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Effect of Weed and Nutrient Management on the Growth and Yield of Barley (*Hordeum vulgare* L.) and Associated Weeds

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A B S T R A C T

Barley is the most important food grain crop among cereals and stands next only to rice in our country. It has significantly contributed in the success of the green revolution and has greatly helped to transform our country from a situation of ship to mouth to being set-sufficient. Barley is a good supplement for nutritional requirement of human body as it contains 8-10% protein and 69.6% carbohydrates, 1.3% fat, 3.9% crude fiber. A field experiment was conducted during 2015-16 and 2016-17at Crop Research Center, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.). The experiment was laid out in split-plot design with three replications. The *rabi* season experiment comprised of five levels of nutrient *viz.*; 100% NPK, 75% N-PK + 25% N through FYM, 75% N-PK + 25% N through vermicompost, 50% N-PK + 50% N through FYM, 50% N-PK + 50% N through vermicompost and four levels of weed control measures *viz.*, Control, Two hand weeding, Trisulfuron 15g a.i ha^{-1} and Carfentrazone ethyl 15g a.i ha^{-1}. The plant height was significantly affected at 30, 60, 90 DAS and at harvest in different treatments. The maximum plant height was recorded with the application of 75% N-PK + 25% N through vermicompost which was significantly superior to all other treatments during both years, the highest number of tillers per meter row. Lowest number of tillers was recorded in 50% N-PK + 50% N through FYM. Weed control treatments gave significantly higher yield attributes compared to control. Among the herbicides Trisulfuron 15g a.i ha^{-1} was found more effective over Carfentrazone ethyl 15g a.i ha^{-1}. Trisulfuron 15g a.i ha^{-1} was significantly effective and gave comparable results to two hand weeding situation. Maximum number of spikelet per spike was observed in two hand weeding and Trisulfuron 15g a.i ha^{-1} during both years.

Introduction

Barley is a major source of food for large number of people living in the cooler semi-arid areas of the world, where wheat and other cereals are less well adapted. It is a stable food of the people in the Tibet, Nepal and Bhutan. In European countries it is used only as breakfast food. The leading countries of its production are USSR, China, France, Canada,

USA and Spain. Barley is an important cereal in India. Total area under barley in the country is about 0.7 million hectares. The chief barley growing regions in the country are higher Himalayas, central parts of eastern Uttar Pradesh, eastern parts of Rajasthan and north western parts of north Bihar. The most important uses of barley in India are as grain feed to livestock and poultry, as malt for manufacture of beer and other liquors like whisky, brandy etc. As food barley flour is used in preparing 'chapatti'. Sometimes barley is mixed with gram or wheat and then ground to flour for preparing better quantity 'chapati'. Grain is roasted and ground and used as 'sattu' (barley flour mixed in sugar and water). Grain is also broken and roughly ground into 'barley' to be used in soup. Barley is a nutritious and easily digestible cereal with 8-10% protein, 69.6% carbohydrate, 1.3% fat, 3.9% crude fiber, 1.5% ash, 26 mg calcium, 215mg phosphorus, 1.2% minerals and 336 calorific value. It is also rich in vitamin B complex and used to prepare dishes like chapati, sattu etc. Globally barley was cultivated on nearly 51.50 million hectare area with a production of 142.01 million metric tons. In India, during 2016-17, Barley occupied nearly 7.72 lakh hectare area producing nearly 17.26 lakh tons grain, with a productivity of 2522 kg/ha Anonymus, (2017). The average productivity of barley in the state is far behind the attainable yielding of 40-50 q/ha Choudhary *et al.*, (2014). Problems further aggravated by weeds compete is with the crop for moisture, nutrients, space, light etc. Moreover they increase production cost, decrease yield of the crop, harbor insects and plant diseases, decrease quality of farm produce and reduce values of the land. The weed in India are causing substantial losses to agriculture production and the annual losses in terms of money come to the Rs-1650 crores (Joshi, 2002) being higher than by insect's pests and diseases. Hence, weed control is essential for increasing barley production. It has been reported that with production of each kilogram of weed, one kilogram barley grains are reduced (Chaudhary *et al.*, 2008). The problem of weed infestation has increased manifold as it created favourable conditions for invasion as well as luxuriant growth of weeds particularly of *Phalaris minor* and *Avena spp*. throughout barley growing area in our country (Gill *et al.*, 1984). Therefore, cultural methods of weed control could not be performed and becomes unaffordable. Plant nutrition plays an important role in growth and productivity of a crop. As barley crop is highly responsive to applied nutrient through various sources, a proper fertility management is an important parameter for optimizing the productivity of this crop. The organic manures being cheaper and eco-friendly like FYM, compost, Vermicompost with fertilizers is receiving great attention are intensive agriculture. Application of organic along with inorganic sources not only improve soil health but with also improve the produce quality and fertilizer use efficiency and thereby reducing the cost of cultivation. Use of organic manure have been found to be promising m arresting the decline in productivity through correction of secondary and micronutrients deficiencies (Tripathi *et al.*, 2010).

