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EFFECT OF PLANTING METHODS ON GROWTH, PHENOLOGY AND YIELD OF MAIZE VARIETIES

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Abstract

Field experiment was conducted at KPK Agricultural University, Peshawar, Pakistan to find out the effect of planting methods on the yield and yield components of maize varieties. Analysis of the data revealed that planting methods had a significant effect on days to tasseling, days to silking, plant height, number of plants ha^{-1} at harvest, thousand grain weight, grain yield, biological yield, fresh weed biomass m^{-2} and non-significant effect on days to emergence, emergence m^{-2}, number of cobs $plant^{-1}$, grains ear^{-1}, harvest index and dry weed biomass m^{-2}. Similarly, the effect of varieties was also significant on all parameters except fresh and dry weed biomass m^{-2}. Maximum emergence m^{-2}, days to tasseling, days to silking, plant height, number of plants ha^{-1} at harvest, grains ear^{-1}, thousand grain weight, grain yield and biological yield were recorded in ridge planting method. Similarly, Jalal sown on ridges took maximum days to emergence, emergence m^{-2}, plant height, number of cobs $plant^{-1}$, grains ear^{-1}, thousand grain weight, grain yield, biological yield, fresh weed biomass and dry weed biomass.

Introduction

Maize (*Zea mays* L.) belongs to the family Poaceae and it is the third important cereal crop of the World after wheat and rice. It is grown extensively in temperate, subtropical and tropical regions of the world. USA, China, Brazil, Mexico, Yugoslavia, Rumania, Argentina and Italy are the leading maize producing countries in the World. Maize is used as a staple food for human consumption and feed for livestock. It is estimated that about 70% production of maize is used directly or indirectly as food and rest of it find its way to starch manufacturing and poultry industry. Maize is produced primarily as an energy source crop, but specialized versions for protein oil, wax, sweet corn and pop corn are also available (Akbar & Taj, 1998). Maize is successfully grown from sea level in plains to as high as 3300 meter above sea level in the highlands from 50° N to 40° S latitude as multi-purpose crop in temperate, subtropical regions of the world (Ihsan *et al*., 2005).

In Pakistan, rainfall is one of the major sources for agricultural production. However, rainfall in Pakistan is highly variable both in amount and distribution from year to year. As a result crop frequently suffers from moisture stress at some stages during their growth period with ultimate results of reduced yield. The uncertainty of precipitation forces farmers to adopt low input crop management practices (Haibu *et al*., 2006). Effective agronomic practices are necessary not only for the utilization of light rains but also to reduce surface run off and storing it in the crop root zone for use during moisture stress (Belachew & Abera, 2010) Planting method is one of a crucial factor for improving crop yield. Different planting methods are practiced in the World at the time of sowing maize crop. In-appropriate planting method results in barren plants. Ear and its size remains smaller, crop become susceptible to lodging, diseases and pests resulting in lower yield per unit area. Ridge tillage can be considered as an alternative to no-tillage in climates and environments which are not very favorable for the latter (Liu & Yong, 2008). Abdullah *et al*., (2008) reported that ridge planting significantly increased yield of maize when compared with other planting methods. Conventional flat planting for winter maize has some disadvantages. The use of flood irrigation can result in water use efficiency and inefficient use of nitrogen. It can also cause crusting of the soil surface following flood irrigation and can contribute to the degradation of some soil properties, which can result in higher crop lodging. A raised bed planting system with a number of defined rows planted on top of the bed with furrow irrigation can overcome these detriments (Nasir & Akbar, 2000). Govaerts *et al*., (2004), Wang *et al*., (2004) and Ortega *et al*., (2008) reported that raised bed planting is the most efficient method of planting for wheat, maize and other crops. Keeping in view the role of crop management practices in crop yield, the present study was designed to investigate the effect of different planting methods and varieties on phenology, growth and yield of maize.

Materials and Methods

The present study was conducted at the New Developmental Farm, KPK Agricultural University Peshawar, Pakistan using randomized complete block design with split plot arrangement having four replications. Planting methods were allotted to the main plots, while varieties to sub plots (4 m x 4 m), having 5 rows each (4 m long) with row to row distance of 75 cm. Fertilizer was applied @ 150 kg N and 90 kg P ha^{-1}. Full dose of phosphorus and half of nitrogen was applied at the time of sowing while the remaining half of the nitrogen at 2nd irrigation. Four methods of planting (broadcast, line, ridge and raised bed) and four cultivars of maize (Pahari, Azam, Jalal and Sarhad white) were studied during the present investigation. All agronomic practices were followed uniformly for all the treatments throughout the growing season.

