Influence of chemical fertilizer and organic manure on enhancing the production of barley (*Hordeum vulgare* L.) crop in Himachal Pradesh".

Abstract

A field experiment was conducted at the Research Farm, School of Agriculture, Abhilashi University, Chail ChowkMandi 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 combination were employed in randomized block design with three replications. Treatment comprises of T_1 (Absolute control)T_2 (RDF 100% + FYM 5 t ha^{-1}), T_3(75% RDF + FYM 5 t ha^{-1}), T_4 (125% RDF + FYM 5 t ha^{-1}), T_5 (150% RDF + Zinc @ 1 kg ha^{-1}), T_6(50% RDF + 50% FYM)&T_7(50% RDF + 25% FYM + 25% VC). The finding of the experiment showed that different integrated nutrient treatments had significantly improved the production and productivity of barley crop. Among the following treatments, T_5 (150% RDF + Zinc @ 1 kg ha^{-1}) had maximum plant height (65.75)(82.44)(86.65), No. of tillers (450.34)(437.64)(425.48) and dry matter accumulation (450.11)(600.33)(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_5 which was at par with $T_4$and T_2.During investigation minimum value of all the growth and yield parameters and yield was observed under treatment T_1*i.e.* absolute control. From the observation it was found that combination of organic and inorganic fertilizer significantly improve production and productivity of barley.

Keywords: Barley, Himachal Pradesh, FYM, organic manure and grain yield

1. INTRODUCTION

Barley (*Hordeum vulgare* L.)has contributed significantly to the global advancement of agriculture (Alnarp*et al.* 2013) [3]. It is grown over nearly the whole planet because it is the most dependable crop in regions with alkaline soils, frost, or drought. After rice, wheat, and maize, it comes in fourth place among the cereals in terms of area and production.Additionally useful for

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its covering and cooling properties that facilitate smooth digestion is barley grain. In addition to these traditional applications, it is a significant industrial crop that supplies raw materials to the brewing, whiskey, and beer industries. 10.6 mg iron, 31.0 mg vitamin B1, 0.1 mg vitamin B2, and 50.0 ug folate are contained in every 100 g of barley grain (Vaughan *et al*. 2006) [52].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 (Kumawat *et al*. 2016) [31].

One way to give the plants nutrition is through integrated nutrient management in barley. (Chaudhary *et al*. 2018) [10]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 (Thakur *et al*. 2011) [49].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 (Yoshida *et al*. 2016) [56], 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 (Gopinath *et al*. 2008) [19], plots treated with inorganic fertilizers had lower soil pH levels than plots treated with organic manures.

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 (Jarvan *et al*. 2017) [21]. Concentrated sources of vital nutrients that are easily absorbed by plants are found in fertilizers (Fairhust *et al*. 2012) [13].

(Tigre 2014) [50]observed that plant height barely increased with increasing N fertilizer rates. The greatest measure of barley's reaction to nitrogen, according to (Workineh*et al*. 2017) [54], is the number of grains per spike, which increased 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 reduces the zinc content of the grain and slows down growth and productivity, according to (Kanbaev and sade2002) [24]. Nowadays, zinc shortage affects millions of hectares of crop plants, and almost one-third of the human population lacks enough zinc. This shows that crops require the addition of micronutrients, particularly zinc, in addition to main nutrients.

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2.MATERIALAND 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 770 East and 310 North, the current study was conducted in the *rabi* 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^{-1}) normal in reaction, low in available nitrogen (245 kg ha^{-1}) and medium in available phosphorus (24 kg ha^{-1}), potassium (134 kg ha^{-1}) and Zn (1.70 $mgkg^{-1}$) sufficient.