Materials and Methods

The present research work was carried out at the experimental field of Crop Research Center, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.). During 2015-16 and 2016-17at with RD-2035 variety of barley in a fourteen year old The treatments comparing of combination of five level of nutrient and four weed management option where tested in Split-Plot design with three replications, Inter Row spacing 22.50 cm Nutrient management 100 % NPK, 75 % N-PK + 25 % N through FYM,

75 % N-PK + 25 % N through vermicompost, 50 % N-PK + 50 % N through FYM, 50 % N-PK + 50 % N through vermicompost and Weed management practices Control, Two hand weeding, Trisulfuron 15 g a.i ha^{-1}, Carfentazone ethyl 15 g a.i ha $^{-1.}$The experiment was conducted at (CRC) farm of the University located in Indo-Gangetic plains of Western Uttar Pradesh in Western plains zone. The farm is geographically located at 29^0 04' 19" N latitude, 77^0 42' 50" E longitudes and at an elevation of 237 metres above the mean sea level. Soil samples were collected to a depth of 0-15 cm from 10 spots in the experimental field prior to sowing of barley crop. The samples thus collected were mixed homogenously and a composite sample was drawn for analyzing various physico-chemical properties. The soil of experimental site was sandy loam in texture, low in organic carbon and nitrogen and medium in available phosphorus and available potassium and neutral in reaction. Such as Organic carbon (%) (Walkey and Black's (1947), total nitrogen (kg/ha.) by Alkaline permanganate method (Subhaiah Asija, 1956), phosphorus (kg/ha.) by Olsen's Calorimetric Method (Olsen *et al.*, 1954), and potassium (kg/ha.) by Flame Photometric Method (Toth and Prince, 1949).

Soil pH and EC measured by Digital pH meter and conductivity meter respectively. The requisite agronomic and plant protection measures were adopted uniformly for all the treatments during the entire growing period. At maturity, data on plant characters and yield components were recorded from five randomly selected plants in each plot. The growth and yield characters were recorded such as plant height at harvest (cm), number of total tillers plant-1, spike length (cm), number of spike lets spike-1, number of grains spike-1, 1000-seed weight (g), grain yield (t ha-1), straw yield (t ha-1), and harvest index (%). The crop from each unit plot was harvested at full maturity to record the data on grain and straw yields. The data was analyzed statistically.

Results and Discussion

Weed growth

The most commonly surveyed weeds in the experimental situations through the two growing seasons were: Grassy weeds Wild oat (*Avena ludoviciana*, L.), Little seed canary-grass (*Phalaris minor* L.) and Non-grassy weeds Blue or Scarlet pimpernel (*Anagallis arvensis* L.), Common lambs quarters (*Chenopodium album* L.), Yellow sweet clover (*Melilotus indica*, L.), White sweet clover (*Melilotus alba* L.), Fumitory (*Fumaria parviflora* L.) and Sedges weeds.

Effect of nutrient managements

Nutrient and weed management practices both had significant effect on dry matter accumulation of total weeds at all the crop stages during both years. The highest total weeds dry matter accumulated where crop was grown with 50% N-PK + 50% N through FYM application during both the years (Table 1). Application of 75% N-PK + 25% N through vermicompost led to significantly reduction in total weeds dry matter accumulation irrespective of the crop growth stages during both years except at 30 DAS during 2015-16. Mean reduction against control was 27.02, 27.12 and 27.09 per cent, respectively at 30, 60 and 90 DAS stages

