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Nutrients removal by crop and weeds under different weed and nutrient management practices in barley (*Hordeum vulgare* L.) and its associated weeds

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Abstract

A field experiment was conducted on sandy loam soil during 2015-16 and 2016-17 at Crop Research Center, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut (U.P.). The treatments comprised five levels of nutrients 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 as main plot 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 as sub plot and it was laid out in split-plot design with three replications. The results indicated that among different nutrient management practices, the maximum NPK uptake in barley and weeds were recorded with the treatment 75% N-PK + 25% N through vermicompost over rest of the other treatments. Among weed management practices, NPK content and uptake were recorded highest in two hand weeding followed by Trisulfuron 15g a.i. ha⁻¹ and control. Therefore, nutrient uptake by crop, status of the soil also improved with the integration of organic and inorganic sources of plant nutrients. Thus 75% NPK + 25% N through vermicompost with Trisulfuron 15g a.i. ha⁻¹ may be recommended for better weed control and higher barley yield.

Keywords: Barley, nutrient management, weed management, nutrient uptake

Introduction

Barley (*Hordeum vulgare* L.) is an important *rabi* cereal crop in India. It has low cost of production and input requirement, so it is preferred by resource poor farmers in the country (Singh, 2017) [3, 14-16]. Barley has a wide range of uses. Its grain is used as a staple food, for malting and for making local drinks, and is sold for cash. The grain is rich of Zinc, iron and soluble fibers and higher content of vitamin A and E than other cereals. Its straw and stem stubs are used for animal feed and thatching (Nand *et al.*, 2019) [10]. 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) [1, 2]. 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, 2]. The average productivity of barley in the state is far behind the attainable yielding of 40-50 q/ha (Choudhary *et al.*, 2014). The low average yield could be partially attributed due to poor weed management, which results in high competition from weeds. Yield gains from weed control, on the other hand, ranges from 14-60 percent depending on the location and type of weed (Negewo *et al.*, 2011) [11]. Weeds are an important constraint in agricultural production systems, acting at same tropic level as the crop; weeds capture a part of the available resources that are essential for plant growth and weeds compete with crop plants for various resources such as water and nutrients, resulting in low crop yields and quality (Kebede *et al.*, 2017) [8]. Weed control play an active role in raising grain yield, since weeds cause great losses in yield reached 48.9% in barley (Metwally *et al.*, 2000) [9]. Weeds can be controlled through different management practices in barley fields. These include cultural, physical, chemical and integrated methods. Hand weeding is the most practiced weed control option in barley. Manual weed control is labour intensive and therefore limits the production area (Dubey, 2014) [6]. Chemical control is the most common, efficient and economical method of control (Kebede *et al.*, 2017) [8].

The barley crop possessed very high tolerance to drought and salt. As it 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 application of FYM in the soil helps in increasing the fertility of the soils as well as physical condition including water holding capacity (Singh *et al.* 2013) [3, 14-16]. FYM which is the major sources of plant nutrients in traditional agriculture received less emphasis with the advent of high analysis chemical fertilizers. Without detracting from the fact that chemical fertilizer will continue to be main instrument for quicking the pace for agriculture production the recent researches indicated that a judicious combination of organic manures and fertilizers can better maintain the long term soil fertility and sustain high levels of productivity. Therefore, use of both organic manure and chemical fertilizers in appropriate proportion assumes special significance as complementary and supplementary to each other in crop production (Singh, 2017) [3, 14-16]. 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 in arresting the decline in productivity through correction of secondary and micronutrients deficiencies (Tripathi *et al.*, 2010) [17].

The purpose of the current field study is to evaluate the effect of different weed and nutrient management practices and associated weeds on nutrient removal by crop and weeds in barley (*Hordeum vulgare* L.) of western Uttar Pradesh.

Materials and Methods

The present research study was carried out at the experimental field of Crop Research Center, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.) during *rabi* seasons (2015-16 and 2016-17). The treatments mainly comparing of combination 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 as main plot 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 as sub plot and at with RD-2035 variety of barley in a fourteen year old where tested in split plot design with three replications. 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 homogeneously 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 & nitrogen and medium in available phosphorus and available potassium and neutral in reaction. The requisite agronomic and plant protection measures were adopted uniformly for all the treatments during the entire growing period. The nutrient content (%) and their uptake (kg ha⁻¹) by crop and the weeds data were analysed and tabulated after statistical test.

