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Comparing the effect of organic manure, biofertilizer and synthetic fertilizer on production and productivity of barley (*Hordeum vulgare* L.) crop

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Abstract
A field experiment was conducted during Rabi 2023-24 at the Research Farm of Abhilashi University, Mandi, Himachal Pradesh, to comparing the effect of organic manure, biofertilizer and synthetic fertilizer on production and productivity of barley (*Hordeum vulgare* L.) crop. The study included eight treatments comprising different combinations of recommended dose of fertilizers (RDF), vermicompost and *Azotobacter*, arranged in a randomized block design with three replications. Among the treatments, T_4 (100% RDF + vermicompost @ 2.5 t ha^{-1} + *Azotobacter*) recorded the highest plant height, spike length, grain yield (45.75 q ha^{-1}), straw yield (67.29 q ha^{-1}) and biological yield (113.04 q ha^{-1}) while the control (T_1) recorded the lowest values. Although the highest harvest index was observed in T_1 (42.71%), integrated nutrient treatments showed significantly improved productivity due to enhanced nutrient uptake, better microbial activity and improved soil health. The study makes clear that INM enhances barley yield potential and fosters sustainable practices in temperate hilly agricultural systems.

Keywords: Barley, Integrated nutrient management, Vermicompost, *Azotobacter*.

Introduction

Barley (Hordeum vulgare L.) grown widely as a rabi crop in India, is known for its capacity to grow under marginal soil fertility and challenging agro-climatic conditions. It is considered a hardy and dependable crop in regions affected by drought, frost, and alkaline soils. Globally, barley is cultivated across temperate regions of Asia, Europe and North America, including countries such as China, Russia, Germany, the United States, Canada, India, Turkey and Australia (Karol *et al*. 2023) [11]. In India, it is primarily grown in the northern plains, particularly in Uttar Pradesh, Haryana, and Rajasthan. Barley covered nearly 453 thousand hectares in 2023, yielding a total production of 1,371 thousand tonnes and an average productivity of 3.0 t ha^{-1} (Anonymous, 2023) [3]. Rajasthan leads in national barley production, contributing over 53% of total output and 47% of the area under cultivation. In Himachal Pradesh, barley is grown on 17.25 million hectares with a production of 28.85 million tonnes and average productivity of 1673.01 kg ha^{-1} (Anonymous, 2023) [3]. The grain of barley is processed and consumed as food, used as feed for animals, and widely utilized in producing various beverages. In rural India, it is processed into flour for chapatis or roasted and ground into *sattu*. Additionally, barley grains are malted for brewing beer, whisky, and other industrial products like vinegar and alcohol. Malt syrup is commonly used in confectionery, breakfast cereals, and pharmaceuticals, while brewing and distillation residues serve as valuable cattle feed (Singh, 2017) [27].

Despite the increasing demand for barley and other cereals, the intensive reliance on inorganic fertilizers has raised serious concerns regarding soil health and environmental sustainability. Continuous use of chemical fertilizers, particularly nitrogenous sources, leads to the degradation of soil structure, reduction in microbial activity, and depletion of organic matter. This, in turn, results in declining native soil nitrogen, phosphorus, and potassium levels, ultimately affecting crop yields (Behera *et al*. 2007 [3], Mahajan *et al*. 2008) [16]. Moreover, excessive nitrogen fertilization increases the risk of nitrate contamination in groundwater, posing health hazards to both humans and animals. Soil microbial communities, which are essential for nutrient cycling and maintaining ecological balance, are adversely impacted by chemical overuse (Karol *et al*. 2023) [11].

This ecological imbalance reduces nutrient-use efficiency and the soil's carbon sequestration potential, further contributing to environmental degradation.

In contrast, the use of organic fertilizers improves soil structure, boosts microbial diversity, enhances water retention, and facilitates better root proliferation. Organic matter acts as a primary energy source for soil microorganisms and is crucial for maintaining soil biological activity and fertility. It also functions as a reservoir for plant-essential macro and micronutrients, making it a key determinant of soil productivity (Dejene and Lemlem. 2012 [7], Karol *et al*. 2023) [11]. Therefore, sustainable nutrient management strategies such as Integrated Nutrient Management (INM) have gained prominence. INM is a holistic approach that synergistically combines the benefits of organic manures, crop residues, composts and chemical fertilizers to meet crop nutrient demands. It enhances nutrient-use efficiency and crop productivity while also sustaining the long-term health of the soil ecosystem. INM practices have been shown to replenish nutrient-depleted soils, maintain humus levels, suppress weeds and diseases and buffer soil pH and toxicity. The integration of both nutrient sources has resulted in superior agronomic performance and economic viability across various cropping systems (Yadav *et al*. 2014 [30], Ram *et al*. 2012) [23]. Given the current challenges in sustaining soil fertility and achieving stable crop productivity, the adoption of INM in barley cultivation offers a promising avenue. It ensures enhanced yield, improved soil resilience and reduced dependency on external chemical inputs, thereby aligning modern agriculture with ecological and economic sustainability goals.

