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Review

A Mini Review on Achievements of Planting Dates of Maize on the Incidence of Stem Borer

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Abstract

The main review purpose this paper provides updated information on the effect of different planting dates on the infestation of maize stem borer (Chilo partellus) were carried out at different areas by different investigators. The results different trials conducted in different agro ecological zone revealed that the damage was higher damage and yield decrease was recorded in late planted maize and the damage was gradually decreased and yield increase in early panted maize in season. Lower infestation was observed in winter season followed by spring and summer season respectively. This study suggests that the percent infestation of maize stem borer can be minimized by sowing early in crop season.

Keywords: Maize Infestation, Planting dates, Stem borer

INTRODUCTION

The yield of maize crop is adversely affected due to insect pests, diseases, weeds, nematodes and birds etc. The major insect pests that attack maize crop include maize aphids, cutworms, stem/shoot fly, root worm and stem borer. The grain losses range from 10-15% due to insect pests alone (Jaipal and Dass, 1993). The damage due to insect pest complex depends upon their population trends in the field which, in turn, rely upon their dynamically of the physical factors of their immediate environment (Isard, 2004). Maize stem borer attack all parts of the plant except roots and cause damage by the destruction of the growing point in the whorl (dead heart), loss of photosynthetic leaf area due to foliar feeding, lodging due to burrowing in the stem, and extensive damage to young kernels due to feeding of larvae from the second and third generations (Thakur et al., 2013).

Three stem borer species, namely Chilo partellus (Swinhoe) (Lepidoptera: Crambidae), Busseola fusca (Fuller) (Lepidoptera: Noctuidae), and African pink stem bore (Sesamia calamistis) (Lepidoptera: Noctuidae) constitute a major constraint to maize and sorghum production in Ethiopia (Getu et al., 2001; Wale et al., 2006). Routine and appropriate farm management practices can potentially alter the pest infestation levels of stem borers (Ebenebe et al., 2001). The most effective and simplest strategy of controlling stem borer are cultural practices, such as crop residue management (Gebre-Amlak, 1988; Dejen, 2004), intercropping (Tsehaye et al., 2007; Wale et al., 2007; Belay et al., 2009), and trap crops (Belay and Foster, 2010) have been recommended for reducing the damage caused by cereal stem borers in Ethiopia. Evaluation of other cultural method to control stem borer such as the planting datecould help to develop alternative strategy and to avoid certain insect infestation and reduce the need for chemical control. Therefore, modification of time of planting as cultural control method was reported to have a pronounced effect on the levels of infestation and subsequent yield loss caused by stalk borers in maize (Swaine, 1957; Harris, 1962; Abu, 1986; van Rensburg et at., 1985, 1987; Gebre-Amlak et al., 1989). This phenomenon has been attributed to the occurrence of distinct periods of moth flight (van Rensburg et al., 1987). Keeping in view the importance of maize crop and the severity of damage caused by maize stem borer. Therefore, in this review attempted made to evaluate the effectiveness of different planting dates for the management of stem borer in different region.

Geographic distribution

B. fusca is distributed widely throughout sub-Saharan Africa countries. In the eastern and southern parts of the continent, B. fusca is restricted to mid-and high elevations areas (>600m), whereas in West Africa, the same species is found at all elevations, but is most abundant in the savanna zone (Overshot et al., 2001). The counties in which B. fusca has been recorded include Angola, Benin, Botswana, Burkina Faso, Cameroon, Ethiopia, Ghana, Guinea, Cote d"Ivoire, Kenya, Lesotho, Malawi, Mali, Mozambque, Nigeria, Rwanda, Sierra Leone, Somalia, South Africa, Swaziland, Tanzania, Uganda, Zaire, Zambia and Zimbabwe (Harris and Nwanze, 1992). The pest population increases on wide number of other cultivated and wild host plants, mostly of the grass family (Khan et al., 1997). In Ethiopia, B. fusca and C. partellus are considered to be the most damaging insect pests, with reported yield losses of 0 to 100, 39 to 100, 10 to 19 and 2 to 27% from South, North, East and Western Ethiopia, respectively (Melaku et al., 2006). Assefa (1985) reported that C. partellus was a predominant species at lower elevation of less than 1700 m and B. fusca was dominant at high elevation of 1160 - 2600 m.a.s.l. and in cooler areas. Emana et al. (2001) also conducted a survey in 1999 and 2000 and reported that C. partellus widened its distribution from 500 - 1700 to 1030 - 1900 m.a.s.l. whereas B. Fusca was recorded between 1030 - 2320 m.a.s.l.