Results and Discussion

Nutrient content and their uptake by weeds

Nitrogen (N)

Nitrogen content and uptake in weeds improved significantly with the application of nutrient management treatments over 50% N-PK + 50% N through FYM during both years (Table 1 & 2). It indicated that maximum nitrogen content (1.26 and 1.23%) and uptake (10.46 and 10.95 kg/ha) in weeds were recorded with the treatment 50% N-PK + 50% N through FYM followed by 50% N-PK + 50% N through vermicompost and 75% N-PK + 25% N through FYM during experimentation. Lowest nitrogen content (1.08 and 1.05%) and uptake (8.32 and 8.72 kg/ha) in weeds was recorded with the application of 75% N-PK + 25% N through vermicompost. Weed control treatments significantly varied in nitrogen content per cent and uptake of the weeds during both years. It indicated that maximum nitrogen content (1.20 and 1.17%) and uptake (12.96 and 13.22 kg/ha) in weeds were recorded in control plot followed by all other treatments with respect to weed control during 2015-16 and 2016-17, respectively. Carfentrazone ethyl 15g a.i. ha⁻¹ also resulted in significantly lower uptake of nitrogen as compared to rest of the herbicidal treatments during 2015-16 and 2016-17, respectively. Lowest nitrogen content (1.12 and 1.10%) and nitrogen uptake (7.50 and 8.03 kg/ha) in weeds were recorded in two hand weeding treatment and Trisulfuron 15g a.i. ha⁻¹ during both the years.

Table 1: NPK content (%) by weeds as influenced by different nutrient management and weed control practices

Treatment	Nutrient content (%)					
	N		P		K	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
Nutrient management						
100% NPK	1.12	1.10	0.16	0.14	1.02	1.00
75% N-PK + 25% N through FYM	1.16	1.14	0.19	0.18	1.06	1.04
75% N-PK + 25% N through vermicompost	1.08	1.05	0.13	0.12	0.92	0.90
50% N-PK + 50% N through FYM	1.26	1.23	0.29	0.26	1.15	1.13
50% N-PK + 50% N through vermicompost	1.21	1.18	0.24	0.22	1.12	1.10
S.Em ±	0.023	0.023	0.005	0.004	0.021	0.020
C.D. (P=0.05)	0.075	0.076	0.015	0.014	0.067	0.067
Weed management						
Control	1.20	1.17	0.24	0.21	1.09	1.07
Two hand weeding (25 & 50 DAS)	1.12	1.10	0.16	0.15	1.01	0.99
Trisulfuron 15g a.i. ha ⁻¹	1.16	1.13	0.20	0.18	1.05	1.03
Carfentrazone ethyl 15g a.i. ha ⁻¹	1.18	1.16	0.22	0.20	1.07	1.05
S.Em ±	0.018	0.018	0.003	0.003	0.016	0.015
C.D. (P=0.05)	0.052	0.050	0.010	0.009	0.047	0.045

Table 2: NPK uptake (kg ha⁻¹) by weeds as influenced by different nutrient management and weed control practices

Treatment	Nutrient uptake (kg ha ⁻¹)					
	N		P		K	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
Nutrient management						
100% NPK	8.74	9.35	1.25	1.19	7.96	8.50
75% N-PK + 25% N through FYM	9.16	9.80	1.50	1.55	8.37	8.94
75% N-PK + 25% N through vermicompost	8.32	8.72	1.00	1.00	7.08	7.47
50% N-PK + 50% N through FYM	10.46	10.95	2.41	2.31	9.55	10.06
50% N-PK + 50% N through vermicompost	9.92	10.03	1.97	1.87	9.18	9.35
S.Em ±	0.22	0.23	0.05	0.05	0.20	0.21
C.D. (P=0.05)	0.71	0.75	0.15	0.15	0.64	0.68
Weed management						
Control	12.96	13.22	2.59	2.37	11.77	12.09
Two hand weeding (25 & 50 DAS)	7.50	8.03	1.07	1.10	6.77	7.23
Trisulfuron 15g a.i. ha ⁻¹	8.24	8.70	1.42	1.39	7.46	7.93
Carfentrazone ethyl 15g a.i. ha ⁻¹	8.73	9.28	1.63	1.60	7.92	8.40
S.Em ±	0.19	0.20	0.04	0.04	0.18	0.18
C.D. (P=0.05)	0.56	0.59	0.12	0.11	0.51	0.53

