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Genetics of Inter Cropping for Crop Productivity Enhancement

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ABSTRACT

Inter cropping which is also known as mixed cropping has ability of increasing usage of nutrient and water efficiently, enhancing crop productivity, and plasticity to abiotic and biotic stress resulted by change in climate. In this agroecological farming method, two or more crops are cultivated together on the same farm area. Cereal with legume is a common combination. Crop selection is not profitable unless characteristics useful in intercrops, such as intercropping in legume and cereal cultivars, are considered. Inter cropping can result in enhanced soil fertility and structure, improved weed suppression, the conservation of soil moisture, and comparatively better control of diseases and pests, resulting greater yield and increased profitability. The biggest benefit of intercropping systems is the fact that they combine above-ground and below-ground benefits: these benefits include both short and tall plant components, which helps them to harness sunlight for photosynthesis, as well as deep and shallow rooted plant components, which assists them in using water and nutrients for crop production. Intercropping is popular in areas of the world including China, Mali, Indonesia, India, Ethiopia, and Niger due to its high growing popularity in agriculture. General & Specific Combining Ability principles in hybrid breeding have been applied for crop combinations and cultivars, and their impacts are recognized as General/ Specific Mixing Ability. The other considerable advantages of intercropping include greater land use efficiency, competitive ability towards weed, favorable exudates from the component legumes, and greater yield stability which cannot be achieved in monocropping. Plant breeding enables intercropping systems to better use their genetic diversity by conducting plant breeding research and harnessing this variability to cross-crop adaptability. High labor inputs in harvesting, higher cost of maintenance and reduction of the main crop are some disadvantages of intercropping.

Keywords: *Monocropping, Agriculture, Agroecological, Biotic stress*

INTRODUCTION

Intercropping involves two or more crops being cultivated in the same field; the planting periods of the two or more crops overlap sufficiently to include the growth phase (Gomez & Wiley, n.d.). Increasing the efficiency of farm resources using intercropping, double cropping, and other

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mixed cropping methods is what is tied to sustainable crop production (Takele et al., 2017). When it comes to year-round ground cover, intercropping offers far greater protection against erosion and desiccation as compared to monocultures. Water usage efficiency, reduction in soil erosion, and soil fertility are maximized by growing two or more crops on the same land, which also cuts down on water pollution and minimizes the need for fertilizer (Kobe & Deisenhofer, 1994). Intercropping helps to avoid peak planting and harvesting times over the year. It might assist to improve production per unit area while simultaneously improving soil quality and nutrient usage due to the mixing of species, which access water and available nutrients in a more efficient manner (Kotschi et al., 1986). Various studies deal with the theory and mechanics of intercropping yield stability. When intercropping is utilized, yields are higher in a certain season, and yields are more stable in other seasons when monocropping is used (Willey et al., 2008). To provide greater harvest security, traditional farmers plant a wide range of crops. Ultimately, the objective of production is to make money, whether first or third world, and this is a function of how productive an area is and the effects it has on costs and the market. Thus, farmers would want both the subsistence and income to better their odds of avoiding risk and fluctuating revenue. The social advantages to both the land-holder and the surrounding community of intercropping may be observed in tandem with the production and revenue it produces (Khan et al., 2006).

The genetic link among crop varieties is the bedrock of all intercrops. Planting intercrops of beans and maize can teach us that it is not necessarily profitable to pick two crops in a row, but it is possible to discover characteristics advantageous to intercrops, such as resistance to lodging. An experiment that developed new grain and legume cultivars for intercropping while meeting farmers' varied desires, such as cash, food, animal feed, or green manure, was referred to as a breeder's design, develop, and evaluate project. In Europe, enhancing biodiversity through intercropping techniques is becoming more popular.