2.2.Experiment details

During the experimentation, randomized block design was used. The experiment comprises of three replications and seven treatments: - T_1 (control), T_2(100% RDF + FYM), T_3 (75% RDF + FYM 5 t ha^{-1}), T_4 (125% RDF + FYM 5 t ha^{-1}), T_5 (150% RDF + Zinc @ 1 kg ha^{-1}), T_6(50% RDF + 50% FYM) and T_7 (50% RDF + 25% FYM + 25% VC). For barley, a recommended nutritional dose was 40:20:20 kg ha^{-1}. 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 the sowing. The remaining 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 was selected randomly and marked from each plots, for the recording of growth and yield parameter 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 number of tiller area of 1 m^2 was marked inside the net plot, plants were counted and data were collected. The plant samples for dry matter accumulation well be taken at 30, 60, 90 DAS and at harvest after sowing from 0.25 m row length selected randomly from each plot. The samples were sun dried and then dried in oven at $72^{o}C \pm 0.5^{o}C$ for 72 hours or till the constant were achieved. The dry matter was expressed in gram per meter row length.Number of effective tillers will be recorded by using a quadrate 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 quadrate of one square meter in each plot at the time of harvest.Five spikes will be selected randomly and their length measured. Figures of all the five spikes will be added and sum will be divided by 5 to get average spike length. It will be recorded in cm. Ten spikes will be select randomly from each plot and numbers of filled grain per ten spikes will be count and average number of grains per spike will be workout.Using a dial spring balance green forage 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 q ha^{-1}.

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-^{2}), dry matter accumulation (g m-^{2}) and yield attributes (no. of effective tillers (m-^{2}), spike length (cm), number of spikes (m-^{2}), grain spike-^{1}, test weight (g), biological yield (q ha-^{1}) and harvest index (%) were recorded during the experimentation.

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2.5. Statistical Analysis

The data recorded from the field was statistically analysed through the analysis of variance method and treatment means were compared following critical differences (CD) suggested by (Gomez and Gomez 1984) [18]for significance at 5 %.

3.RESULTS AND DISCUSSION

3.1. Growth parameters:

Growth parameters were significantly affected by the various nutrients treatment 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 no nitrogen, phosphorus and potassium application in the plots.

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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 nutrients treatments. At 60, 90 DAS and at harvest, the maximum plant height was recorded under treatment T_5[150% RDF + Zinc @ 1 kg ha^{-1}(86.65)], which was statistically at par with treatment T_4 [125% RDF + FYM 5 t ha^{-1}(85.22)] and T_2 [100% RDF + FYM 5 t ha^{-1} (80.37)]. The minimum plant height was recorded under T_1[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 2009) [16] also reported that the use of organic manures in combination with mineral fertilizers maximized the plant height than the application of inorganic fertilizers alone. Similar results were reported by (Manohar *et al.* 1988) [31], (Gaur *et al.* 2003) [15], (Ravankar *et al.* 2005) [44], (Kumawat *et al.*2006) [30], (Pareta *et al.* 2009) [41] and (Kumar *et al.* 2010) [29].

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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_1	Absolute Control	8.88	33.45	69.27	74.45
T_2	100% RDF + FYM	16.76	58.45	74.33	80.37

T_3	75% RDF + FYM 5 tones/ha	14.27	50.82	72.43	77.88
T_4	125% RDF + FYM 5 tones/ha	17.32	63.34	80.06	85.22
T_5	150 % RDF + Zinc @ 1 kg/ha	18.55	65.75	82.44	86.65
T_6	50 % RDF + 50 % FYM	13.45	48.16	70.63	76.11
T_7	50 % RDF + 25% FYM + 25 VC	15.22	55.53	73.21	79.58
SEm±		***2.15***	***0.911***	***2.30***	***1.10***
CD at 5%		***NS***	***2.83***	***7.17***	***3.44***

