 6 tablespoons of dishwashing liquid soap were added to the filtrate and shaken vigorously, to act as a surfactant
Tephrosia vogelii leaf extract:	30 kg plant powder per hectare which had been shade dried and pounded was used with 2 kg soaked in 20 liter of water and let it stand under shed for 12hrs, then filtered the mixture was used

	within 24 hrsThe filtrate was applied into leaf whorls during the afternoon when the FAW infestation level reached 20%. 6 tablespoons of dishwashing liquid soap were added to the filtrate and shaken vigorously, to act as a surfactant
Neorautanenia mitis (Mphanjobvu)	Weighed 6kg of tubers, cut into pieces and pound (90kg/ha). Soaked 6 kg in 20litres of water overnight and sieved the mixture. Applied the filtrate to the maize crop when the FAW infestation level reached 20%.

Table 2: FAW infestation level (%) at weekly interval for Kandiyani 2022/23 winter season

Treatment Week	T1	T2	T3	T4	T5	T6	T7	T8	T9
1	0	0	2	2	0	6	4	1	0
2	0	0	4	5	2	7	5	2	0
3	17	15	17	18	16	16	16	15	3
4	28	19	10	32	28	37	29	13	6
5	5	13	7	4	11	34	13	12	9
6	4	12	4	3	15	36	16	16	7
7	24	17	29	19	25	38	17	25	29
8	4	12	4	4	15	32	16	2	6
9	4	5	12	6	12	36	23	13	6
10	30	25	36	9	48	26	40	37	29
11	8	11	4	5	39	24	42	33	36
12	20	31	22	17	43	21	27	37	16
13	2	6	4	2	29	31	21	17	12

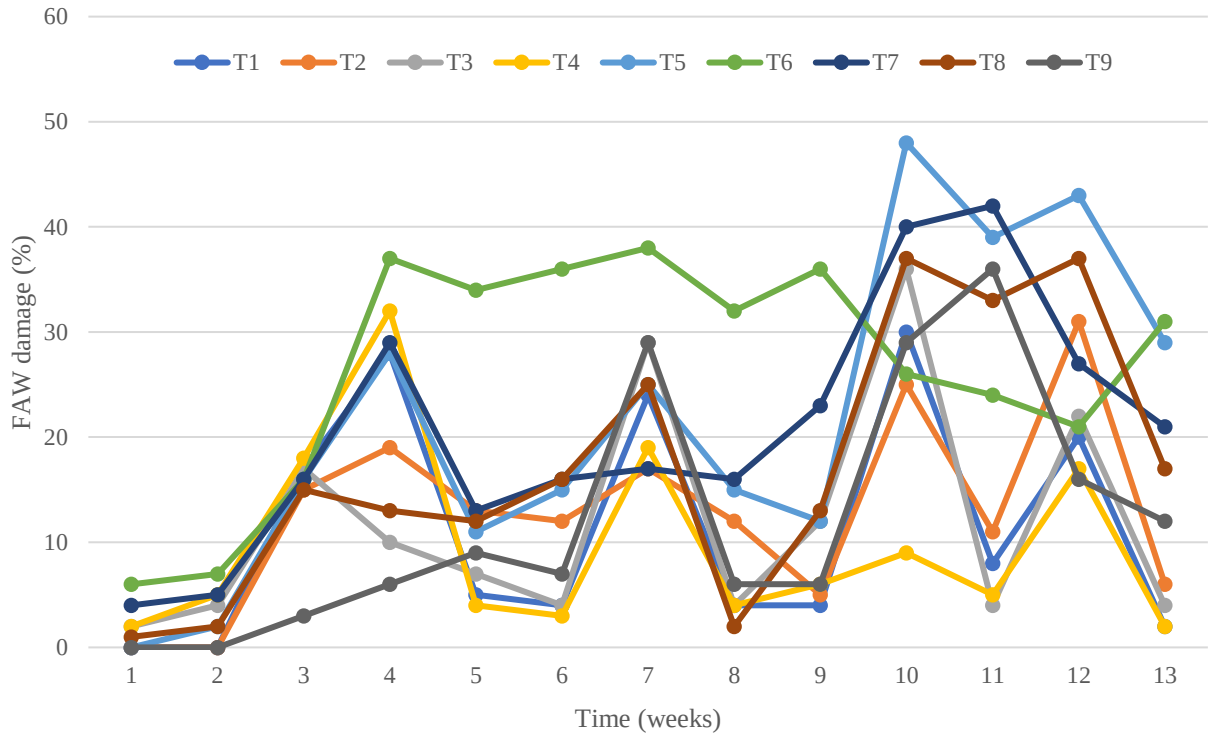


Figure 7: FAW infestation levels (%) at Kandiyani during 2022 winter season

1.2.9. Scouting results

Neem and Mphanjobvu were observed to be highly effective in controlling FAW damage more similar to synthetic pesticides. Maize pigeon pea intercrop was also observed as highly effective in controlling FAW as compared to soy bean and cowpea intercrops