The major objective of farmers and agriculturists is crop production enhancement. It is possible that a sustainable agriculture's objective is improved productivity per unit area with the extension of arable land. To meet the challenge of an increasingly crowded agricultural landscape, it is now critical for agriculture managers and nongovernmental organizations to consider the use of multiple cropping as a strategy to enhance the amount of agricultural produce. While industrialized nations utilize rotating mono-culture cropping systems, emerging countries adopt poly-culture cropping systems. Another reason of using multi crop systems includes usage of space and labor more efficiently. The biophysical reasons of intercropping concerned better yield stability in variable environment, conservation of soil and better utilization of environmental factors. As far as socio economic concern related to multi crops these include magnitude of outputs and inputs and their role in the improvement of house hold food supply. Most of the farmers grow crops in the mixtures in East Africa due to the dry, semi-arid and humid environmental conditions; common mixture crops are maize/beans, maize/beans/potatoes and bananas/coffee. It is reported that cassava/tomato/maize, cassava/beans/maize and sweet potato/maize results 1.5 to 2.8 times more production yield than their mono crops individually. Maize has the ability to be inter cropped with many vegetables like beetroot, celery, tomato, carrot, potatoes, leeks, strawberries and reddish.

Advantages of Intercropping:

Intercrops use resources efficiently and gives higher yield as compared to the sole crops (Szumigalski & Van Acker, 2008). Intercrops use complete and efficient growth resources like soil nutrients, solar energy and water. Intercrops when differ in their growth duration use maximum growth resources due to different requirements at different times(Fukai & Trenbath, 1993). There should be minimum

25 percent difference in crops in the duration of intercrops to obtain yield advantage(Gebru, 2015). Plants having the component causing early maturity should be grown with the crops of late maturity and in this way results high productivity. Time and space are the other factors of intercropping for the effective use of growth resources. Vertical and horizontal expansions are the conventional ways of intensification of intercropping. Enhanced light use is possible in intercropping when two or more species occupy same land space but different foliage pattern during the certain growing season(Francis, 1986).

Also significant is the fact that the species mature at various times, and this would lead to varied nutrient demands among intercropping species, thus giving rise to the temporal dimension of the system. Because the temporal dimension is greater, resources will be used more efficiently as intercrop components do not compete for resources (Trenbath, 1986). When using two crop species with distinct growth periods, greater utilization of space and time result in higher total yields. Intercropping may emphasize both space and time resources, and therefore increases the total amount of available growth resources, while mono cropping can accentuate just one of these dimensions. Intercropping caused the canopy to cover to grow more quickly, resulting in a significant increase in radiation interception because of more canopy coverage. Instead of growing only one crop on a given piece of land, intercropping gives the benefit of effective interception and utilization of radiation than mono cropping. By intercropping, for example, more interception of radiation and/or improved radiation usage efficiency might be obtained. To aid in the efficient use of incident radiation, you can minimize the amount of radiation energy that reaches the bottom.

Time-specific benefits of intercropping short- and long-duration species are made possible by the improved ability to collect radiation throughout time. A more efficient use of radiation energy produced more biomass, or a higher percentage of biomass dedicated to production (Ramakrishna & Ong, 1994).

Interactions in intercropping:

The two most essential interactions in intercropping are competition and complementarity. Competitive relationships, known as intercropping, are separated into three broad categories: mutual inhibition, where the yields of both species are lower than expected; mutualism, where the yields of both species are higher than expected; and compensation, where one species yields, but not as much as expected. The integration of crop species with natural plant species may be a critical aspect of natural vegetation and intercrops. When component crops vary in their use of growth resources in such a way that when they are all grown together, one crops the resources that the other crops did not use, advantage is obtained. They are more prepared to supplement each other, and are thus better positioned to make the most effective use of resources as a team. There are not the same resources (space or time) between the component crops, and hence competition from intercropping is less than competition from in tracing. Spatial and temporal complementarity are contrasted with each other frequently. in temporal complementarity, growth patterns change in time; crops draw water at varying points of time, especially in systems where water scarcity is a problem. It requires a temporal displacement that causes the intercrop to collect additional resources rather than efficiency in the usage of resources. Combined leaf or rootage intercropping leads to enhanced resource use due to improved utilization of sunlight, water, and nutrients since intercropped components interact with different soil layers or canopy heights. Each type of crop has its own nutritional requirements, and they each have unique methods of accessing nutrients in the soil. This crop utilizes a higher amount of soil than any other crop (Society, 2018). Resources acquired in intercrops are more efficiently utilized

compared to solely crops. When the different parts of a crop's maturity and protein demands are genetically different or must be changed based on planting dates, the more growth factors the crop is capable of producing, which results in yield over-yielding. As a result of complimentary effects between component crops, utilization of growing resources has the potential to substantially increase yield advantages (Wallace et al., 1990).

