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EFFECT OF NITROGEN APPLICATION ON YIELD AND YIELD COMPONENTS OF BARLEY (*HORDEUM VULGARE* L.)

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Abstract

The present research was aimed to study the effect of different levels of inorganic fertilizer N on the yield and yield components of barley varieties at KPK Agricultural University, Peshawar, Pakistan. The experiment was laid out in randomized complete block design with split plot arrangements. Barley varieties (local and sterling) were sown in the main plots whereas different nitrogen levels (i.e. 0, 20, 40, 60, 80 and 100 kg ha^{-1}) were allotted to sub-plots. The results showed that different varieties and nitrogen levels had significantly ($p<0.05$) affected plant height, 1000 grains weight, grains $spike^{-1}$, straw yield, grain yield, biological yield, grain and plant N. Maximum grain $spike^{-1}$, thousand grain weight and grain yield was recorded in sterling. Taller plants, highest biological yield, straw yield, grain and plant N was observed in local variety. Nitrogen applied at the rate of 60 kg ha^{-1} resulted in maximum grain $spike^{-1}$, thousand grain weight, biological yield, grain yield, grain and plant N.

Introduction

Barley (*Hordeum vulgare* L.) is the major cereal in many dry areas of the world and is vital for the livelihoods of many farmers. Barley is an annual cereal crop and grown in environments ranging from the desert of the Middle East to the high elevation of Himalayas (Hayes *et al*., 2003). It is the major food source in many North African countries. In Pakistan, it is mainly grown for grain and straw for small ruminants during winter, with green fodder sometimes used for winter grazing. Barley can replace wheat as the dominant crop due to its tolerance to drought and salinity. Barley assumes fourth position in total cereal production in the world after wheat, rice, and maize. Barley is more productive under adverse environments than other cereals. Barley serves as a major animal fodder, base malt for beer and certain other distilled beverages.

Nitrogen is commonly the most limiting nutrient for crop production in the major world's agricultural areas and therefore adoption of good N management strategies often result in large economic benefits to farmers. Among the plant nutrients, nitrogen plays a very important role in crop productivity (Zapata & Cleenput, 1986; Ahmad, 1999; Miao *et al*., 2006; Oikeh *et al*., 2007; Worku *et al*., 2007). Efficient use of N is also important for minimizing environmental contamination (Scharf & Alley, 1988). Nitrogen is the key element in achieving consistently high yields in cereals. Nitrogen is a constituent of many fundamental cell components such as nucleic acids, amino acids, enzymes, and photosynthetic pigments. The rate of uptake and partition of N is largely determined by supply and demand during various stages of plant growth. Soil N supply, for example must be high at tillering, stem elongation, booting, heading and grain filling requiring a greater amount of the development and growth of its reproductive organs and for an enhanced and high accumulation of proteins in the kernel. Nitrogen is considered one of the most important factors affecting crop morphology (Amanullah *et al*., 2008a), crop growth rate and grain yield (Amanullah *et al*., 2008b) in Northwest Pakistan. The amount of nitrogen that a barley crop needs to maximize yield and quality will depend on the seasonal conditions, soil type, and rotational history of the soil as well as the potential yield of the crop. Nitrogen is needed for early tiller development of barley to set up the crop for a high yield potential. Ayoub *et al*., (1994) reported that spilt N application had little effect on yield, but decreased lodging and spike population with increased grain weight. Singh & Uttam (1992) recorded increased grain yield with increase in nitrogen level. However, increasing N fertility beyond a certain limit induced lodging and ultimately decreased grain yield and its components. Nowadays, both to avoid pollution by nitrates and to maintain a sufficient profit margin, farmers have to reduce the use of nitrogen fertilizer. These objectives can be met through efficient farming techniques, but also by using plant varieties that have better nitrogen use efficiency (Gallais & Hirel, 2004). For NUE, genetic variability and genotype x nitrogen fertilization level interactions reflecting differences in responsiveness have been observed in maize (Bertin & Gallais, 2000). The present study was carried out to investigate the response of barley varieties to different nitrogen levels.