Material and methods

A field experiment entitled "Comparing the effect of organic manure, biofertilizer and synthetic fertilizer on production and productivity of barley (*Hordeum vulgare* L.) crop" was conducted during the rabi season of 2023-24 at the Research Farm, School of Agriculture, Abhilashi University, Mandi, Himachal Pradesh, situated at 31°N latitude, 77°E longitude and an altitude of 1391 m above mean sea level. The site falls under the mid-hill sub-humid agro-climatic zone characterized by temperate summers and cool winters. The experiment was conducted using a randomized block design with eight treatments and three replications. Treatments included various combinations of 100%, 75%, and 50% recommended dose of fertilizers (RDF), vermicompost (2.5 t ha^{-1}) and *Azotobacter*. The barley variety used was BHS-380 (Pusa Losar) sown manually on November 26, 2023 at 20 cm row spacing using a seed rate of 100 kg ha^{-1}. The recommended fertilizer dose was 40:20:20 kg N: P_2O_5: K_2O per hectare. Standard field operations including irrigation (three times) weed control (manual and herbicide application) gap filling and harvesting were undertaken as per schedule.

Observations on growth parameters such as plant height, number of tillers per m^2 and dry matter accumulation were recorded at 30, 60, 90,120 days after sowing (DAS) and at harvest. The yield attributes evaluated included the number of effective tillers, length of the spike, number of grains per spike, test weight and the grain, straw and total biological yield. The harvest index was determined too. The gathered data were subjected to statistical analysis through ANOVA following the procedure of Gomez and Gomez (1984) [10] and treatment means were compared using the critical difference (CD) at a 5% level of significance.

Results and discussion

Growth studies: Plant height (cm)

Data on plant height at various crop growth stages are presented in Table 1 and Fig. 1. At 30 days after sowing (DAS), no significant differences were observed among the treatments. However, at later stages (60, 90,120 DAS and at harvest), treatment T_4 (100% RDF + vermicompost @ 2.5 t ha^{-1} + *Azotobacter*) recorded the tallest plants, closely followed by T_3 (100% RDF + vermicompost @ 2.5 t ha^{-1}), both being statistically at par. The shortest plant height was consistently observed in the control treatment (T_1). The improved plant height under integrated treatments may be attributed to the gradual and sustained release of nutrients from vermicompost, enhanced microbial activity, better moisture retention and improved nitrogen fixation due to *Azotobacter* application. These factors likely created favourable conditions for root development and nutrient uptake, leading to vigorous vegetative growth. The positive effect of combining organic and inorganic nutrient sources on plant height aligns with the findings of Getachew 2009, Gaur *et al*. 2003 [9], Ravankar *et al*. 2005 [24], Kumawat *et al*. 2006, Pareta *et al*. 2009 and Kumar *et al*. 2010 who also reported that integrated nutrient management promotes better growth compared to sole application of either source.

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

The number of tillers per square meter at different growth stages (30, 60, 90, 120 DAS and at harvest) are presented in Table 2 and Figure 2. The data revealed that integrated nutrient management (INM) practices had a significant impact on tiller production at all observed stages with the exception of 30 DAS where the differences were non-significant. Treatment T_4 [100% RDF + vermicompost @ 2.5 t ha^{-1} + *Azotobacter*] had the highest number of tillers m^{-2} with values of 180.23, 279.32, 308.03 and 301.37 tillers m^{-2} at 60, 90 and 120 days after sowing as well as at harvest, respectively. This was comparable to T_3 [100% RDF + vermicompost @ 2.5 t ha^{-1}] which recorded 176.20, 264.45, 293.51 and 287.50 tillers m^{-2}. The treatment T_1 [Control] had the fewest tillers at 60, 90, 120 and harvest stages with values of 104.86, 150.33, 180.82 and 173.87 tillers m^{-2}, respectively. This implies that the absence of extra organic or microbial inputs greatly hampered tiller development. The improved soil structure, microbial activity and synchronized nutrient release—particularly nitrogen which is essential for fostering vegetative growth—are responsible for the increased tiller production in treatments that included both organic (vermicompost) and biofertilizer (*Azotobacter*) components. In addition to providing macro- and micronutrients, vermicompost enhances the physical and biological characteristics of the soil promoting improved root growth and nutrient absorption. These results are consistent with those of previous studies by Suhar *et al*. 2006 and Upadhyay & Vishwakarma 2014, who found that using biofertilizers in addition to organic sources increased the number of tillers produced by cereals because of better microbial activity and nitrogen fixation.

