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Research Article

Growth, productivity and nutrient uptake of barley (*Hordeum vulgare*) as influenced by different varieties and clipping management

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Abstract

A field experiment was conducted at research farm of Punjab Agricultural University, Ludhiana during winter (*rabi*) seasons of 2015-16 and 2016-17 to study the effect of different varieties and clipping management on growth, productivity and nutrient uptake of barley (*Hordeum vulgare* L.). Variety DWRUB 52 produced significantly higher dry-matter, tiller count, grain yield, straw yield and nutrients uptake (N, P, K and Zn) than PL 807 and PL 426, while plant height of this variety was statistically similar with PL 807. Zn foliar spray at anthesis and early milk stage with clipping increased the plant height and dry matter of crop, while clipping alone reduced these growth parameters. Grain yield of control crop was statistically similar with both clipping stages viz. at 50 and 60 DAS. However, there was an increase of 5.7% in the grain yield when clipping was done at 50 DAS over no clipping. Clipping at 50 and 60 DAS along with Zn application brought about 13.1 and 8.5% increased the grain yield over control crop. Zn foliar application significantly increased the nitrogen, phosphorous, potassium and zinc nutrients uptake by grain and straw of barley crop than control.

Keywords: Barley, clipping management, grain yield, nutrient uptake, Zn spray

1. Introduction

Barley (*Hordeum vulgare* L.) is a fast growing, cool season, annual grain crop, that could be used as forage as well as, cover crop to improve soil fertility and it is the fourth most important cereal crop of the world after wheat, rice and maize. Its grains contain 8 to 10% protein and 74% carbohydrates besides the minerals and vitamin B-complex and thus forms a staple food, cattle feed, malt for manufacturing of beer and other liquor products (Singh *et al.*, 2009). Its straw is also used for making hay and silage. A variety of any crop having good yield potential, resistance to insect-pest and disease sometimes becomes susceptible to such biotic factor and thus loses the yield potential. Clipping an annual plant at progressively later stages of growth would also be expected to decrease total production and especially grain yield. However, clipping affects the plant height, growth and productivity depending on the stage of crop at the time of clipping. Clipping at tillering stage, did not impede regrowth of barley under semi-arid conditions (El-Shatnawi *et al.*, 1999). Micronutrient malnutrition is a global health problem affecting more than 3 billion people world-wide (Cakmak *et al.*, 2010). About 44% children under five years of age are zinc (Zn) deficient in India (Kapil and Jain, 2011). About 66 and 85% women and children are anemic in Punjab and India, respectively (Singh, 2009). Deficiency of Zn cause serious human health complications such as infections, impaired brain functions, poor mental development, weak babies and anaemia (Fraga, 2005). Low dietary-intake is the main cause of microelement deficiencies in humans (Cakmak *et al.*, 2010). Zn is also essential in human body as a co-factor for more than 200 enzymatic reactions which are vital for growth, development, immune function and resistance to infections (Fischers and Black, 2004). In a global study initiated by FAO, it was shown that about 30% of the cultivated soils of the world are Zn deficient. It is estimated that Zn deficiency is the most widespread micronutrient deficiency in cereals. Foliar spraying of different nutrients make them readily absorbed by plant leaves and are not lost through fixation, decomposition and leaching. The positive effect of spraying zinc on growth and yield of different crops has been reported by several investigators. So, present study was devised with the objective to study the impact of clippings on growth, productivity and uptake of barley varieties through Zn biofortification.