Materials and Methods

The present study was conducted at KPK Agricultural University, Peshawar, Pakistan using randomized complete block design with split plot arrangements replicated four times. Six levels of nitrogen (0, 20, 40, 60, 80 and 100 kg N ha^{-1}) and two barley varieties (sterling and local variety) were studied during the present experiment. A plot size of 2.5 m x 2 m having 6 rows, 30 cm apart was used. Phosphorus at the rate of 30 kg ha^{-1} was applied as basal dose. All other input and agronomic practices was carried out uniformly.

Procedures for data recording: Data on days to emergence was recorded by counting the days taken by each treatment from the date of sowing till the completion of emergence. Emergence m^{-2} was noted by counting number of plants emerged in one meter row length at three randomly selected rows in each plot. Days to anthesis was recorded by counting days from date of sowing till about 50% of plants in subplot gave a clear indication of anthesis formation. Height of five plants in each treatment at random was measured at physiological maturity from soil surface to the tip of spike. Data on total and productive tillers m^{-2} was recorded by counting tillers in three points of each sub plot and converted into m^{-2}. Spike length data was recorded by measuring spike length of six plants in each sub plot and averaged. Number of grain $spike^{-1}$ data was observed by counting the number of grain for five spikes randomly taken in each sub-plot and then averaged. After threshing, 1000 grain weight was recorded with the help of electronic balance at random from the produce of each subplot. Grain yield was recorded in four central rows in each subplot and then converted into kg ha^{-1}. The data on biological yield was taken on four central rows of each subplot at maturity and then converted into kg ha^{-1}. Harvest index was calculated as percentage ratio of grain yield and biological yield. Nitrogen percentage in straw and grain was determined by kjeldhal method of Bremner and Mulvaney (1982).

Statistical analysis: All data are presented as mean values of three replicates. Data were analyzed statistically for analysis of variance (ANOVA) following the method described by Gomez & Gomez (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

Plant growth and development: Varieties, nitrogen levels and their interactions did not significantly ($p>0.05$) affected days to emergence and emergence m^{-2} (Figs. 1 and 2). Our results are in line with Le Gouis *et al*., (1999) and Moselhy & Zahran (2002) who reported that nitrogen application had little or no effects on days to emergence. Days to anthesis, plant height and tillers m^{-2} was significantly ($p<0.05$) affected by varieties and nitrogen levels. Interaction between varieties and nitrogen levels was non significant (Figs. 3, 4 and 5). Sterling variety took minimum days to anthesis as compared to local variety. Maximum days to anthesis (106 days) were recorded from plants which received 60 kg N ha^{-1} and beyond. Similar results were reported by Kernich and Halloran. (1996), who observed that nitrogen fertilizer considerably influenced duration of the pre-anthesis period and spike in barley. Our results indicated that taller plants (107.58 cm) were produced by local variety when compared with sterling (95.71 cm). Plant height was maximum (107.38 cm) when nitrogen was applied at the rate of 100 kg ha^{-1}, followed by 80 kg N ha^{-1} with plant height (103.88 cm). The probable reason might be that optimum nitrogen supply played an essential role in plant growth and development. Maqsood *et al.,* (2001), Kenbaev & Sade, (2002), Salwa *et al*., (2005), Soylu *et al*., (2005), Arif *et al*., (2006) and Pervez *et al*., (2009) reported significant increase in plant height of wheat with application of nitrogen.

More tillers m^{-2} was recorded in sterling as compared to local variety. In case of N levels, maximum tillers m^{-2} was produced with the application of 60 kg N ha^{-1} when compared with other treatments (Fig. 5). The probable reason might be that optimum nitrogen availability plays an essential role in plant growth whereas low or very high dose of nitrogen caused reduction in above ground vegetative growth of plant. Increase in the number of tillers m^{-2} of wheat due to N application was also reported by Rajput *et al*., (1993) and Ahmad (1999). The result showed that lodging score was significantly ($p<0.05$) affected by varieties, N levels and their interactions (Fig. 6). Maximum lodging was recorded with the application of 100 kg N ha^{-1}, followed by 80 kg N ha^{-1}. Mean value of the data also showed more lodging in local compared with sterling.

