

**Influence of Chemical Fertilizer and Organic Manure on Enhancing the Production of Barley (*Hordeum vulgare* L.) Crop in Himachal Pradesh, India**

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## ABSTRACT

A field experiment was conducted at the Research Farm, School of Agriculture, Abhilashi University, Chail Chowk Mandi during the Rabi season of 2022-23 to look into the "Influence of chemical fertilizer and organic manure on enhancing the production of barley (*Hordeum vulgare* L.) crop in Himachal Pradesh". During the investigation seven treatment combinations were employed in randomized block design with three replications. Treatment comprises of T<sub>1</sub> (Absolute control) T<sub>2</sub> (RDF 100%+FYM 5 t ha<sup>-1</sup>), T<sub>3</sub> (75% RDF+FYM 5 t ha<sup>-1</sup>), T<sub>4</sub> (125% RDF+FYM 5 t ha<sup>-1</sup>), T<sub>5</sub> (150% RDF+Zinc @ 1 kg ha<sup>-1</sup>), T<sub>6</sub> (50% RDF+50% FYM) & T<sub>7</sub> (50% RDF+25% FYM+25% VC). The finding of the experiments showed that different integrated nutrient treatments had significantly improved the production and productivity of barley crop. The highest plant height (65.75), (82.44) and (86.65) was observed in treatment T<sub>5</sub> (150% RDF+Zinc @ 1 kg ha<sup>-1</sup>). No. of tillers (450.34), (437.64) and (425.48) and dry matter accumulation (450.11), (600.33) and (795.66). The yield attributes i.e., No. of effective tillers (419.33), Spike length (8.27), No. of spikes (417.84), Grains per spike (45.57) and grain yield (44.23), straw yield (67.39) and biological yield (111.62) were also significantly influenced by the treatment T<sub>5</sub> which was at par with T<sub>4</sub> and T<sub>2</sub>. During investigation minimum value of all the growth and yield parameters and yield was observed under treatment T<sub>1</sub> i.e. absolute control. From the observation it was found that combination of organic and inorganic fertilizers significantly improve production and productivity of barley.

**Keywords:** Barley; Himachal Pradesh; FYM; organic manure; grain yield.

## 1. INTRODUCTION

Barley (*Hordeum vulgare* L.) has contributed significantly to the global advancement of agriculture [1]. It is grown over nearly the whole planet because it is the most dependable crop in regions with alkaline soils, frost, or drought. In terms of area and production, it ranks fourth among the cereals, behind rice, wheat, and maize. A additionally useful for its covering and cooling properties that facilitates smooth digestion is barley grain. In addition to these traditional applications, it is a significant industrial crop that supplies raw material to the brewing, whiskey, and beer industries. Barley contains 10.6 mg iron, 31.0 mg vitamin B1, 0.1 mg vitamin B2, and 50.0 µg folate are contained in every 100 g of barley grain [2]. Fast-growing, cool-season barley is an annual grain crop that can be used as a cover crop to increase soil fertility and as fodder. Light-textured soils with low organic matter contents cannot meet their nutritional needs if fertilizers are applied without incorporating any organic fertilizer. Organic matter preserves the soil's beneficial physio-chemical and biological qualities in addition to providing necessary nutrients [3-8].

One way to give the plants nutrition is through integrated nutrient management in barley. Chaudhary et al. [9] suggest that integrated nutrient management holds considerable potential for sustaining increased productivity and enhancing crop production stability. The management and integration of chemical and organic sources have demonstrated encouraging outcomes in terms of maintaining soil health and improving nutrient usage efficiency, in addition to yielding results in

terms of productivity [10]. The replenishment of chemicals lost from the soil by the crop, the preservation of the humus level in the dirty physical texture of the soil, the prevention of weeds, pests, and diseases, and the management of soil acidity and toxicity are all addressed by integrated nutrient management (INM) strategies. According to research by [11], using chemical fertilizers excessively and unbalanced over time reduces crop production, biological activity, soil physical qualities, and increases nitrate and heavy metal accumulation as well as soil acidity. According to [12], plots treated with inorganic fertilizers had lower soil pH levels than plots treated with organic manures [13-17].

A form of fertilizer made from natural sources including plant matter, animal dung, and other organic elements is called organic manure, sometimes referred to as natural manure. In order to support healthy plant growth and production, it is used to increase the fertility, structure, and nutritional content of the soil. Organic carbon from FYM helps to stimulate the biotic life of the soil's flora and fauna. One of the more important organic fertilizers for preserving soil fertility in alternative agricultural systems is FYM [18]. Concentrated sources of vital nutrients that are easily absorbed by plants are found in fertilizers [19]. [20] observed that plant height barely increased with increasing N fertilizer rates. The greater measure of barley's reaction to nitrogen, according to [21], is the number of grains per spike, which increases in response to nitrogen. Zinc is a crucial component of the enzymes that support plant growth and development and regulates the quantity of auxin in plants. About 30% of the world's farmed soils, according to FAO, have low zinc contents, which hinders growth and productivity. Growing cereals on zinc-

deficient soil reduce the zinc content of the grain and slows down growth and productivity, according to [22]. Nowadays, zinc shortage affects millions of hectares of crop plants, and almost one-third of the human population lacks enough zinc [23, 24]. This shows that crops require the addition of micronutrients, particularly zinc, in addition to main nutrients. To study the effect of chemical fertilizer and organic sources on growth parameters and yield of barley crop [25-27].

