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REVIEWING THE POTENTIAL EFFICACY OF DIVERSE HYBRIDS OF MAIZE CROP (*ZEA MAYS* L.) GROWN UNDER DIVERSE CLIMATIC FACTORS: AN UPDATE

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Abstract

Maize is a warm-weather crop, growing under the diverse environmental condition in India. It easily germinated to sufficient moisture during 4-6 days after sowing, fast growth, and development in a short duration. Maize behaves as C_4 crop due to the RUBISCO system which created to CO_2 and provides more stability insufficient nutrition. The regulated photosynthesis of maize crops is controlled leaf temperature to regulated photon yields. Only the reproductive phase of the maize crops showed sensitivity to water stress and reduced grain yield. Therefore irrigation is more necessary in the reproductive phase along with sufficient fertilizers during *Rabi* and *Kharif* Season maize crop but fertilizer doses should be one-third part applied under rainfed environment maize crop. Some chemical regulation is also helpful in the development and stability of maize crop under different environmental condition, in which maize hybrid showed more stability in comparison to normal maize development under warm the climatic condition in low moisture and provide better grain yield. Such types in this review, paper determine the potential of maize crop through different physiological parameters of climatic condition, chemical regulation, soil moisture carrying stability, improvement photosynthesis, C_4 mechanism and CO_2 in different environment.

Key words : C_4 crop; Climatic condition; CO_2 Mechanism; Chemical Regulation; Soil moisture.

Introduction

Maize (*Zea mays* L.) is a short day biannual crop, play a major nutritional role in the human population. Maize cultivation ranks is third in India, after rice and wheat, mainly used as a staple food and animal feed in most developing countries (Mboya *et al.*, 2011). Maize cultivation environment is highly heterogeneous in India which consumed by people along with different food products (Badu Apraku *et al.*, 2006). Maize is widely constituted more than 80% of the total global cereals production (Sofi *et al.*, 2009). Maize crop has been adapted for the hot and cool environment, grow well in temperate and tropical areas with good draining, nutrient-rich soils (Ufaz and Galili, 2008) at normal pH range (5.5 to 7.0). Maize grain is a staple food product containing the total calorific value 15% in the rural areas where animal protein is scarce and expensive and unavailable to a large sector of the population (Wegarya *et al.*, 2011). It is livestock for humans and used as industrial raw material for manufacturing different products in food and feed industries. Knowledge of the maize nature and magnitude power of genotypic and phenotypic variability plays a vital role in a successful breeding program. In developing countries, farmers select and maintain superior maize varieties to adapt in a specific location (Paliwal, 2000).

Maize grains are the primary product, its utilization for silage in common in industrial agriculture (Klopfenstein *et al.*, 2013). Maize crop grain yield is increased from

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the past 30 to 50 years (Ding *et al*., 2005), due to advance farming technology (Niu *et al.,* 2013) and cultivation conditions (Zhang *et al*., 2013). Some smallholders are also use maize livestock systems for a new variety of grain yield (DeGroote *et al.,* 2013), with maize stovers. Maize is showing more sensitivity during the flowering stage because maize crop pollen and stigma are dispersed in environment and easily dry in a hot environment (Monneveux *et al.,* 2006). Maize crop sensitivity particularly showing before one week silking and after two weeks flowering (Campos *et al.,* 2004), due to average yield losses 20% to 50% (Neilson *et al.,* 2017). The maize crop is associated with high temperatures above 30°C (Jagadish *et al.,* 2011), due to increases in respiration, light interception, photosynthesis (Vani *et al.,* 2001). Normal and hybrid maize crop cultivation techniques are similarly developed under *Rabi* and *Kharif* season (Saket *et al.,* 2018). The single cross hybrid formation was governed by the author (2017) between 30 hybrid germplasm and one check (Malviya Makka hybrid 2) in one irrigated and one rain-fed the environment during *Rabi* (winter) season 2015-16 and *Kharif* season 2016. The newly released maize hybrid showing less photosynthetic capacity after anthesis associated with the smaller non-stomatal condition due to higher phosphoenolpyruvate carboxylase activity and better photosynthetic physiological characteristics (Long *et al.,* 2006). The relationship between maize grain yield and leaf photosynthesis rate is associated with a photosynthetic mechanism that enhances maize crop grain yield (Chen *et al.,* 2013). Photosynthesis is the main factor for grain development in maize crops (Li *et al.,* 2013), dry matter accumulation largely contributes to increase grain development but harvest index maintain constant (Ding *et al.,* 2005).