2. Materials and methods

A field experiment was conducted at research farm of Punjab Agricultural University, Ludhiana, Punjab on loamy sand soil during winter (*rabi*) season of 2015-16 and 2016-17. The soil of experimental site had a pH of 7.4 and 7.3, containing 0.37 and 0.39% organic carbon, 179.2 and 192.8 kg/ha available N, 28.5 and 31.3 kg/ha available P and 143.9 and 137.1 kg/ha available K during growing season of 2015-16 and 2016-17, respectively. Total rainfall received during crop season was 80.4 and 100.3 mm during growing season of 2015-16 and 2016-17, respectively. The experiment comprised of 15 treatments was laid out in split plot design with four replications having three varieties, viz. DWRUB 52, PL 807 and PL 426 were taken in main plot. Five clipping management practices, viz. control, clipping at 50 and 60 DAS without Zn spray and with 0.5% Zn foliar application at anthesis and early milk stage were taken as sub plot treatments (Table 1). Recommended dose of nutrients to barley was applied as 62.5 kg N/ha, 30 kg P_2O_5 and 15 kg K_2O through urea (46.4% N), single super phosphate (16% P_2O_5) and muriate of potash (60% K_2O), respectively at the time of sowing. The site was a under sunhemp-wheat (*Triticum aestivum* L.) cropping system for 3 years before the establishment of the experiment. Crop was sown at 5 cm depth with a seed drill at row spacings of 22.5 cm on November 17 and October 25 during crop season of 2015-16 and 2016-17, respectively. Crop was sown by a uniform seed rate of 87.5 kg/ha. Clipping was taken with hedge trimmer as per treatments by 10-15 cm and leaving plant for further regeneration. The harvesting of crop was done on 7th April, 2016 and 31st March, 2017. Ten random plants were selected from each plot, excluding the border row, for taking observation on plant height. Representative plant samples at 120 days after sowing (DAS) from 25 cm-row length in penultimate rows were oven dried to record dry weight. The number of tiller/m row length at 120 DAS at marked spots in penultimate rows of each plot was counted and converted into tillers/m2. The grain and straw yield of net plot was converted into tonnes/ha. Grain and straw sample were collected at harvest and were dried, processed and examined for N, P, K and Zn uptake.

3. Results and discussion

Growth attributes

The growth attributes, viz. plant height, dry matter accumulation and number of tillers were significantly affected due to varieties. PL 807 being at par with DWRUB 52 proved superior to PL 426 for plant height (Table 1) and probably attributed to their genetic constitution. These findings are in line with the results of

Table 1. Crop growth and grain and straw yield and grain straw ratio of barley as influenced by different varieties and clipping management (data pooled over 2 years).

Treatment	Plant height (cm)	Dry-matter (t/ha)	Tiller count (no/m2)	Grain yield (t/ha)	Straw yield (t/ha)
Varieties					
DWRUB 52	93.2	11.1	349.9	3.97	8.2
PL 807	94.1	10.4	338.1	3.77	7.79
PL 426	89.5	9.5	324.5	3.25	7.35
SEm±	1.41	0.46	7.34	0.21	0.25
CD (P = 0.05)	1.3	0.2	6.9	0.12	0.21
Clipping management					
Control	94.5	10.06	337.7	3.51	7.63
Clipping at 50 DAS	92.2	10.24	340.8	3.71	7.72
Clipping at 60 DAS	89.9	9.72	333.9	3.32	7.47
Clipping at 50 DAS + Zn (s)	93.3	10.97	340.7	3.97	8.14
Clipping at 60 DAS + Zn (s)	91.5	10.67	334.4	3.81	7.94
SEm±	0.78	0.22	1.48	0.11	0.12
CD (P = 0.05)	1.2	0.2	4.1	0.21	0.23

Zn (s) = 0.5% ZnSO4 foliar spray at anthesis and early milk stage

Sardana and Zhang (2005). DWRUB 52 variety registered significantly higher dry matter accumulation and number of tillers than PL 807 and PL 426. Varietal differences for dry matter accumulation have been reported by Karwasra *et al.* (1998) and Sardana and Zhang (2005).

Under clipping management, unclipped control crop produced the highest plant height which was significantly higher than clipping at 50 and 60 DAS and clipping at 60 DAS + Zn (s) and was at par with clipping at 50 DAS + Zn (s). Lower plant height under clippings treatments might be attributed to removing vegetation by clipping reduced plant height. The increase in plant height in clipping at 50 DAS + Zn (s) and clipping at 60 DAS + Zn (s) treatments is might be attributed to the physiological role of Zn in plant metabolism and growth. These results confirms the findings of Day *et al.* (1968). Dry matter accumulation was significantly higher with Zn foliar application under clipping at 50 DAS. Whereas, tiller number of control, clipping at 50 DAS and clipping at 50 DAS + Zn (s) were statistically at par with each other. Similar results were obtained earlier by Pandey *et al.* (2001).