## 2. MATERIALS AND METHODS

### 2.1 Study Area

At the Abhilashi Farm, School of Agriculture, Abhilashi University Mandi, Himachal Pradesh, India, which is located at an altitude of 1500 meters and at longitudes 77°E and 31°N, the current study was conducted in the *rab* season of 2022–2023. The soil of the experimental field was moderately acidic (pH 4.83) in reaction, very high in organic carbon (1.80%), EC (0.24 dsm<sup>-1</sup>) normal in reaction, low in available nitrogen (245 kg ha<sup>-1</sup>) and medium in available phosphorus (24 kg ha<sup>-1</sup>), potassium (134 kg ha<sup>-1</sup>) and Zn (1.70 mg kg<sup>-1</sup>) sufficient.

### 2.2 Experiment Details

During the experimentation, randomized block design was used. The experiment comprises of three replications and seven treatments:- T<sub>1</sub> (control), T<sub>2</sub> (100% RDF + FYM 5 t ha<sup>-1</sup>), T<sub>3</sub> (75% RDF + FYM 5 t ha<sup>-1</sup>), T<sub>4</sub> (125% RDF + FYM 5 t ha<sup>-1</sup>), T<sub>5</sub> (150% RDF + Zinc @ 1 kg ha<sup>-1</sup>), T<sub>6</sub> (50% RDF + 50% FYM) and T<sub>7</sub> (50% RDF + 25% FYM + 25% VC). For barley, recommended nutritional dose was 40:20:20 kg ha<sup>-1</sup>. In the field, nutrients were administered in accordance with the treatments throughout the study. Using urea, administer half the nitrogen dose, and using DAP and MOP to administer the full doses of potassium and phosphorus were applied at the time of sowing. There maining half of the nitrogen was applied as a top dressing after first irrigation. Zinc was administered topically during the stages of tillering (45 DAS). Based on the treatments, FYM and Vermicompost were applied individually.

### 2.3 Data Collection

Plants were selected randomly and marked from each plot, for the recording of growth and yield parameters and yield data. For data collection of plant height five randomly selected plants were tagged and height was measured from bottom of plant to the top leaf. In case of nu-

number of tiller area of 1 m<sup>2</sup> was marked inside the net plot, plants were counted and data were collected. The plants samples for dry matter accumulation were taken at 30, 60, 90 DAS and harvested after sowing from 0.25 m row length selected randomly from each plot. These samples were sun-dried and then dried in oven at 72°C ± 0.5°C for 72 hours until the constant weight was achieved. The dry matter was expressed in gram per meter row length. Number of effective tillers were recorded by using a quadrat of one square meter in each plot as per procedure followed for counting number of tillers at each successive stage. Total no. of spikes was counted by using a quadrat of one square meter in each plot at the time of harvest. Five spikes were selected randomly and their length measured. Figures of all the five spikes were added and sum was divided by 5 to get average spike length. It was recorded in cm. Ten spikes were selected randomly from each plot and numbers of filled grain per ten spikes was counted and average number of grains per spike was worked out. Using dial spring balance green for age yield for each treatment, the harvest of each net plot at the 30th day of assaying was precisely weighed in fractions of kilograms stated in qha<sup>-1</sup>.

In a similar manner, the net plot area is used to gather grain and straw yields. The crop was harvested at 3 May 2024, they were threshed, sun-dried, kept at 12% moisture content, and their weight was measured right away.

### 2.4 Observation Recorded

The growth parameters of a barley crop, such as plant height (cm), number of tillers (m<sup>-2</sup>), dry matter accumulation (gm<sup>-2</sup>) and yield attributes (no. of effective tillers (m<sup>-2</sup>), spike length (cm), number of spikes (m<sup>-2</sup>), grains spike<sup>-1</sup>, test weight (g), biological yield (qha<sup>-1</sup>) and harvest index (%) were recorded during the experimentation.

### 2.5 Statistical Analysis

The data recorded from the field was statistically analyzed through the analysis of variance method and treatment means were compared following critical differences (CD) suggested by [28] for significance at 5%.

## 3. RESULTS AND DISCUSSION

### 3.1 Growth Parameters

Growth parameters were significantly affected by the various nutrient treatments throughout the crop growth period. However, during the early phase of crop growth i.e., 30 DAS, the treatments were unable to perform significant impact on growth parameters. The lowest value of growth parameters were recorded with nonitr

ogen, phosphorus and potassium application in the plots.