Climatic condition and maize crop origin in India

As a warm-weather crop, Maize grew in a wide range of climatic conditions (ICAR, 2006). It requiring warm temperature between 25-30°C and, usually cause cessation of growth and development in the cool night below 8°C temperature (Birch *et al.,* 2003). Maize is an excellent crop for biomass, their straw is being used as animal fodder in India. Maize is growing in India from latitude 12° to 30°N while the altitude range is from 49m, Bihar to 1,250m in the area of Himachal Pradesh. In India, maize is usually more grown in the *Kharif* season, which is governed to more than 35°C the temperature under rain condition (Lopes *et al.,* 2001). About 85% of maize is grown during *Kharif* season, where over than 80% total annual precipitation is received. Maize crop can be successfully grown in areas where receiving annual rainfall about 60 cm, it will be good survive to low irrigation during germination and flowering in *Rabi* season maize crop. Maize soil optimum temperature is 25±2°C for both germination and seedling growth during *Kharif* season. Jain (1973) was preferred considers that 21°C ideal temperature for maize germination and development. Minimum temperature is 10±1°C for maize germination and growth, after flowering maize development going to 15°C temperature for grain development which completed about 80 days after germination in *Kharif* season but less in *Rabi* season (Pallavi *et al.,* 2019). Maize is grown in a number of environments such as dry-land and irrigated condition (Farreland O'Keefe, 2007). Generally, it grown sub tropically between 30°North and 30°South and temperate maize beyond 34°C latitudes. In tropical and subtropical regions maize crop is grown mainly on marginal lands and prone to face various extreme climatic conditions and different biotic and abiotic stresses (Zaidi, 2002).

An early hypothesis proposed that *Z. mays* sp. is a product for the natural hybridization of *Tripsacum sp.* and *Zea sp*. Archaeological records suggest that domestication of maize crop began from at least 6000 years ago independently, occurring in regions of the southwestern United States, Mexico, and Central America. The mesoamerican region is the center of origin for maize crops, situated at the Mexican highlands, from where it spread rapidly (Matsuoka *et al.,* 2002). From the discovery of the Americas during the 15th-century maize spread in temperate zones around the world (Farnham *et al.,* 2003). This maize is demonstrated in Spain after the return of Columbus from America and it spread France, Italy, and Turkey. In India, Portuguese introduced maize during the seventeenth century. It went to China from India and later it was introduced in the Philippines and the East Indies. Corn now is being grown in the USA, China, Brazil, Argentina, Mexico, South Africa, Rumania, Yugoslavia, and India (OECD, 2006). Maize is suitable for mechanical cultivation including entire development. In India not only maize production and consumption have been rising consistently but also maize consumption pattern has changed in the whole year (Kumar *et al.,* 2012). The development of new cultivars and Indian appropriate production technology has been increasing winter season maize cultivation in an alternative part of India. In the rural region, maize emerged as a good source of income and fodder for the farmers, within 2 months it prepare green fodder after sowing (Chaudhary *et al.,* 2012). In the *Rabi* season maize crop soil texture is more helpful for maintaining moisture and nutrients availability. Maize can be grown on different types of soils but loam soil or brown silt clay loam type soil containing more moisture which provides water for developing maize variety. Soil moisture is very imperative to maintain adequate water holding capacity through proper drainage. Such types of more than 50% of total water need in developing maize varieties under 30 to 35 days after tasseling and adequate soil moisture cover at grain filling stage (Campos *et al*., 2006). *Kharif* (Rainy) maize is produced nearly 100 million hectares with almost 70 % total maize production from developing countries which is a part of low and lower middle income countries in the developed world (Faostat, 2010).

