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Nutrient content and uptake by barley as influenced by various combinations of nitrogen fertilizer, *biomix* and vermicompost

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Abstract
The major problems causing yield reduction of barley in India is declining soil fertility. Therefore, considering this in view a field experiment entitled, "Nutrient studies of *barley* as influenced by various combinations of nitrogen fertilizer, *biomix* and vermicompost" was conducted at the Agronomy Research Farm of Chaudhary Charan Singh Haryana Agricultural University, Hisar during the *rabi* season of 2017-18. The objective of the experiment was to evaluate the effect of different nutrient management practices on nutrient content and uptake of barley. The soil of the experimental field is sandy loam in texture, slightly alkaline in reaction, low in organic carbon and nitrogen, medium in available phosphorus and potassium. The experiment was laid out in Randomized Block Design replicated thrice with ten different treatments *viz*. T_1(Control), T_2 (*Biomix*), T_3 (Vermicompost @ 5 t ha^{-1}), T_4 (*Biomix* + Vermicompost @ 5 t ha^{-1}), T_5 (50% RDN + *Vermicompost* @ 5 t ha^{-1}), T_6 (75% RDN + *Vermicompost* @ 5 t ha^{-1}), T_7 (50% RDN + *Biomix* + Vermicompost @ 5 t ha^{-1}), T_8 (75% RDN + *Biomix*+ Vermicompost @ 5 t ha^{-1}), T_9 (RDN) and T_{10} (RDN + *Biomix* + Vermicompost @ 5 t ha^{-1}). Among various nitrogen management practices treatment T_{10} produced significantly higher N content and uptake in grain and straw and total N uptake of barley followed by treatment T_9 and T_8. Markedly, highest value of P content and uptake in grain and straw and total P uptake was recorded in treatment T_{10}, followed by treatment T_8 and T_9. Treatment T_{10} recorded highest value of K content in grain and straw, K uptake by grain and straw and total K uptake. There was no significant effect of various combinations of nitrogen fertilizer, *biomix* and vermicompost on straw K content of barley. There was no significant difference due to application of various combinations of nitrogen fertilizer, *biomix* and vermicompost on N, P and K status of soil after harvesting of barley.

Keywords: Barley, biomix, nitrogen fertilizer and vermicompost

Introduction
Barley (*Hordeum vulgare*) has low input requirement and cost of production, so it is preferred by the resource poor farmers throughout the country. It also has the widest ecological range of adaptation among all the cereals, which is grown throughout the tropical and temperate areas of the world. Barley grains are considered for valuable input for industries for extracting malt to be utilized in brewing, baby foods, distillation, cocoa malt drinks and aryuvedic medicines. Its straw is a good quality fodder for livestock. Barley is also a rich source of B vitamins, including niacin, thiamin, and pyridoxine (vitamin B-6). It also contains beta-glucans, a type of fiber that researches have linked to various health benefits. Now days, use of chemical fertilizer is increasing to boost up crop yield. Simultaneously, cost of chemical fertilizer is increased day by day, besides these, only use of chemical fertilizers is injurious to soil health and soil productivity. Food security, maintenance of proper soil health and leaving rightful heritage for upcoming generation are the main focus of agricultural development. The integrated approach of nutrient supply by fertilizers and organic manures is important because this system reduces the dependence on costly inorganic fertilizer and provides an ecofriendly approach. Application of chemical fertilizer in combination with organic manures significantly improved crop productivity, concentration and uptake of nutrients by grain and straw, organic carbon and available nutrients of soil after harvest of crops. The beneficial effect of this approach was visualized in first crop and its residual effect of organic manures like FYM and vermicompost in next crop of the sequence by sustaining the soil fertility as well productivity. The combined use of organic fertilizer, inorganic fertilizer and biofertilizers like *biomix* improve the physical properties of soil as well as the soil structure (Katyal, 2000).

Reducing soil fertility is one of the major problems causing yield reduction of food barley in India. Therefore, keeping the above aspects in view a field experiment was carried out to determine the combined effects of nitrogen fertilizer, *biomix* and vermicompost farm on nutrient studies of barley in semi-arid climate of Haryana.