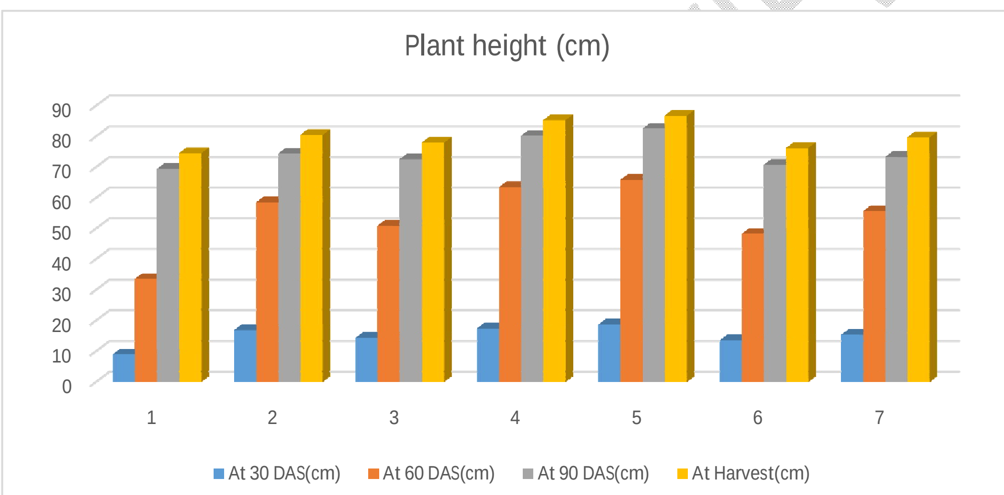

Fig. 1Influence of chemical fertilizer and organic manure on plant height of barley crop

3.1.2 No. of tillers (m^{-2}):

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 result showed that integrated nutrition approaches had a substantial effect on the number of tillers at all stages of crop growth except at 30DAS. During the crop growth period, highest number of tillers $m^{-2}$was recorded under treatment T_5 [150% RDF with zinc @ 1 kg ha^{-1}(450.34)(437.64)(425.48)] at the 60, 90, and at harvest phaseswhich were at par with treatment T_4[125% RDF + FYM 5 t ha^{-1}(438.63)(426.45)(412.13)] and T_2[100% RDF + FYM 5 t ha^{-1}(343.76) (328.32) (316.34)].On the other hand, T_1(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 most likely resulted from the availability of more nutrients. This may be the result of increased nitrogen application, which improved photosynthetic processes and photosynthates translocation by plants. Enhancing barley development significantly involves tillering, a feature that is crucial for grain output. The primary factor influencing effective tillering is improved soil physical conditions brought about by the addition of vermicompost (Kakraliya*et al.* 2016) [22].The rise in barley tillers in INM may be the consequence of providing the crop with a sufficient amount and balanced ratio of plant nutrients as needed throughout the growing season, creating an environment that is conducive to crop growth. (Suthar. 2006) [47] and Upadhyay and Vishwakarma (2014) [51] have noted similar outcomes.

Table-2 Effect of chemical fertilizer and organic manure on number of tillers (m^{-2}) of barley crop

Sr.No.	Treatments	At 30 DAS	At 60 DAS	At 90 DAS	At Harvest
T_1	Absolute Control	110.18	165.33	155.22	148.31
T_2	100% RDF + FYM	133.27	343.76	328.32	316.34
T_3	75% RDF + FYM 5 t ha^{-1}	128.56	278.68	264.11	258.16
T_4	125% RDF + FYM 5 t ha^{-1}	136.39	438.63	426.45	412.13
T_5	150 % RDF + Zinc @ 1 kg ha^{-1}	138.72	450.34	437.64	425.48
T_6	50 % RDF + 50 % FYM	124.91	260.11	249.33	240.77
T_7	50 % RDF + 25% FYM + 25 VC	131.44	315.84	307.67	295.76
SEm±		**6.93**	**4.26**	**3.80**	**4.46**
		NS	**13.29**	**11.86**	**13.89**