Procedures for data collection: Data regarding days to emergence was recorded from the date of sowing till when 80% of the seedling emerged in each subplot. The data on emergence m^{-2} was recorded from an area of one meter square in each subplot accordingly. Silking date was recorded when the silk became visible on the topmost ear of at least 50% of plants in a plot (Tollenaar *et al.,* 2004; Lee *et al.,* 2005). The number of days from planting to silking was then expressed as days to silking (Hinze and Lamkey, 2003). Days to tasseling were observed by counting the number of days from sowing till when 80% of the plants produced tassels and silks in each subplot. Plant height was recorded at the time of physiological maturity from bottom to top excluding tassel (Guzman and Lamkey, 2000). Number of plants at harvest was recorded by harvesting the total plants in three central rows of each subplot and converted accordingly. Number of ears $plant^{-1}$ was noted by counting the number of ears in three central rows and were then averaged. The ears harvested from randomly selected plants in each subplot were dried and shelled. Number of grains ear^{-1} was counted in selected plants and their average was then worked out. Thousand grain weights were taken on randomly selected shelled ears of each subplot and then their average weight was

recorded. Grain yield data was recorded in each subplot and converted in kg ha^{-1}. Dry weight of the stalk along with stover was recorded after two weeks of sun drying from each subplot and then converted in to kg ha^{-1} to record data on biological yield. Harvest index was calculated as % age ratio of economic and biological yield. Data regarding fresh and dry weight of weed biomass was recorded 26 days after sowing. Fresh weight of weeds was recorded in one square meter area. After recording fresh weight, weed samples were oven dried at 80°C for 24 hours and re-weighed for dry weight.

Statistical analysis: Data were analyzed statistically for analysis of variance (ANOVA) following the method described by Gomez & Gomaz (1984). MSTATC computer software was used to carry out statistical analysis (Bricker, 1991). The significance of differences among means was compared by using Least Significant Difference (LSD) test (Steel &Torrie, 1997).

Results and Discussion

Phenology and growth: Days to emergence were significantly ($p<0.05$) affected by various varieties, while the effect of sowing methods was non significant. Similarly, interaction between sowing methods and varieties was also significant ($p<0.05$; Fig. 1). Maximum days to emergence were taken by Jalal while Pahri recorded minimum days to emergence. This could be due to the differential genetic make up of the varieties. The data also revealed that days to emergence were less in ridge planting compared with other methods of sowing. The probable reasons could be favorable environment which supplied essential nutrient for quick emergence. Our result also showed that days to tasseling and silking were significantly ($p<0.05$) affected by planting methods and varieties, while their interaction was non-significant ($p>0.05$; Fig. 2). Days to tasseling were more in ridge planting. Fewer days to tasseling were noted in broadcast method. These results are in line with the findings of Siddique & Bakht (2005) who investigated that days to tasseling and silking were more in ridge planting. In case of varieties, more days to tasseling were taken by Pahari, while less by Azam. This could be due to the fact that tasseling is a physiological process and is mainly affected by genotypes and environment interaction. Similar results are also reported by Khan & Shafi (2008). The influence of planting methods and maize varieties on days to silking is presented in Fig. 3. Days to silking were significantly ($p<0.05$) affected by planting methods and varieties, while their interaction was non-significant ($p>0.05$). Highest number of days to silking was recorded in ridge, while lowest in broadcast sowing method. Similarly, maximum days were observed in Pahari compared with other varieties. These results agree with the findings of Siddique & Bakht (2005) and Khan & Shafi (2008).