CO_2 Mechanism of maize crop

The C_4 photosynthesis is a key feature for the CO_2 mechanism in the leaves, which suppresses apparent photorespiration. Photosynthesis is overcome when maize plants are grown at higher atmospheric CO_2 and promoting crop growth (Lobell and Field, 2008). C_4 photosynthesis is characterized by the presence of a metabolic CO_2 that concentrates CO_2 in the vicinity of the main enzyme carbon dioxide fixation (fig. 1(b), ribulose-1, 5-bisphosphate carboxylase, and oxygenase (Edwards *et al*., 2004). Maize crops convert carbon dioxide to high energy compounds that catalyze enzymes (Rubisco, Ribulose bisphosphate carboxylase) and make up about 50% leaf protein and 25% leaf nitrogen. Therefore under drought conditions, C_4 crops have produced higher yields. The CO_2 affects stomata behaving less water loss and improved water use efficiency, due to the affected *Rubisco* system (Wall *et al*., 2001). Maize yield is not affected to crop growth rate at elevated CO_2 concentration under non-limiting water availability (Leaky *et al*., 2006). Increasing photosynthetic rates were requires greater efficiencies in C_4 crops from light capturing that conversion into chemical energy, therefore improve crop yield from increase photosynthesis. It utilizes CO_2 fixation and newly carbohydrate synthesis and outcome in plant system (Long *et al*., 2006), through addition of atmospheric CO_2, major driving force creates for the evolution and ecological success of C_4 crop (Westhoff and Gowik, 2010). Maize is an important crop grown in the whole world (Tesfaye, 2017), adapted at high temperature and face high light intensity and severe water stress condition of plant species that maintain the partial opening of stomata. Maize crop contain different physiological traits resulting provide a wide genetic base for selection; therefore, it is adapt for a wide range of yield capability (Paliwal, 2000). The maize crop is considered complex inherited characters and therefore, directs selection for yield in per season crop production.

The C_4 crop bundle sheaths contain chloroplast 3 to 6 times higher CO_2 than in the atmosphere (Von Caemmerer and Furbank, 2003), due to maize crops avoid

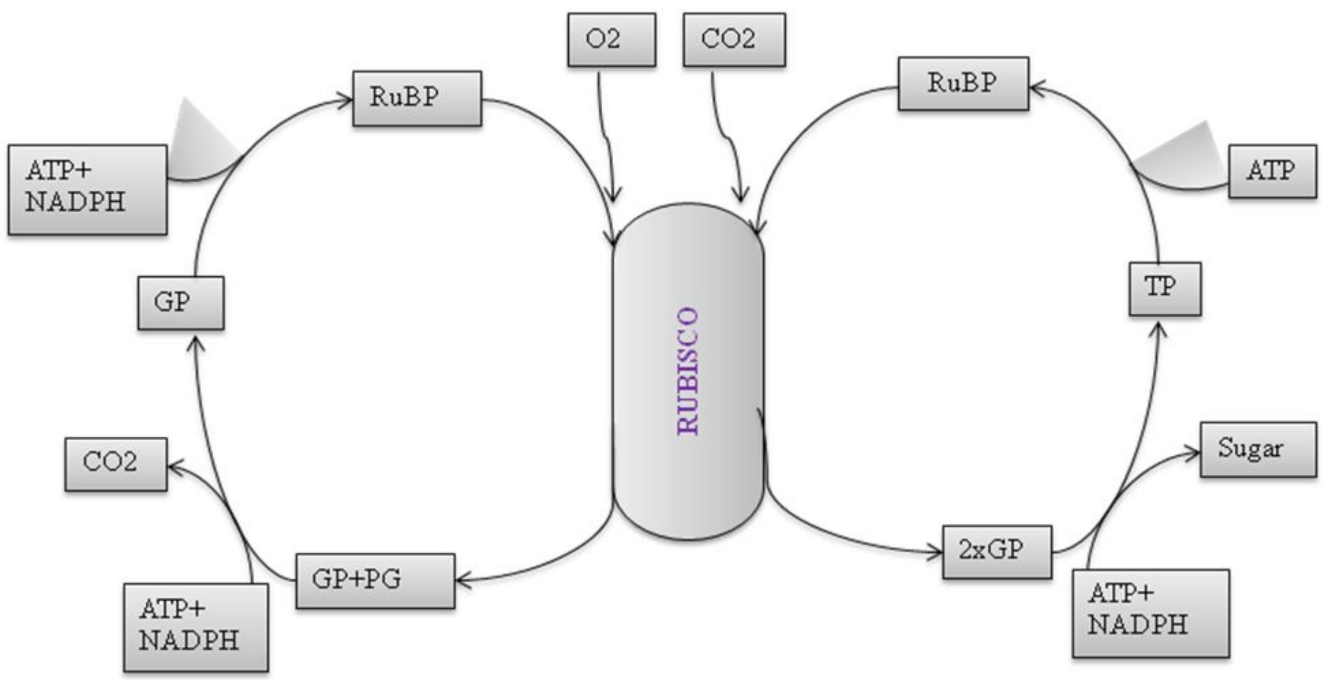

Fig. 1: Demonstration of (a) Photorespiration and (b) Photosynthesis in maize crop represented by Edwards (2004) and Ghannoumet (2011).

