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Research Paper

Impact of intercropping tomato and maize on the infestation of tomato fruit borer [*Helicoverpa armigera* (Hubner)]

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Abstract. A field experiment was carried out at the Teaching and Research Farm of Faculty of Agriculture, University of Maiduguri during 2012 and 2013 cropping seasons in a Randomised Complete Block design with five treatments replicated three times. Treatments comprised of one sole tomato (1:0) and four inter crop patterns (1:1, 1:2, 2:2 and 1:3). The objective of the study was to investigate the effect of intercropping tomato (base crop) and maize (component crop) in reducing the incidence and damage of tomato fruit borer (*Helicoverpa armigera)* in Northern Guinea Savannah of Nigeria. The results showed that fruit borer larvae holes per plant was found minimum when tomato was intercropped and maximum in sole crop tomato. Higher fruit damaged per plant and lower undamaged fruits were recorded in sole crop tomato than intercrop tomato and this supported the higher fruit weight and total fruit yield in intercrop tomato than sole tomato. This study therefore recommends maize and tomato intercrop for more effective fruit borer control. There should be a need for identifying effective intercropping patterns in other cropping systems for a sustainable vegetable production in Nigeria.

Keywords: Tomato, fruit borer, intercropping, maize.

INTRODUCTION

Intercropping is the cultivation of two or more crops at the same time in the same field. A wide range of crops can be used for intercropping (Gomez, 1990; Andow, 1991). Intercropping has some suppressing effects on most of the insect pests through the changed cropping canopy and resultant change in micro-climate (Jayaraj, 2002; Ijoyah, 2012; Degri et al., 2014).

Monocropping on the other hand is often highly productive and efficient, but criticized for their genetic uniformity and increased pest susceptibility (Chatterjee and Mandal, 1992). Tomato crop is prone to many insect pest infestations (Mailafiya et al., 2014) particularly the devastating fruit borer *(Helicoverpa armigera*) which is a serious pest of tomato in both rainy and dry season in Nigeria and other tomato growing countries (Trenbath, 1993; Pino et al., 1994; Degri and Mailafiya, 2013). Intercropping which is closely associated with peasant agriculture is a practice that involves the growth of two or more crops in proximity, in the same field during a growing season to promote interactions between them. The main reasons for practicing intercropping by poor-resource farmers than monocropping include reduction in pests and diseases incidence, increase biodiversity, crop stability, risk spreading, food security, effective use of labour, increased crop productivity and erosion control (Willey, 1985; Uva, 1985; Trenbath, 1993; Gomez, 1990). Intercropping leads to the diversity of crops grown and reduction of plants of the same species is increased due to the planting of other crops between them, alteration of more beneficial insect pests especially when following crops are included in the cropping system and reduction of weed population (Patil et al., 1997; George and Jeruto, 2010; Ram and Singh, 2010).

Tomato intercrops with other crops of different canopy significantly influence tomato insect pest populations' density and reduces fruit damage than sole tomato crops (Prasad et al., 1987; Pino et al., 1994; Sharma and Tiwari, 1996). It proved to create a successful barrier in checking the incidence of tomato fruit borer. Intercropping influences the migration of insect pests in such a way that crop colonization is delayed thus lower population level of the insect pest species in intercropped crops than sole crops (Risch, 1983; Steiner, 1984; Hugar and Palled, 2008; Altieri and Liebman, 1994).

The use of insecticides has been the major control measures for tomato fruit borer in Nigeria (Degri and Mailafiya, 2013). Since the fruits are eaten raw in salad, the health and environmental hazards associated with insecticides should be avoided. The current interest in integrated pest control and organic agriculture in Nigeria, therefore, needs alternative control measures that are effective, affordable, adoptable and safe to users and consumers. The use of intercropping systems is one of such alternatives to insecticides. It is a non-chemical cultural practice that has the potential to reduce pest infestation because it increases crop diversity. However, much intercropping studies have been focused on cereal–legume (Ofori and Stern, 1987; Clue, 1993; Sullivan, 2003; Woomer et al., 2004; Degri et al., 2012; Degri et al., 2014) and fewer studies on cereal-vegetable intercropping. A study on the designs and patterns of maize-tomato intercropping systems with respect to tomato fruit borer control is worthwhile. Thus the aim of this study was to assess the influence of tomato planted at different intercrop patterns with maize in reducing the incidence and damage of fruit borer in this agro-ecological zone of Nigeria.