Yield and yield components: Significant ($p<0.05$) differences were observed in productive tillers m^{-2}, spike length, grains $spike^{-1}$, 1000 grain weight, grain yield, straw yield, biological yield, harvest index, grain and straw N due to various levels of N and varieties (Figs. 8-16). More productive tillers m^{-2} (305.25), lengthy spikes (18.25 cm) highest grain $spike^{-1}$ (27.13), 1000 grain weight ((36.99 g), grain yield (2187 kg ha^{-1}) and biological yield (7481 kg ha^{-1}) was produced by the application of 60 kg N ha^{-1}. Similarly, grain and straw N was more (2.31% and 2.16% respectively) when N was applied at the rate of 60 kg N ha^{-1}. In case of varieties, sterling performed better than local for all the yield parameters except biological yield. Walter *et al*., (1995) who observed that nitrogen application significantly affected productive tillers m^{-2}. Cantero *et al*., (1995), Le Gouis *et al*., (1999) and Oweis *et al*., (1999) observed similar results for grain $spike^{-1}$ in barley. Weight and number of grains $spike^{-1}$ was significantly increased with increasing N fertilization as reported by Moselhy & Zahran, (2002). They further revealed that application of nitrogen fertilizer significantly increased spike length, number of grains $spike^{-1}$, 1000 grain weight, grain yield and N uptake by the crop (Chaudhary & Mehmood, 1998; Bakhsh *et al*., 1999; Tilahun *et al*., 2000; Ennin & Clegg, 2001; Ahmad & Rashid, (2004); Imran *et al*., 2005; Caglar & Ozturk, 2007; Zebarth *et al*., 2009; Pervez *et al*., 2009).

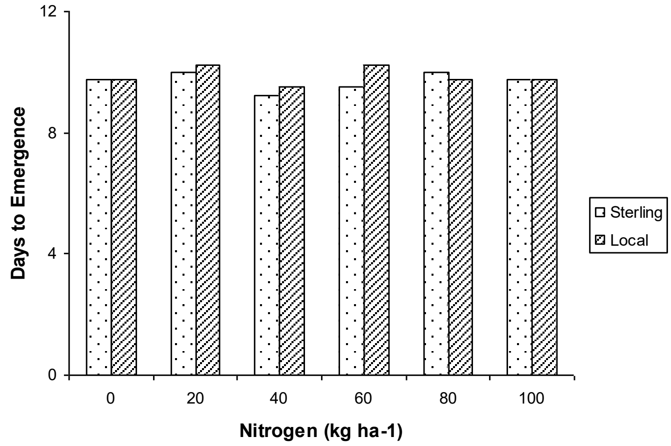

Fig. 1. Days to emergence of barley varieties as affected by different N levels. Bars shows LSD value at $p<0.05$.

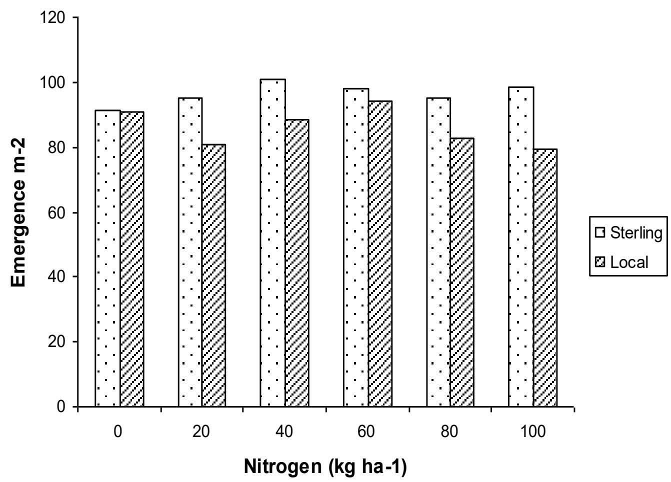

Fig. 2. Emergence m^{-2} of barley varieties as affected by different N levels. Bars shows LSD value at $p<0.05$.