Effect of weed managements

All the weed control measures reduced dry matter accumulation of total weeds significantly all the crop growth stage during both years (Table 1). Among the herbicides Trisulfuron 15g a.i ha^{-1} gave significantly better control of dry matter accumulation of

total weeds 60 and 90 DAS stages followed by Carfentrazone ethyl 15g a.i ha^{-1} during both years. At 90 DAS the mean reduction in dry matter accumulation of total weeds was 73.13, 63.91, and 58.94 per cent, respectively with two hand weeding, Trisulfuron 15g a.i ha^{-1}, and Carfentrazone ethyl 15g a.i ha^{-1} against control treatment. Total dry matter reduction of weeds was significant amongst the herbicidal treatment. Trisulfuron 15g a.i ha^{-1} resulted in maximum dry matter reduction and the results obtained under these treatments. The reduction in dry matter of weeds was because of effective control of weeds by these herbicides.

Dry matter accumulation of weeds viz.; *Phalaris minor, Avena ludoviciana, Chenopodium album, Angallis arvensis, Melilotus indica* and others weeds were significant effect on weed control measures (Table 1). The significantly higher dry matter accumulation was found under control and it increase up to 60 DAS and their after reduction was observed. Among the herbicides Trisulfuron 15g a.i ha^{-1} gave best control of dry matter of weeds followed by Carfentrazone ethyl 15g a.i ha^{-1}. These results are in close conformity with reports of (Singh *et al.,* 2010).

Barley growth

Effect of nutrient management

Plant height (Table 2) increased at a faster rate during at 60 to 90 DAS was significantly affected by different nutrients treatments. The plant height was significantly affected at 30, 60, 90 DAS and at harvest in different treatments. The maximum plant height was recorded with the application of 75% N-PK + 25% N through vermicompost which was significantly superior to all other treatments during both years, except at 30 DAS. The 50% N-PK + 50% N through FYM plots resulted significant reduction in plant height than rest of the treatments at all the growth stages. Such a higher plant height in 75% N-PK + 25% N through vermicompost can be associated with sufficient nutrient supply at the active growth stage. Similar results of increased plant height were also reported by Ram and Mir (2006); Singh *et al.,* (2007); Singh *et al.*, (2008) and Singh and Pal (2011).

Effect of weed managements

Growth of barley plant in terms of plant height, number of tillers per running meter and dry matter accumulation reflects a significant improvement under different weed control treatments as compared to the control. This remarkable improvement in crop growth and development can be accounted on reduced crop weed competition. Trisulfuron 15g a.i ha^{-1} was the best treatment for weed control during both years which resulted in maximum availability of moisture, nutrient, light and space to the crop. These results are in conformity with findings of Dixit and Singh (2008); Singh *et al.,* (2010) and Barthwal *et al.*, (2013).

Barley yield and its attributes

Effect of nutrient management

The number of tillers (Table 3) increased up to at 60 DAS and started declining their after at 90 DAS and at harvest. The highest number of tillers per meter row was recorded in 75% N-PK + 25% N through vermicompost followed by 100% NPK. Lowest number of tillers was recorded in 50% N-PK + 50% N through FYM plots at 30, 60, 90 DAS and harvest. Such a higher number of tillers in these treatments can be linked with optimum supply of essential nutrients at active tillering stage. Similar results were also reported by Pandey *et al.,* (2009); Usadadiya and Patel (2013) and Jat *et al.*, (2013).

Table.1 Effect of nutrient and weed management practices on dry weight of total weed (g m^{-2}) in barley at different stages