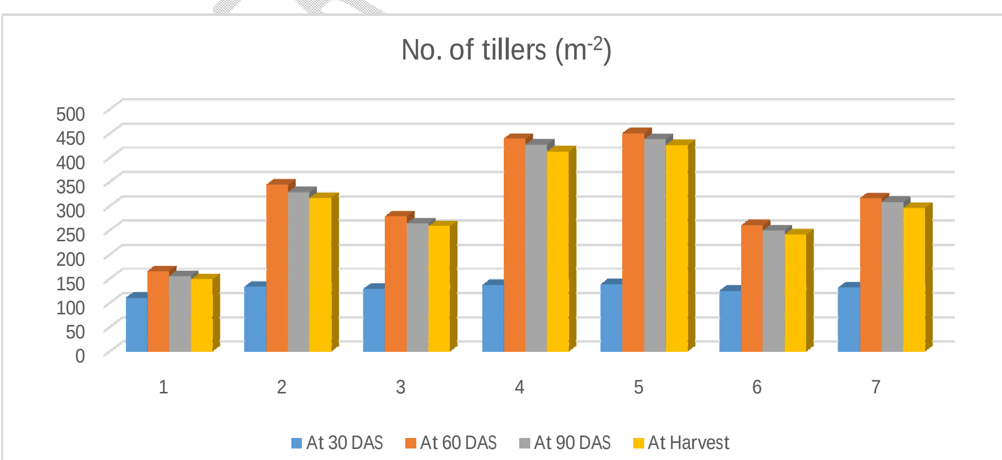

Fig.2.Influence of chemical fertilizer and organic manure on no. of tillers (m^{-2}) in barley crop

3.3 Dry matter accumulation (gm^{-2}):

. 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_5 (150% RDF + Zinc @ 1 kg ha^{-1}) which were at par with treatment T_4[125% RDF + FYM 5 t ha^{-1}) (104.66) (438.00) (578.45) (769.48)]andT_2[100% RDF + FYM 5 t ha^{-1}) (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 (Moreno *et al*. 2003 [34]; Meena *et al*. 2012) [33].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 (Gaur *et al*. 2003) [15],(Ravankar *et al*. 2005) [44], (Kumawat *et al*. 2006) [30], (Pareta *et al*. 2009) [41] and (Kumar *et al*. 2010) [28].

Table-3. Influence of chemical fertilizer and organic manure on Dry Matter Accumulation (gm^{-2}) in Barley crop

Sr.No.	Treatments	At 30 DAS	At 60 DAS	At 90 DAS	At Harvest
T_1	Absolute Control	50.21	280.37	419.56	470.56
T_2	100% RDF + FYM	98.26	396.38	537.23	689.23
T_3	75% RDF + FYM 5 tones/ha	75.92	353.62	466.38	605.11
T_4	125% RDF + FYM 5 tones/ha	104.66	438.00	578.45	769.48
T_5	150 % RDF + Zinc @ 1 kg/ha	106.37	450.11	600.33	795.66
T_6	50 % RDF + 50 % FYM	66.87	316.84	450.90	570.85
T_7	50 % RDF + 25% FYM + 25 VC	87.94	377.32	498.45	630.57
SEm±		***12.16***	***5.91***	***7.59***	***9.02***
CD		***NS***	***18.43***	***23.64***	***28.11***

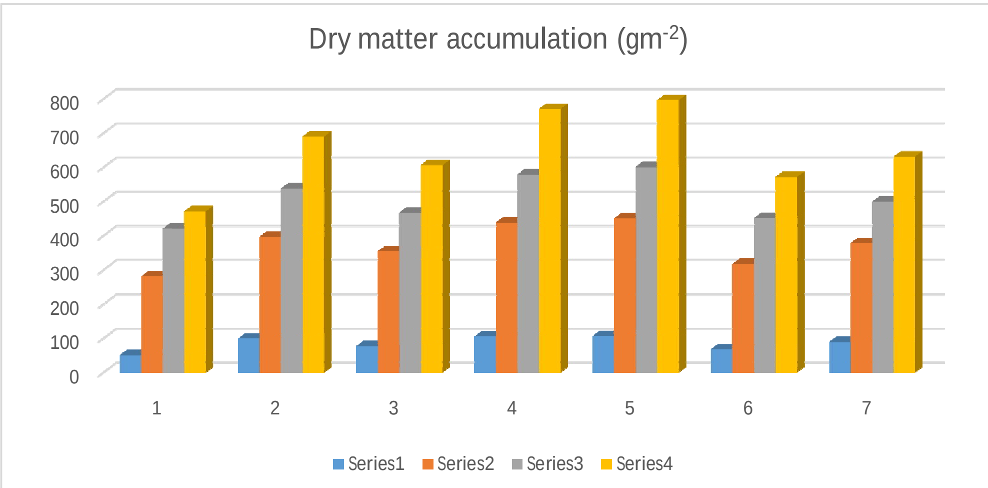

Fig. 3.Influence of chemical fertilizer and organic manure on dry matter accumulation (gm^{-2}) in barley crop