Material and Methods

Field experiment was conducted during *rabi* 2017-2018 at the Agronomy Research Farm of Chaudhary Charan Singh Haryana Agricultural University, Hisar which is situated at latitude of 29°10' North, longitude of 75°46' East and elevation of 215.2 m above mean sea level in the semi-arid, subtropical climate zone of India. The experiment was laid out in sandy loam (62.8% sand, 19.5% silt and 16.9% clay) soil which is slightly alkaline in reaction, low in organic carbon and nitrogen, medium in available phosphorus and potassium. The experiment was laid out in Randomized Block Design replicated thrice with ten different treatments *viz*. T_1(Control), T_2 (*Biomix*), T_3 (Vermicompost @ 5 t ha^{-1}), T_4 (*Biomix* + Vermicompost @ 5 t ha^{-1}), T_5 (50% RDN + *Vermicompost* @ 5 t ha^{-1}), T_6 (75% RDN + *Vermicompost* @ 5 t ha^{-1}), T_7 (50% RDN + *Biomix* + Vermicompost @ 5 t ha^{-1}), T_8 (75% RDN + *Biomix*+ Vermicompost @ 5 t ha^{-1}), T_9 (RDN) and T_{10} (RDN + *Biomix* + Vermicompost @ 5 t ha^{-1}). Prior to sowing, the seed pertaining to inoculated plots was treated with *Biomix* culture obtained from Department of Microbiology, CCS Haryana Agricultural University, Hisar, as per treatment. The seed was wetted with sugar solution and 50 ml of bio inoculants was used as per the recommendation. The treated seed was kept in shade for the completion of inoculation. Both treated and untreated seeds were sown as per the treatments. Sowing of barley was done manually with the help of hand plough by *pora* method on 1st December 2017 at about 5.0 cm depth by drilling in rows using 90 kg seed ha^{-1}and spacing of 22 cm between rows. Pre-sown irrigation of 5 cm depth was applied on 18th November 2017. One post sown irrigation was applied on 16th January 2018. Harvesting was done with the help of sickles manually by cutting the plants from the net area of each plot separately on 20th April 2018. Full dose of Phosphorous and Potassium and half of nitrogen as per treatment were applied as broadcast and mixing in soil through DAP, MOP and urea, respectively before sowing of barley at the time of field preparation. Remaining half of nitrogen was top dressed at first irrigation. Vermicompost @ 5 t ha^{-1} was applied as per treatment by incorporation in soil before sowing of barley crop. The other cultural practices were carried out as recommended for the crop. For the analysis of N, P and K, oven dried plant material and grain from each plot was grinded separately with grinder and analysis the Nitrogen (Nessler's reagent method, Lindner, 1944) [4], phosphorus (Vanadomolybdo-phosphoric acid yellow colour method, Jackson, 1973) [1] and potassium (Flame photometer method, Richards, 1954) [8] content in sample were analyzed. The uptake (N, P and K) of each nutrient was computed as:

$$\text{Nutrient uptake by grain (kg ha}^{-1}) = \frac{\text{Nutrient content in grain (\%)} \times \text{Grain yield (kg ha}^{-1})}{100}$$

$$\text{Nutrient uptake by straw (kg ha}^{-1}) = \frac{\text{Nutrient content in straw (\%)} \times \text{straw yield (kg ha}^{-1})}{100}$$

The composite soil samples from 0-15 cm depth were analyzed before sowing and after harvesting for determining the available nitrogen, phosphorus and potassium. The initial available nitrogen is 134 kg ha^{-1} (Subbiah and Asija, 1956) [10], available phosphorus 16.0 kg ha^{-1} (Olsen *et al*., 1954) and available potassium 374 kg ha^{-1} (Jackson, 1967) [2].

Results and Discussion

Nutrient studies

Nitrogen content and uptake by grain and straw

The data pertaining to nitrogen content (%) and uptake (kg ha^{-1}) in grains and straw of barley are presented in Table 1 indicate that increasing dose of fertilizer resulted in significant increase in N content and its uptake in grain and straw of barley.

N content in grain was recorded highest in treatment T_{10} (1.88%), being significantly higher than other treatments but statically at par with treatment $T_{7\text{ to}}$ $T_{9.}$ Treatment T_{10} being at par with T_4 to T_9 was significantly superior in N content in straw as compared to all other treatments. The difference in N content in straw in treatment T_1 (0.31%), T_2 (0.33%) and T_3 (0.34%) were not significant.

Treatment T_{10} (75.99, 32.63, 108.62 kg ha^{-1}) produced significantly higher N uptake in grain and straw and total N uptake of barley followed by treatment T_9 (71.22, 30.42, 101.64 kg ha^{-1}) and T_8 (66.81, 29.58, 96.39 kg ha^{-1}). However, the difference in N uptake by grain and total N uptake of barley in treatment $T_{8,}$ T_9 and T_{10} were not significant. The range of total N uptake in barley was between 50 (T_1) to 108.62 kg ha^{-1} (T_{10}). Similarly, the difference in N uptake by straw in treatment T_7 *to* T_{10} was not significant. It may also be due to the fact that nutrient uptake followed the yield pattern which increased due to seed inoculation with biomix and vermicompost application. Because of better root proliferation and growth in INM treatment higher total uptake of N, P and K was observed. Similar results for higher total N, P and K uptake by barley were reported by Malik (2017) [5].