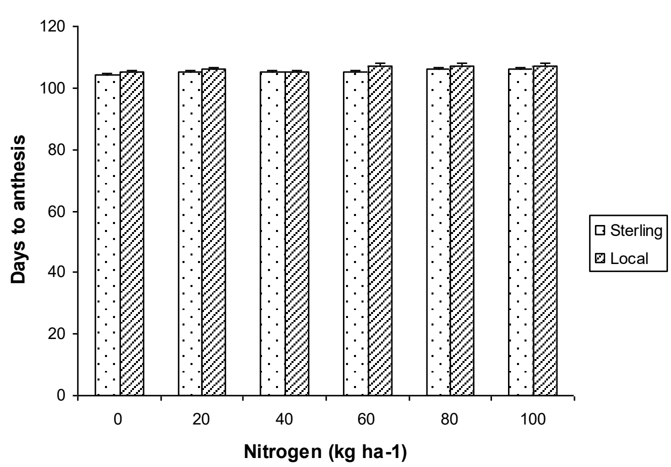

Fig. 3. Days to anthesis of barley varieties as affected by different N levels. Bars shows LSD value at $p<0.05$.

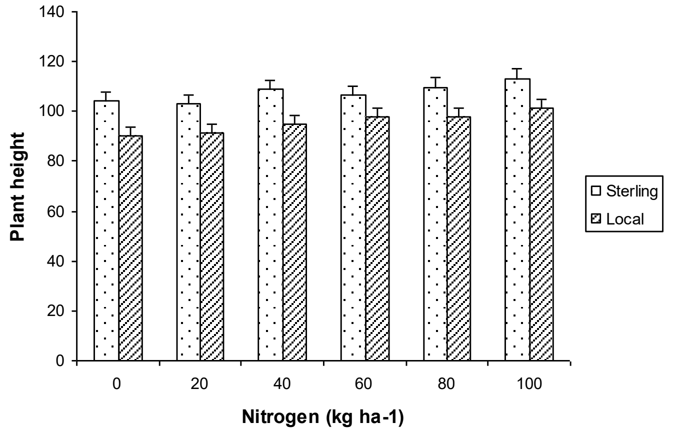

Fig. 4. Plant height of maize varieties as affected by different N levels. Bars shows LSD value at $p<0.05$.

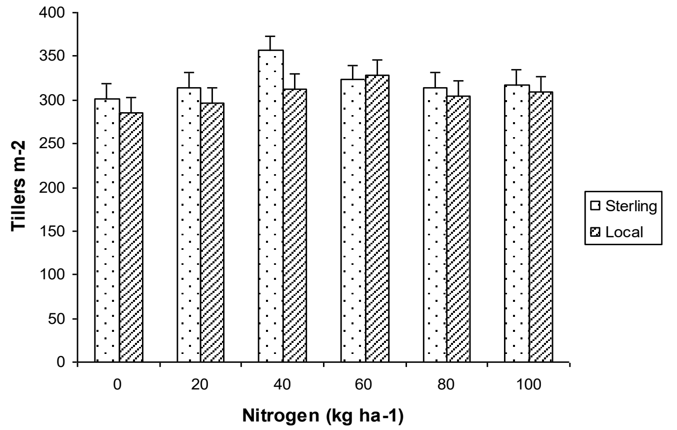

Fig. 5. Tillers m^{-2} of barley varieties as affected by different N levels. Bars shows LSD value at $p<0.05$.

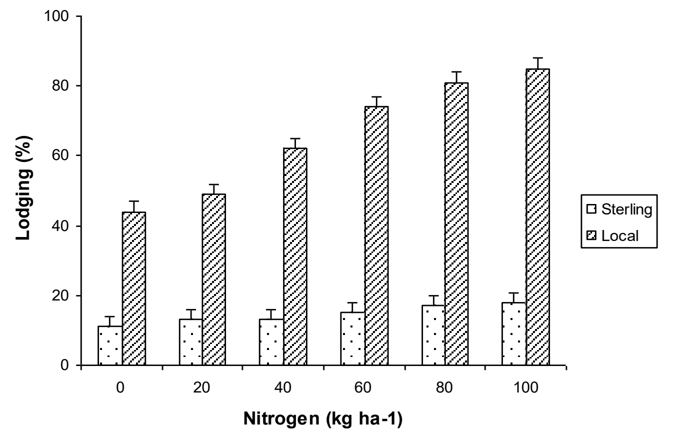

Fig. 6. Lodging (%) of barley varieties as affected by different N levels. Bars shows LSD value at $p<0.05$.

