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Effect of fertilizer management and cutting schedule on yield and quantity of dual purpose barley crop (*Hordeum vulgare* L.)

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Abstract
A field experiment was carried out at Agronomy Research Farm, Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhaya (U.P.) during Rabi season 2016-17. The experiment was laid out in split plot design with three replications. Main plot were treated with fertilizer levels, F_1 (60 kg N+30kg P_2O_5ha^{-1}), F_2 (80 kg N+40 kg P_2O_5 ha^{-1}), F_3 (100 kg N+50 kg P_2O_5 ha^{-1}) and F_4 (120 kg N+60 kg P_2O_5 ha^{-1}) and sub plot were treated with cutting schedule at (first cut taken at different time) at 45 DAS, 55 DAS, 65 DAS and 75 DAS. The data revealed that the maximum grain (2.51 t ha^{-1}) and straw yield (4.34 t ha^{-1}) and green fodder yield (18.77 t ha^{-1}) were obtained with the application of 120 N+ 60 P_2O_5 kg ha^{-1} followed by 100 kg N+50 kg P_2O_5 ha^{-1}. Similar trend was found in case of yield attributing characters. However, in cutting schedule the maximum green fodder yield (26.40 t ha^{-1}) were recorded with cutting on 75 DAS, which was significant higher over rest of the treatments. The maximum cost of cultivation(Rs. 34256 ha^{-1}), gross return (Rs. 66170.24 ha^{-1}), net return (Rs. 33566.24 ha^{-1}) and B:C ratio (1.03) were computed maximum when applied the fertilizers @ 120 N+ 60 P_2O_5 kg ha^{-1}along with cutting schedule 45 DAS followed by 100 kg N+50 kg P_2O_5 ha^{-1} with cutting schedule 55 DAS.

Keywords: Nitrogen & phosphorus, barley, green fodder, yield, cutting schedule and economics

Introduction

Barley (*Hordeum vulgare* L.) grain largest use as animal feed in all over the world and in India also, a major share of barley grain is used as animal feed either alone or mixture with fodder crops. Barley has tremendous potential and variation for production of very high amount of digestible dry matter as well as protein yield per hectare. It is grown successfully in a wider range of climatic conditions than any other cereals. Barley has such morpho-physiological traits that make it suitable for dual purpose cultivation for fodder and grain production than other cereals. It is highly efficient in the utilization of water and nutrients in limiting conditions. It is high capacity of crop for tillering and re-growth after cutting and additional capacity for large accumulation of biomass. It sets seed rapidly after re-growth, thus escaping terminal stress due to high temperature and warm winds often experienced in the region. Thus, as a dual purpose (green forage and feed/grain) crop it provides a welcome boost to the confidence of forage growers and fits well for crop diversification in the integrated crop-livestock farming system. Area under barley in world is 47.5 mha with 123.7 mt production and 2.68 t/ha productivity. Russian federation holds first position in all over the world in terms of area and production with 4.94 mha and 8.35 mt respectively (FAOSTAT, 2016). In India, barley is an important coarse cereal crop, being grown in *rabi* season in northern plains and hills. Area under the barley crop is mainly concentrated in the states namely, Rajasthan, Uttar Pradesh, Madhya Pradesh, Punjab, Haryana, and Bihar in plains and Himachal Pradesh, Uttarakhand and Jammu & Kashmir in the hills. In India, barley crop was grown over an area of 695.0 thousand hectare with a production of 1743.2 thousand tonnes and productivity of 2.51 t ha^{-1} during 2012-13 (Anonymous, 2013) [1]. Uttar Pradesh is one of the most important barley growing states of India. In Uttar Pradesh, the area under cultivation of barley is about 168.0 thousand ha^{-1} with a production of 441.0 thousand tonnes and productivity of 2.63 t ha^{-1} (Anonymous, 2013) [1]. Dual purpose barley is an excellent alternate crop for fodder purpose.

.Stage of harvesting is one of the most important factors which determine the higher production level with higher nutritive value. The nutritive value of green fodder is highest at 50% flowering stage and decreases after flowering stage in most of the crops.