Biology of B. fusca fuller

The female lays many eggs in batches of 30-50, inserted between the sheath and the stem. Incubation lasts about 1 week. After hatching, the larvae feed on the young blades of the leaf whorl and then, suspended from silk strands, spread to neighboring plants. They penetrate the stems by boring through the whorl base. Generally, they destroy the growing points and tunnel downward. After passing through six to eight stages (30-45 days), they chew an outlet for the adult and pupate in the tunnel. Pupation lasts 10-20 days. Up to four generations are produced per year. At the end of the rainy season, larvae of the last generation enter diapause in maize and sorghum stubble or in wild grasses. They pupate a few months later, just before the start of the following rainy season. In the mid and high elevation an area of eastern and southern Africa, B. fusca is often the most important stem borer of maize. Yield losses have been estimated to be about 12% for every 10% of plants infested (Harris and Nwanze, 1992). In Sub-Saharan African countries, which include Ghana, B. fusa is considered the most important pest of maize, yield loss as high as 40% has been attributed to B. fusca infestations. In Zaire for instance, B. fusca occasionally caused yield losses of 8-9% in early-planted maize, and 22-25% in late planted maize. In Cameroon, Cardwell et al. (1997) reported grain loss at 4.6g per borer in low land fields and 8.7g per borer in highland fields.

Economic impact of stem borer

C. partellus is a major pest of maize, sorghum and pearl millet in Asia and in parts of Africa where it has become established. It has been shown to be generally less important but locally troublesome on rice, sugarcane and other crops. Its importance as a pest is growing in Southern Africa. Kfir (1997) showed that C. partellus populations have overtaken other stem borers as an important pest, even at higher altitudes than the coastal regions where it had first become established. Studies in Kenya investigating yield infestation relationships on maize (Reddy and Sum, 1992) and the development of predictive estimations of maize loss in South Africa (Bate et al., 1992) show the economic implications of C. partellus. Kfir et al. (2002) provides an interesting overview of losses experienced throughout Africa due to this pest. South African yield losses in both maize and sorghum due to this pest are estimated to exceed 50%. Similar or higher yield losses are experienced in other African countries; in Mozambique third generation C. partellus larvae have been reported to infest 87% of late planted maize cobs and 70% of grain crops. In particular Provinces in Mozambique 100% plant infestation resulting in considerable yield losses has been recorded. High levels of damage are common throughout resource-poor production areas in Africa where costs preclude the use of insecticides. Kfir et al. (2002) summarizes a 50-60% yield loss for sorghum and 30-70% infestation rate in maize in resource-poor areas in Zimbabwe. Corresponding yield losses in commercial production areas where insecticides are used are less than 30%. The high yield losses experienced in Africa due to the introduction and spread of C. partellus demonstrate the destructive potential of this stem borer should it establish and spread in Australia. While a range of management tools are currently available to reduce yield losses due to C. partellus these tools may be costly or not always applicable in an Australian production context. The estimated economic impact for C. partellus should it be introduced and spread in Australia is high.

Management Options for maize Stem Borers

Cultural control

Practice good crop hygiene, this includes the destruction of crop residues (stems and stubbles). Remove volunteer crop plants and/or alternative hosts. This reduces carryover of stem borers from one growing season to the next, and will help limit the most damaging attacks on young crops early in the growing season. Burning of crop debris breaks the life cycle by destroying larvae that hibernate inside stalks and plant material. It has been suggested that the partial burning of stalks will result in the killing of 95% of larvae, a practice not yet adopted by West African farmers (Adesiyum and Ajays,1980). Where previous cultivation practice has depended upon crop debris adding organic matter to the soil to maintain soil structure, other organic material input methods need to be developed. Damage avoidance by manipulation of sowing dates may also be used to avoid periods of peak adult activity. However, this is not practical in situations where lack of water is a major constraint as farmers often plant after first rains. Studies on several stem borers in Africa showed that soil nutrient levels, such as nitrogen, greatly influenced nutritional status of the plant and the plant's tolerance to stem borer attack. Although an increase in nitrogen is related to higher pest level loads and tunnel damage, there is also an increase in plant vigor with a net benefit to the plant as reflected in lower yield loses (Sétamou et al., 1995; Mgoo et al., 2006). Intercropping maize with cowpea is an effective way of reducing damage by the spotted stem borer caterpillars migrating from neighboring plants. Intercropping maize with molasses grass (Melinis minutiflora), a non-host for stem borers, will also reduce stem borer infestation on maize. This grass produces volatile agents which repel stem borers but attract the parasitic wasp Cotesia sesame. Planting an outer encircling row of some highly preferred hosts to act as a trap plant is also useful for the management of stem borers. Examples of trap plants are Napier grass (Pennisetum purpeum) and Sudan grass (Sorghum vulgare sudanense), which are common fodder plants in Africa. Napier grass for example, is highly attractive to egg laying moths, but only a few caterpillars complete their lifecycles on it. When they enter the stem the plant produces a gummy substance that kills the caterpillars. Thus Napier grass provides natural control of stem borers by acting as a trap crop attracting moths. In Africa a "Push-Pull" strategy has been developed combining use of intercropping and trap crop systems where farmers used Napier grass and the legume Disodium as intercrops

Chemical control

Granular formulations of benfuracarb, carbofuran and furathiocarb were evaluated as soil applications at planting in maize field trials in South Africa and were found to be effective in the control of C. partellus, Busseola fusca and Cicadulina mbila. These chemicals provided effective residual protection over most of the pre-tasseling period (Van Rensburg et al., 1991). Because of the cost, use of chemical control is rarely justified in low input agricultural systems (Ingram, 1958; Mathez 1972). In addition, the boring characteristic of the larvae protects them against the sprays and hence regular sprays may be required which subsistence farmers in developing countries cannot afford (Sithole, 1989). Good control responses in India were obtained using Quinalphos 5G and endosulfuran 4G (Katti and Verma, 1988).

