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Review on critical period of weed competition and management in maize (*Zea mays* L.)

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Abstract

Maize (*Zea mays* L.) is one of the major cereal crop produced worldwide after wheat and rice mainly as food for human and as animal feed. Maize is the most sensitive crop to weed competition during its early growth stage and weed control is an important management practice for maize production that should be carried out to ensure optimum grain yield. Weeds compete with the corn plants for resources such as light, nutrients, space, and moisture, water, especially during that good weed control within the first 4 to 6 weeks after crops are planted is critical in order to avoid a yield reduction from weeds. The critical period for weed control (CPWC) is defined in the crop growth cycle during which weeds must be controlled to prevent yield losses. The maximum weed competition in maize occurs during the period of 40 to 45 weeks after sowing suggesting the importance of maintaining the field weed-free during this critical period of weed competition. Weed competition is maximum during early stage of crop growth. Weed competition early in the season reduces yields more than late season competition. Although yield is not greatly reduced by late season weeds, they may cause difficulty in harvesting, low crop quality and reduce protein content. So, this paper is a review on Critical Period of Weed Competition and Management in Maize (*Zea mays*, L.) it can control optimum and minimum weed by using management methods.

Keywords: Critical period, maize, weed competition

Introduction

Maize (*Zea mays* L.) is one of the major cereal crop produced worldwide after wheat and rice the most widely grown staple food crop in sub-Saharan Africa (SSA) occupying more than 33 million ha each year (FAOSTAT, 2015). The crop covers nearly 17% of the estimated 200 million ha cultivated land in SSA, and is produced in diverse production environments and consumed by people with varying food preferences and socio-economic backgrounds. More than 300 million people in SSA depend on maize as source of food and livelihood. The top 20 countries, namely South Africa, Nigeria, Ethiopia, Tanzania, Malawi, Kenya, Zambia, Uganda, Ghana, Mozambique, Cameroon, Mali, Burkina Faso, Benin, DRC, Angola, Zimbabwe, Togo, and Cote d'Ivoire, account for 96% of the total maize production in SSA. (FAOSTAT, 2015).

Maize is vital for food security in Ethiopia. More than 9 million smallholders grow maize on about 2 million ha (14% of total land area in Ethiopia) and around 88% of their production is used for food consumption (Abate *et al.*, 2015) [1]. In terms of calorie intake, maize is the most important staple crop for the rural Ethiopian population (Berhane *et al.*, 2011) [5, 6]. Maize is Ethiopia's most important cereal crop both in terms of level of production and area coverage. About 9 million farmers, i.e., 70% of the total farmers produced about 6 million tons of maize over two million hectares of land. The farmers grow maize mostly for subsistence, with 75 % of all maize produced is consumed by the farming households (CSA, 2012) [9]. Maize is the cheapest source of calorie, providing 16.7 % of per capita calorie intake nationally (Rashid *et al.*, 2010). Maize is thus an important crop for overall food security. Among crops grown in Ethiopia, maize is the most important cereal crop in terms of total production, area coverage and better availability and utilization of new production technologies (CSA, 2014) [8].

Weeding is an important management practice for maize production that is carried out to insure optimum grain yield. The critical period for weed control (CPWC) in most crops often begins within a few days or weeks of emergence during the early phases of vegetative development Helford *et al.*, 2001; Martin *et al.*, 2001 [17].

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Maize is very sensitive to weed competition during the first 4-6 weeks after emergency, and weed control is very important. Weeding is mostly done by hand, crop rotation, and by other such as chemical application biological method and including Atrazine 2,4, D and datagram Atrazine for used for per emergency to control broad leaved weeds and germinating weedy grass (George, 2011). Weed must be properly managed to avoid economic losses in crop production. Initial 6 weeks after sowing are found very susceptible to weed infestation in maize, significantly decreasing final grain yield (Das *et al.*, 2016).

Objective

To review on critical period of weed competition and management in maize crop.