Grain and straw yield

Variety DWRUB 52 recorded significantly higher grain and straw yield than PL 807 and PL 426 (Table 1). Variety PL 426 produced significantly lower grain and straw yield than both the varieties viz. PL 807 and DWRUB 52. Variety DWRUB 52 produced 5.3 and 22.1% higher grain yield than PL 807 and PL 426, respectively. Reduction in the grain yield of PL 426 was attributed to lower leaf area index.

The highest grain yield was recorded in clipping at 50 DAS + Zn (s) which was statistically at par with clipping at 60 DAS + Zn (s) and significantly higher than other treatments. Clipping increased the grain yield with Zn foliar spray at 50 (13.1%) and 60 (8.5%) DAS than control crop. Grain yield of control crop was statistically at par with both clipping stages i.e. at 50 and 60 DAS. Grain yield was higher in clipping at 50 DAS than control (Table 1). There was significant effect of foliar application of Zn with both clipping stages i.e. at 50 and 60 DAS on grain yield of crop. Clipping at 50 DAS + Zn (s) recorded the highest straw yield which was statistically at par with clipping at 60 DAS + Zn (s) and significantly higher than other treatments. These results are in conformity with those of Narwal *et al.* (2010), Kutman et al. (2010), Shi *et al.* (2010) and Jan *et al.* (2013).

Nutrients uptake

Nutrients uptake (N, P, K and Zn) by barley (grain and straw) was significantly affected by different barley varieties and clipping management (Table 2). Variety DWRUB 52 recorded significantly highest nutrients uptake (N, P, K and Zn) which is due to higher grain yield and straw produced by this variety. Zn foliar application significantly increased the nutrients uptake by grain

Table 2. Nutrients uptake (N, P, K and Zn) by grain and straw as influenced by different varieties and clipping management (data pooled over 2 years).

Treatment	Nitrogen (kg/ha)		Phosphorus (kg/ha)		Potassium (kg/ha)		Zinc (g/ha)	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
Varieties								
DWRUB 52	79.5	47.3	14.2	11.1	22	72.3	197	212.9
PL 807	71.4	42.3	12.8	10.1	19.9	66.1	176.2	184.6
PL 426	58.5	37.3	10.3	8.8	17	61.4	149.2	165.8
SEm±	6.11	2.89	1.14	0.67	1.45	3.15	13.8	13.6
CD (P = 0.05)	3.4	1.3	0.6	0.5	0.9	2.3	8.6	6.8
Clipping management								
Control	67.4	41.5	11.9	9.8	18.8	65.1	149.9	147.4
Clipping at 50 DAS	68.1	41.5	12.2	9.7	19.4	65.3	162.6	161.7
Clipping at 60 DAS	60.6	39.6	11	9.3	17.4	62.5	156.8	176.6
Clipping at 50 DAS + Zn (s)	78.7	45.1	13.8	10.7	21.7	71.1	201.3	223.5
Clipping at 60 DAS + Zn (s)	74.3	43.7	13.2	10.4	20.8	68.8	200.1	229.7
SEm±	3.1	0.96	0.49	0.25	0.75	1.51	11	16.5
CD (P = 0.05)	4	1.1	0.7	0.3	1.1	1.8	10	9.2

Zn (s) = 0.5% ZnSO4 foliar spray at anthesis and early milk stage and straw of barley. Significantly higher nitrogen and potassium uptake in straw was observed in clipping at 50 DAS + Zn (s) than other clipping treatments. While nitrogen, phosphorus, potassium and zinc uptake by straw and phosphorus and zinc uptake by grain of treatment clipping at 50 DAS + Zn (s) and clipping at 60 DAS + Zn (s) were statistically similar.

Thus it is concluded that variety DWRUB 52 gave significantly higher grain yield, straw yield and nutrients uptake. Clipping at 50 DAS improved the growth, productivity and nutrients uptake compared to clipping at 60 DAS, while Zn foliar application at anthesis and early milk stage improved productivity

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