photorespiration (Fig. 1(a) and CO_2 saturated at the current atmospheric condition but elevated C_4 crops is typically reduced (Ainsworth and Long, 2005). Higher atmospheric CO_2 level tend to reduce transpiration rate and stomatal conductance (Bernacchi *et al.,* 2007). C_4 cycle improve maize hybrid potential to carrying high moisture use efficiency through long root and root hairs and development of the *Kranz* anatomy. This moisture is also maintains water use efficiency associated with good cultivars and irrigation management pattern about traditional use cropping pattern (Zhang *et al.,* 2005). It noted that moisture and nitrogen use efficiency are greater (4%) than C_3 crops, therefore maize crop can easily operate *Rubisco* system (figure 1) and require 50–80% less photosynthetic rate (Ghannoum *et al.,* 2011) due to loss low water. Maize also save more water due to less photosynthesis under high temperature and allow survive longer time during growth in *Rabi* season (Markelz *et al.,* 2011). Summer maize crop if cultivated in semi-arid environment faces high temperature (Cairns, 2012), water scarcity, and a combination of dry factors in field conditions. Some tropical maize are very sensitive to heat in the Indian environment, particularly after 8_{th} leaf stage (Chen, 2010), and changing in climatic condition (Chen, 2012), these stresses become major threats grain yields and decreases 15–20% maize in annual production (Lobell, *et al.,* 2011).

Chemical regulation of maize crop

Plant hormone and exogenous chemicals (ABA and $CaCl_2$) are playing important role in heat tolerance of maize crop. ABA is a chemical messenger and also a secondary metabolite it is generated from maize root and transported in the crop xylem and phloem through the root branches of vascular bundle (Giuliani *et al*., 2005). ABA is induces stomata close to more water status and exogenous $CaCl_2$ increases maize cell membrane antioxidant capacity and improve heat tolerance in maize crops (Jovanoviæ *et al*., 2000). Maize crop irrigation time increasing to improves heat tolerance and increases kernel weight during *Rabi* (winter) maize crop but create minerals and fertilizers loss during *Kharif* (Rainy) maize crop (Zhang 2003). Optimizing moisture of soils improves leaf chemical composition under high temperatures (35 and 40°C) due to enhance high temperature tolerance in maize crop (Zhu *et al*., 2011).

Physiological function of maize crop decreases under abiotic stress but loss more energy for nutrient management; in this condition adequate potassium fertilizer supplied to increase cell membrane stability, turgor pressure, water potential. The sufficient content of nitrogen supplement improves photosynthesis radiation capture efficiency and CO_2 assimilation rate of maize crop. Maize crop zinc deficiency decreases photosynthesis rate, conductance stomata, and superoxide dismutase activity (Wang and Jin 2005). This strategy improves heat tolerance in *Kharif* (Rainy) season maize crop. Generally, maize is less water stress tolerant (Beckingham; 2007), after germination maize seedlings do not absorb more fertilizers because that use self-store nutrients during this condition supplements of more fertilizers seedling not high tolerate and therefore first dose of fertilizer should be supplied at least 5cm to the side of the seedling after germination (Hughes, 2006).

Soil moisture carrying stability

Kharif (Rainy) season maize is sowing mostly in the last month of June to the second week of July month in during this condition rain fall start and that period is require less amount of water, this crop requires more rain fall during August to September month, where more rain fall occurs in *Kharif* (Rainy) season maize crop. Such types some rain-fall occurs in November month during *Rabi* (winter) season, so this period is favorable for maize crop sowing. The maize crop is mature under 3 month during this period, some rainfall occurs during the first week of January month, their maize crop has been starting for flowering, so this rainfall will be more beneficial to *Rabi* (winter) season maize crop (Saket *et al.,* 2017). Minimum sun light also helps less amount loss of water to photosynthesis in this condition. In India mostly areas found alluvial soil. The alluvial soil is best for maize crop growth and development during rain-fed and irrigated environments. After the examination observed that if moisture amount is zero in the upper layer of soil (0 to 30cm) then sufficient moisture available in lower layer of soils (31-60cm and 61 to 90cm), this moisture is sufficient for maize crop development and in taking sufficient nutrient after irrigation in two intervals after maize seed germination and flowering.