Literature Review

Origin, Taxonomy and Distribution of Maize Crop

Maize is a cereal crop in the family Poaceae originates in the Balsas River Valley of south-central Mexico in Central America where it was domesticated by indigenous people about 10,000 years ago, dispersed into lower Central America by 5600 BC and valleys of Colombia between 5000-4000 BC (Piperno, 2011; Kennett *et al.*, 2015) [21]. Maize spread over large area of Spain, Portugal, France, Italy, South Eastern Europe and North Africa in the years. The Portuguese brought it to West Coast of Africa in the beginning of 16th century and somewhat later to India and China. Maize is also known as corn (American), is a cereal grain first domesticated by indigenous peoples in southern Mexico about 10,000 years ago (Benz, 2016). The leafy stalk of the plant produces pollen inflorescences and separate ovuliferous inflorescences called ears that yield kernels or seeds, which are fruits. Maize has become a staple food in many parts of the world, with the total production of maize surpassing that of wheat or rice to being consumed directly by humans (often in the form of masa), maize is also used for corn ethanol, animal feed and other maize products, such as corn starch (Jonathon *et al.*, 2019) [14]. The six major types of maize are dent corn, flint corn, pod corn, popcorn, flour corn, and sweet corn (Linda C *et al.*, 2013) [24].

According to (Jonathon *et al.*, 2019) [14] sugar-rich varieties called sweet corn are usually grown for human consumption as kernels, while field corn varieties are used for animal feed, various corn-based human food uses (including grinding into cornmeal or masa, pressing into corn oil, and fermentation and distillation into alcoholic beverages like bourbon whiskey), and as chemical feedstock. Maize is also used in making ethanol and other biofuels.

Maize is widely cultivated throughout the world, and a greater weight of maize is produced each year than any other grain (IGC, 2013) in 2014, total world production was 1.04 billion tones. Maize is the most widely grown grain crop throughout the Americas, with 361 million metric tons grown in the united states alone in 2014 (2011). Genetically modified maize made up 85% of the maize planted in the united states in 2009 Way back Machine, (2010). Subsidies in the United States help to account for the high level of cultivation of maize in the United States and the fact that the U.S. is the world's largest maize producer.

Maize Production and productivity

Maize is the most widely distributed cereal crop in the

world. It is one of the three leading global cereals in terms of production, with 1,016 million metric tons produced on 184 million hectares globally and the first most important crops at a global and local level followed by rice and wheat (Shiferaw *et al.*, 2011, Njeru, 2010, FAOSTAT, 2013) [29, 38]. The maize agri-food systems CRP focuses on (sub-) tropical maize in the low and middle-income countries that provide 64% of total maize production and where maize plays a key role in the food security and livelihoods of millions of poor farmers (Wongnaa, 2016) [45]. Maize is the most widely distributed crops of the world. It is cultivated in tropics, sub-tropics and temperate regions unto 500 and from sea level to 4000 m. Al under irrigated to Semi-arid conditions. Tremendous choice is available as regards to varieties maturing in 85 days to more than 200 days with variability in grain color and texture etc.

Maize is produced across temperate and tropical zones and spanning all continents. It was domesticated from teosinte in Mexico some 7,000 to 10,000 years ago and rapidly extends through the Americas. It spread to the rest of the world in the 16th through 18th centuries. World- wide more than 400 million people, primarily in sub-Saharan Africa and Central America, maize is used as a staple food (Abdulai *et al.*, 2018) [2]. It is comparable to that of rice or wheat in Asia, with consumption rates being the highest in East South Africa (ESA) (Ntabakirabose, 2017; Wongnaa, 2016) [30, 45]. Maize accounts for almost half of the calories and protein consumed in ESA and one-fifth of the calories and protein consumed in West Africa. With its multiple uses; maize is the world's most multi-purpose crop. Aside from its staple food use, it makes a significant contribution to animal feed (especially poultry) as well as bio-fuel and industrial uses (Ntabakirabose, 2017; Wongnaa, 2016) [30, 45].

Maize is the most important staple in terms of calorie intake in rural Ethiopia. The 2004/5 national survey of consumption expenditure indicated that maize accounted for 16.7 % of the national calorie intake followed by sorghum (14.1 %) and wheat (12.6 %) among the major cereals (Berhane *et al.* 2011) [5, 6]. Compared to the 1960s the share of maize consumption among cereals more than doubled to nearly 30% in the 2000s, whereas the share of teff, a cereal that occupies the largest area of all crops in Ethiopia, declined from more than 30% to about 18% during the same period (Demeke 2012) [8].