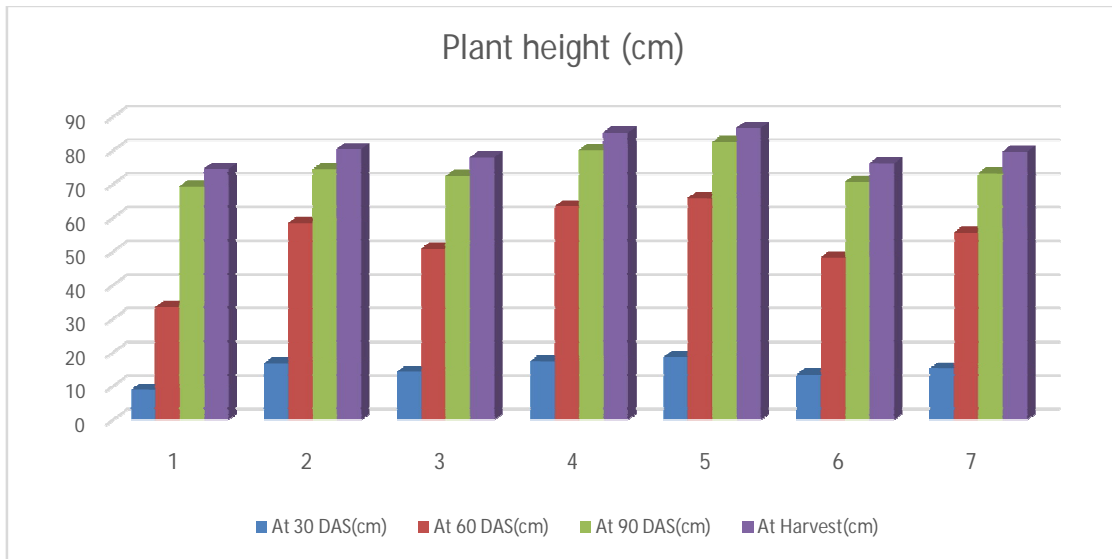
### 3.1.1 Plant height (cm)

During the investigation, it was recorded that at 30 DAS, the plant height was found to be non-significantly affected by the various nutrient treatments. At 60, 90 DAS and at harvest, the maximum plant height was recorded under treatment T<sub>5</sub> [150% RDF + Zinc @ 1 kg ha<sup>-1</sup> (86.65)], which was statistically at par with treatment

T<sub>4</sub> [125% RDF + FYM 5 t ha<sup>-1</sup> (85.22)] and T<sub>2</sub> [100% RDF + FYM 5 t ha<sup>-1</sup> (80.37)]. The minimum plant height was recorded under T<sub>1</sub> [Absolute control (74.45)]. This may be attributed to gradual mineralization and availability of nutrients along with increased moisture holding capacity of soil by FYM. Getachew [29] also reported that the use of organic manure in combination with mineral fertilizers maximized the plant height than the application of inorganic fertilizers alone. Similar results were reported by [3, 30-33] and [34].

**Table 1. Influence of chemical fertilizer and organic manure on plant height (cm) of barley crop**

Sr.No.	Treatments	At 30 DAS	At 60 DAS	At 90 DAS	At Harvest
T <sub>1</sub>	Absolute Control	8.88	33.45	69.27	74.45
T <sub>2</sub>	100% RDF + FYM	16.76	58.45	74.33	80.37
T <sub>3</sub>	75% RDF + FYM 5 tones/ha	14.27	50.82	72.43	77.88
T <sub>4</sub>	125% RDF + FYM 5 tones/ha	17.32	63.34	80.06	85.22
T <sub>5</sub>	150% RDF + Zinc @ 1 kg/ha	18.55	65.75	82.44	86.65
T <sub>6</sub>	50% RDF + 50% FYM	13.45	48.16	70.63	76.11
T <sub>7</sub>	50% RDF + 25% FYM + 25VC	15.22	55.53	73.21	79.58
SEm±		<b>2.15</b>	<b>0.911</b>	<b>2.30</b>	<b>1.10</b>
CD at 5%		<b>NS</b>	<b>2.83</b>	<b>7.17</b>	<b>3.44</b>



**Fig. 1. Influence of chemical fertilizer and organic manure on plant height of barley crop**

### 3.1.2 No. of tillers (m<sup>-2</sup>)

Table 2 and Fig. 2 shows data related to the number of tillers recorded at 30, 60, 90 DAS, as well as during harvest. The results showed that integrated nutrition approaches had a substantial effect on the number of tillers at all stages of crop growth except at 30 DAS. During the crop growth period, highest number of tillers m<sup>-2</sup> was recorded under treatment T<sub>5</sub> [150% RDF with zinc @ 1 kg ha<sup>-1</sup> (450.34), (437.64) and (425.48)] at the 60, 90, and at harvest phases which were at par with treatment T<sub>4</sub> [12

5% RDF + FYM 5 t ha<sup>-1</sup> (438.63), (426.45) and (412.13)] and T<sub>2</sub> [100% RDF + FYM 5 t ha<sup>-1</sup> (343.76), (328.32) and (316.34)]. On the other hand, T<sub>1</sub> (control) at 60, 90 DAS and at harvest, showed the lowest value (165.33), (155.22) & (148.31). More tillers per square meter than in the other treatments mostly resulted from the availability of more nutrients. This may be the result of increased nitrogen application, which improved photosynthetic processes and photosynthetic translocation by plants. Enhancing barley development significantly involves tillering, a feature that