Phosphorus (P)

Phosphorus content and uptake in weeds was significantly affected by different nutrient treatments (Table 1 & 2). It indicates that maximum phosphorus content (0.29 and 0.26%) and phosphorus uptake (2.41 and 2.31 kg/ha) in weeds were recorded with the treatment 50% N-PK + 50% N through FYM was statistically superior to the rest of the treatments during both years. Lowest phosphorus content (0.13 and 0.12%) and uptake (1.0 and 1.0%) in weeds were recorded in 75% N-PK + 25% N through vermicompost plots. Phosphorus content and uptake in weeds was significantly affected by different weed control practices. It indicates that maximum phosphorus content (0.24 and 0.21%) and phosphorus uptake (2.59 and 2.37) in weeds were recorded in control treatment and Carfentrazone ethyl 15g a.i. ha⁻¹ were statistically at par to each other in respect of phosphorus content and followed by Trisulfuron 15g a.i. ha⁻¹ in uptake but better than the control, during both years. Lowest phosphorus content (0.16 and 0.15%) and uptake (1.07 and 1.10%) in weeds were found in two hand weeding treatment.

Potassium (K)

Potassium content and uptake in weeds was significantly affected by different nutrient treatments (Table 1 & 2). It indicates that maximum potassium content (1.15 and 1.13%) and potassium uptake (9.55 and 10.06 kg/ha) in weeds were recorded with the treatment 50% N-PK + 50% N through FYM followed by 50% N-PK + 50% N through vermicompost during both years. Lowest potassium content (0.92 and 0.90%) and uptake (7.08 and 7.47 kg/ha) in weeds were recorded in 75% N-PK + 25% N through vermicompost plots. Potassium content and uptake in weeds was significantly affected by different weed control practices. It indicates that maximum potassium content (1.09 and 1.07%) and potassium uptake (11.77 and 12.90 kg/ha) in weeds was recorded in control plot than rest of the treatments during both years. Carfentrazone ethyl 15g a.i. ha⁻¹ and Trisulfuron 15g

a.i. ha⁻¹ followed by each other in respect of potassium uptake but significantly different than two hand weeding treatment during both years. Lowest potassium content (1.01 and 0.99%) and uptake (6.77 and 7.23 kg/ha) in weeds were recorded in two hand weeding treatment.

Nutrient content (%) and their uptake (kg ha⁻¹) by crop Nitrogen (N)

Application of nutrient management treatments significantly affected the nitrogen content and uptake in grain as well as straw during both years study (Table 3). Nitrogen uptake was more during 2015-16 in both grains as well as in straw. It indicates that maximum nitrogen content (1.75 and 1.59%) and nitrogen uptake (76.21 and 65.95 kg/ha) in grain were recorded with the treatment 75% N-PK + 25% N through vermicompost followed by 100% NPK during both years. Highest nitrogen content (0.52 and 0.47%) and nitrogen uptake (37.02 and 31.82 kg/ha) in straw were recorded in treatment 75% N-PK + 25% N through vermicompost followed by 100% NPK, 75% N-PK + 25% N through FYM and 50% N-PK + 50% N through vermicompost during 2015-16 and 2016-17, respectively. Lowest nitrogen content in grain (1.63 and 1.46%) and nitrogen uptake by grain (55.69 and 46.19 kg/ha) and straw (25.14 and 21.26 kg/ha) were recorded in 50% N-PK + 50% N through FYM plots. Similarly lowest nitrogen content was found in straw during both the years. Maximum nitrogen content (1.78 and 1.62%) in grain and (0.52 and 0.47%) in straw and nitrogen uptake (79.74 and 68.44 kg/ha) in grain and (38.02 and 32.41 kg/ha) in straw were recorded in two hand weeding followed by Trisulfuron 15g a.i. ha⁻¹ during both years. Lowest nitrogen content in grain (1.48 and 1.35%) and nitrogen uptake by grain (43.20 and 36.27 kg/ha) and straw (20.93 and 17.92 kg/ha) were recorded in control treatment. Similarly lowest nitrogen content was found in control treatment straw during both the years.