Emergence m^{-2} was significantly ($p<0.05$) affected by varieties, while the effect of planting methods and their interaction with varieties was non-significant ($p>0.05$; Fig. 4). The data showed that emergence m^{-2} was more in case of Jalal when compared with other varieties. This could be due to the inherited character of the variety. These results are in agreement with the findings of Bakht *et al*., (2006). Emergence m^{-2} was non-significantly in ridge sowing compared with other methods. The reason for this might be to the proper availability of loose and fertile soil which resulted in good emergence. These results are confirmed by Siddique & Bakht (2005) who reported that ridge sowing improved seedling emergence as well as plant fresh weight. Statistical analysis of the data also revealed that plant height was significantly ($p<0.05$) affected by planting methods and varieties. The combined effect of planting methods and varieties was non-significant (Fig. 5). Taller plants were attained by ridge planting, while smaller plants in broadcast. This might be due to the fact that ridge planting provided better soil conditions for nutrient uptake and reduced lodging. Similar results are also reported by Majid *et al*., (1986), Siddique & Bakht (2005), Bakht *et al*., (2006) and Belachew & Abera (2010). These researchers found that taller plants were obtained with ridge sowing. In case of height varieties, maximum plant height was recorded from Jalal, while minimum was noted in Pahari. This might be due to variation in varietal characteristics that deviated in their expression from each other. These results are in agreement with Khan & Shafi (2008) who reported tallest plants in variety Jalal.

Planting methods and varieties had a significant ($p<0.05$) effect on number of plants ha^{-1} at harvest. Interaction between planting methods and varieties was non-significant ($p>0.05$; Fig. 6). Maximum number of plants ha^{-1} at harvest was obtained from ridge planting, while minimum in broadcast. It might be due to high survival rate in ridge planting as compared with broadcast method. These results are in line with the findings of Siddique & Bakht (2005) who concluded that ridge sowing improved seedling emergence. In case of maize varieties, maximum number of plants ha^{-1} at harvest was recorded in Azam, while minimum was noted in Pahari. This could be due to the genetic superficies of Azam, which resulted in higher number of plants at harvest. Fresh weed biomass was significantly ($p<0.05$) affected by planting methods. The effect of varieties and interaction between planting methods and varieties was non-significant ($p>0.05$; Fig. 7). Maximum fresh weed biomass was recorded in broadcast method and minimum in ridge planting. These results agree with those reported by Abdullah *et al*., (2008). Similarly, highest fresh weed biomass was noted in Jalal compared with other varieties. Our results further suggested that planting methods, varieties and their interactions had a non-significant ($p>0.05$) effect on weed dry biomass (Fig. 8).

Yield and yield components: Number of ears $plant^{-1}$ was significantly ($p<0.05$) affected by varieties, while the effect of sowing methods and interaction between sowing methods and varieties was non-significant ($p>0.05$; Fig. 9). Number of ears $plant^{-1}$ was non-significantly more in raised bed method, while minimum was noted in broadcast sowing. Maximum number of ears $plant^{-1}$ was produced by Jalal when compared with other varieties. These results are in line with Khan & Shafi (2008) who reported that maximum number of cobs $plant^{-1}$ was recorded from Jalal. Grains ear^{-1} were significantly ($p<0.05$) affected by varieties, while the effect of sowing methods and interaction between sowing methods and varieties was non-significant ($p>0.05$; Fig. 10). Non-significantly maximum grains ear^{-1} was produced by ridge method when compared with other methods of planting. This could be due to the availability of fertile and well aerated soil. These results are supported by Arif *et al*., (2001), Siddique & Bakht (2005), Bakht *et al*., (2006) and Abdullah *et al*., (2008). They concluded that maximum number of grains ear^{-1} was recorded in ridge planting. Similarly, grains ear^{-1} were more in case of Jalal, while minimum grains ear^{-1} were recorded by Pahari. These results are confirmed by Khan & Shafi (2008) who observed maximum number of grains ear^{-1} in case of Jalal.

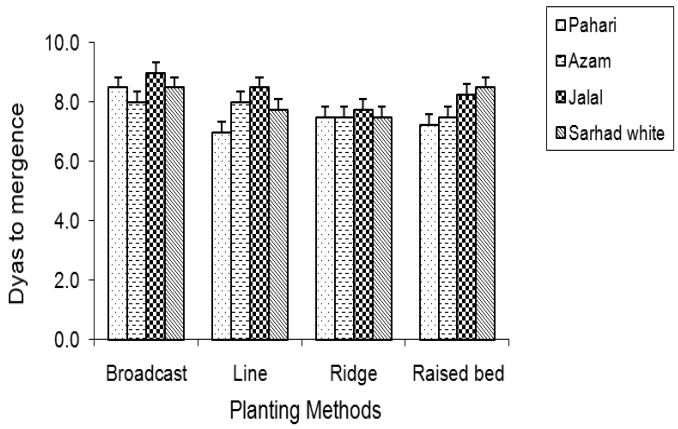

Fig. 1. Effect of planting methods on days to emergence of maize varieties. Bars shows LSD at p<0.05.

