Review Article

A review on plant population study in maize crop

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Abstract

A review study on plant population was done to assess the optimum population for improved grain yield and biological yield. The main perspective of this review study to evaluate the different planting population and to recommend it for future application. The increasing consumption of maize contributes a prominent place in economy of agriculture. The significance of planting density as a feature defining yield and growth has remained well recognized for the key areas of production of maize. Defining maize density reaction is a frequent part of study but it is unreliable across management practices and diverse environment. The grain yield of maize rise from 10.1 to 10.8 t ha⁻¹ as population rise from 59000 to 89000 plants ha⁻¹. The grain yield of maize normally reveals a quadratic comeback to planting population with a rise through a series of lower populations, a steadily reducing amount of yield increase comparative to population rise and lastly a yield plateau at certain reasonably higher populations of plant. Planting density influenced generally maize growth parameters in most promising growth condition and therefore it is measured as a vital aspect to regulate the range of interplant competition. Optimal planting density enlarged number of grains per cob, 1000-grain weight and eventually improved maize grain yield. This paper has reviewed the research work performed by numerous scientists in Pakistan and abroad.

Keywords: Economy; Grain yield; Maize; Plant population

Introduction

Corn (*Zea mays* L.) comes in the family of Poaceae. Maize plant forms key dietary measure of many people in the form of porridge, bread and cake. Further it is a key grain food consumption of human [1]. One of the supreme main active causes is no use of finest planting density per hectare [2].

Greater planting densities upsurge sterility of plant and the interval among female and male blooms, and lessen the grains number per ear [3]. Planting density studies are too attractive for at least two causes for researchers of maize. Suitable population can add to substantial yield of grain rises for farmers [4]. Furthermore, yield of maize reaction to

density hang on environmental and genotypic influences [5], and moreover the damaging comebacks to a certain factor of the crop can be confirmed beyond some restrictions. Stand populations influences architecture of plant, modifies growth and developmental designs and affects partition and production of carbohydrate [6]. Maize is sensitive to distinctions in population of plant than further family of grass members [7]. At lower populations, various recent hybrids of maize deprived of tiller effectively and relatively often give one ear per plant. Thus, maize do not share the most tillering attribute grasses of recompensing for smaller area of leaf and smaller reproductive components by branching [8]. Denser planting density will provide lesser space for competing weeds in between crop rows [9]. Moreover the use of dense populations improves interplant competition for nutrients, water and light. Plant population is one of the essential features that upset maize yield of grain, being promising to rise yield of maize, average rate of grain-filling and water use efficiency [9]. Judicious density of maize is the center for producing effective population organization that includes appropriate leaf area index and creates full use of light energy for enriched photosynthetic capacity of leaf [10]. Though, if the population is too excessive it will decrease the light ability to enter the lower canopy [11], causing senescence of the lower leaves earlier [12] and lessening the utilization efficiency of radiation [13]. The review study was carried out to evaluate different planting population and to compare the yield of these populations. To know about the proper population that will leads towards maximum yield and to practice them in future upcoming researches. The review study of different population will lead us to know which population is optimum for greater yield so that researcher may apply them. In May 2019 literature reviews were together on diverse feature about maize planting

density. The determination of this review study was to identify the dissimilar density practices of planting on yield quality and maize growth. The appropriate and significant published work accessible on maize has been studied.

Influence of planting density on maize growth

Leaf area plant⁻¹ declined, while leaf area index rises in right manner with rise in planting density. By increasing density we condensed the space among plants and subsequently increase intraspecific competition, which as an end result decrease the plants individual size in terms of leaves number, total leaf area and size of leaf [14]. Moreover, increasing density of plant increased maize LAI. [15] Initiated that height of plant improved with rises in density up to 10 plants m⁻². Greater plant populations lead to the weaker plants of more size which prone to lodging and diseases and resulted in lower yield of grains [16]. [17] Find the taller plant with the maximum planting density. [18] Who conveyed that increasing planting density increased ears m⁻² and declined cobs per plant. They stated that the cobs number per plant was reduced significantly probably due to more light, nutrients and aeration competition and thus allowing the plants in these treatments to endure reproductive growth lesser. [19] Concluded that the length of cob reduced by rise in planting density. These findings specify that there is a positive association among length of cob and spacing of plant in maize, possibly due to variable competition of plant. [3] Initiated that length of cob gets reduction by an increase of planting density. [20] Perceived that as plant population increased the diameter of stem reduced, an inverse relationship between stem diameter and plant population was found. Decline in diameter of stem as a result of higher planting densities might be due to greater competition of plant for existing resources like water, air, nutrients and space.