Table 3: Nitrogen content (%) and uptake (kg/ha) of barley as influenced by different nutrient management and weed control practices

Treatment	N Content (%)				N uptake (kg ha ⁻¹)				Total N uptake (kg ha ⁻¹)	
	Grain		Straw		Grain		Straw			
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
Nutrient management										
100% NPK	1.72	1.58	0.51	0.46	70.82	61.66	34.64	29.61	105.46	91.27
75% N-PK + 25% N through FYM	1.69	1.56	0.48	0.44	66.34	57.98	31.08	26.98	97.42	84.96

75% N-PK + 25% N through vermicompost	1.75	1.59	0.52	0.47	76.31	65.95	37.02	31.82	113.33	97.77
50% N-PK + 50% N through FYM	1.63	1.46	0.46	0.42	55.69	46.19	25.14	21.26	80.83	67.45
50% N-PK + 50% N through vermicompost	1.65	1.49	0.48	0.44	59.31	49.55	27.60	23.40	86.92	72.95
S.Em ±	0.032	0.030	0.009	0.008	1.52	1.35	0.70	0.62	2.23	1.98
C.D. (P=0.05)	0.096	0.09	0.029	0.028	4.96	4.41	2.30	2.04	7.26	6.45
Weed management										
Control	1.48	1.35	0.44	0.40	43.20	36.27	20.93	17.52	64.39	53.98
Two hand weeding (25 & 50 DAS)	1.78	1.62	0.52	0.47	79.74	68.44	38.02	32.41	118.64	101.96
Trisulfuron 15g a.i. ha ⁻¹	1.76	1.60	0.51	0.46	75.04	64.22	35.40	30.07	111.10	95.15
Carfentrazone ethyl 15g a.i. ha ⁻¹	1.74	1.58	0.49	0.44	67.33	58.14	30.74	26.24	98.42	85.16
S.Em ±	0.026	0.023	0.007	0.007	1.20	1.02	0.58	0.49	1.78	1.52
C.D. (P=0.05)	0.075	0.068	0.022	0.021	3.48	2.96	1.67	1.42	5.15	4.38

NS – Non-significant

Total uptake of nitrogen increased significantly by the application of nutrient management and weed control practices during both years (Table 3). It indicated that highest total uptake of nitrogen (113.33 and 97.77 kg/ha) by barley was recorded with the treatments 75% N-PK + 25% N through vermicompost and significantly higher than rest of the treatments during both years. Lowest total nitrogen uptake (80.83 and 67.45 kg/ha) was recorded in 50% N-PK + 50% N through FYM plots during 2015-16 and 2016-17, respectively. Total uptake of nitrogen increased significantly with all the weed management during both years over the control. The highest total nitrogen uptake (118.64 and 101.96 kg/ha) two hand weeding treatment followed by application of Trisulfuron 15g a.i. ha⁻¹. This herbicide treatment was superior to all other treatments with respect to weed control during both years. Lowest total nitrogen uptake (64.39 and 53.98 kg/ha) was recorded in control treatment during 2015-16 and 2016-17, respectively.