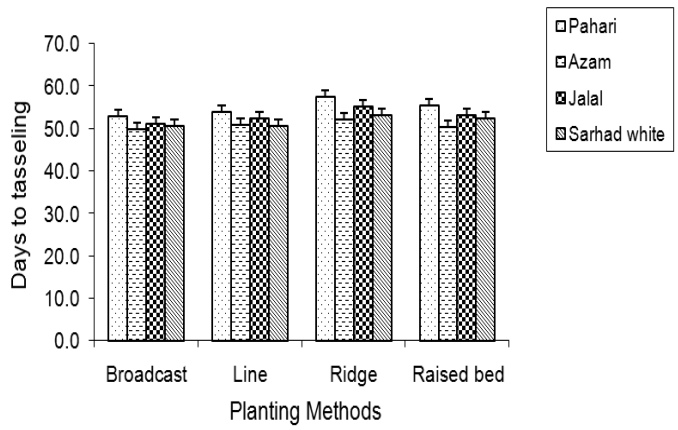

Fig. 2. Effect of planting methods on days to tasseling of maize varieties. Bars shows LSD at p<0.05.

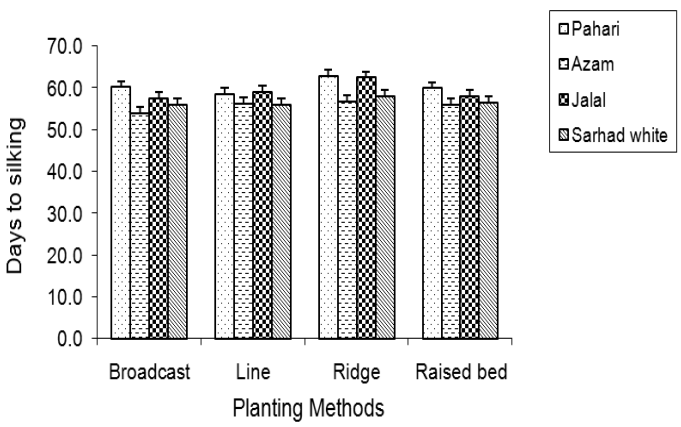

Fig. 3. Effect of planting methods on days to silking of maize varieties. Bars shows LSD at p<0.05.

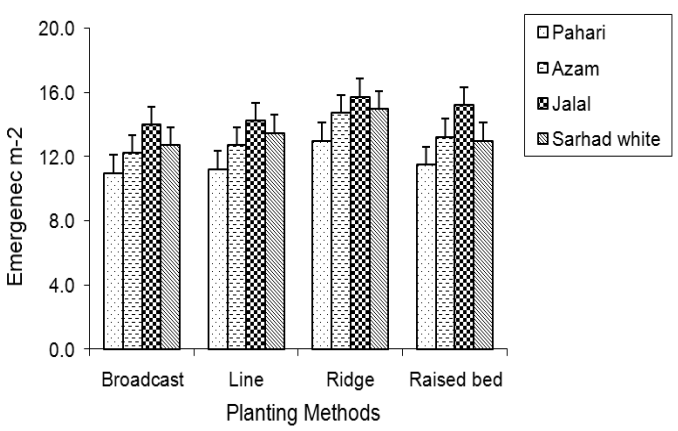

Fig. 4. Effect of planting methods on emergence m-2 of maize varieties. Bars shows LSD at p<0.05.

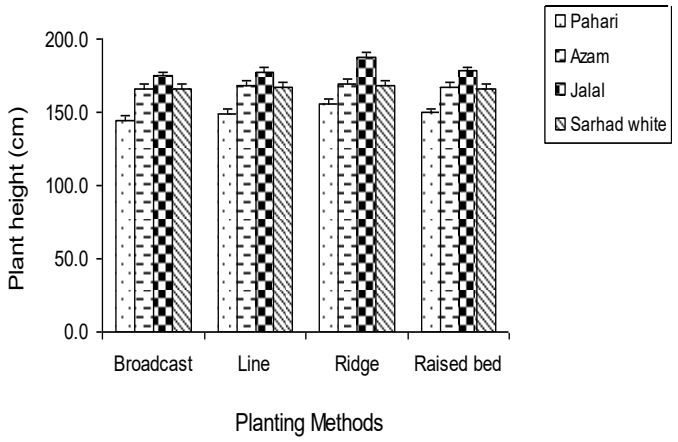

Fig. 5. Effect of planting methods on plant height (cm) of maize varieties. Bars shows LSD at p<0.05.

