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Genotype and Environment Interaction Determines the Yield Potential of a Crop under Changing Climate

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Abstract

Climate change is evolving as one of the leading environmental problems facing modern world. A serious threat is to the crop sector which is vulnerable to change in temperature and rainfall. Extremes in climate variations are increasing and threaten the security of our livelihoods and assets. Long term changes result in both creating opportunities and threats to crops and farming systems and timing of sowing and genotype selection affecting farm production. Therefore it is important to learn to live with these changes, make use of the opportunities and deal with the threats to prevent losses. This study documented different researcher's results regarding sowing dates and genotype selection. The results indicated that both sowing dates and genotype has a key role in final crop productivity. The study suggested that sowing dates and genotype selection are to be adjusted according to changing climate to minimize losses.

Keywords: Sowing Dates; Genotype; Climate Change; Temperature

Introduction

Genotype and environment interactions (GEI) are the primary factor in determining yield potential of a crop for an area. Optimum sowing time and appropriate variety selection, in addition to soil health, temperature and irrigation facility are the major factors determining crop productivity in an area [1]. Planting at right time is very important for optimum production. With delay in sowing date of a crop, significant decrease in yield is obvious due to limited growth period in season [2]. Higher yield is attributed to appropriate sowing time with appropriate variety selection for an area in addition to adapting recommended management practices during crop growth and development [3]. For best utilization of soil moisture, available nutrients and taking advantage of solar energy, optimum sowing time for a variety is critical factor of production for a cropping system in prevailing climate [4]. With identification of a high yielding cultivar, suited well for sowing time in a climate, yield of existing major crops can be improved with better management [5].

Planting date has been reported critical to affect yield in crop production due to extreme variations in temperatures during growth period from sowing to harvesting. Hybrids cultivation in cropping system has increased, which took more duration as compare to OPV. It is a challenge faced by growers in the scenario of changing climate to find a suitable variety for maximum yield [6]. Selection of a suitable high yielding variety is a key factor for highest net return in an area under changing climate. Despite of increase in use of fertilizer application and improved varieties most crops yield is low due to sowing of unsuitable variety/hybrid on inappropriate time. For growers, selection of an appropriate sowing time for a crop is a key agronomic concern as yield losses are associated with inappropriate sowing time. In any cropping system, selection of a cultivar is basic management decision as cultivars bred for one region may not perform equally at other regions [7,8]. Some cultivars adapt readily and perform well under changing conditions while the others fail to do so. While selecting a cultivar, different agronomic traits like yield potential, growth period and quality should be considered. Comprehensively speaking, yield potential of a crop can be highly enhanced when high yielding cultivar is planted on a suitable time.

Discussion

Change in climate surely affects crop growth and development, which may ultimately influence its overall production performance. In some regions, agriculture productivity may increase, this can be an opportunity while in some areas the production can be decrease and is disadvantage for a crop due to climate change [9]. Climate change affects production of a crop in different regions with different magnitude [10]. Recent climate changes effect has been observed in all over the world and its effects on crops has been noticed. However, revalidation of the agronomic practices is need of the day to ensure production performance of major crops e.g. maize, wheat and rice which is

grown on a significant area every year and its production plays an important role in the economy as well as food security of the country. Selection of an optimum sowing time in the present scenario of changing climate is utmost important for efficient utilization of the available resources by plants and harvesting its maximum potential yield. In Pakistan, high summer temperature was an issue of maize crop productivity particularly its effect on grain development and causes reduction in yield [11]. Due to changing climate, a substantial effect on maize yield has already been observed [12]. Among many other reasons, low maize yield under rapidly changing climate in vegetative stage of the crop is of great concern for the selection of a suitable variety and/or adjusting its sowing timing for a cropping system [13].

Change in the climate has a significant effect on most of the environment related systems like agriculture, forestry, eco-system and environment etc. Regarding agriculture, changes in total amount and distribution of precipitation, its intensity and duration, solar radiation which affect mean seasonal temperature will eventually cause changes in the crop yield, cropping intensity, field operations scheduling, moisture content of grain at harvest and ultimately disturbs overall performance of agriculture. Crop growth duration decreases with increase in seasonal temperature due to increase in the crop growth rate. High temperature may negatively affect crop growth rate. On the other hand, in arid and semi-arid areas with increase in rainfall, photosynthetic rate increases, which results in higher crop yield. Study reported that adaptation of crop to climate change needs more tolerance of higher summer temperature in the current maize cultivars and/or a complete change of the varieties with new ones to adapt the local weather [14]. Selection of optimum sowing date for each crop has utmost importance for utilizing the potential of each variety and increasing the use efficiency of every environmental factor. Losses in yield have been observed for very early or late sowing.

Selection of high yielding varieties not only enhanced yield and quality but also increased farmer's income per unit area in comparison to traditional varieties [15]. Potential of old varieties are decreasing day by day. Therefore, adoption of varieties with high yield potential and adaptation to current scenario of climate change are need of day. Final grain yield is the combined result of genotype x environment interaction. Under the same environment, different varieties produced different yield. Optimum sowing date along with high yielding variety for each area are important factors for efficient utilization of natural and synthetic resources to gain the maximum output in terms of yield. The realization of a successful crop depends on many factors, among which cultivar selection and planting date management are most crucial for development and final outcome of the crop. The potential of a cultivar in a region is primarily attributed to sowing time management because conducive growing conditions for a crop are associated with sowing time [16]. The crop growth, development and yield as well as insect pest management are considerably influenced by sowing time [17]. Concluded that early planting is more beneficial when larger amount of heat units accrued early in season due to which plants mature and harvested before inclement fall weather [18]. Detected differential performance of cultivars in an array of environments. He further concluded that cultivar choice according to the prevailing climatic conditions is a strong component of realizing target yield [19].

Conclusion

By examining the above discussion, it can be concluded that sowing a suitable variety on optimum time in season is a key to higher yield. Despite of using standard cultural practices, maximum yield potential of a crop cannot be attained when an unsuitable variety is sown on inappropriate time in season.

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