Mechanical control

Destruction of alternative host plants and deep ploughing of crop residues can assist with control as adults' experience difficulty in emerging from pup aria buried deeply in soil. In South Africa, slashing maize and sorghum stubble was found to result in the destruction of 70% of the C. partellus population in these crops. Subsequent ploughing and disking was found to destroy a further 24% of the population (Kfir et al., 2002). The effects of tillage on reducing stem borer populations are a combination of the damage it inflicts on larva/pupae (through either direct damage, burial in the soil or exposure to adverse weather) along with exposing larvae to natural enemies such as birds, rodents and spiders (Kfir et al., 2002).

Biological control

There are a number of known natural enemies of cereal stem borers in East Africa including parasitoids of eggs, larvae and pupae. Predators like ants, spiders, earwigs, nematodes and microbial pathogens have also been reported to attack different life stages under various natural conditions. In general, evidence has shown that indigenous natural enemies are unable to keep stem borer populations below economic injury levels (Bonhof et al 1997). Natural enemies successful in controlling C. partellus include the pathogen Bacillus thuringiensis kurstaki and the parasitoid Cotesia flavipes. B. thuringiensis kurstaki attacks stem borer larvae and Cotesia flavipes has been successful in attacking stem borer larvae in Kenya, Pakistan, South Africa, Uganda and Tanzania (CAB 2007). Parasitoids mentioned in the literature are usually members of the Hymenoptera and Diptera families. Information on the biology of the main genera and species has been recorded in the papers of Smith et al (1993) and Polaszek (1998). Recent research work on stem borers has been focusing on the introduction of exotic parasitoids in countries where C. partellus is widespread. Cotesia flavipes is a small wasp that acts by locating the stem borers while the stem borers are feeding inside the plantstems. The wasp lays about 40 eggs into the stem borer. Once they hatch the larvae of the parasitic wasp feed internally in the stem borer before exiting and spinning cocoons

Review of Recommendation Effect of planting dates on Stem bore

Studies on the effect of different planting dates and varieties of maize on the infestation of maize stem borer (Chilo partellus) were carried out at research field of National Maize Research Program, Rampur, Chitwan, Nepal in 2010/11 and 2011/12 reported that higher damage was observed in April (58.2%) and the damage was gradually decreased toward the month of January/February (13.2 to 25.6%) and November /December (13.3 to 16.5%) (Bhandari et al., 2018). Lower infestation was observed in winter season (22.5%) followed by spring (47.1%) and summer season (47.0%) respectively. Other research works reported the lowest range of leaf damage (6.0-9.3%) was recorded in the planting months from end of December to mid-February in both the genotypes and the lowest range of dead heart (0.7-1.0) was recorded from first week of September to mid of October (Achhami et al., 2015). Based on the work of Muhammad Sarwar, (2012) it was found that early sown rice crop (last week of June) was the most resistant having the lowest borer infestation among other plantings and the mean percent infestation of stem borers under natural conditions on late sown crop also varied significantly $P< 0.05$ on different varieties.

Sowing date manipulations conducted at Hawassa, Ethiopia indicated that early-planted maize suffers less from the attack of B. fusca (Assefa Gebre-Amlak et al., 1989). Similar results were obtained from investigations carried at Areka. Plantings should not be delayed later than April. The study showed that early planting as soon as the rain starts can off-set the damage caused by B. fusca and ensures high yield without using insect Sowing date trials conducted at Abobo (Gambela) showed that early plantings suffer less from the attack of Chilo partellus (Daniel and Belayneh, 2001). Relatively lower levels of infestation and higher yields were observed from the second (May 8) and May 23 plantings. Research results obtained at Arsi-Negele (Ethiopia) indicated that early sowing with cypermethrin treatment doubled the yield of maize grain. If maize has to be grown without cypermethrin treatment, it should be sown between 20 April and 10 May. The highest economic return with cypermethrin treatment at the rate of 0.30 kg / ha applied at 4 and 6 weeks after crop emergence was obtained with early sowing, indicating that early infestation of stem borer is very detrimental for maize production at Arsi Negele (Emana and Tsedeke, 1999). Tsedeke and Elias (1998) also reported that early sowing had a yield advantage of more than 58.2% over late sowing. In study (Ebenbe et al., 1999) the effect of the time of planting of maize on the incidence of infestation and yield loss caused by Busseola fusca (Fuller) was studied using five successive plantings (early November to early January) during the 19951 96 and 1996/97 growing seasons at Lesotho. B. fusca infestation resulted in yield losses in both early (November) and late (mid-December to early January) plantings. Early planting of maize (November) is, therefore, recommended in order to minimize yield loss due to second generation infestation. Seasonal variation in yield loss due to B. fusca damage ranged between 0.4% and 5.3% during the 1995/96 season and between 12.7% and 36during the 1996/97 season.

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