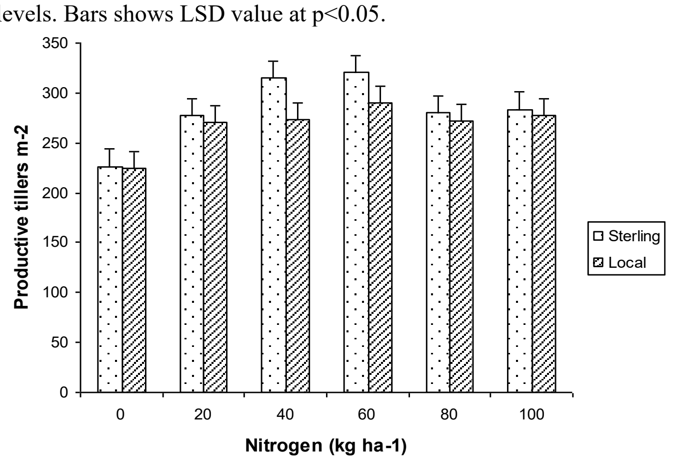

Fig. 7. Productive tillers m^{-2} of barley varieties as affected by different N levels. Bars shows LSD value at $p<0.05$.

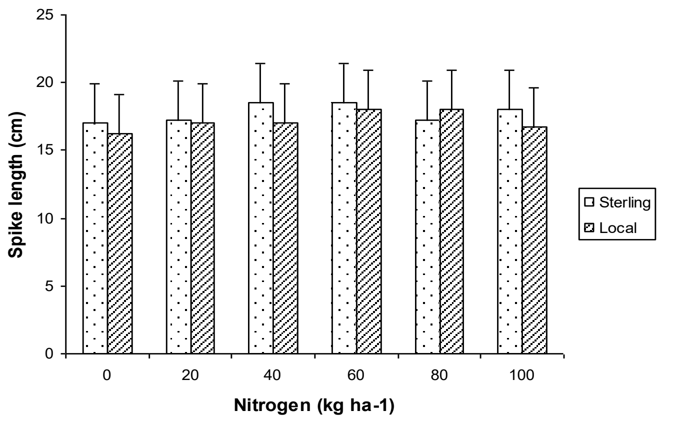

Fig. 8. Spike length (cm) of barley varieties as affected by different N levels. Bars shows LSD value at $p<0.05$.

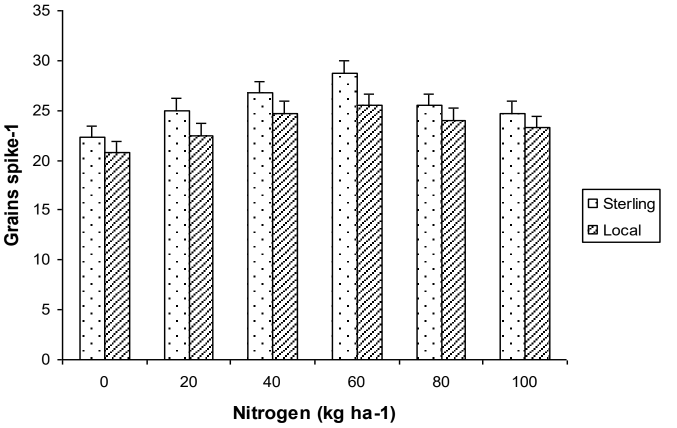

Fig. 9. Grains $spike^{-1}$ of barley varieties as affected by different N levels. Bars shows LSD value at $p<0.05$.