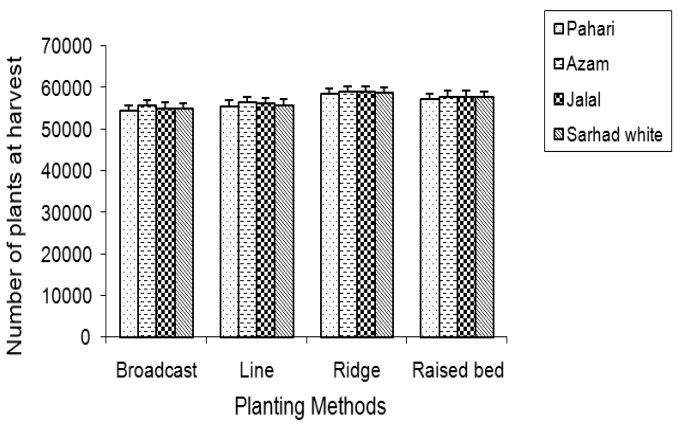

Fig. 6. Effect of planting methods on number of plant harvest of maize varieties. Bars shows LSD at p<0.05.

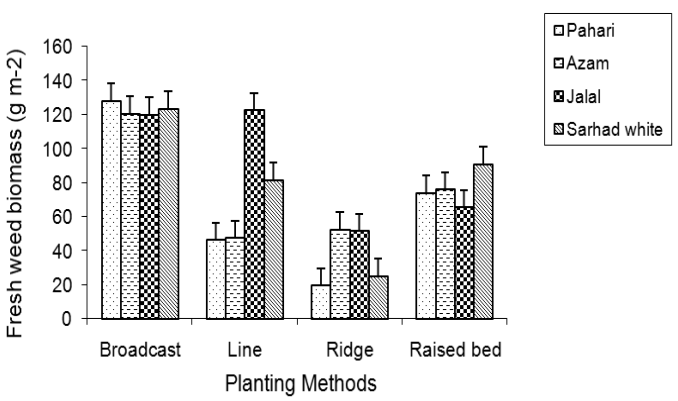

Fig. 7. Effect of planting methods on fresh weed biomass (g m-2) of maize varieties. Bars shows LSD at p<0.05.

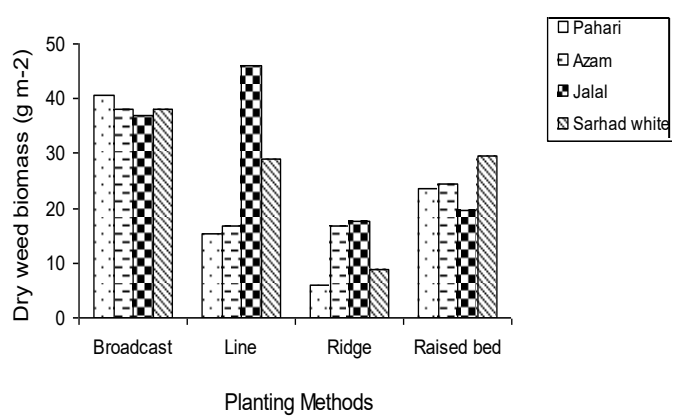

Fig. 8. Effect of planting methods on dry weed biomass (g m-2) of maize varieties.

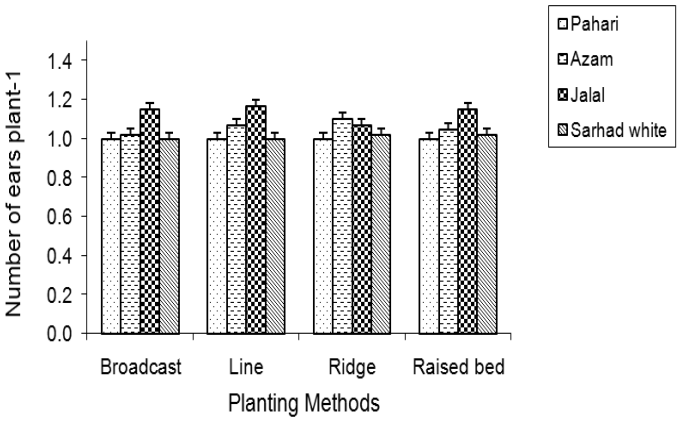

Fig. 9. Effect of planting methods on number of ears plant-1 of maize varieties. Bars shows LSD at p<0.05.