1.2.10. Data collection at harvest

At harvest data was collected using the following equipment and tools;

i. Weighing balance (kitchen digital balances)
ii. Moisture meter
iii. Cob damage scoring chart and writing materials
iv. Sampling materials (sacks, 500g plastic bags)

The yield sub plot (ysp) on the treatment plot were established thereafter randomly sampled and harvested 30 cobs from the sub plot. The harvested cobs were kept into sacks and recorded the type of treatment on the sack. The cobs were dehusked and look for presence of FAW larvae or other earworms. The cobs were then shelled and recorded.

Table : Number cobs with of FAW entry holes, damage score, moisture content, cob and grain weight in kgs per ha for Kandiyani 2022 winter season

	N. of cobs with FAW entry holes	Cob damage score	Average Moisture Content	No. of FAW larvae	No. of other earwom larvae	Cob weight (Kg/ha)	Grain yield (Kg/ha)
Neem	0	1	13.8	0	0	2086	1696
Tephrosia	1	2	16.45	1	0	2156	1750
Mphanjobvu	2	2	15.35	0	2	2155	1726
Synthetic pesticides	0	1	16.65	0	0	1713	1353
Mulching	2	2	17.73	1	2	2027	1656
Control	4	3	17.16	1	1	1616	1253
Maize/cowpea	1	1	16.87	0	3	1832	1505
Maize/soy	2	1	15.7	0	2	1925	1527
Maize/pigeon pea	0	1	16.2	0	4	2489	2073

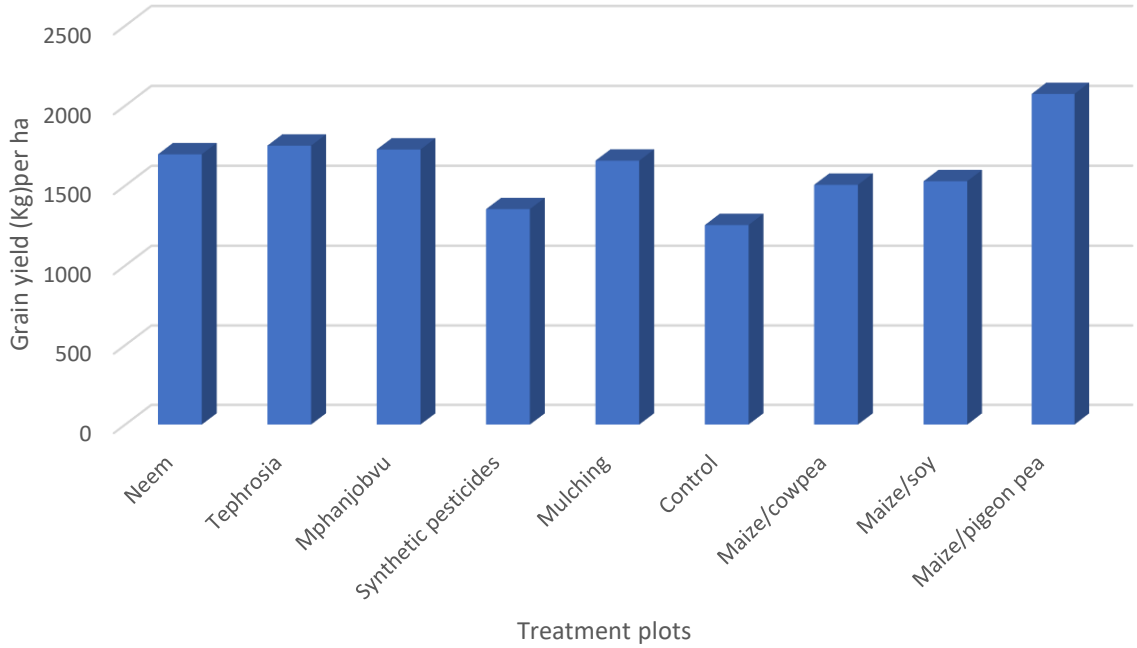


Figure 8: Grain yield (Kg/ha) for Kandiyani winter demonstration

1.2.11. Yield results

The treatment plot for maize/pigeon pea intercrop had the highest grain yield followed by plot treated by Tephrosia and Mphanjobvu. On the other hand, control had the lowest grain weight. This could be suggested that the maize/pigeon pea plot could harbor natural enemies/predators that feeds on FAW hence reduced the damage as compared to the control plot. This in turn resulted in high yields realized in maize/pigeon pea intercropped plot. Also, treatment plots on which Neem, Mphanjobvu and Tephrosia were applied had slightly high yields than on control plot. This could be due to reduced FAW damage as a result of application of those botanicals.