3.2. Yield studies:

3.2.1. No. of effective tillers (m^{-2})

The data related to number of effective tillers (m^{-2}) 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^{-2} at harvest of barley rise considerably when different integrated nutrition treatments were used. Significantly highest effective number of tillers m^{-2}at harvest of barley was recorded with the application of 150% RDF + Zinc @ 1 kg ha^{-1} (419.33) (T_5) which was closely followed by treatments T_4[125% RDF + FYM 5 t ha^{-1} (410.43)] and T_2[(100% RDF + FYM 5 t ha^{1}.(312.66)] but found superior to T_1(145.90), T_3(256.12), T_6(191.16) and T_7(290.88). Meanwhile lowest number of effective tillers were recorded under treatment T_1[Absolute control (145.90)].

3.2.2. No. of spike (m^{-2})

The findings for the number of spikes m^{-2}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}. The largest number of spikes per square meter was recorded with treatment T_5which is150% RDF + Zinc @ 1 kg ha^{-1} (417.84) which were at par with treatment T_4[125% RDF + FYM 5 t ha^{-1}(411.89)] and T_2[100% RDF + FYM 5 t ha^{-1}(310.23)] The lowest number of spikes was recorded under

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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 the integrated nutrient techniques had to significant effect on spike length. The maximum spike length (8.27) was seen in treatmentT_5, which is150% RDF + Zinc @ 1 kg ha^{-1} which were at par with treatment T_4[125% RDF + FYM 5 t ha^{-1}(7.94)] and treatment T_2 [100% RDF + FYM 5 t ha^{-1}. (7.35)]. This might be due to that organic source enabled the plant to absorb largest amount of NPK through their well develop root system. Secondly, the chemical fertilizer not only increase 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 (Prakash *et al.* 2011) [43] and (Maurya *et al.* 2018) [5].Meanwhile lowest length of spikes were recorded under treatment T1 (5.21) in control.

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3.2.4. No. of grains/ spikes

The results with respect to number of grains $spikes^{-1}$ have been recorded and present in Table -4 and illustrate in fig.-4 as per result indicated that the integrated nutrient method was significantly affected on number of grains $spikes^{-1}$. The highest number of grains $spikes^{-1}$ recorded under treatment (T_5)**[**150% RDF + Zinc @ 1 kg ha^{-1} (45.57)] which were at par with treatment T_4[125% RDF + FYM 5 t ha^{-1}(43.90)] and treatment T_2[100% RDF + FYM 5 t ha^{-1}(41.36)] over other treatments. The lowest number of grain $spikes^{-1}$ recorded under control (34.88) plots.

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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_5**[**150% RDF + Zinc @ 1 kg ha^{-1} (43.23)] and the lowest test weight was recorded under treatment T_1 control (36.17).In comparison to the control, the fertilizers employed in the experiment enhanced the 1000-grain weight (Mutlu, 2021)[35]. 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 (Nayak *et al*. 2001)[38] and Kumar *et al*. (2014) [25].

Similar findings were also reported by (Abay and Tesfaye, 2012) [1]that the significant increase were recorded in the number of productive tillers m^{-2}, number of grains $spike^{-1}$and grain weight, above ground dry biomass and grain yield of barley with the combined application of organic and inorganic fertilizers than the application of inorganic NPK alone.The similar finding have been also reported by (Prakash *et al*. 2011) [43] and (Fazily *et al*. 2021) [14].