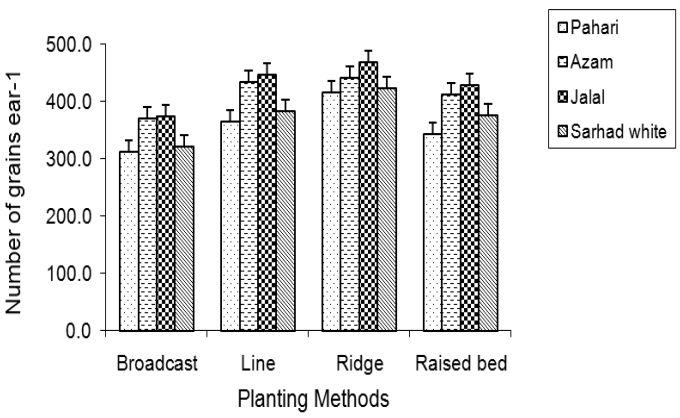

Fig. 10. Effect of planting methods on number of grains ear-1 of maize varieties. Bars shows LSD at p<0.05.

Thousand grain weight was significantly (p<0.05) affected by planting methods and varieties while their interactions was non-significant (p>0.05; Fig. 11). Heavier grains were produced by ridge planting when compared with other planting methods. This might be due to the proper aeration of roots which enhanced its nutrient absorption capacity. Majid *et al*., (1986), Muhammad *et al*., (2002), Siddique & Bakht (2005) and Asdaullah *et al*., (2008) recorded maximum 1000-grain weight from ridge sowing. The data also revealed that a maximum thousand grain weight was noted in Jalal while minimum in Pahari. These results agree with the findings of Khan & Shafi (2008). Our results indicated that grain yield was significantly (p<0.05) affected by planting methods and varieties while their interactions were non-significant (p>0.05; Fig. 12). Maximum grain yield was produced by ridge planting method whereas minimum was observed in broadcast sowing. This might be due to the fact that ridge planting provided good soil conditions for proper root development, reduced lodging and ensured efficient use of irrigation water and nutrients for proper growth and development. These results agree with those reported by Arif *et al*., (2001), Oswald *et al*., (2002), Rasheed *et al*., (2004), Bakht *et al*., (2006), Liu & Young (2008) and Belachew & Abera (2010). They concluded that maximum grain yield was recorded in ridge planting. Among varieties, maximum grain yield was noted in Jalal and minimum in Pahari. Similar results are also reported by Khan *et al*., (2006).

Biological yield was significantly (p<0.05) affected by planting methods and varieties while their interactions were non-significant (p>0.05; Fig. 13). Maximum biological yield was produced by ridge planting, while minimum in broadcast method. This might be due to the fact that ridge planting provided better growth environment and enhanced nutrient absorption capacity. Arif *et al*., (2001), Siddique & Bakht (2005), Bakht *et al*., (2006), Khan & Shafi (2008) and Belachew & Abera (2010) concluded that ridge sown maize produced maximum biological yield. In case of varieties, highest biological yield was produced by Jalal when compared with other varieties. These results are confirmed by Khan & Shafi (2008) who observed maximum biological yield from Jalal, while minimum from Pahari. The data further suggested that harvest index was significantly (p<0.05) affected by varieties. Planting methods and combined effects of planting methods and varieties were non-significant (p>0.05; Fig. 14). Maximum harvest index was recorded in line method, while minimum in raised bed planting. In case of varieties, maximum harvest index was recorded in Pahari, while minimum harvest index was observed in Jalal.