In dual purpose barley crop, stage of harvesting also determine the regenerative potential of the crop, the regeneration capacity is adversely affected by the higher stage of harvesting for green fodder. That's why, it's important to determine the right stage of harvesting the crop to obtain the highest green fodder as well as grain yield.In addition, suitable seed rate and cutting schedule is also important for dual purpose barley varieties for realizing higher green fodder as well as grain yield (Thomson *et al.*, 2009). Several authors have agreed upon the importance of rapid regeneration of leaf area after forage removal to establish sufficient photosynthetic capacity to support maximum grain yield (Singh *et al.*, 2009) [3].

Adequate mineral fertilization is considered to be one of the most important pre-requisite in this respect. Amongst nutrients, nitrogen plays an important role in synthesis of chlorophyll, amino acids and other organic compounds of physiological significance in plant system. Minale *et al.* (2006) [4] reported that the application of 92 kg P_2O_5/ha enhanced the biological yield components and yield of barley, next to nitrogen, phosphorus is a second importance element for energy transfer in living cells by mean of high energy phosphate bonds of ATP. Thus it plays vital role in formation and translocation of carbohydrates, fatty acids, glyceroids and other essential intermediate compounds. It also affects seed plumpness, malting quality and protein content of the barley grain as well as fodder (Narolia *et al.*, 2009) [5].

Materials and methods

The field experiment was conducted at Agronomy Research Farm, Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (U.P.), during rabi season 2016-2017. The experimental site falls under sub-tropical zone in Indo-gangatic plains, lies between 26.47^0 Northern latitude, 82.12^0 Eastern longitudes, at an altitude of about 113.0 meters from mean sea level and is subjected to extremes of weather conditions.

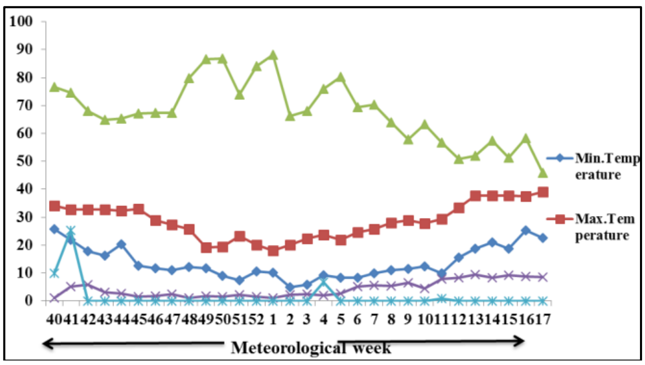

Fig 1: Mean weekly meteorological observation during crop season (October, 2016 to April, 2017)

The region comes under sub-tropical climate with an average annual rainfall of around 1200 mm, which is mostly received from July to September with a few showers in winter. The total rainfall during course of experimentation was 42.67 mm. Metrological conditions such as maximum and minimum temperature, distribution of rainfall, relative humidity and sunshine hours recorded during the crop period season, the lowest temperature 4.9^{0}C was recorded in the month of January and the maximum 39^{0}C in the month of April. The highest mean relative humidity 88.20% was recorded in the month of January.