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### 3.1.3 Dry matter accumulation (gm<sup>-2</sup>)

The data on dry matter accumulation at the 30, 60, 90, and harvest stages of the crop are reported in Table 3 and visually shown in Fig. 3. Different nitrogen management strategies did not significantly affect plant dry matter accumulation at 30 days post sowing. The highest dry matter accumulation (106.37), (450.11), (600.33), (795.66) was seen at treatment T<sub>5</sub> (150% RDF + Zinc @ 1 kg ha<sup>-1</sup>) which were at par with treatment T<sub>4</sub> [125% RDF + FYM 5 t ha<sup>-1</sup>] (104.66), (438.00), (578.45), (769.48)] and T<sub>2</sub> [100% RDF + FYM 5 t ha<sup>-1</sup>] (98.26), (396.38), (537.23), (689.23)].The control plot showed the lowest plant dry matter accumulation (50.21), (280.37), (419.56), (470.56). Applying nitrogen promoted plant tillering and height, which in turn boosted the production of dry matter [38,39]. The beneficial effect of FYM is due to its contribution

in supplying additional plant nutrients improvement of soil physical conditions and biological processes in soil. Metabolic root activities increased resulting absorption of moisture and other nutrients resulting in to higher dry matter production. Similar results were observed by [30,31,32,33] and [40].

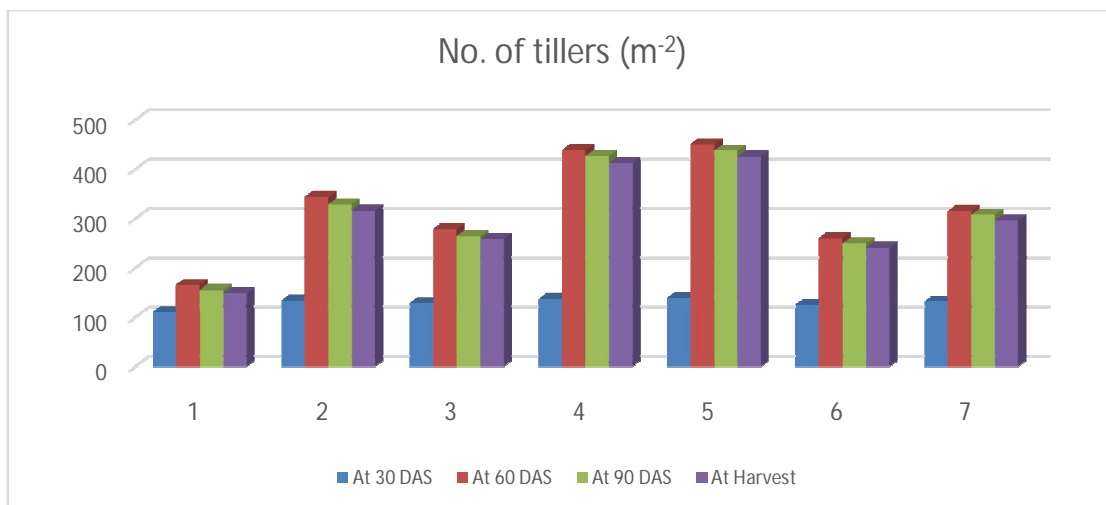
## 3.2 Yield Studies

### 3.2.1 No. of effective tillers (m<sup>-2</sup>)

The data related to number of effective tillers (m<sup>-2</sup>) revealed that it was significantly influenced by different integrated nutrient management treatments and have been reported in Table 4 and shown in Fig. 4. The effective number of tillers m<sup>-2</sup> at harvest of barley rise considerably when different integrated nutrition treatments were used. Significantly highest effective number of tillers m<sup>-2</sup> at harvest of barley was recorded with the application of 150% RDF + Zinc @ 1 kg ha<sup>-1</sup> (419.33) (T<sub>5</sub>) which was closely followed by treatments T<sub>4</sub> [125% RDF + FYM 5 t ha<sup>-1</sup>] (410.43)] and T<sub>2</sub> [(100% RDF + FYM 5 tha<sup>-1</sup>.(312.66)] but found superior to T<sub>1</sub> (145.90), T<sub>3</sub> (256.12), T<sub>6</sub> (191.16) and T<sub>7</sub> (290.88). Meanwhile lowest number of effective tillers were recorded under treatment T<sub>1</sub> [Absolute control (145.90)].

