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Optimizing Plant Spacing to Enhance Maize Yield

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Abstract

The impact of plant spacing on maize yield is crucial for optimizing agronomic practices and improving productivity. This study was conducted to evaluate the effects of different plant spacings on the yield attributes of maize (Zea mays L.) variety BARI Maize-5. This study evaluates four plant spacings: 75 cm × 25 cm, 75 cm × 20 cm, 60 cm × 25 cm, and 60 cm × 20 cm. in a randomized complete block design with three replications. Results demonstrated that plant spacing significantly affects maize yield attributes and overall yield. The 75 cm × 25 cm spacing produced the highest number of cobs plant^{-1} (1.44), grains cob^{-1} (530.39), thousand-grain weight (131.85 g), grain yield (5.18 t ha^{-1}), and harvest index (41.14%). In contrast, the 60 cm × 20 cm spacing resulted in the lowest values for grains per cob, 1000-grain weight, and grain yield. It may be recommended that optimizing plant spacing is vital for maximizing maize yield, with the 75 cm × 25 cm spacing being most effective for cultivating maize cv. BARI Maize-5.

Keywords: Plant Spacing, Maize Yield, Grain Yield, Harvest Index

Introduction

Maize (Zea mays L.) is a crucial cereal crop globally and has gained prominence in Bangladesh due to its high productivity and diverse uses (Tajul *et al*., 2013). In Bangladesh, maize is cultivated on about 350,000 hectares, producing approximately 2.3 million metric tons of grain (Baral, 2016) [4]. It is integral to crop diversification and intensive cropping programs (Zamir *et al*., 2011). Maize is used in various forms including green cobs, roasted cobs, popped grain, and as ingredients in edible oil, cornmeal, and flour. Additionally, maize by-products such as stover and cob sheaths serve as livestock feed and fuel (Ahmed, 1994) [1]. It is recognized for its high content of carbohydrates, fats, proteins, vitamins, and minerals, making it a vital component of food security and nutrition (Prasanna *et al*., 2001).

Despite its benefits, the average yield of maize in Bangladesh remains low at 6.45 t ha^{-1} compared to over 8 t ha^{-1} achievable with modern varieties (AIS, 2015) [2]. Plant population and spacing significantly influence maize growth and yield. Inadequate plant density and poor nutrient management can limit productivity (Dawadi and Sah, 2012) [6]. Proper plant spacing enhances the efficient use of solar radiation and nutrients, minimizes soil moisture evaporation, and reduces competition among plants. Conversely, closer spacing can hinder plant development and reduce yields. Optimal plant spacing is crucial for maximizing growth and yield (Bullock *et al*., 1988) [5]. To maximize maize yield, it is essential to determine and implement the most effective plant spacing. This study aims to investigate the impact of different plant spacings on the yield performance of maize.

Materials and Methods

The experiment was conducted at the farmer's field at Digharkanda village in Mymensingh Sadar district of Bangladesh (AEZ-9) from November 2015 to April 2016 to evaluate the effect of plant spacing on maize yield. The study employed a randomized complete block design with three replications, testing four plant spacings: 75 cm × 25 cm, 75 cm × 20 cm, 60 cm ×

25 cm, and 60 cm × 20 cm. Each unit plot measured 4.5 m × 4.0 m. Fertilizers were applied according to the recommendations outlined in the fertilizer recommendation guide (BARC, 2010) [3]. The maize cultivar used was BARI Maize-5, developed by BARI.

For data collection, five plants were randomly selected from each plot to assess yield attributes and overall yield. At full maturity, the crop was harvested plot-wise. Cobs were dried in the sun, shelled, and cleaned. The grains and stalks from each plot were individually dried before weighing. Grains were sun-dried to 14% moisture content, weighed carefully, and the yield was recorded in metric tons per hectare (t ha^{-1}). Stalks were also sun-dried, and the final stalk yield per plot was recorded in t ha^{-1}. The harvest index (%) was calculated using the standard formula:

$$\text{Harvest index} = \frac{\text{Economic yield (grain yield)}}{\text{Biological yield (grain yield + stover yield)}} \times 100$$

Results and Discussion

Yield attributes

The 75 cm × 25 cm planting spacing yielded the highest number of cobs per plant (1.44), grains per cob (530.39), and 1000-grain weight (131.85 g), whereas the lowest values for these attributes were observed at the 60 cm × 20 cm spacing (Table 1). The reduced yield attributes at the closer spacing were attributed to increased competition for essential resources such as sunlight, moisture, nutrients, and air. Similar findings have been reported by Hashemi *et al.* (2005) and Dawadi and Sah (2012) [6], who documented a negative correlation between plant density and yield attributes. The high plant density at the 60 cm × 20 cm spacing led to diminished yield attributes due to inadequate assimilation sinks and suboptimal light energy conservation.