Phosphorus (P)

Phosphorus content and uptake was more in grain as compared to straw during both years (Table 4). It indicated that maximum phosphorus content (0.36%) and phosphorus

uptake (16.18 and 14.02 kg/ha) in grain was recorded with the treatment 75% N-PK + 25% N through vermicompost followed by 100% NPK and 75% N-PK + 25% N through FYM during 2015-16-2016-17. Highest phosphorus content (0.13 and 0.11%) and phosphorus uptake (11.65 and 10.10 kg/ha) in straw were recorded in treatment 75% N-PK + 25% N through vermicompost followed by 100% NPK and significantly higher than rest of the treatments during both years. Lowest phosphorus content in grain (0.32 and 0.29%) and (0.10 and 0.10%) in straw and phosphorus uptake by grain (10.98 and 9.36 kg/ha) and (5.80 and 4.94 kg/ha) by straw were recorded in 50% N-PK + 50% N through FYM plots. Application of different herbicides had significantly different the phosphorus content in grain during both years of study. Maximum phosphorus content (0.15 and 0.14%) and phosphorus uptake (16.41 and 14.03 kg/ha) in straw was recorded in two hand weeding treatment followed by Trisulfuron 15g a.i. ha⁻¹ during 2015-16 however, during 2016-17. Lowest phosphorus content in grain (0.31 and 0.29%) and (0.11 and 0.10%) in straw and phosphorus uptake by grain (9.28 and 7.75 kg/ha) and (5.15 and 4.30 kg/ha) were recorded in control treatment.

Table 4: Phosphorus content, uptake and its total uptake by barley as influenced by different nutrient management and weed control practices

Treatment	P Content (%)				P uptake (kg ha ⁻¹)				Total P uptake (kg ha ⁻¹)	
	Grain		Straw		Grain		Straw			
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
Nutrient management										
100% NPK	0.35	0.32	0.14	0.13	14.86	12.68	9.86	8.42	24.72	21.10
75% N-PK + 25% N through FYM	0.34	0.31	0.13	0.11	13.53	11.54	8.45	7.20	21.98	18.74
75% N-PK + 25% N through vermicompost	0.36	0.33	0.16	0.14	16.18	14.02	11.65	10.10	27.83	24.12
50% N-PK + 50% N through FYM	0.32	0.29	0.10	0.10	10.98	9.36	5.80	4.94	16.78	14.30
50% N-PK + 50% N through vermicompost	0.33	0.30	0.12	0.11	11.86	10.11	6.86	5.85	18.72	15.95
S.Em ±	0.006	0.005	0.003	0.002	0.30	0.27	0.18	0.16	0.48	0.42
C.D. (P=0.05)	0.022	0.018	0.011	0.007	0.98	0.87	0.58	0.51	1.56	1.38
Weed management										
Control	0.31	0.29	0.11	0.10	9.28	7.75	5.15	4.30	14.43	12.06
Two hand weeding (25 & 50 DAS)	0.36	0.33	0.15	0.14	16.41	14.03	11.15	9.54	27.56	23.57
Trisulfuron 15g a.i. ha ⁻¹	0.35	0.32	0.14	0.13	15.18	13.04	9.77	8.39	24.96	21.42
Carfentrazone ethyl 15g a.i. ha ⁻¹	0.33	0.31	0.12	0.12	13.06	11.34	8.02	6.98	21.08	18.31
S.Em ±	0.005	0.005	0.002	0.002	0.24	0.21	0.16	0.14	0.40	0.34
C.D. (P=0.05)	0.016	0.015	0.007	0.005	0.71	0.60	0.47	0.40	1.17	1.01

NS – Non-significant

Total uptake of phosphorus in barley was significantly affected by different nutrient management treatments over the 50% N-PK + 50% N through FYM during both years (Table 4). It indicates that highest total phosphorus uptake (27.83 and 24.12 kg/ha) in barley was recorded with the treatment 75% N-PK + 25% N through vermicompost gave significantly higher than rest of the treatments during both years. Lowest

total phosphorus uptake (16.78 and 14.30 kg/ha) was recorded in 50% N-PK + 50% N through FYM plots during 2015-16 and 2016-17, respectively. The total uptake of phosphorus increased significantly with all weed control treatments over the control plot during both years. Show that highest total phosphorus uptake (27.56 and 23.57 kg/ha) in barley was recorded in two hand weeding treatment during both years

however, followed by Trisulfuron 15g a.i. ha⁻¹ during 2015-16 and 2016-17 and superior to all other treatments. Lowest total phosphorus uptake (14.43 and 12.06 kg/ha) was observed in control treatment during both years.