Land was thoroughly prepared to obtained proper fine soil tilth, pre-sowing irrigation was given to the field about 12 days prior to the sowing of the experimental crop. First ploughing was done by tractor drawn soil turning plough in order to get field free from weeds and crop stubbles and two ploughing were given deeply by tractor drawn cultivator followed by planking. The field was free from clods, weeds and properly leveled for effective distribution of irrigation water. The crop variety NB 2 has sown at proper moisture, sowing was done as broadcasting under the treatment with the depth of 4-5 cm. certified seed was used @ 100 kg ha^{-1} in all the plots on 22 October 2016. 60 kg N ha^{-1} and 30 kg P_2O_5 ha^{-1} was applied from urea and DAP in first treatment, 80 kg N ha^{-1} and 40 kg P_2O_5 ha^{-1} applied in second treatment, 100 kg N ha^{-1} and 50 kg P_2O_5 ha^{-1} applied in third treatment and 120 kg N ha^{-1} and 60 kg P_2O_5 ha^{-1} was applied in fourth treatment, in all the treatment 1/3 dose of nitrogen and full dose of phosphorus was applied at the time of sowing of dual purpose barley crop and remaining dose of nitrogen was applied in two split doses first split dose was applied after first irrigation and second split dose was applied after first cutting. Tube-well was the source of irrigation, Harvesting of dual purpose barley crop for green fodder was done as per treatments (45, 55, 65 and 75 DAS) and then it was left to regenerate for grain production and final harvesting for grain was done after getting maturity of the crop. Soil of the experimental field was classified as silt loam in texture with alkaline reaction (pH-8.3), low in organic carbon (0.46%) and available nitrogen (178.67 kg ha^{-1}), medium in phosphorus (16.25 kg ha^{-1}), and potassium (263.00 kg ha^{-1}).

The leaf area was measured at 45, 55, 65, 75 DAS at first cut and at harvest stage to calculate the leaf area index. The plants of 25 cm^2 area were taken and green leaves were separated to record their surface area by automatic leaf area meter. All the leaves were grouped into three viz. small, medium and large. Five leaves from each plant were taken and their surface area was measured. Area of leaves was multiplied with respective leaf number of a group and sum of all three gave the total leaf area. For obtaining leaf area index, Leaf area was divided by ground area.

$$\text{Leaf area index} = \frac{\text{Leaf area}}{\text{Ground area}}$$

Results and discussion

Yield attributes

The maximum length of spike, number of spikes per hill, number of grains per spike, and test weight were recorded with treatment F_4 (120 kg N+60 kg P_2O_5ha^{-1}). The lowest value of yield attributing characters were obtained under the treatment F_1 (60 kg N +30 kg P_2O_5ha^{-1}) because plants were subjected to utilize the least amount of available nitrogen and phosphorus which resulted into reduced translocation of photosynthesis from source to sink and thus led to poor growth and various yield attributing characters. Similar findings were reported by Thakur (2004) [6]. In case in cutting schedule. The maximum value of all the yield attributes were recorded under treatment C_1 (45 DAS) This could possibly be due to continuous availability of nitrogen and phosphorus in plant at all the critical stages might have resulted in enhanced photosynthetic activities of leaves which increased the translocation of photosynthates from source of leaves and stem to the sink, leading to highest yield attributes because of more time duration availability for the regenerated crop. The minimum yield attributing characters were recorded at subsequent cutting 75 DAS due to low availability of time for regenerated crop after cutting. Similar finding were reported by Midha *et al.* (1994) [7].

Green fodder yield (t ha^{-1})

Green fodder yield were significantly affected by fertilizer levels and cutting schedule. The maximum green fodder yield (18.77 t ha^{-1}) was obtained when fertilizer applied @ 120 kg N +60 kg P_2O_5ha^{-1} followed by 100 kg N+50 kg P_2O_5 ha^{-1} (18.30 t ha^{-1}), which was significantly higher over rest of the treatments. This might be due to adequate nitrogen and phosphorus availability which contributed to increase dry matter accumulation. Productivity of green fodder of a crop is collectively determined by vigorous vegetative growth, development as well as yield attributes. Better vegetative growth coupled with high yield attributes resulted into higher green fodder yield. The minimum green fodder yield recorded under treatment F_1 (60 kg N + 30 kg P_2O_5ha^{-1}). This might be due to lack of fertility of soil results poor vegetative growth which ultimately decrease the green fodder yield. Similar finding were reported by Hundal *et al.* (2014) [8]. Whatever, in cutting schedule, the maximum green fodder yields was recorded, when crop sown at 75 DAS. This might be due crop get long time for growth and development, which causes maximum fresh weight was obtained that ultimately increase the green fodder yield of oat crop. The minimum green fodder yield was recorded when crop sown at 45 DAS. This might be due to got less time during the growth period than the other treatments. Abdullah *et al.* (2000) [9].