Importance and Use of Maize

Nutritional Value of Maize

Maize is also considered an important source to enhance health and prevent diseases, including phenolic, carotenoids (yellow maize), anthocyanin's (blue maize), phobaphenes (red maize), insoluble and soluble dietary fiber and polar and nonpolar lipids (Serna Saldivar, 2016) [37]. Maize accounts for 40% of the cereal production in Sub-Saharan Africa (SSA), where more than 80% is used as food (FAOSTAT, 2016) [13]. The crop provides at least 30% of the total calorie intake of people in Sub-Saharan Africa. (Nuss, E, 2010) [31]. Maize is consumed as a staple in the African region where intake ranges from 52 to 450 g/person/day and in the Latin American region where it varies from 50 to 267 g/person/day.

Maize can be consumed in several forms: green maize roasted or boiled, steamed products, porridges, beverages, bread, and snacks. (Ranum *et al.*, 2014) [35]. Maize-based foods are available in Africa with each country having

different processing methods, food products and forms of consumption (Mensah, J, 2013) [27] sometimes differences in maize food processing and consumption patterns within the same socio-cultural group exist to communicate individual cultural identity and social class (Zilic, S *et al.* 2012) [46].

The presence of an anti-nutrient like phytate, a high amount of nutrients (20–50%) can be lost during maize processing in general (Ranum *et al.* 2014) [35]. Efforts to improve the nutritional quality of maize have mainly focused on breeding, by developing bio fortified maize with higher protein quality or higher content of provitamin A or zinc (Ohna, I, 2012). However, the possibility to improve nutrient security by acting on home-based and street vendor processing and formulation aspects have been largely neglected (Ranum *et al.*, 2014) [35]. Nutritional importance Maize grains have great nutritional value as they contain 72% starch, 10% protein, 4.8% oil, 8.5% fiber, 3.0% sugar and 1.7% ash. Maize kernel is an edible and nutritive part of the plant. It also contains vitamin C, vitamin E, vitamin K, vitamin B1 (thiamine), vitamin B2 (niacin), vitamin B3 (riboflavin), vitamin B5 (pantothenic acid), vitamin B6 (pyridoxine), folic acid. Potassium is a major nutrient present which has a good significance because an average human diet is deficient in it (Kumar & Jhariya, 2013) [22, 23]. The oil contains 14% saturated fatty acids, 30% Monounsaturated fatty acids, and 56% polyunsaturated fatty acid.

Health Benefits of Maize

Maize has various health benefits. The B-complex vitamins in maize are good for skin, hair, heart, to reduce the chance of heart diseases and cancer, brain, and proper digestion. They also prevent the symptoms of rheumatism because they are believed to improve the joint motility. The presence of vitamins A, C, and K together with beta-carotene and selenium helps to improve the functioning of thyroid gland and immune system. Potassium is a major nutrient present in maize which has diuretic properties. Maize silk has many benefits associated with it. (Kumar & Jhariya, 2013) [22, 23].

In many countries of the world such as India, China, Spain, France and Greece it is used to treat kidney stones, urinary tract infections, jaundice, and fluid retention. It also has a potential to improve blood pressure, support liver functioning, and produce bile. It acts as a good emollient for wounds, swelling, and ulcers. Decoction of silk, roots, and leaves are used for bladder problems, nausea, and vomiting, while decoction of cob is used for stomach complaints (Kumar & Jhariya, 2013) [22, 23].

Raw materials for industrial products

Maize is very important because of good source of minerals, vitamins, fiber and oil present in maize (rich in embryo) (Dilip K, 2013) [11]. This oil is used for cooking and soap making companies. Maize starch is famous in pharmaceutical Industries as diluents and also used in cosmetics. Its seeds used to make alcohol stem fibers used for manufacture of paper. Maize is poor in Ca but rich in P and K like other cereals. Mg, Na and Cl are very less and Fe is sufficient. Maize is used as an important ingredient in animal feed (Dilip K, 2013) [22, 23].