Phosphorus content and uptake by grain and straw

The data pertaining to phosphorus content (%) and uptake (kg ha^{-1}) in grains and straw and total K uptake by barley are presented in Table 2. Phosphorus content in grain was highest in treatment T_{10} (0.44%), being significantly higher than T_1 to T_7 but statically at par with treatment T_8 and $T_{9.}$ Significantly lower value for P content in grain was recorded in treatment T_1 (0.34%). But the difference in N content in grain in treatment T_1 *to* T_7 was not significant.

Various combinations of nitrogen fertilizer, *biomix* and vermicompost significantly influence P content in straw of barley also. P content in straw was highest in treatment T_{10} (0.27%), being significantly higher than T_1 to T_5 but statically at par with treatment T_6 to $T_{9.}$

Significantly higher P uptake by grain and straw were recorded in treatment T_{10} (17.78 and 22.02 kg ha^{-1}), being statistically at par with treatment T_8 and $T_{9.}$ Similarly, significantly higher total P uptake was observed in treatment T_{10} (39.80 kg ha^{-1}). However, the difference in total P uptake of barley in treatment T_6 to T_{10} was not significant. Total P uptake was lowest in treatment T_1 (18.19 kg ha^{-1}) and it was followed by treatment T_2 (21.15 kg ha^{-1}). Sayed *et al.* (2000) [9] also reported that *Azospirillum* inoculation alone or in combination with *PSB* significantly increased N, P and K uptake. Increase in nutrient concentration with treatment T_{10}

seem to be affected by greater mobilization of nutrients from vegetative parts (leaf and stem) to ear head (grain).

Potassium content and uptake by grain and straw

The data pertaining K content and uptake by grain and straw of barley are presented in Table 3. A perusal data showed that treatment T_{10} (0.48%) being at par with T_4 to T_9 resulted in significantly higher K content in grain over rest of the treatments. There was no significant effect of various combinations of nitrogen fertilizer, *biomix* and vermicompost on straw K content of barley. Straw K content was highest in treatment T_8 and T_{10} (1.57%), but the difference was not significant with other treatments. Due to the combined application of chemical fertilizers, vermicompost and *biomix* inoculation more nutrients availability might have increased the cation exchange capacity of roots thereby increasing the nutrient absorption and nutrient contents in grain and straw (Kumar *et al*., 2002) [3].

Soil studies

Perusal of data in table 4 pertaining to NPK status of soil after harvesting revealed that various combinations of nitrogen fertilizer, *biomix* and vermicompost fail to influence N, P and K status of soil after harvesting of barley. The range of soil nitrogen status varies from 101.45 (T_1) to 136.05 (T_3). Similarly, the range of soil phosphorus status varies from 13.81 (T_1) to 15.33 (T_3) and soil potassium status from 285.13 (T_1) to 338.92 (T_{10}).

Table 1: Effect of integrated nutrient management practices on N content (%) and its uptake (kg ha^{-1}) by barley

Treatments	N content (%)		N uptake (Kg ha^{-1})		Total N uptake (Kg ha^{-1})
	Grain	Straw	Grain	Straw	
T_1: Control	1.43	0.31	34.53	15.47	50
T_2: *Biomix*	1.51	0.33	40.24	17.34	57.58
T_3: Vermicompost @ 5 t ha^{-1}	1.55	0.34	47.26	20.17	67.43
T_4: *Biomix* + Vermicompost @ 5 t ha^{-1}	1.58	0.36	51.54	22.55	74.09
T_5: 50% RDN + Vermicompost @ 5 t ha^{-1}	1.61	0.36	57.43	26.76	84.19
T_6: 75% RDN + Vermicompost @ 5 t ha^{-1}	1.65	0.35	62.06	27.39	89.45
T_7: 50% RDN + *Biomix* + Vermicompost @ 5 t ha^{-1}	1.69	0.37	63.75	29.36	93.11
T_8: 75% RDN + *Biomix*+ Vermicompost @ 5 t ha^{-1}	1.73	0.37	66.81	29.58	96.39
T_9: RDN (60 kg N ha^{-1})	1.79	0.38	71.22	30.42	101.64
T_{10}: RDN + *Biomix* + Vermicompost @ 5 t ha^{-1}	1.88	0.40	75.99	32.63	108.62
S.Em ±	0.07	0.02	3.59	1.15	3.74
CD at 5%	0.22	0.05	10.71	3.4	11.11

Table 2: Effect of integrated nutrient management practices on P content (%) and its uptake (kg ha^{-1}) by barley