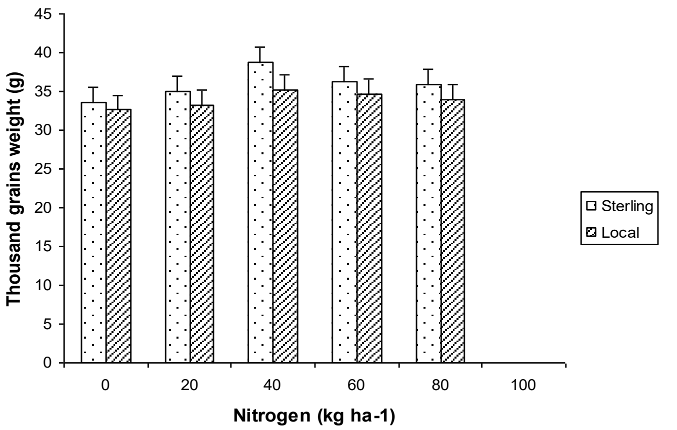

Fig. 10. Thousand grains weight of barley varieties as affected by different N levels. Bars shows LSD value at $p<0.05$.

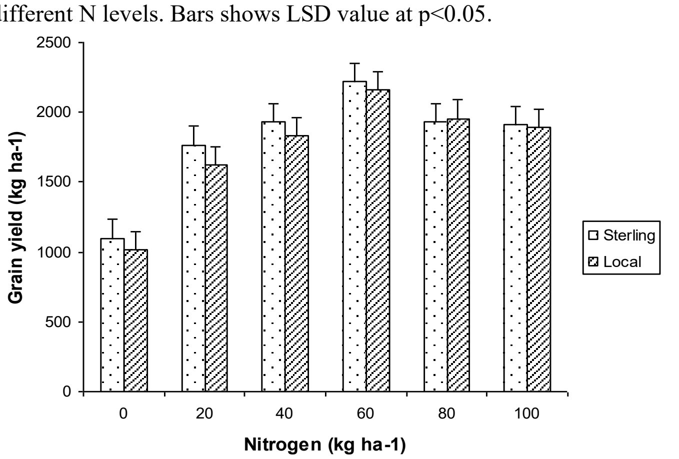

Fig. 11. Grain yield (kg ha^{-1}) of barley varieties as affected by different N levels. Bars shows LSD value at $p<0.05$.

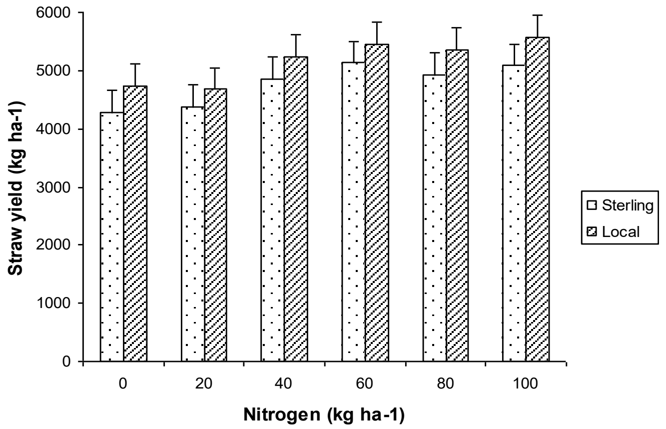

Fig. 12. Straw yield (kg ha^{-1}) of barley varieties as affected by different N levels. Bars shows LSD value at p<0.05.

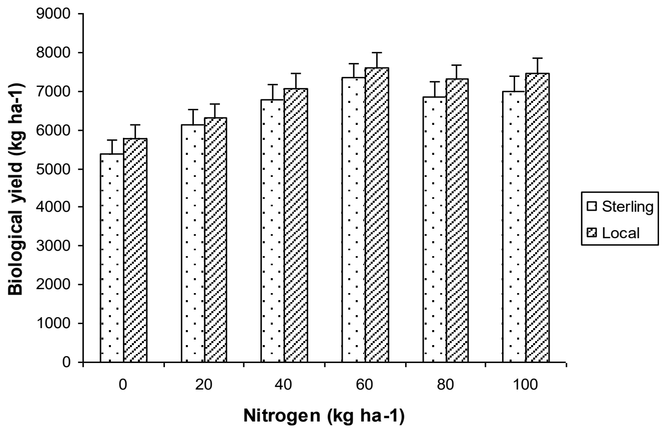

Fig. 13. Biological yield (kg ha^{-1}) of barley varieties as affected by different N levels. Bars shows LSD value at p<0.05.