**Table2.Effectofchemicalfertilizerandorganicmanureonnumberoftillers(m<sup>-2</sup>)ofbarleycrop**

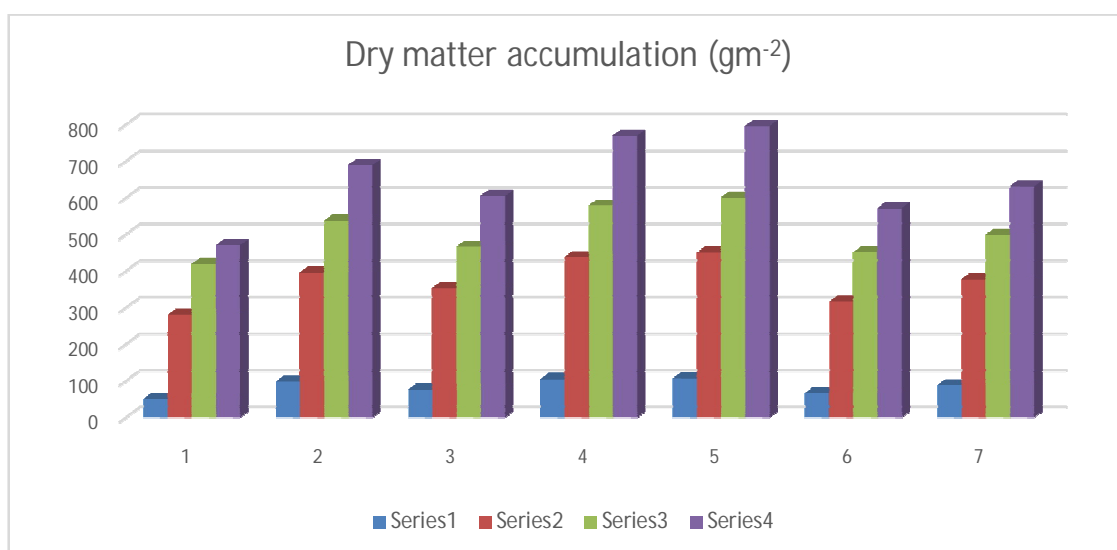
Sr.No.	Treatments	At30DAS	At60DAS	At90DAS	AtHarvest
T <sub>1</sub>	AbsoluteControl	110.18	165.33	155.22	148.31
T <sub>2</sub>	100%RDF+FYM	133.27	343.76	328.32	316.34
T <sub>3</sub>	75%RDF+FYM5tha <sup>-1</sup>	128.56	278.68	264.11	258.16
T <sub>4</sub>	125%RDF+FYM5tha <sup>-1</sup>	136.39	438.63	426.45	412.13
T <sub>5</sub>	150%RDF+Zinc@1kgha <sup>-1</sup>	138.72	450.34	437.64	425.48
T <sub>6</sub>	50%RDF+50%FYM	124.91	260.11	249.33	240.77
T <sub>7</sub>	50%RDF+25%FYM+25VC	131.44	315.84	307.67	295.76
SEm±		<b>6.93</b>	<b>4.26</b>	<b>3.80</b>	<b>4.46</b>
		<b>NS</b>	<b>13.29</b>	<b>11.86</b>	<b>13.89</b>



**Fig.2. Influence of chemical fertilizer and organic manure on no. of tillers (m<sup>-2</sup>) in barley crop**

**Table 3. Influence of chemical fertilizer and organic manure on dry matter accumulation (gm<sup>-2</sup>) in barley crop**

Sr.No.	Treatments	At 30 DAS	At 60 DAS	At 90 DAS	At Harvest
T <sub>1</sub>	Absolute Control	50.21	280.37	419.56	470.56
T <sub>2</sub>	100% RDF + FYM	98.26	396.38	537.23	689.23
T <sub>3</sub>	75% RDF + FYM 5 tones/ha	75.92	353.62	466.38	605.11
T <sub>4</sub>	125% RDF + FYM 5 tones/ha	104.66	438.00	578.45	769.48
T <sub>5</sub>	150% RDF + Zinc @ 1 kg/ha	106.37	450.11	600.33	795.66
T <sub>6</sub>	50% RDF + 50% FYM	66.87	316.84	450.90	570.85
T <sub>7</sub>	50% RDF + 25% FYM + 25 VC	87.94	377.32	498.45	630.57
SEm <sub>±</sub>		<b>12.16</b>	<b>5.91</b>	<b>7.59</b>	<b>9.02</b>
CD		<b>NS</b>	<b>18.43</b>	<b>23.64</b>	<b>28.11</b>



**Fig. 3. Influence of chemical fertilizer and organic manure on dry matter accumulation (gm<sup>-2</sup>) in barley crop**

### 3.2.2 No. of spike (m<sup>-2</sup>)

The findings for the number of spikes m<sup>-2</sup> was recorded and given in Table 4, as shown in Fig.

4. The results indicated that the integrated nutrient techniques had a considerable effect on the number of spikes  $m^{-2}$ .

<sup>2</sup>. The largest number of spikes per square meter was recorded with treatment T<sub>5</sub> which is 150% RDF + Zinc @ 1 kg ha<sup>-1</sup>

<sup>1</sup> (417.84) which were at par with treatment T<sub>4</sub> [125% RDF + FYM 5 t ha<sup>-1</sup>

<sup>1</sup> (411.89)] and T<sub>2</sub> [100% RDF + FYM 5 t ha<sup>-1</sup>

<sup>1</sup> (310.23)]. The lowest number of spikes was recorded under treatment T<sub>1</sub> control (142.76). These findings are in conformity with the results of [41], Nataraja et al. [42] and Panda and Rai [43].