Intercropping effected by plant population:

A relevant measure of plant populations is the plant density per unit area, and one may consider ideal or essential population densities to prevent crop output from being limited by population. Plant population establishment guarantees that the crop that is produced is of a quality that the consumer accepts. The number of plants in an agricultural area relies on the kind and growth pattern of crops, the fertility of the soil, the amount of rainfall, and other growth needs. Dense situations lead to competition for solar light, thereby resulting in unfavorable growth effects in crops with branching structures. When the whole plant density is above that of either of the sole crops, intercropping provides a yield benefit (Gebru, 2015). The total population of faba bean and maize grew from 75% to 100% and from 25% to 75% for maize and faba bean correspondingly. For example, a 50:50 component population/total population intercropping system would be regarded to have half the optimal population of each component as if they are each given a value of 100. (Zlokolica et al., 2002).

Genetics of Intercropping:

The fundament of all intercrops is genetics, within the crop or between crops. cultivars designed for monocrops also are the simplest choice for intercrops (Waddington et al., 1990). Data to prove or disprove this is often not available. A logical suggestion would be to style cultivars for intercrops. supported experiences with maize and beans, it's probably not worthwhile to pick the 2 crops simultaneously. It might be more important to pick for traits useful in intercrops, like resistance to lodging, following the quality breeding methods. Considering that not all traits are influenced by plant-plant interaction, this will certainly be true. However, plant-plant interactions can't be selected for without the presence of other plants. Waddington, 1990, calls on breeders to: While delivering the farmers' numerous demands, such food, cash, animal feed, or manure, along with competitive advantages, designers, developers, and evaluators produce cereal and legume cultivars for intercropping compatibility, physical and physiological competition, and pest issues. According to our findings, it seems that there's a plan to conduct an intercrop using crops that are suited for intercropping, although some debate exists as to the specific techniques to use. The robustness of any sort of line is that the combination of the minimum yield and therefore the effect stresses have had on the ultimate yield (Chen et al., 2017). The sort of genetic diversity was the purpose of attention. A Composite Cross Population (CCP) may be a population derived from crossing several cultivars and is that the most genetically diverse(Phillips & Wolfe, 2005). Cultivar mixtures are crop mixtures composed of several cultivars by mixing the seeds, no additional activities are needed. Landraces are populations often grown within the Centre of origin and are maintained by selecting and resowing of previous harvests. Improved varieties and cultivars are comparable from a genetic diversity point of view during which interesting crop traits are often combined. Improved lines originate from a population, are single plant descendants, thus genetically homogeneous, and contain characteristics which have drawn the eye to the first parental plant. These characteristics make them closer to a crop than a wild plant. In breeding lines, these characteristics are enhanced. Lines are single plant descendants, often from landraces. The Improved line, Breeding line and Line are from a genetic diversity standpoint similar as they're all homogeneous. The Improved line and Breeding line both have a Line as origin; the difference is that the degree of selection that has taken place within the process. A Line originates from one plant that was self-

fertilized variety of times to possess all genetically identical offspring. Within the case of an Improved line, this was done to explore a particular trait that has sparked the interest of the developer. Within the case of a Breeding line, this was done to such an extent that the resulting Line is suitable to be utilized in a breeding programme. The genetic diversity between plants belonging to at least one of those three sorts of lines is equal and next to zilch. because the final goal of each kind of Line isn't an equivalent, data shouldn't be pooled as equal(Onwueme & Sinha, 1991).

Disadvantages of Intercropping

On the other hand, intercropping systems have drawbacks as well. Cultivar yield decrease, crop loss due to drought, and excessive labour input are included in this category. Because there is competition among intercropped plants for light, nutrients, and water, the yield is often lower in an intercropping system than in a monoculture. If this yield reduction results in a higher market value for the most crop characteristics, it might also be economically important (Yildirim & Guvenc, 2005). Other possible downsides may include increased maintenance costs, particularly for weeding, which must be done by hand. This is not an issue in nations where labor is plentiful, such as Ethiopia. Intercropping usually ends in increased expenses only when labor is scarce. Additionally, harvesting of one crop may harm the crop being harvested. Intercropped canopy cover may also result in a microenvironment that favors pathogen outbreaks, particularly with respect to fungal diseases (Willey et al., 2008).

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