Table 1: Effect of plant spacing on the yield attributes and yield of maize

Spacing (cm × cm)	Cobs plant^{-1} (no.)	Grains cob^{-1} (no.)	1000- grain weight (g)
75 x 25	1.44a	530.39a	131.85a
75 x 20	1.41ab	494.73b	113.45b
60 x 25	1.40b	471.17c	107.89c
60 x 20	1.33c	374.39d	104.82c
CV (%)	2.11	4.63	4.59
Level of significance	**	**	**

** Indicates significance at 0.01 level probability

Grain yield, stover yield and harvest index

Plant spacing significantly impacted grain yield, stover yield, and harvest index. The highest grain yield was achieved with a spacing of 75 cm × 25 cm, reaching 5.18 t ha^{-1}, while the lowest yield of 4.62 t ha^{-1} was recorded at 60 cm × 20 cm spacing. The decrease in grain yield with closer spacing was attributed to reduced availability of solar radiation, nutrients, moisture, and air. This observation aligns with the findings of Ramulu *et al.* (2006). Conversely, Dawadi and Sah (2012) [6] reported a positive relationship between grain yield and plant density, attributing it to the higher number of cobs per unit area in denser plantings.

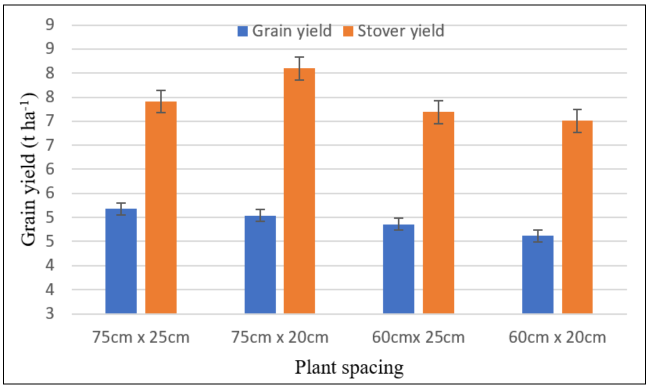

Fig 1: Effect of plant spacing on grain yield and stover yield of maize

The maximum stover yield of 8.10 t ha^{-1} was recorded at the 75 cm × 20 cm spacing, followed by 7.41 t ha^{-1} at 75 cm × 25 cm. The stover yields at these spacings were statistically similar to those at 60 cm × 25 cm and 60 cm × 20 cm spacings. The spacing of 75 cm × 25 cm produced the highest harvest index of 41.14%, while the lowest harvest index of 38.36% was observed at 75 cm × 20 cm spacing.

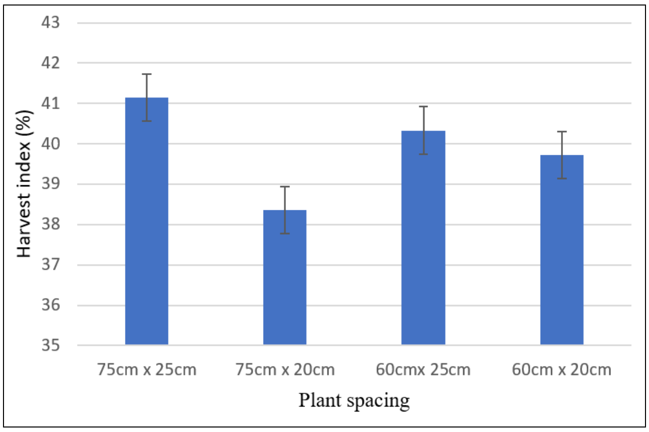

Fig 2: Effect of plant spacing on harvest index of maize

Conclusion

The findings of this study indicate that a plant spacing of 75 cm × 25 cm is most effective for maximizing the yield of maize cv. BARI Maize-5. This spacing consistently resulted in superior yield attributes, including the highest grain yield, stover yield, and harvest index compared to narrower spacings. Therefore, it may be recommended that optimizing plant spacing is vital for maximizing maize yield, with the 75 cm × 25 cm spacing being most effective for cultivating maize cv. BARI Maize-5.

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