Treatment	Dry weight of total weed (g m^{-2})					
	30 DAS		60 DAS		90 DAS	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
Nutrient management						
100% NPK	5.4 (28.7)	5.8 (33.8)	6.8 (46.5)	7.5 (56.3)	7.1 (49.9)	7.7 (59.3)
75% N-PK + 25% N through FYM	5.6 (31.1)	6.1 (36.6)	7.1 (50.4)	7.8 (61.0)	7.4 (54.1)	8.0 (64.2)
75% N-PK + 25% N through vermicompost	5.2 (26.2)	5.6 (30.8)	6.5 (42.4)	7.2 (51.4)	6.8 (45.5)	7.4 (54.1)
50% N-PK + 50% N through FYM	6.0 (35.9)	6.5 (42.2)	7.6 (58.2)	8.4 (70.5)	7.9 (62.4)	8.6 (74.2)
50% N-PK + 50% N through vermicompost	5.9 (35.0)	6.4 (41.2)	7.5 (56.7)	8.3 (68.7)	7.8 (60.8)	8.5 (72.3)
SEm(±)	0.02	0.02	0.03	0.04	0.04	0.04
C.D. (P=0.05)	0.07	0.08	0.11	0.12	0.11	0.12
Weed management						
Control	6.2 (38.5)	6.8 (45.3)	13.5 (182.2)	13.8 (192.1)	12.4 (153.5)	12.8 (164.4)
Two hand weeding	4.8 (22.5)	5.2 (26.5)	6.1 (36.4)	6.7 (44.1)	6.3 (39.0)	6.8 (46.4)
Trisulfuron 15g a.i ha^{-1}	5.5 (30.2)	6.0 (35.5)	7.0 (48.9)	7.7 (59.2)	7.3 (52.4)	7.9 (62.3)
Carfentrazone ethyl 15g a.i ha^{-1}	5.9 (34.4)	6.4 (40.4)	7.5 (55.7)	8.2 (67.4)	7.7 (59.6)	8.4 (70.9)
SEm(±)	0.02	0.02	0.03	0.03	0.03	0.03
C.D. (P=0.05)	0.05	0.06	0.08	0.09	0.08	0.09

Table.2 Effect of weed management and nutrient management on plant height (cm) of barley

Treatment	Plant height (cm)							
	30 DAS		60 DAS		90 DAS		At harvest	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
Nutrient management								
100% NPK	19.80	17.35	49.45	43.33	71.81	58.26	90.04	85.54
75% N-PK + 25% N through FYM	18.51	16.22	46.24	40.54	67.13	54.43	85.71	81.43
75% N-PK + 25% N through vermicompost	21.65	17.79	55.81	49.00	80.97	65.57	93.44	88.77
50% N-PK + 50% N through FYM	17.65	15.46	44.09	38.61	64.04	51.93	82.27	78.16
50% N-PK + 50% N through vermicompost	18.28	16.02	45.67	40.03	66.31	53.84	85.63	81.35
SEm(±)	0.34	0.67	0.95	0.88	1.34	0.94	1.68	1.60
C.D. (P=0.05)	1.12	1.65	3.08	2.87	4.37	3.08	5.47	5.20
Weed management								
Control	18.65	16.50	47.04	41.24	68.29	55.41	70.02	66.52
Two hand weeding	19.71	17.38	49.53	43.42	71.91	58.28	95.19	90.44
Trisulfuron 15g a.i ha^{-1}	19.48	17.25	49.16	43.12	71.35	57.88	93.22	88.56
Carfentrazone ethyl 15g a.i ha^{-1}	18.86	16.59	47.28	41.44	68.66	55.65	91.24	86.68
SEm(±)	0.28	0.52	0.59	0.58	0.83	0.70	1.37	1.30
C.D. (P=0.05)	0.81	1.30	1.72	1.68	2.40	2.01	3.96	3.76

Table.3 Effect of weed management and nutrient management on number of tillers (m-1 row length) of barley

Treatment	Number of tillers (m^{-1} row length)							
	30 DAS		60 DAS		90 DAS		At harvest	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
Nutrient management								
100% NPK	51.3	48.7	75.6	71.9	83.7	79.5	81.9	78.6
75% N-PK + 25% N through FYM	50.4	48.3	71.9	68.3	80.5	76.5	78.9	75.7
75% N-PK + 25% N through vermicompost	53.5	50.8	77.6	73.8	85.8	81.5	83.8	80.6
50% N-PK + 50% N through FYM	46.8	44.5	68.8	65.4	76.4	72.5	74.8	71.8
50% N-PK + 50% N through vermicompost	48.1	45.7	69.8	66.3	78.8	74.9	76.7	73.7
SEm(±)	**0.95**	**1.03**	**1.40**	**1.33**	**1.58**	**1.50**	**1.55**	**1.49**
C.D. (P=0.05)	**3.09**	**3.35**	**4.56**	**4.34**	**5.16**	**4.90**	**5.06**	**4.86**
Weed management								
Control	41.4	39.5	58.9	55.9	56.6	53.7	54.9	52.7
Two hand weeding	53.8	51.3	79.0	75.1	91.2	86.6	89.4	85.8
Trisulfuron 15g a.i ha^{-1}	52.8	50.2	77.7	73.8	89.4	84.9	87.6	84.1
Carfentrazone ethyl 15g a.i ha^{-1}	51.9	49.4	75.5	71.7	86.9	82.6	85.1	81.7
SEm(±)	**0.78**	**0.76**	**1.14**	**1.08**	**1.27**	**1.21**	**1.24**	**1.19**
C.D. (P=0.05)	**2.26**	**2.21**	**3.28**	**3.12**	**3.68**	**3.49**	**3.59**	**3.45**