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

Sr. No.	Treatments	No. of effective tiller (m^{-2})	No. of Spikes (m^{-2})	Spike Length(cm)	No. of grain $spike^{-1}$	Test Weight(g)
T_1	Absolute Control	145.90	142.76	5.21	34.88	36.17
T_2	100% RDF + FYM	312.66	310.23	7.35	41.36	40.43
T_3	75% RDF + FYM 5 t ha^{-1}	256.12	255.31	6.78	37.27	38.26
T_4	125% RDF + FYM 5 t ha^{-1}	410.43	411.89	7.94	43.90	42.20
T_5	150 % RDF + Zinc @ 1 kg ha^{-1}	419.33	417.84	8.27	45.57	43.23
T_6	50 % RDF + 50 % FYM	191.16	190.27	6.41	36.49	37.69
T_7	50 % RDF + 25% FYM + 25% VC	290.88	288.42	7.12	39.32	39.87
SEm±		***3.00***	***3.07***	***0.12***	***1.073***	***1.55***
CD		***9.37***	***9.58***	***0.39***	***3.34***	***NS***

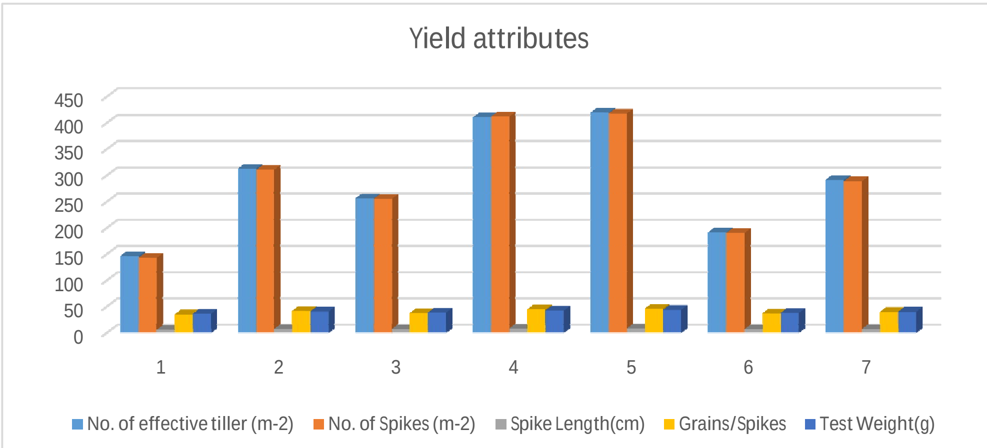

Fig.4. Influence of chemical fertilizer and organic on yield attributes of barley crop

3.3. Yields of crop

3.3.1. Grain yield (q ha^{-1})

The data reported to grain yield (q ha^{-1}) as influenced by different treatments have been presented in Table-5 and depicted in fig.-5. Among integrated nutrient management practices, T_5[150% RDF + Zinc @ 1 kg ha^{-1} (44.23)] recorded maximum height and it was at par with treatment T_4[125% RDF + FYM 5 t ha^{-1}**(43.36)]** and treatmentT_2 100% RDF + FYM 5 t ha^{-1}(38.28)]. The lowest grain yield was recorded under control (20.16). The improvement in yield/plant may be attributed in increase in grain size and number of grains per plant. Organic matter in the fertilizers is an importantsource of plant nutrients. In addition, organic matterhas 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 ofgrains. Similar results on the effects of organic fertilizers have been reported by other researchers (Chaturvedi. 2006) [8], Panda and Rai (2008) [39], Ibrahim *et al*. (2008) [20] and Tas. (2020) [48].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 (Berhanu *et.al.*2013) [6].

3.3.2. Straw yield (q ha^{-1})

The data reported to straw yield (q ha^{-1}) 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_5) 150% RDF + Zinc @ 1 kg ha^{-1} (67.39) which were at par with treatment T_4[125% RDF + FYM 5 t ha^{-1}(62.45)]and treatmentT_2[100% RDF + FYM 5 t ha^{-1}(58.17)]. The lowest was recorded under treatment T_1[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 ofvermicompost @4.5 t ha^{-1} +40 kg N ha^{-1} gave higher grain yield and straw yield over rest of other combinations of organic manure and nitrogen (Kumawat*et al*. 2006) [30]. The similar finding have been also reported by (Singh *et al*. 2020) [46], Pandey *et al*. (2009) [40] and (Akhtar *et al*. 2018) [2].