Major types of weeds and their management in maize

The period of weed free maintains required after maize emergence top produce maximum yield is achieved by using

controlling measures like, cultural, biological, chemical and IWM methods.

The major constraint of maize production is have several weed like *Cynodon dactylon*, *Cyperus rotundus*, *Parthenium hysterophorus* L. and *Chenopodium album* L. (Abdullah *et al.*, 2016) [3]. The important weeds noticed during winter season were *Phalaris minor*, *Poa annua* among grass and *Medicago denticulata*, *Anagallis arvensis*, *Cirsium arvense*, and *Chenopodium album* among broad-leaf weed (Stanzen *et al.*, 2016) [40].

Weed competition in maize

Weeds compete with the corn plants for resources such as light, nutrients, space, and moisture, water, especially during that good weed control within the first 4 to 6 weeks after crops are planted is critical in order to avoid a yield reduction from weeds. Crop that influence the morphology and phenology of crop, reduce the yield, make harvesting difficult, and the quality of grains. Furthermore, high weed infestation increases the cost of cultivation, lowers value of land, and reduces the returns of corn producers (Takim F, 2012) [43]. The growth of maize plants in the first week is rather slow and it is during this period that weeds establish rapidly and become competitive. Maximum weed competition in maize occurs during the period of 40 to 45 weeks after sowing (Hung Arica *et al.* 2012) [4]. Suggest that importance of maintaining the field weeds free during this critical period of weed competition. Weeds and crops both need to photosynthesis. Thus, weeds and crops compete for light, carbon dioxide, water, minerals and rooting space. Thus, weeds reduce crop yields. Maize requires well drained soil and cannot with stand water logged situation. It can be grown on the soils having pH ranging from 5.5-8.0 (Hung Arica *et al.*, 2012) [4].

Critical Period for Weed Control

The critical period of weed control is said to be the period of time in which weed control is necessary to avoid significant yield loss (Nazarko *et al.*, 2005) [28]. Critical period of weed competition is up to 40-45 DAS. Maize yield was reduced as much as 25-80%. Weeds associated with maize are: grass weed and broad-leaf weed.

Cultural control

The maximum grain yield and minimum weed density and dry weight of major weed species among grass and broad-leaf weed Critical Period 2 hand weeding (HW) at 15 and 30 days after sowing (DAS) (Kumar *et al.*, 2017) [22, 23].

Biological Method

Biological control of weeds involves the use of any organisms or management practice using an organism to reduce, effects of weed population. The use of insect, pathogens, herbivores or parasites that naturally attach weeds. (Thomas, 2002) [44].

Chemical control

According to (Sahoo *et al.*, 2017) highest grain yield obtained with by using the application of Atrazine / Simazine (1-2 kg/ha) hold the weeds for 4-6 weeks in the maize. Metribuzin (0.75 – 3 kg/ha) a Superior pre-emergence to control grasses weed (*Palmaris minor*, *Poa annua*) and broad leaved weeds like *Medicago denticulata*, *Anagallis arvensis*, *Cirsium arvense*, and

Chenopodium album among.

Integrated weed management

According to (Abdullah *et al.*, 2016)^[3] the most effective in controlling weed population and increasing the grain yield of maize were by using atrazine @ 1.00 kg ha, Hand Weeding and paddy straw mulching, producing grain yield as compared to unwanted weeded.

Conclusion

Maize (*Zea Mays* L.) is one of the major cereal crop produced worldwide after wheat and rice. It is the most widely grown staple food crop in sub-Saharan Africa (SSA) used for human food, animal feed and a source of industrial raw material for the production of oil, alcohol, and starch, maize is the highly domesticated of all field crop. This does not survive in nature. As it is Nutritional importance Maize grains have great nutritional value as they contain 72% starch, 10% protein, 4.8% oil, 8.5% fiber, 3.0% sugar and 1.7% ash. Weed are one the most important factors in maize production the case important losses sub Saharan Africa and Ethiopia maize production respectably (96% and 88%). Weed control is an important management practice for maize production that cared out to insure optimum grain yield. Weed control in maize is carried out by using controlling measures like, cultural, biological, and chemical and IWM methods. The critical period for weed control (CPWC) in maize crops often begins within a few days or weeks of emergence during the early phases of vegetative development.

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