Potassium (K)

Potassium content and uptake in grain and straw was significantly affected by different nutrient treatments over 50% N-PK + 50% N through FYM during both years (Table 5). It indicated that significantly maximum potassium content (0.46 and 0.42%) and uptake (20.11 and 17.42 kg/ha) in grain was recorded with the treatment 75% N-PK + 25% N through vermicompost followed by 100% NPK and 75% N-PK + 25% N through FYM during both years. Highest potassium content (1.70 and 1.54%) and potassium uptake (122.21 and 105.90 kg/ha) by straw was recorded with the treatment 75% N-PK + 25% N through vermicompost followed by 100% NPK and

75% N-PK + 25% N through FYM during both years. Lowest potassium content in grain (0.41 and 0.38%) and (1.59 and 1.46%) straw and potassium uptake in grain (14.25 and 12.14 kg/ha) and (87.75 and 74.79 kg/ha) straw were recorded in 50% N-PK + 50% N through FYM plots. Different weed control treatments had no marked effect on nitrogen content of grain and straw over control but there is a significant higher in potassium uptake in grain as well as in straw over the control plot during both years. The maximum potassium content in grain (0.46 and 0.42%) and (1.72 and 1.57%) straw and potassium uptake (20.68 and 17.69 kg/ha) in grain and 126.60 and 108.27 kg/ha) by straw were recorded in two hand weeding followed by Trisulfuron 15g a.i. ha⁻¹ during both years. Lowest potassium content in grain (0.41 and 0.37%) and (1.48 and 1.34%) straw and potassium uptake in grain (11.97 and 10.00 kg/ha) and (70.43 and 58.86 kg/ha) straw were recorded in control treatment.

Table 5: Potassium content, uptake and its total uptake by barley as influenced by different nutrient management and weed control practices

Treatment	K content (%)				K uptake (kg ha ⁻¹)				Total K uptake (kg ha ⁻¹)	
	Grain		Straw		Grain		Straw			
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
Nutrient management										
100% NPK	0.45	0.40	1.67	1.50	18.57	15.84	114.52	97.71	133.08	113.55
75% N-PK + 25% N through FYM	0.43	0.39	1.64	1.48	17.08	14.56	107.55	91.67	124.63	106.23
75% N-PK + 25% N through vermicompost	0.46	0.42	1.70	1.54	20.11	17.42	122.21	105.90	142.32	123.32
50% N-PK + 50% N through FYM	0.41	0.38	1.59	1.46	14.25	12.14	87.75	74.79	101.99	86.93
50% N-PK + 50% N through vermicompost	0.42	0.39	1.62	1.48	15.36	13.08	93.73	79.82	109.09	92.90
S.Em ±	0.008	0.008	0.032	0.029	0.38	0.34	2.40	2.12	2.78	2.47
C.D. (P=0.05)	0.028	NS	NS	NS	1.25	1.11	7.83	6.93	9.07	8.05
Weed management										
Control	0.41	0.37	1.48	1.34	11.97	10.00	70.43	58.86	82.40	68.86
Two hand weeding (25 & 50 DAS)	0.46	0.42	1.72	1.57	20.68	17.69	126.60	108.27	147.29	125.96
Trisulfuron 15g a.i. ha ⁻¹	0.44	0.41	1.70	1.55	19.03	16.33	118.57	101.77	137.60	118.10
Carfentrazone ethyl 15g a.i. ha ⁻¹	0.43	0.39	1.67	1.52	16.61	14.40	104.98	91.02	121.60	105.42
S.Em ±	0.007	0.006	0.025	0.023	0.31	0.26	1.91	1.63	2.22	1.89
C.D. (P=0.05)	0.021	0.018	0.074	0.066	0.89	0.76	5.52	4.70	6.41	5.45