Table.4 Effect of weed management and nutrient management on spike length (cm), no. of spikelets/spike, no. of grain/spike and test weight (g) of barley

Treatment	Spike length (cm)		No. of spikelets/spike		No. of grain/spike		Test weight (g)	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
Nutrient management								
100% NPK	9.7	9.5	12.5	11.2	39.9	38.3	40.6	38.6
75% N-PK + 25% N through FYM	9.3	9.4	11.2	10.1	37.4	35.8	38.9	36.8
75% N-PK + 25% N through vermicompost	10.5	10.5	13.7	12.5	41.9	39.7	41.4	38.9
50% N-PK + 50% N through FYM	8.9	9.1	9.7	8.9	35.4	32.9	37.6	34.7
50% N-PK + 50% N through vermicompost	8.7	9.3	10.4	9.6	35.3	32.8	38.7	35.6
SEm(±)	**0.16**	**0.13**	**0.16**	**0.13**	**0.43**	**0.33**	**0.15**	**0.17**
C.D. (P=0.05)	**0.53**	**0.44**	**0.51**	**0.43**	**1.40**	**1.12**	**0.50**	**0.57**
Weed management								
Control	7.5	8.3	9.3	8.4	34.5	33.7	36.9	34.6
Two hand weeding	10.6	10.9	13.9	12.7	40.6	38.1	41.3	38.8
Trisulfuron 15g a.i ha^{-1}	10.1	10.0	12.2	11.1	39.1	36.5	40.3	37.6
Carfentrazone ethyl 15g a.i ha^{-1}	9.5	9.1	10.6	9.7	37.8	35.3	39.3	36.7
SEm(±)	**0.13**	**0.18**	**0.09**	**0.08**	**0.42**	**0.34**	**0.23**	**0.25**
C.D. (P=0.05)	**0.38**	**0.54**	**0.27**	**0.25**	**1.24**	**0.98**	**0.66**	**0.71**

The beneficial effect of organic manures on grain, straw, biological yields and yield attributing characters might be assigned to the fact that after proper decomposition and mineralization, these manures supplied available plant nutrients directly to the plants and also had solubilising effect on fixed forms of nutrients in soil. Similar findings were also reported by (Mubarak and Singh, 2011). The combination use of organic manures and chemical fertilizers enhanced the inherent capacity of soil as reported by Pandey *et al.,* (2009); Verma and Mathur (2009); Verma, *et al.,* (2010) and Meena *et al.,* (2012).

Effect of weed managements

Increase in spike length in two hand weeding was 41.6 and 31.17 per cent (Table 4) over the control during 2015-16 and 2016-17 respectively, followed by Trisulfuron 15g a.i ha^{-1} and Carfentrazone ethyl 15g a.i ha^{-1} was significantly higher over control.

Maximum number of spikelet per spike was observed in two hand weeding 13.97 and 12.67 during both years followed by Trisulfuron 15g a.i ha^{-1} during 2015-16 and 2016-17. Highest grains per spike and test weight was observed in two hand weeding 40.60 and 38.12 and 41.33 and 38.79 g followed by Trisulfuron 15g a.i ha^{-1} and significantly superior to control during both years. Similar finding were also reported by Chopra *et al.,* (2008). The harvest index was significantly higher in two hand weeding (42.06 and 39.46) followed by Trisulfuron 15g a.i ha^{-1} and Carfentrazone ethyl 15g a.i ha^{-1} during 2015-16 and 2016-17. The better performance of these treatments in terms of yield could be attributes to better expression of their yield attributes due to reduction in crop weed competition. This could be attributed to the selectivity of these herbicides to crop and significantly effect on weeds has already been reported Dixit and Singh (2008).

It is concluded that the adoption of 75% N-PK + 25% N through vermicompost significantly improved the growth, yield attributing characters, yield and productivity of barley crop. Application of 100% NPK gave at par results for these parameters. Among the weed control practices Trisulfuron 15g a.i ha^{-1} improved the different growth parameters and yield of barley crop over the control.

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