MATERIALS AND METHODS

Experimental site

The experiment was conducted at the Teaching and Research farm University of Maiduguri, Nigeria during rainy season (June to October) in 2012 and 2013. The main objective of the study was to investigate the influence of intercropping tomato and maize in reducing the incidence and damage of tomato fruit borer (*Helicoverpa armigera*). The site is sandy-loam soil, well drained and flat.

Material collection

The variety of tomato Roma VFN used and maize variety Obatanpa, intermediate maturity type are both popular varieties grown by farmers and show good adaptation to the local environment. The seeds of both the tomato and maize were purchased from the input store of Borno State Agricultural Development Programme (BOSADP). The seeds were treated and well sealed in water proof nylon bags.

Experimental procedures, designs and cultural practices

The experiment was conducted in a Randomised Complete Block design with five treatments replicate three times. The treatments comprised of sole tomato (1:0), one row tomato and one row of maize (1:1), one row of tomato and two rows of maize (1:2), two rows of tomato and two rows of maize (2:2) and one row of tomato and three rows of maize (1:3). Tomato seedlings were raised in a shade nursery at the beginning of the rainy seasons at the Faculty of Agriculture Orchard. Prior to the seedling transplant, field plots of 4.0 m × 3.0 m size with 1.0 m interspace, 1.5 m alley and 2.0 m outside border were prepared after cleaning, harrowing and ridging the entire field to achieve a minimum tillage. Tomato seedlings were watered in the nursery and drain-off to field capacity. Five weeks after sowing (5 WAS), tomato seedlings were gently uprooted with their roots covered with soil and transplanted at 2 to 3 cm deep at a spacing of 60 cm × 60 cm in their appropriate intercrop patterns. Maize was planted at the same time with tomato at inter-row spacing of 25 cm at their respective number of rows (single, double, triple rows) on top of the ridges in between tomato rows at the seed rate of 2 to 3 seeds per stand and 2 to 3 cm deep. The maize stands were later at one week after planting (WAP) thinned to 2 plants per stand. One week after transplanting of tomato and during thinning of maize plants, failed stands of both tomato and maize were filled to maintain all the existing gaps. After the filled gaps were established the plots were weeded and NPK 15:15:15 fertilizer applied twice to each crop at 4 and 7 weeks after planting and transplanting for both the sole and intercrops.

Maize was harvested at 11 WAP, when the tassels and leaves turned yellowish and fallen off which were signs of senescence and cob husks dried as a sign of maturity. The tomato fruit were harvested when the green fruits turned yellow or red, which were signs of ripening.

Data collection

Data taken for tomato included the incidence of fruit borer larval holes at 7 days intervals from appearance of the fruit to crop maturity (fruit ripening and harvest) by counting number of larval holes on fruits per 5 tagged plants in each plot. Total number of fruits damaged and undamaged were counted, weighed from the same 5 tagged plants in each plot. The damaged and undamaged fruits were sorted and weighed separately from each plot. Damaged fruits caused by fruit borer were characterized by tunnels or holes inside the fruit and

Table 1. Effect of intercropping tomato and maize on number of larval holes/plant in 2012 and 2013 cropping season.

Intercropping pattern	No. of holes/plant %	Reduction over control
1:0	5.64	-
1:1	3.72	34.04
1:2	1.32	76.59
2:2	2.83	49.82
1:3	1:30	76.95
SE±	0.30	
LSD	0.04	

Table 2. Effect of intercropping tomato and maize on number of damaged and undamaged fruits in 2012 and 2013 cropping seasons.

Intercrop pattern	No. of damaged fruits/plant	No. of undamaged fruits
1:0	10.28	39.60
1:1	6.90	49.76
1:2	4.13	42.33
2:2	5.33	56.65
1:3	3.27	68.71
SE±	0.02	0.33
LSD (0.05)	0.03	0.81

entranced exit holes on the fruit. Undamaged fruits were recognised on the bases of the absence of the fruit borer tunnels or entrance or exit holes.

The harvested fruits were weighed and recorded separately from each plant while the total fruit yield data was obtained from the weight of all the fruits harvested from each plot separately (damaged and undamaged fruits from each plot).

Data analysis

The data collected in respect of fruit borer count, fruit damaged and undamaged, fruit weight and fruit yield were subjected to analysis of variance (ANOVA). Fisher's least significant Difference (LSD) was used to separate the treatment means.