NS – Non-significant

Total potassium uptake by barley was significantly affected by different nutrient management treatment over 50% N-PK + 50% N through FYM during both years (Table 5). It indicated that highest total potassium uptake (142.32 and 123.32 kg/ha) by barley was recorded with the treatment 75% N-PK + 25% N through vermicompost and significantly higher than rest of the treatments during both years. Lowest total potassium uptake (101.99 and 86.93 kg/ha) was recorded in 50% N-PK + 50% N through FYM plots during 2015-16 and 2016-17, respectively. All the weed control treatments recorded significantly higher total uptake of potassium over the control treatment during both years. It indicated that highest total potassium uptake (147.29 and 125.96 kg/ha) by barley in two hand weeding after was observed in Trisulfuron 15g a.i. ha⁻¹. This herbicide treatment was superior to all other treatments with respect to weed control during 2015-16 and 2016-17, respectively. Lowest total potassium uptake (82.40 and 68.86 kg/ha) was recorded in control treatment during both years. Higher uptake of nutrients by the crop under the influence of weed control treatments was due to the fact that weed control treatments controlled the weeds effectively and consequently made more nutrient available to barley resulting in enhanced nutrient concentration and yield and thereby higher uptake of nutrients. Similar findings have been reported by Pandey *et*

al. (2000) [12] and Brar and Walia (2008) [4]. Higher NPK uptake by crop in two hand weeded or herbicide treated plots has also been reported by Pandey *et al.* (2001) [12] and Brar and Walia (2008) [4].

Fertility status of soil

Available nitrogen in soil (kg ha⁻¹)

Application of nutrient management treatment significantly improved the available nitrogen in soil over 100% NPK during both years. It indicated that highest available nitrogen (213.03 and 208.77 kg/ha) in soil was recorded with the treatment application 50% N-PK + 50% N through FYM than rest of the treatments during both years. Lowest available nitrogen (198.40 and 194.43 kg/ha) was recorded in 75% N-PK + 25% N through VC plots during 2015-16 and 2016-17, respectively (Table 6). Weed control treatments did not influence the nitrogen status of soil during both years of study. It indicated that highest available nitrogen (208.42 and 204.25 kg/ha) in soil was recorded in control treatment which was closely followed by Carfentrazone ethyl 15g a.i. ha⁻¹ during both years. Lowest available nitrogen (202.46 and 198.41 kg/ha) was recorded in two hand weeding treatments during 2015-16 and 2016-17, respectively.

Table 6: Fertility status of soil after crop harvest as influenced by different nutrient management and weed control practices

Treatment	Available nutrient (kg ha ⁻¹)						Organic carbon (%)	
	N		P		K		2015-16	2016-17
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17		
Nutrient management								
100% NPK	198.40	194.43	13.27	13.01	202.35	198.30	0.39	0.39
75% N-PK + 25% N through FYM	205.38	201.27	15.31	15.02	203.55	199.48	0.42	0.40
75% N-PK + 25% N through vermicompost	203.00	198.95	14.32	14.04	197.17	193.23	0.40	0.39
50% N-PK + 50% N through FYM	213.03	208.77	17.33	16.98	211.57	207.34	0.46	0.44
50% N-PK + 50% N through vermicompost	209.05	204.87	16.25	15.92	208.12	203.96	0.44	0.42
S.Em ±	4.03	3.95	0.30	0.30	4.00	3.92	0.009	0.008
C.D. (P=0.05)	12.09	11.85	1.01	0.98	12.02	11.76	0.028	0.026
Weed management								
Control	208.42	204.25	15.98	15.66	206.48	202.35	0.44	0.42
Two hand weeding (25 & 50 DAS)	202.46	198.41	14.28	13.99	201.54	197.51	0.41	0.39
Trisulfuron 15g a.i. ha ⁻¹	205.45	201.35	15.30	14.98	204.36	200.27	0.42	0.40
Carfentrazone ethyl 15g a.i. ha ⁻¹	206.76	202.62	15.64	15.32	205.84	201.72	0.43	0.41
S.Em ±	3.16	3.10	0.24	0.23	3.15	3.08	0.007	0.006
C.D. (P=0.05)	NS	NS	0.68	0.67	NS	NS	0.019	0.018

Available phosphorus in soil (kg ha⁻¹)