2. Chitedze FAW management demonstrations under rainfed

2.1.1. Weed management and mulching

In order to maintain the fields free of weeds, harness, a pre-emergence herbicide was applied. The herbicide was applied at the rate of 300ml in 16 liters of water as stipulated on the instruction

manual. According to the protocol, mulching is one of the treatments and maize stovers were used as mulch.

2.1.2. Fertilizer application

The fertilizer was applied just once as basal dressing on 24th January, 2023.

2.1.3. Hand weeding

Soon after the weeds appeared in the field hand weeding was carried out. This was to ensure that the demonstration block remained weed free.

2.1.4. Staff trainings

Staff trainings on pest scouting and data collection at harvest were conducted. Pest scouting orientation was conducted on 23rd December, 2023. This was to equip the staff involved in data collection right skills and knowledge on pest identification.

2.1.5. Pest scouting, data collection and pesticides application

. The procedure for scouting as described for Kandiyani demonstrations was used.

2.1.6. Pest scouting results

Table 3: FAW infestation level (%) at weekly interval for Chitedze rainfed season 2023.

Treat. Week	T1	T2	T3	T4	T5	T6	T7	T8	T9
1	0	0	0	0	0	0	0	0	0
2	0	0	1	0	0	1	1	0	0
1	0	2	1	1	1	0	0	2	1
4	2	6	8	3	5	4	5	4	8
5	18	20	28	18	16	14	12	12	4
6	3	7	2	12	4	13	8	12	7
7	11	16	9	14	19	20	11	6	8
8	3	9	2	5	13	38	18	8	8
9	42	40	38	28	64	48	28	40	12
10	3	8	6	2	18	4	8	6	20

11	4	13	8	12	23	9	6	8	3
12	18	27	16	38	42	20	8	6	4
13	2	5	2	9	39	18	5	6	2

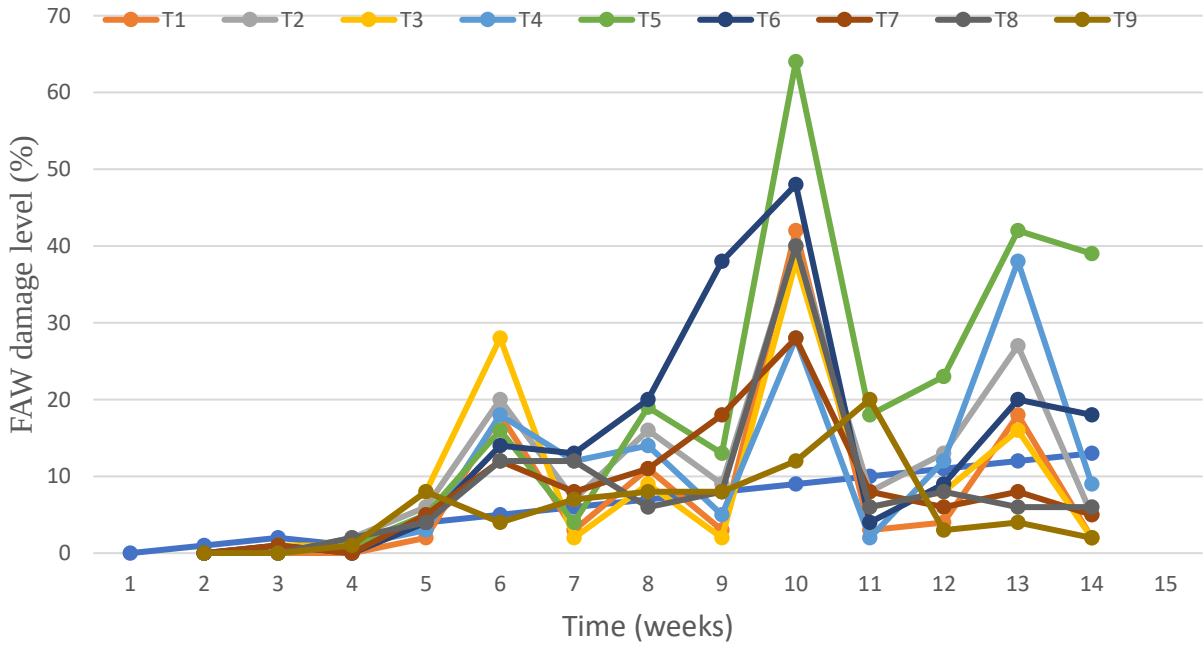


Figure 9: FAW damage level (%) for Chitedze during 2022/2023 rainfed demonstration

The three botanicals Neem, Mphanjobvu and Tephrosia were observed with low FAW damage levels as compared to control and mulching treatment plots. Treatment with maize pigeon pea intercrop was also observed with low level of FAW damage.