Competition of plant decreases water and nutrient uptake that eventually diminishes production of assimilates and their supply towards stem. [21] Described that diameter of stem were lesser in higher plant populations as a consequence of interplant competition. [22] Directed that the consequence is largely due to competition for nutrients of soil, light and moisture. In research, it was detected that plant density of maize at 80,000 plants ha⁻¹ used strong influence on height of maize, lodging percent and diameter of stalk. [23] Explained the detected tendency of height of plant and length of internodes with rising in planting density for light competition. Moreover the fashion perceived for diameter of stalk and lodging percent with rise in density of maize plant. Maize plants become more susceptible to stalk lodging as plant density increases [24]. [25] Resulted from the study that the highest physiological growth indices were attained in higher planting population, as photosynthesis rises by development of leaves area and rises TDW. Planting density has vital effects on reproductive and vegetative maize growth. Maize physiological development indices are lower with low planting density because of smaller leaf area per plant plasticity. [26] Found that maturity overdue with the planting density increases. The tough interplant competition at greater densities for nutrients, water and light might have extended the vegetative development of the plants as related to lower planting densities. This proposed that denser populations may have marginally reduced down the plant rate development as of more competition in higher density. [27] Plants will produce smaller ears, fewer kernels per ear and/or less grain weight per year in densely sown crops, but greater number of ear will result in a higher yield. [28] Exposed that due to crowding effect of the plant and greater intra-specific competition for resources increases. Plants number rises in a particular area the

competition amongst the plants for capture of light and uptake of nutrients also increased that resulted in taller plants. The practice of lower than optimum planting density delays closure of canopy, declining seasonal capture of incident solar radiation, leading to great production of grain per plant but low production per area of grain [27].

Influence of planting density on maize yield

Grain yield per unit area rises with planting density till the rise in attributes of yield to plants is decreases by decline in mean yield per plant [28]. Lower than optimal populations suffer closure of canopy with reduced capture of seasonal incident of solar radiation, prominent to larger grains number per plant, but lower grain yield per unit area. [29] Described that biological yield enlarged with the increase of planting density. [30] Obtained higher biological yield at 80,000 and 95,000 plants ha⁻¹ respectively as compared with 55000 and 60000 plants ha⁻¹. [31] Reported that grain rows and number of rows ear⁻¹ changed significantly due to greater planting population. In the same approach, several researchers perceived that grains per ear frequently decrease with rise in plant population. [32] Plant biomass was increased with increasing plant density, whereas harvest index with a downward tendency. [33] Resulted that increase in biological yield at higher density of planting might be due to rise in number of plants as well as in height of plant of single plants at denser populations. [33] Reported greater biological yield at higher planting density in maize crop. [19] Revealed that weight of 1000-grains increased with reducing planting density in maize. [34] Stated that there were varietal dissimilarities in 1000-grain weight that increased with the rising in plant spacing. [35] Reported unreliable optimal density levels of plants ranging from 86000 to 101270 plants ha⁻¹ for corn grain yield. [36] Who conveyed that yield of fodder increased

with rise in planting density. [37] Who concluded that use of higher planting density reduced size of grain, number of grains per row and grains number per plant. High plant population beyond optimal leads to extreme interplant competition for occurrence of photosynthetic photon flux density, soil water and nutrients of soil. This outcomes in partial supplies of nitrogen and carbon and resulting barrenness increases and kernel number per plant and size of kernel decreases. [38] Who perceived that cobs number, cobs weight and weight of grain per cob were maximum at wide spacing. [39] Who described that weight of thousand grains increased when population in maize decreased. [40] Revealed an increased kernel yield with planting density up to 51,000 plants ha⁻¹, followed by yield decreasing with more rises of population up to 72,000 plants ha⁻¹. Reproductive response of maize to plant density has normally displayed that yield of individual plant decreases as plant per unit

area rises [41]. [42] Resulted that population of maize for maximum economic yield of grain diverges among 30,000 to 90,000 plants ha⁻¹. Coefficient of Variance of grain yield through the four grown seasons were increased with the increasing plant density [43]. Using of high planting densities may decrease the photosynthates, nitrogen supply and water to developing ear. High stand establishment creates competition for nutrients, aeration, light and subsequently causing the plants to endure fewer reproductive growth [43]. [44] Reported that optimum density of plant gave greater yield due to soil nutrients utilization more powerfully joined with further factors regarding growth. They also detected lower yield of grain with highest density as of smaller size of ear, less ears number plant⁻¹ due to more competition for factors regarding growth. Grain yield and WUE both showed parabolic relations with plant density [45].

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Figures 1-10. Some of the results in the form of figures from different researches are presented from 1 to 10.

Conclusion

Planting density ultimately affects the growth and development of maize crop. The application of planting density up to 90000 plants ha^{-1} increase the growth traits, yield and yield components of maize. High planting density increases plant height, grain yield and biological yield. This study of various literature it can be concluded that planting density from 60000 to 90000 ha^{-1} should be practiced for achieving high yield.

Authors' contributions

Conceived and designed the experiments: F Ahmad, MR Khan & M Shafi, Performed the experiments: F Ahmad, J Ahmad, S Iqbal & SMA Shah, Analyzed the data: Z Mehmood, KU Rehman, AR Khan & Abidullah, Contributed materials/ analysis/ tools: M Tauseef, M Ahmad, M Ali & A Saleem, Wrote the paper: F Ahmad, M Shafi & J Ahmad

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