The maize leaf growth is high sensitivity to water deficits is considered as a ‘stress avoidance’, which enables plants to tolerate severe drought scenarios from saving soil water. There is considerable stable variability to water deficits under different temperatures and tropical maize varieties in the sensitive leaf expansion. Leaf rolling (Epinasty) is a reversible mechanism in maize crops that full essentially similar functions from decreasing the active leaf area. However, high sensitivity of maize leaf growth and movements towards water availability to several potential drawbacks (Welcker *et al.,* 2007), other loss of leaf areas are limiting photosynthesis to reduced rate of biomass accumulation. Maize crop leaves are essentially divided into two part viz. adaxial and abaxial. The upper part (adaxial) and lower part (abaxial) leaves operate independently for photosynthesis regulation and stomata conductance that are very useful to prevailing environmental condition (Soares-Cordeiro *et al.,* 2011), but in some other C_4 crop may avoid a limitations on photosynthesis due to leaf curling (Ripley *et al.,* 2010). Mostly leaf water loss is decreased due to adaxial surface stomata are completely closed under normal stress condition and those on the abaxial surface are partially closed and supply some water (Soares-Cordeiro *et al.,* 2009). Maize crops are smoothly subjected to stress due to maize leaf mechanisms control cell growth under adverse climatic conditions. Functional analysis of the aquaporins (proteins) form channels to facilitate water transport, thereby increases the hydraulic conductivity of leaf tissues and conducted in maize crops (Hachez *et al.,* 2008). Some other traits are also identified such as high lysine content, amylase enzyme, phytase enzyme appearance for drought tolerance in maize (Stein and Rodriguez-Cerezo, 2009).

Improved biomass with control photosynthesis

Spring maize photosynthetic is a production potential under optimum temperature and water conditions (Zhao *et al*., 2008). Photosynthesis is the most important part of maize crop creative sensitive symptom to high temperature compared with other crop. Net photosynthesis rate was 50"60% lower in maize under more high temperature (35/30°C to 40/35°C day/night) compared to low-temperature (25/20°C to 30/25°C day/night) conditions (Ben-Asher *et al*., 2008). Chloroplasts are structural and function key of photosynthesis, thylakoids and a matrix is the basic organelle for photosynthesis in maize crop. The photosystem I (PSI), photosystem II (PSII) are two main light-harvesting pigments that absorb light energy and electron transfer all location in the thylakoid membrane. The thylakoid membrane is more sensitive to high temperature. Maize crop stability to thylakoid membrane is particularly important for photosynthesis due to provide moisture in form of irrigation under stress conditions (Savchenko *et al*., 2002) to release electrolytes and reduce thermal stability in cell membrane of maize crop (Wahid *et al*., 2007).

Heat stress reduces rain-fed maize crop due to chlorophyll *a* and chlorophyll *b* contents leading to net photosynthetic rate is inhibited and depressed electron transfer mechanism therefore decrease leaf photosynthetic capacity in maize crop (Zong *et al*., 2014).

Maize biomass increases with improved photon yield that associated with faster canopy closure during exponential early growth conditions. Photosynthetic capacity is increased through genetic manipulation due to an increase in crop yield potential (Pellny *et al.,* 2004). A photosynthetic capacity table is showing table1 that maize leaf crop photosynthesis decrease due to increases in leaf temperature and photon yield. The maize growth rates are increased in two ways, the first way to increase the photosynthetic capacity of the crop canopy, and second, the crop growth rate can be increased by enriching CO_2 from crop atmosphere. This type of crop is called a C_4 balance crop because it forms the first product from the four-carbon compound. The negative relationship also exists between photosynthetic capacity and leaf size and morphology in maize crops (Lee and Tollenaar, 2007).

Table 1: Generated photosynthetic capacity from the increases leaf temperature of maize hybrid crop by Pellny (2004).