Application of nutrient management treatment significantly increased the available phosphorus in soil over 100% NPK during both years. It indicated that highest available phosphorus (17.33 and 16.98 kg/ha) in soil was recorded with the application of 50% N-PK + 50% N through FYM followed by 50% N-PK + 50% N through VC during both years. Lowest available phosphorus (13.27 and 13.01 kg/ha) was recorded in 75% N-PK + 25% N through VC plots during 2015-16 and 2016-17, respectively (Table 6). There was significantly effect of weed control treatments available phosphorus in soil during both years of study. It indicated that highest available phosphorus (15.98 and 15.66 kg/ha) in soil was recorded in control treatment which was closely followed by Carfentrazone ethyl 15g a.i. ha⁻¹ during both years. Lowest available phosphorus (14.28 and 13.99 kg/ha) was recorded in two hand weeding treatments during 2015-16 and 2016-17, respectively.

Available potassium in soil (kg ha⁻¹)

Nutrient management treatments significantly increased the available potassium in soil over 100% NPK during both years. It indicated that highest available potassium (211.57 and 207.34 kg/ha) in soil was recorded with the application of 50% N-PK + 50% N through FYM than rest of the treatments during both years. Lowest available potassium (197.17 and 193.23 kg/ha) was recorded in 75% N-PK + 25% N through VC plots during 2015-16 and 2016-17, respectively (Table 6). Available potassium in soil varied significantly due to different weed control treatments during both years. It indicated that highest available potassium (206.48 and 202.65 kg/ha) in soil was recorded in control treatment which was closely followed by Carfentrazone ethyl 15g a.i. ha⁻¹ during both years. Lowest available potassium (201.54 and 197.51 kg/ha) was recorded in two hand weeding treatments during 2015-16 and 2016-17, respectively.

Increase in NPK nutrients in soil by the application of organic manures was also reported by Dhaliwal and Walia (2008) [7] and Prasad *et al.* (2010) [13]. Angiras and Singh (1989) [3, 14-16] reported that increase the fertility levels and control of weeds by either mechanical or chemical method increased the available NPK status of soil after crop harvest.

Organic carbon in soil

Organic carbon content in soil was influenced significantly by

nutrient management and weed control treatments. It indicated that highest organic carbon content (0.46 and 0.44%) in soil was recorded with the application 50% N-PK + 50% N through FYM followed by 50% N-PK + 50% N through VC during both years. Lowest organic carbon (0.39 and 0.40%) was recorded in 75% N-PK + 25% N through VC plots during 2015-16 and 2016-17, respectively (Table 6). Among weed control treatments significantly highest content of organic carbon (0.44 and 0.42%) was recorded by control plots followed by Carfentrazone ethyl 15g a.i. ha⁻¹ during both years. Trisulfuron 15g a.i. ha⁻¹ was recorded similar content of organic carbon followed by Carfentrazone ethyl 15g a.i. ha⁻¹ during both 2015-16 and 2016-17, respectively. Studies conducted by various workers have established the fact of maintenance of soil fertility in terms of improved organic content and available nutrients in soil by application of organic manures in combination with chemical fertilizers in different ratio (Singh *et al.* 2008; Verma and Mathur, 2009 and Verma *et al.*, 2009) [3, 10, 14-16, 18].

Conclusion

On the basis of experimental results, it can be concluded that among different nutrient management practices, the maximum NPK uptake in barley and weeds were recorded with the application of 75% N-PK + 25% N through vermicompost over rest of the other treatments and the lowest was recorded in 50% N-PK + 50% N through FYM during both the year of study. Among the weed management practices, highest NPK content (%) and uptake (kg/ha) were recorded under two hand weeding followed by Trisulfuron 15g a.i. ha⁻¹ and control plot in weeds respectively and the lowest was recorded in control treatment and two hand weeding treatment followed by Trisulfuron 15g a.i. ha⁻¹ in crop and weeds during both the years. Therefore, nutrients uptake by crop and status of the soil health also improved with the integration of organic and inorganic sources of plant nutrients. Thus 75% NPK + 25% N through vermicompost with Trisulfuron 15g a.i. ha⁻¹ may be recommended for better weed control and higher barley yield.

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