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3.3.3. Biological yield (q ha^{-1})

The data pertaining to biological yield q ha^{-1} 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 recordedunder treatment T_5[150% RDF + Zinc @ 1 kg ha^{-1} (111.62)] and it was at par treatment T_4**[**125% RDF + FYM5 t ha^{-1}**(**105.81)**]** and T_2 [100% RDF + FYM 5 t ha^{-1}(96.45)]. The lowest biological yield was recorded under treatment T_1control (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 (Choudhary *et al.* 2021)[12].

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_4[125%RDF + FYM 5 t ha^{-1}(40.97)] and the minimum harvest index was recorded under treatment T_1(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. Thesimilar finding have been also reported by (Fazily *et al.* 2021) [14].

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

Sr. no.	Treatments	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Biological yield (q ha^{-1})	Harvest Index (%)
T_1	Absolute Control	20.16	35.24	55.40	36.38
T_2	100% RDF + FYM	38.28	58.17	96.45	39.69
T_3	75% RDF + FYM 5 t ha^{-1}	35.37	55.83	91.20	38.78
T_4	125% RDF + FYM 5 t ha^{-1}	43.36	62.45	105.81	40.97
T_5	150 % RDF + Zinc @ 1 kg ha^{-1}	44.23	67.39	111.62	39.62
T_6	50 % RDF + 50 % FYM	32.63	53.56	86.19	37.85
T_7	50 % RDF + 25% FYM + 25VC	37.11	56.64	93.75	39.58
SEm±		**0.657**	**2.01**	**2.142**	**1.526**
CD at 5%		**2.048**	**6.263**	**6.672**	**NS**

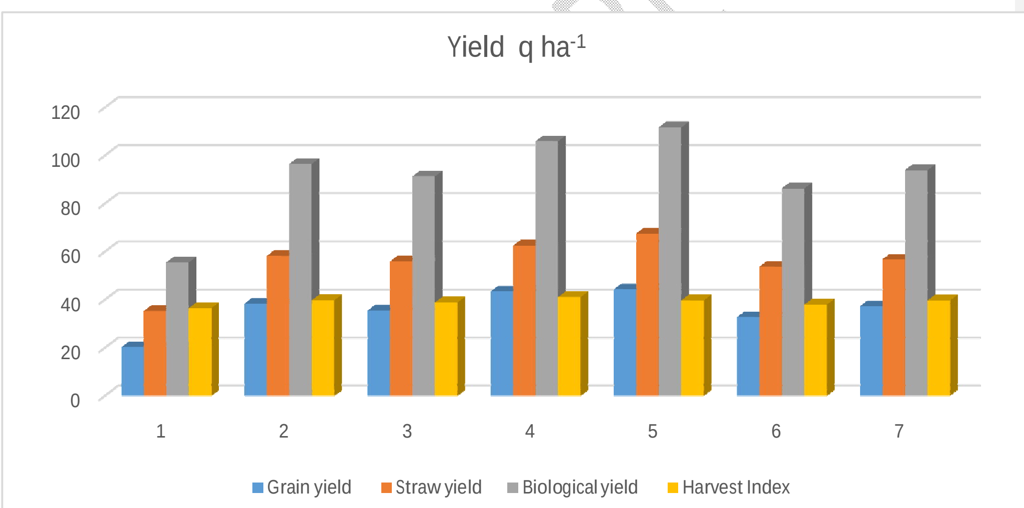

Fig.5 Influence of chemical fertilizer and organic manure on barley crop

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^{-1}, 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^{-1}(T_5).Although, the better production of barley crop could be achieved by adopting integrated nutrient management treatment combination as 125% RDF + FYM 5 t ha^{-1} and100% RDF + FYM 5 t ha^{-1}.

Reference:

Comment [Mdj35]: use one style to present your references following the journal's format or style (More than one style has been used).

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