Leaf temperature	Photon yields	Photosynthetic capacity	Daily integral
22°C	19%	26%	34%
30°C	44%	12%	45%

In fast-growing summer maize crop rising CO_2 becomes more efficient, therefore a lot of variation creates between plant functional groups and supplement balance water and fertilizers (Ainsworth & Long, 2005). This enables are increased to greater nitrogen supplements after irrigation due to increase leaf area index in per unit leaf area that reflects production for greater content of proteins associated with photosynthesis. The increased amount of chlorophyll content is stimulating leaf absorbance with greater leaf area and increases light interception in the maize leaf portion (Wall *et al.,* 2001). C_4 crops possess naturally higher photosynthesis rate and promoting more grain yield of the crop through an efficient approach (Crafts Brandner and Salvucci, 2002). Photophosphorylation and carbon metabolism are increased photosynthesis capacity in fully leaf areas that associated with electron transport channels thereby increasing photosynthetic efficiency (Kimball *et al.,* 2002). Therefore irrigation is most important in rain-fed maize crop environment for temperature and photosynthesis maintain during *Rabi* season sowing. Improving photosynthesis is considered to photosynthetic rate and capacity because both are important in maize crop field situations.

Production and productivity of maize crop

Identification of high yield maize crop to drought-prone environments using multi-location testing, it is inherently complicated by year to year variability in the available soil water and nutrients in the breeding programs (Banziger *et al.,* 2004). It is preferable for higher yield potential, accompanied to stress tolerance, ultimately low-yielding genotypes with reduced drought tolerance and water use efficiency is increased to reduced transpiration (Ripley *et al*., 2010). Maize yields depend on dry matter accumulation and allocation of grain source in balance condition (Tollenaar and Lee, 2006). The maize crop is economically more important for higher grain yield and wider adaptation in dry environmental condition (Centre for Monitoring Indian Economy, 2015). Maize crop yield improvement could be achieved under elevated CO_2 if reduced stomatal conductance to lowers water use and conserving soil moisture (Ghannoum *et al.,* 2000), for the best performance in low moisture (Thomson *et al.,* 2005). Maize is produced more biomass in moist environments as well as dry environments (Taylor *et al.,* 2010), it also produces more leaf size in per unit area of xylem and potentially allow faster canopy growth in maize dry environments (Kocacinar and Sage, 2004). Through maximizing soil moisture-absorbing after transpiration enhance biomass produce under most drought condition which minimizes water loss through soil evaporation (Blum, 2011).

Some strong pieces of evidence were supported in the adaptation to abiotic stresses which comes from retrospective comparisons of the performance hybrids maize in the USA (Tollenaar and Lee, 2006). Maize crop yield stability does not appear directly and increasing yield potential to the high-level association to general stress tolerance in selected new maize hybrids (Duvick *et al.,* 2004). More dry matter accumulation starts during grain filling conditions in the newer hybrids which are adapted to new environment densities (Tollenaar and Lee, 2006). Maize crops are often considered as drought control crop partially able to maintain leaf photosynthesis in close stomata. Even photosynthesis can be decreased under drought conditions in other crops (Carmo-Silva *et al.,* 2008), therefore maize is considered as a better adaptation in water limiting condition (Sanchez *et al.*, 2002). C_4 crop productivity is contributing 20% total global primary productivity in the world, so they are important from an ecological, agricultural, and atmospheric perspective (Faostat, 2009). Days to tasseling, days to sinking, and days to maturity were negatively correlated in grain yield measurement per plant (Umakanth and Sunil, 2000). Findings of plant height (Aminu *et al.*, 2014), ear length (Choudhary and Chaudhary, 2002), ear girth (Pavan *et al.,* 2011), ear height (Sudika *et al.*, 2015), the number of kernels per row (Sadek *et al.,* 2006), and 100-seed weight (Kumar *et al.,* 2006) are observations in the consistent amount. Grain yield of the maize crop is significantly correlated to ear girth, ear length, ear height and a number of kernels per row of a season.