### 3.2.3 Length of spikes (cm)

The data on spike length were recorded and reported in Table 4 as shown in Fig. 4. The results indicated that the integrated nutrient techniques had a significant effect on spike length. The maximum spike length (8.27) was seen in treatment T<sub>5</sub>, which is 150% RDF + Zinc @ 1 kg ha<sup>-1</sup>

<sup>1</sup> which were at par with treatment T<sub>4</sub> [125% RDF + FYM 5 t ha<sup>-1</sup>

<sup>1</sup> (7.94)] and treatment T<sub>2</sub> [100% RDF + FYM 5 t ha<sup>-1</sup>

<sup>1</sup> (7.35)]. This might be due to that organic source enabled the plant to absorb largest amount of NPK through their well developed roots system. Secondly, the chemical fertilizer not only increases the photosynthesis production but also translocation of source to sink which resulted in increased spike length and it has a positive relationship with grain and straw yield. The similar findings have been also reported by [44] and [45]. Meanwhile the lowest length of spikes were recorded under treatment T<sub>1</sub> (5.21) in control.

### 3.2.4 No. of grains/spikes

The results with respect to number of grain spikes  $m^{-2}$  have been recorded and present in Table 4 and illustrated in Fig. 4 as per result indicated that the integrated nutrient method was significantly affected on number of grain spikes  $m^{-2}$ .

The highest number of grain spikes  $m^{-2}$  recorded under treatment (T<sub>5</sub>) [150% RDF + Zinc @ 1 kg ha<sup>-1</sup>

<sup>1</sup> (45.57)] which were at par with treatment T<sub>4</sub> [125% RDF + FYM 5 t ha<sup>-1</sup>

<sup>1</sup> (43.90)] and treatment T<sub>2</sub> [100% RDF + FYM 5 t ha<sup>-1</sup>

<sup>1</sup> (41.36)] over other treatments. The lowest number of grain spikes  $m^{-2}$  recorded under control (34.88) plots.

### 3.2.5 Test weight (g)

The data on test weight (g) were recorded and reported in Table 4 and shown in Fig. 4. During the research, it was found that various nutrient treatments had no significant effect on test weight. Although, maximum test weight was recorded under treatment T<sub>5</sub> [150% RDF + Zinc @ 1 kg ha<sup>-1</sup>

<sup>1</sup> (43.23)] and the lowest test weight was recorded under

treatment T<sub>1</sub> control (36.17). In comparison to the control, the fertilizer employed in the experiment enhanced the 1000-

grain weight [46]. The use of microbial and organic fertilizers increased the concentration of plant nutrients, promoting better plant development and a greater 1000-

grain weight for the barley cultivar. Results confirm the finding [47] and Kumara et al. [48].

Similar findings were also reported by [49] that the significant increase were recorded in the number of productive tillers  $m^{-2}$ , number of grain spikes  $m^{-2}$  and grain weight, above ground dry biomass and grain yield of barley with the combined application of organic and inorganic fertilizer than the application of inorganic NPK alone. The similar findings have been also reported by [44] and [19].