RESULTS

The result of number of larval holes per plant showed that the sole tomato crop (1:0) had the highest number with 5.64 while the minimum was from intercropped plots (1:3 and 1:2 with 1:30 and 1:32 holes/plant respectively (Table 1).

The number of damaged fruits per plant was higher (10.28) when tomato was planted sole than intercrops (Table 2). Tomato intercropped with maize at 1:2, 2:2 and 1:1 had moderate (4.13, 5.33 and 6.90) damaged fruits while the lowest (3.27) damaged fruits per plant was recorded when tomato was intercropped at 1:3. The maximum number of undamaged tomato fruits was from 1:3 intercrop patterns with 68.71 followed by 2:2 and 1:1 intercrop patterns with 56.65 and 49.76 damaged fruits per plant respectively. Tomato planted sole had the lowest number of undamaged fruits per plant.

Tomato fruit weight and fruit yield were significantly influenced by the intercropping patterns (Table 3). During the two year studies maximum fruit weight (35.12 g) and fruit yield (30.84 t/ha) were from 1:3 intercrop pattern while the minimum fruit weight (25.98 g) and fruit yield (18.74 t/ha) were from sole tomato crops. Tomato intercrop pattern 1:1, 1:2 and 2:2 had moderate fruit weight (26.49, 32.41 and 30.61 g) and fruit yield of 21.92, 28.44 and 22.36 t/ha, respectively.

DISCUSSION

All the intercrop patterns were significantly better in reducing the infestation of tomato by fruit borer than the sole tomato crop. The intercrop patterns were able to reduce the number of larval holes per plant, the number of damaged fruits/plant while improving the number of undamaged fruits/plant, fruit weight and fruit yield. This indicates that intercropping tomato and maize has a potential of reducing tomato fruit borer incidence and as noticed (Ram and Singh, 2010; Degri et al., 2014). The maximum number of larval holes per plant, higher number of damaged fruits/plant, lower fruit weight and fruit yield recorded in sole tomato crop indicate that

Table 3. Effect of intercropping tomato and maize on fruit weight and total yield in 2012 and 2013 cropping seasons.

Intercrop pattern	Fruit weight (g)	Total fruit yield t/ha
1:0	25.98	18.74
1:1	26.49	21.92
1:2	32.41	28.44
2:2	30.61	22.36
1:3	35.12	30.84
SE±	0.44	0.21
LSD(0.05)	1.10	0.50

monocropping encourages pest incidence build up and damage compared to intercropping (Prasad et al., 1987; Trenbath, 1993; Pino et al., 1994). Jayaraj (2002) reported that intercropping base crop with component crop have some suppressing effects on most insect pests through the changed cropping canopy and resultant change in micro climate. The higher number of undamaged fruits/plant, higher fruit weight and fruit yield registered in intercropped tomato with maize implies that tomato fruit borer which is a specific pest of tomato did not spread as easily through an intercrop as it did in a sole crop (Adelana, 1984; Patil et al., 1997). George and Jeruto (2010) reported that intercropping causes reduction of insect/mite pest populations due to the diversity of crops grown, the distance between plants of the same species is increased due to the planting of the component crop between them. The higher number of undamaged fruits, fruit weight and fruit yield recorded in 1:3 intercrop pattern indicated that the distance between tomato to tomato were increased due to the planting of the 3 rows of maize crop between them. This result further shows that maize-tomato intercrop are compatible crop in the reduction and control of fruit borer (Hugar and Palled, 2008). Maize crop acted as a barrier against the spread of the tomato fruit borer (Olasantan and Lucas, 1992; Pino et al., 1994; Ijoyah, 2012). Martine (2011) reported that in tomato-maize intercrop, adult whitefly and fruit borer presence were decreased and fruit quality was better. The insect pest can be misled by the canopy of an intercrop and not recognize the specific crop they use as a host (Willey and Reddy, 1981; Clue, 1993). Substances that other crops produce may drive insect pests away from base crop in the intercrop (Willey, 1985; Uva, 1985; Patil et al., 1997).

CONCLUSION

Maize-tomato intercrop of different patterns proved to be successful and effective in checking the incidence and damage of fruit borer (*Helicoverpa armigera*) in tomato. Sole crop tomato suffered more attack and damage by the fruit borer while intercrop tomato had significantly lower attack and damage. As such intercropping as a cultural practice is greatly encouraged over sole cropping for sustainable tomato crop production by poor-resource farmers in the northern Guinea Savannah of Nigeria.

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