Treatments	P content (%)		P uptake (kg ha^{-1})		Total P uptake (kg ha^{-1})
	Grain	Straw	Grain	Straw	
T_1: Control	0.34	0.20	8.21	9.98	18.19
T_2: *Biomix*	0.36	0.22	9.59	11.56	21.15
T_3: Vermicompost @ 5 t N ha^{-1}	0.36	0.23	10.98	13.65	24.63
T_4: *Biomix* + Vermicompost @ 5 t ha^{-1}	0.35	0.24	11.42	15.03	26.45
T_5: 50% RDN + Vermicompost @ 5 t ha^{-1}	0.37	0.22	13.2	16.35	29.55
T_6: 75% RDN + Vermicompost @ 5 t ha^{-1}	0.36	0.23	13.54	18	31.54
T_7: 50% RDN + *Biomix* + Vermicompost @ 5 t ha^{-1}	0.38	0.24	14.33	19.04	33.37
T_8: 75% RDN + *Biomix*+ Vermicompost @ 5 t ha^{-1}	0.4	0.26	15.45	20.79	36.24
T_9: RDN (60 kg N ha^{-1})	0.42	0.25	16.71	20.01	36.72
T_{10}: RDN + *Biomix* + Vermicompost @ 5 t ha^{-1}	0.44	0.27	17.78	22.02	39.8
S.Em ±	0.02	0.02	0.93	0.76	2.31
CD at 5%	0.05	0..05	2.77	2.26	7.03

Table 3: Effect of integrated nutrient management practices on K content (%) and its uptake (kg ha^{-1}) by barley

Treatments	K content (%)		K uptake (kg ha^{-1})		Total K uptake (kg ha^{-1})
	Grain	Straw	Grain	Straw	
T_1: Control	0.36	1.53	8.69	76.36	85.05
T_2: *Biomix*	0.39	1.54	10.39	80.93	91.32
T_3: Vermicompost @ 5 t ha^{-1}	0.41	1.55	12.5	91.96	104.46
T_4: *Biomix* + Vermicompost @ 5 t ha^{-1}	0.43	1.54	14.03	96.45	110.48
T_5: 50% RDN + Vermicompost @ 5 t ha^{-1}	0.44	1.55	15.69	115.23	130.92
T_6: 75% RDN + Vermicompost @ 5 t ha^{-1}	0.45	1.54	16.92	120.54	137.46
T_7: 50% RDN + *Biomix* + Vermicompost @ 5 t ha^{-1}	0.43	1.56	16.22	123.79	140.01
T_8: 75% RDN + *Biomix*+ Vermicompost @ 5 t ha^{-1}	0.45	1.57	17.38	125.52	142.9
T_9: RDN (60 kg N ha^{-1})	0.47	1.56	18.7	124.88	143.58
T_{10}: RDN + *Biomix* + Vermicompost @ 5 t ha^{-1}	0.48	1.57	19.4	128.06	147.46
S.Em ±	0.02	0.07	0.68	4.88	5.56
CD at 5%	0.06	NS	2.03	14.5	16.55

Table 4: Effect of integrated nutrient management practices on soil NPK status

Treatments	N (kg ha^{-1})	P_2O_5 (kg ha^{-1})	K_2O (kg ha^{-1})
T_1: Control	101.45	13.81	285.13
T_2: *Biomix*	123.69	13.95	288.31
T_3: Vermicompost @ 5 t ha^{-1}	136.05	15.33	320.04
T_4: *Biomix* + Vermicompost @ 5 t ha^{-1}	131.72	14.87	319.18
T_5: 50% RDN + Vermicompost @ 5 t ha^{-1}	127.34	13.98	288.31
T_6: 75% RDN + Vermicompost @ 5 t ha^{-1}	128.17	15.18	299.45
T_7: 50% RDN + *Biomix* + Vermicompost @ 5 t ha^{-1}	130.94	12.58	318.31
T_8: 75% RDN + *Biomix*+ Vermicompost @ 5 t ha^{-1}	125.12	14.33	297.18
T_9: RDN (60 kg N ha^{-1})	129.89	14.08	288.31
T_{10}: RDN + *Biomix* + Vermicompost @ 5 t ha^{-1}	130.02	14.11	338.92
S.Em ±	5.67	0.63	14.74

Conclusion

Among nutrient management practices treatments T_{10} recorded significantly higher protein content, N, P and K content in grain and straw (except K content in straw) of barley. Performance in terms of nutrient studies of barley in treatment T_8 (75% RDN + *Biomix*+ Vermicompost @ 5t ha^{-1}) was at par with treatment T_9 (RDN) and T_{10} (RDN + *Biomix* + Vermicompost @ 5t ha^{-1}). But various combinations of nitrogen fertilizer, *biomix* and vermicompost failed to produce any significant variation in K content (%) in straw and available N, P and K status of soil after the harvest of barley.

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