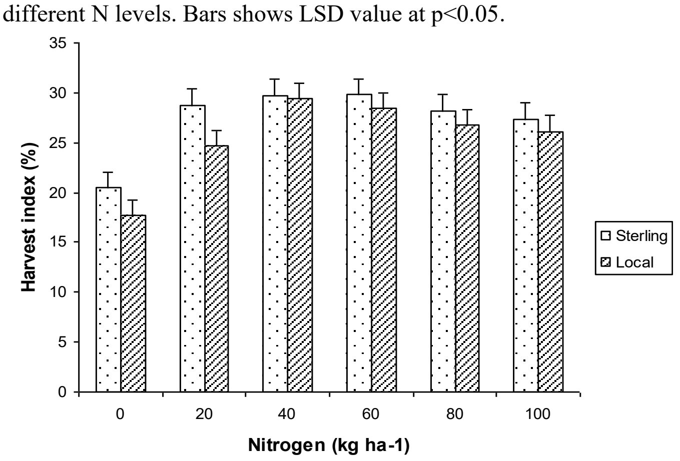

Fig. 14. Harvest index (%) of barley varieties as affected by different N levels. Bars shows LSD value at p<0.05.

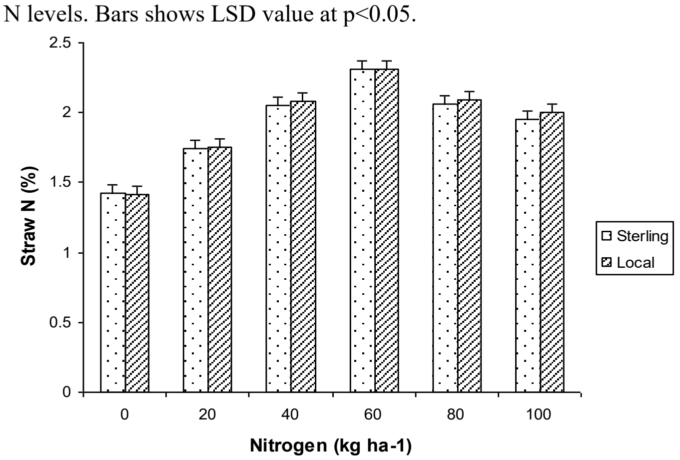

Fig. 15. Straw N (%) of barley varieties as affected by different N levels. Bars shows LSD value at p<0.05.

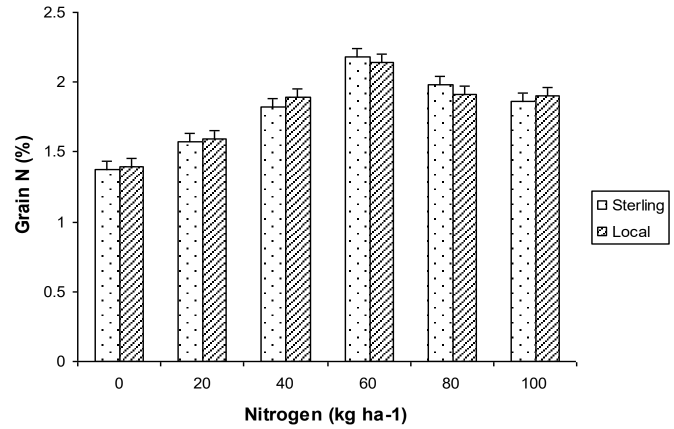

Fig. 16. Grain N (%) of barley varieties as affected by different N levels. Bars shows LSD value at p<0.05.

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