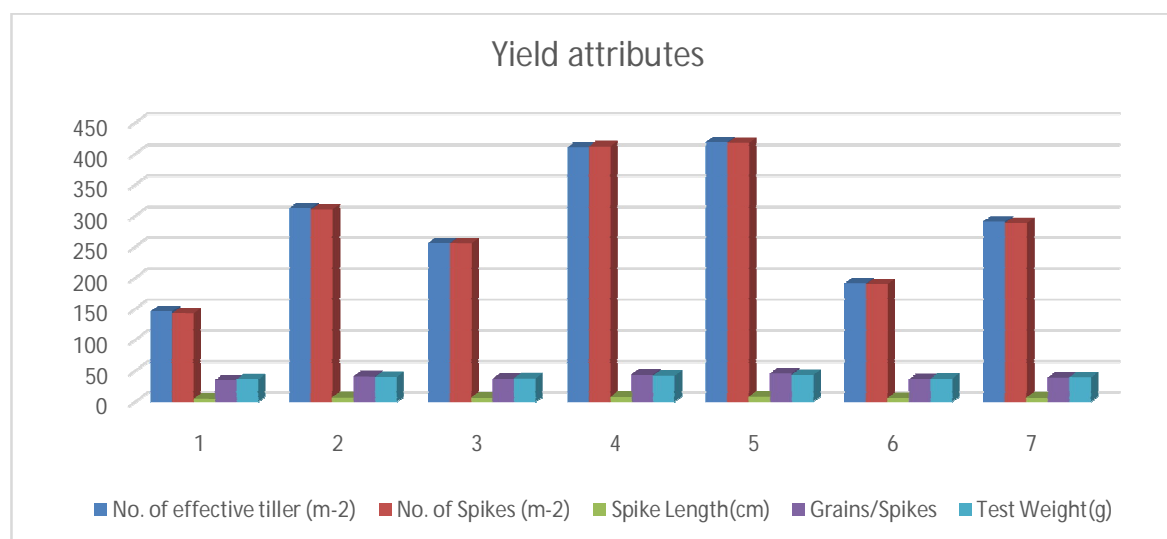
## 3.3 Yields of Crop

### 3.3.1 Grain yield (q ha<sup>-1</sup>)

The data reported to grain yield (q ha<sup>-1</sup>) as influenced by different treatments have been presented in Table 5 and depicted in Fig. 5. Among integrated nutrient management practices, T<sub>5</sub> [150% RDF + Zinc @ 1 kg ha<sup>-1</sup> (44.23)] recorded maximum height and it was at par with treatment T<sub>4</sub> [125% RDF + FYM 5 t ha<sup>-1</sup> (43.36)] and treatment T<sub>2</sub> [100% RDF + FYM 5 t ha<sup>-1</sup> (38.28)]. The lowest grain yield was recorded under control (20.16). The improvement in yield/plant may be attributed to increase in grain size and number of grains per plant. Organic matter in the fertilizers is an important source of plant nutrients. In addition, organic matter has been reported to have several other beneficial effects on soil physical, chemical and biological properties of soils. Therefore, application of organic substances consequently improved the grain yield and quality of grains. Similar results on the effects of organic fertilizers have been reported by other researchers [41], Panda and Rai [43], Ibrahim et al. [50] and Tas [51]. The highest grain yield (103%) was obtained with 120 kg N compared to the control, the grain yield increased by 23.4% and 44% with FYM and residue, respectively, against the untreated control [52].

**Table4. Influence of chemical fertilizer and organic manure on yield attributes of barley crop**

Sr.No.	Treatments	No. of effective tiller (m <sup>-2</sup> )	No. of Spikes (m <sup>-2</sup> )	Spike Length (cm)	No. of grains spike <sup>-1</sup>	Test Weight (g)
T <sub>1</sub>	Absolute Control	145.90	142.76	5.21	34.88	36.17
T <sub>2</sub>	100% RDF + FYM	312.66	310.23	7.35	41.36	40.43
T <sub>3</sub>	75% RDF + FYM 5 t ha <sup>-1</sup>	256.12	255.31	6.78	37.27	38.26
T <sub>4</sub>	125% RDF + FYM 5 t ha <sup>-1</sup>	410.43	411.89	7.94	43.90	42.20
T <sub>5</sub>	150% RDF + Zinc @ 1 kg ha <sup>-1</sup>	419.33	417.84	8.27	45.57	43.23
T <sub>6</sub>	50% RDF + 50% FYM	191.16	190.27	6.41	36.49	37.69
T <sub>7</sub>	50% RDF + 25% FYM + 25% VC	290.88	288.42	7.12	39.32	39.87
<b>SEm±</b>		<b>3.00</b>	<b>3.07</b>	<b>0.12</b>	<b>1.073</b>	<b>1.55</b>
<b>CD</b>		<b>9.37</b>	<b>9.58</b>	<b>0.39</b>	<b>3.34</b>	<b>NS</b>



**Fig.4. Influence of chemical fertilizer and organic manure on yield attributes of barley crop**

### 3.3.2 Straw yield (q ha<sup>-1</sup>)

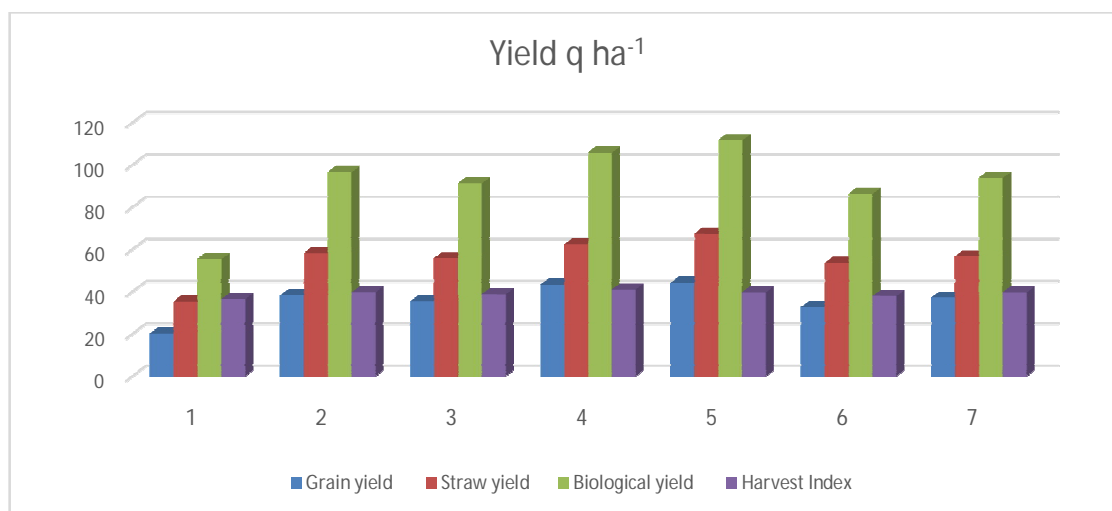
The data reported to straw yield (q ha<sup>-1</sup>) as influenced by different treatment have been presented in Table 5 and depicted in Fig. 5. The highest straw yield was recorded under treatment (T<sub>5</sub>) 150% RDF + Zinc @ 1 kg ha<sup>-1</sup> (67.39) which were at par with treatment T<sub>4</sub> [125% RDF + FYM 5 t ha<sup>-1</sup> (62.45)] and treatment T<sub>2</sub> [100% RDF + FYM 5 t ha<sup>-1</sup> (58.17)]. The lowest was recorded under treatment T<sub>1</sub> [control (35.24)]. The maximum straw yield of wheat might be due to sufficient nutrient availability in soil enhanced the yield attributes of wheat which ultimately increased straw yield. The combined application of vermicompost @ 4.5 t ha<sup>-1</sup> + 40 kg N ha<sup>-1</sup> gave higher grain yield and straw yield over rest of other combinations of organic manure and nitrogen [32]. The similar finding have been also reported by [53], Pandey et al. [54] and [55].