Grain & straw yield (t ha^{-1})

Different fertilizer levels and cutting schedule had significantly influenced on grain & straw yield of barley crop. The maximum grain & straw yield were recorded significantly with the application of 120 kg N +60 kg P_2O_5ha^{-1}. It enhanced yield of grain to the tune of 0.22, 0.30 and 0.53 tonnes respectively. This might be due to adequate dose of nitrogen and phosphorus fertilizer applied, which contributed to increase dry matter accumulation. Reduced nitrogen and phosphorus supply as in case of rest of the treatment, recorded lowest yield due to both poor growth and yield attributes, Sharma *et al.* (2001) [10]. In case in cutting schedule, the maximum grain & straw yields were recorded under the treatment C_1 (45 DAS). This might be due to improvement in yield attributing characters and growth of crops because of more time duration availability after the first cutting. The minimum grain and straw yield were recorded under the treatment C_4 (75 DAS). Similar finding were reported by Manohar and saini. (2017) [11].

Biological yield (t ha^{-1})

The maximum biological yield was obtained with the application of fertilizer @ 120 kg N +60 kg P_2O_5 ha^{-1} followed by 100 kg N+50 kg P_2O_5 ha^{-1}, which was significantly higher over rest of the two treatments. This might be due to adequate nitrogen and phosphorus availability in soil cause more nutrients uptake by plant from the soil which has contributed to increase dry matter accumulation. Productivity of biological yield of a crop is collectively determined by vigour of the vegetative growth, development as well as yield attributes. Better vegetative growth coupled with high yield attributes resulted into higher biological yield. The minimum biological yield recorded under treatment F_1 (60 kg N + 30 kg P_2O_5ha^{-1}) lowest yield due to both poor growth and yield attributes. Similar finding were reported by Katiyar and Uttam (2007) [12]. The maximum biological yield was recorded when first cut taken at 45 DAS. The increase in biological yield under this treatment was mainly due to improvement in yield attributing characters and growth of crops because of more time available from first cut to till the harvest stage.

Harvest index (%)

Harvest index of dual purpose barley crop was not affected significantly due to fertilizer levels and cutting schedule. However, the performance was better in (F_4) treatment (120 kg N +60 kg P_2O_5ha^{-1}) along with first cut at 45 DAS.

Economics

The highest gross return of Rs. 66170.24 ha^{-1}with net return Rs. 33566.24 ha^{-1}was obtained where, 120 kg N +60 kg P_2O_5 ha^{-1} was applied along with first cutting at 45 DAS followed by gross return Rs**.**62913.67 ha^{-1}with net return Rs. 30309.67 ha^{-1} where 120 kg N +60 kg P_2O_5ha^{-1} was applied along with first cutting at 55 DAS. The lowest gross return Rs. 44018.67 ha^{-1}with net return Rs. 13770.67 was recorded in F_1C_4 treatment combination where 60 kg N +30 kg P_2O_5ha^{-1}applied and first cutting at 75 DAS due to lowest grain and straw yield. Maximum cost of cultivation Rs.34256 ha^{-1} was recorded under F_4C_1followed by F_3C_1, $F_2C_1$and F_1C_1, respectively.

Maximum benefit cost ratio Rs. 1.03 was recorded in F_4C_1 treatment combination, where 120 kg N +60 kg P_2O_5ha^{-1}was applied followed by Rs. 0.93 in F_4C_2 treatment. Similar finding were reported by Narolia and Pareek (2004) [13].

Conclusion

- An application of 120 kg N + 60 kg P_2O_5 ha^{-1} was found better for maximum green fodder as well as grain and straw production followed by 100 kg N + 50 kg P_2O_5 ha^{-1}.
- Maximum grain (2.51 t ha^{-1}) & straw yield (4.34 t ha^{-1}) were obtained at cutting schedule of 45 DAS, which was most profitable in almost all treatments.
- Among the economics of various treatment combinations the maximum net return (Rs. 33566.24) and B:C ratio 1.03 were obtained with the application of 120 kg N + 60 kg P_2O_5 ha^{-1}along with cutting schedule at 45 DAS.

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