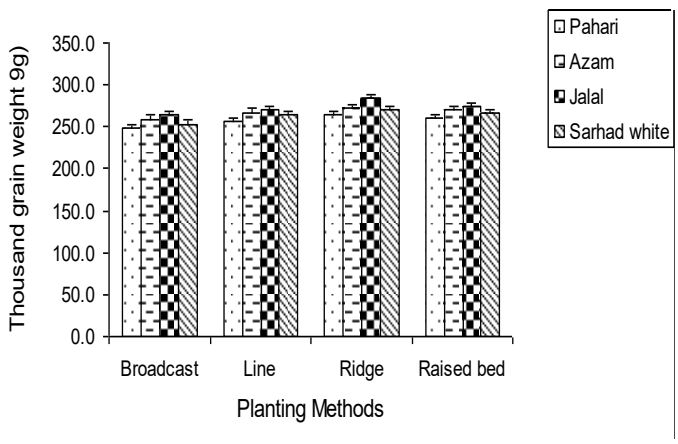

Fig. 11. Effect of planting methods on thousand grain weight (g) of maize varieties. Bars shows LSD at p<0.05.

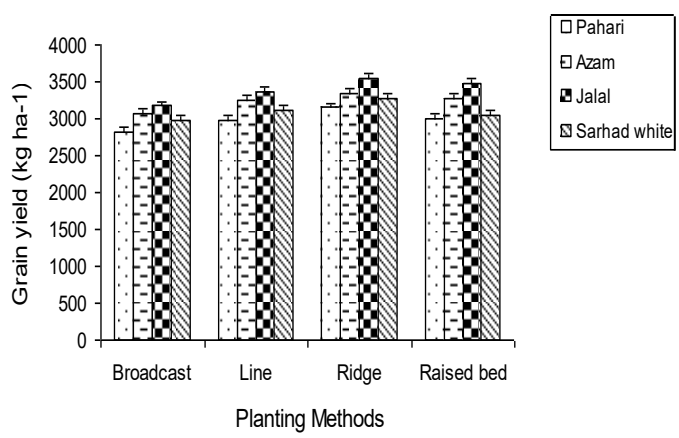

Fig. 12. Effect of planting methods on grain yield (kg ha-1) of maize varieties. Bars shows LSD at p<0.05.

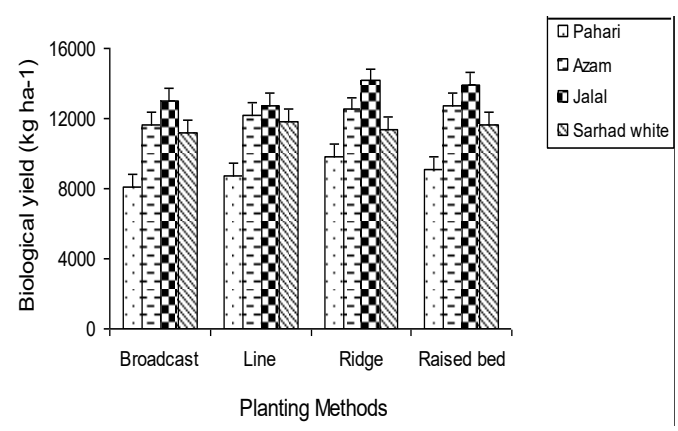

Fig. 13. Effect of planting methods on yield (kg ha-1) of maize varieties. Bars shows LSD at p<0.05.

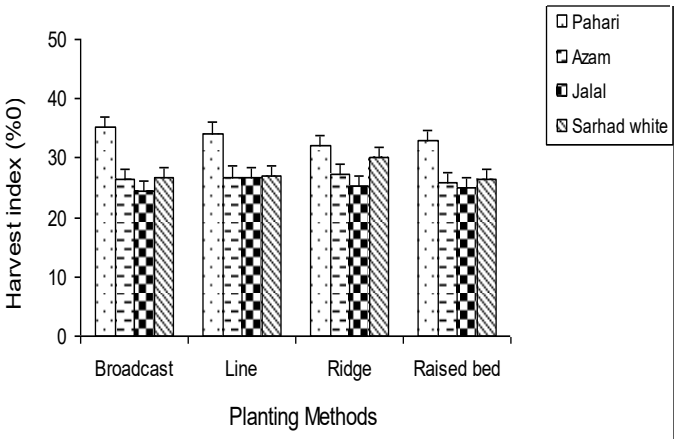

Fig. 14. Effect of planting methods on harvest index (%) of maize varieties. Bars shows LSD value at $p<0.05$.

Conclusion and Recommendation

It can be concluded from the results that variety Jalal when sown in ridges performed better than other cultivars sown under different planting methods. Therefore, variety Jalal with ridge planting is recommended for better yield.

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