### 3.3.3 Biological yield (q ha<sup>-1</sup>)

The data pertaining to biological yield q ha<sup>-1</sup> as influenced by integrated nutrient management practices are presented in Table 5 and depicted in Fig. 5. Among integrated nutrient management practices, the highest biological yield was recorded under treatment T<sub>5</sub> [150% RDF + Zinc @ 1 kg ha<sup>-1</sup> (111.62)] and it was at par treatment T<sub>4</sub> [125% RDF + FYM 5 t ha<sup>-1</sup> (105.81)] and T<sub>2</sub> [100% RDF + FYM 5 t ha<sup>-1</sup> (96.45)]. The lowest biological yield was recorded under treatment T<sub>1</sub> control (55.40). This might be due to maximum number of tillers, plant height, leaf area index and crop dry matter accumulation at different crop growth stages recorded more grain and straw yield under these treatments. The similar finding have been also reported by [56].

**Table 5. Influence of chemical fertilizer and organic manure on yield of barley crop**

Sr.no.	Treatments	Grain yield (qha <sup>-1</sup> )	Straw yield (qha <sup>-1</sup> )	Biological yield (qha <sup>-1</sup> )	Harvest Index (%)
T <sub>1</sub>	Absolute Control	20.16	35.24	55.40	36.38
T <sub>2</sub>	100% RDF + FYM	38.28	58.17	96.45	39.69
T <sub>3</sub>	75% RDF + FYM 5 t ha <sup>-1</sup>	35.37	55.83	91.20	38.78
T <sub>4</sub>	125% RDF + FYM 5 t ha <sup>-1</sup>	43.36	62.45	105.81	40.97
T <sub>5</sub>	150% RDF + Zinc @ 1 kg ha <sup>-1</sup>	44.23	67.39	111.62	39.62
T <sub>6</sub>	50% RDF + 50% FYM	32.63	53.56	86.19	37.85
T <sub>7</sub>	50% RDF + 25% FYM + 25VC	37.11	56.64	93.75	39.58
SEm±		<b>0.657</b>	<b>2.01</b>	<b>2.142</b>	<b>1.526</b>
CDat5%		<b>2.048</b>	<b>6.263</b>	<b>6.672</b>	<b>NS</b>



**Fig. 5. Influence of chemical fertilizer and organic manure on barley crop**

### 3.3.4 Harvest Index (%)

Data regarding harvest index is presented in Table 5 and illustrated in Fig. 5. The data showed that the maximum harvest index was

achieved with treatment T<sub>4</sub> [125% RDF + FYM 5 t ha<sup>-1</sup>(40.97)] and the minimum harvest index was recorded under treatment T<sub>1</sub> (control). The harvest index for all treatments ranged from 36-40%. The increase in grain and biological yield might be due to adequate quantities and balanced proportions of plant nutrients supplied by FYM to the crop as per need during the growth period resulting in favourable increase in yield attributing characters which ultimately led towards an increase in economic yield. The similar finding have been also reported by [57].

#### 4. CONCLUSION

The results obtained from the present investigation indicated that integrated treatments involving combined application of inorganic fertilizer and organic manure had pronounced influence in improving the crop yield status as compared to control and inorganic alone. The maximum plant height, total number of tillers, dry matter accumulation, effective number of tillers, no. of spikes, spike length, grain spike weight, test weight, grain yield, straw yield, biological yield and harvest index was obtained with the application of application of 150% RDF + Zinc 1 kg ha<sup>-1</sup> (T<sub>5</sub>). Although, the better production of barley crop could be achieved by adopting integrated nutrient management treatment combination as 125% RDF + FYM 5 t ha<sup>-1</sup> and 100% RDF + FYM 5 t ha<sup>-1</sup>.

#### DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

#### COMPETING INTERESTS

Author has declared that no competing interest exist.

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