Current status of hybrid maize production in India

Maize is a heterogeneous crop, therefore, grain yield cannot be directly improved through desirable crops, therefore, selection of agronomic traits which certainly boost grain yield under the control environment. India is the first country in the world to focus improvement of maize quality, soon after improving maize crop nutritional value. Maize crop grain yield is positively correlated with days to silking and tasseling, plant height, days to maturity, cob length and cob diameter in *Rabi* and *Kharif* season (Malik *et al.,* 2005). According to Nemati *et al.,* (2009), number of rows per cob, 100-grain weight, cob diameter and plant height are more important traits for measurement grain yield in hybrids maize crops. More than 85% of the maize crop produced rural and urban area in India and used for human consumption, particularly in economically deprived areas where protein malnutrition and hunger are present. Now maize production level has substantially raises (Fig. 2) according to the demand for maize for poultry feed (51%), human food (25%), animal feed (11%), starch (11%), seed (1) and brewery (1%) as well as industrial processes to produce value-added products (James, 2008).

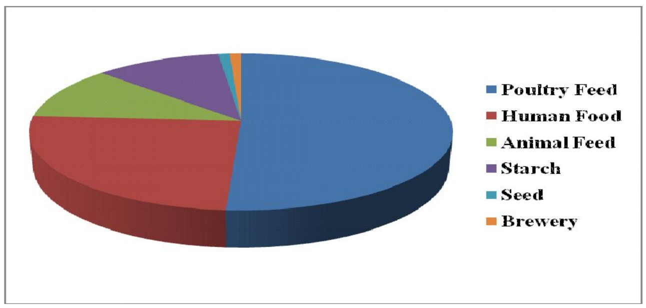

Fig. 2: Different way of maize crop food and feed consumption in different part of India, according to James (2008).

In most developing countries, about 77 % of maize is used for human food in the form of flour or boiled and other for cattle feed but in industrial countries, about 70 % of this crop is used as cattle feed either in the form of fodder grazing, forage and ethanol production used as bio-fuel and industrial products; only 3 % is used human food production in the form of seed which different from ongoing duration (Smale *et al.,* 2011). According to Zhai (2002) hybrids and normal maizes are used for an experiment in poultry and pigs under control environment in which found that poultry not good increase amino acid but in case of pigs significantly increase higher amino acids together weight through QPM hybrid. On the basis of additional demand maize used as animal feed will continue to grow at a very fast rate, which is estimated to increase production from 165 Mt to 400 Mt till December 2030. The maize growth area (2.83 %), production (30.93 %) and productivity (27.35%) are over the past years to other principal cereal crops (Paliwal, 2000).

Conclusions

This review develops a multi-directional approach for measurement potential of maize crop hybrid in irrigated and rain-fed environment, to enhance food production and improvement in different seasons. Some maize crop hybrid is showing the substantial phenotypic strategy to adaptive specializations, therefore maize crop hybrid important for dryland areas also, where limited maize hybrid yields and biomass quality produce. Maize is an important C4 crop in Indian agricultural economy in which major maize growing states are Uttar Pradesh, Bihar, Rajasthan, Madhya Pradesh, Punjab, Andhra Pradesh, Himachal Pradesh, West Bengal, Karnataka and Jammu & Kashmir in India, jointly producing over 95% of the total production under dry and irrigated regions. The amount of maize production was 13-14 million tons during 2007 from 7.2 million hectares area with average productivity of 2t/ha. Maize is often referred, a symbol of drought control due to limited photosynthesis and closed stomata, widely used selecting criteria for high yield maize crop determination in a dry environment. The stability of grain yield esteemed to drought susceptibility index in each genotype derived from the yield difference between irrigated and rain-fed environments. *Rabi* (winter) and *Kharif* (Rainy) seasons are two different crop-growing seasons in Northern India; mostly all Indian formers are enhancing *Rabi* maize production along with the traditional culture of maize crop cultivation. Alluvial soil is best performing for the highest productivity of maize crops than other soils. Some Indian farmers are also affected by climate change because of poor knowledge of technologies and monsoon patterns and finances for mitigation and adaptation. Recently agricultural sectors are appreciating for the significant crop in national double income as an important segment of the economy. These are revealing the comparative advantages and quality parameters of maize crop yield and physiological performance for abiotic parameters. Therefore more opportunities are creating in maize crop physiological improvement under the selected environment.

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Abbreviation

QPM= Quality Protein Maize, DSI= Drought Susceptibility Index, HCN= Hydrogen cyanide CCSHAU=*Chaudhary Charan Singh Haryana Agricultural University*, VPKAS= Vivekanand Parvatiya Krishi Anushandhan Sansthan, USA= *United States of America* , CO_2= Carbon Dioxide

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