Field days

As a way of showcasing the FAW management practices being demonstrated, field days were supposed to be conducted at least for three times thus; during the growing period; at Vegetative stage, at Tasselling/cobbing stage and at harvest stage. During the tasselling stage, the organizing committee of the field day held a meeting to plan for logistical arrangements for the field day. In the process it was agreed that the committee should visit the field to appreciate the technologies. The committee observed following:

1) The crop was heavily attacked by leaf blight disease such that the effects of the treatments being demonstrated are not visibly clear. This was due to heavy rains that had provided conducive environment for the leaf blight disease development.

2) The crop was not looking health because it did not receive adequate fertilizer hence the crop was miserably looking yellowish. This happened because the implementers did not receive financial support at the time when fertilizer application was needed.
3) The field was weedy because there was no financial support to hire labor force at the time weeding was to be carried out.

With the outlined issues it was felt that the field day should be cancelled because it would not portray the message that was intended to be shared with the target audience.

2.1.7. Data collection at harvest

At harvest data was collected using the following equipment and tools;

v. Weighing balance (kitchen digital balances)
vi. Moisture meter
vii. Cob damage scoring chart and writing materials
viii. Sampling materials (sacks, 500g plastic bags)

The yield sub plot (ysp) on the treatment plot were established thereafter randomly sampled and harvested 30 cobs from the sub plot. The harvested cobs were kept into sacks and recorded the type of treatment on the sack. The cobs were dehusked and look for presence of FAW larvae or other earworms. The cobs were then shelled and recorded. The botanicals were applied starting from week number 5 and continued on week 7, 10 and 9.

2.1.8. Yield results

Table 4: Number cobs with of FAW entry holes, damage score, moisture content, cob and grain weight in kgs per ha for Chutedze 2022/23 winter season

	N. of cobs with FAW entry holes	Cob damage score	Average Moisture Content	No. of FAW larvae	No. of other earworm larvae	Cob weight (Kg/ha)	Grain yield (Kg/ha)
Neem	0	1	15.9	0	0	1729	1425
Tephrosia	1	1	14.4	0	0	1628	1278
Mphanjobvu	0	1	16.3	0	0	1582	1341
Synthetic pesticides	0	1	15.0	0	0	1864	1633
Mulching	2	2	15.7	1	0	1671	1457
Control	2	2	13.8	1	0	1493	1211
Maize/cowpea	0	1	16.4	0	0	1692	1309

Maize/soy	0	1	15.6	0	1	1726	1520
Maize/pigeon pea	0	1	16.0	0	0	1789	1591

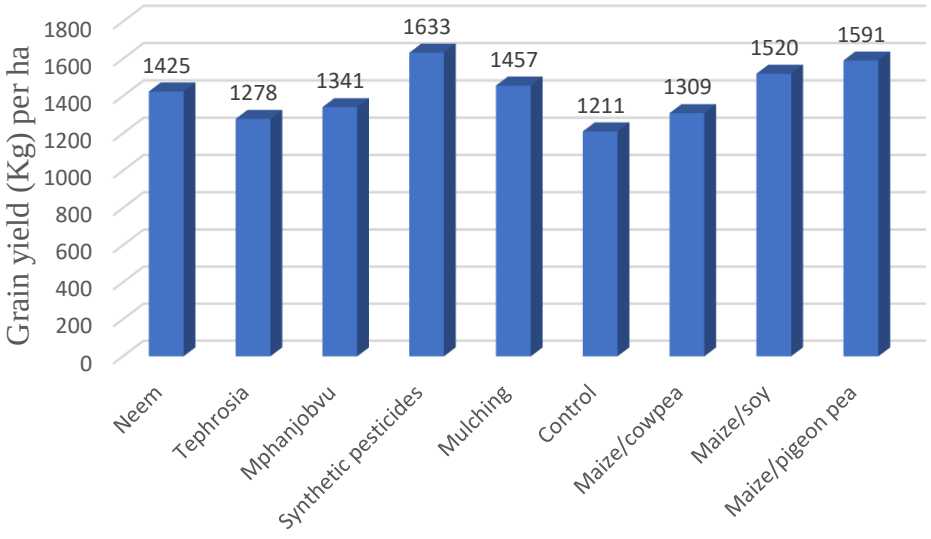


Figure 10: Grain yield for Chitedze demonstration during 2022/2023 season

The treatment plot on which synthetic pesticides was observed with highest grain yield as while control had lowest grain yield. Maize/pigeon pea intercrop as well as maize/soy intercrop also had higher grain yields. Reduction in FAW damage could be among the factors for higher yields.

Conclusion

Basing on the findings from the demonstrations it is use recommended that fall army can be managed through use of local plant botanicals and practicing maize legume intercrop.