Dry matter accumulation (g m⁻²)

Dry matter accumulation at 30, 60, 90 and 120 DAS as well as at harvest is illustrated in Figure 3 and detailed in Table 3. At all growth stages, the dry matter accumulation was significantly impacted by various integrated nutrient management (INM) treatments. At 30 DAS, however, the variation was not statistically significant. Treatment T_4 [100% RDF + vermicompost @ 2.5 t ha^{-1} + *Azotobacter*] had the highest dry matter accumulation across all stages—160.64 (30 DAS), 480.36 (60 DAS), 680.08 (90 DAS), 887.40 (120 DAS) and 1075.71 g m^{-2} at harvest. T_3 [100% RDF + vermicompost @ 2.5 t ha^{-1}] yielded high dry matter values (146.28, 461.85, 650.54, 862.73, and 1052.07 g m^{-2} at various stages). The treatment T_6 [75% RDF + vermicompost @ 2.5 t ha^{-1} + *Azotobacter*] also resulted in high dry matter accumulation showing the beneficial role of biofertilizers in enhancing nutrient availability. The control treatment (T_1) had the lowest values at all stages (98.65, 310.29, 501.18, 654.57 and 729.91 g m^{-2}) emphasizing the need for nutrient supplementation. The increase in dry matter accumulation under integrated treatments is due to improved nutrient availability and uptake which promotes plant growth and biomass accumulation. The addition of vermicompost and *Azotobacter* most likely improved soil structure, microbial activity and nutrient mineralization which aided plant growth. These findings are consistent with those reported by Moreno *et al*. 2003 [18], Gaur *et al*. 2003, Ravankar *et al*. 2005 [24], Kumawat *et al*. 2006, Pareta *et al*. 2009 [9], Kumar *et al*. 2010 and Meena *et al*. 2012 [17] all of whom reported increased dry matter production as a result of integrated nutrient management practices.

Yield studies

Number of effective tillers (m⁻²)

The data related to the number of effective tillers (m^{-2}) at harvest of barley presented in Table 4 and shown in Fig. 4 due to integrated nutrient management (INM). Treatment T_4 [100% RDF + vermicompost @ 2.5 t ha^{-1} + *Azotobacter*] had the highest number of effective tillers (296.80 m^{-2}), followed closely by treatment T_3 (285.37 m^{-2}) which used vermicompost @ 2.5 t ha^{-1} alone with 100% RDF. In terms of tiller production, these treatments performed much better than the others. However, because no nutrient supplementation was applied the control treatment (T_1) produced the fewest number of productive tillers (170.21 m^{-2}). Improved microbial activity, improved soil structure and more nutrient availability may all be responsible for the higher tiller production under integrated treatments. Meena *et al*. 2012 [17] and Prakash *et al*. 2011 [22], who also reported comparable outcomes under INM conditions corroborate these findings.

Spike length (cm)

Data regarding spike length as influenced by different treatments are presented in Table 4 and illustrated in Fig. 4. Among the treatments T_4 (100% RDF + vermicompost @ 2.5 t ha^{-1} + *Azotobacter*) recorded the maximum spike length (8.32 cm) which was statistically at par with T_3 (100% RDF + vermicompost @ 2.5 t ha^{-1}; 7.41 cm) and T_6 (75% RDF + vermicompost @ 2.5 t ha^{-1} + *Azotobacter*; 7.09 cm). These results highlight the beneficial effect of integrating organic and biofertilizer components with chemical fertilizers. The enhanced spike length observed in integrated nutrient management (INM) treatments may be attributed to improved nutrient uptake and availability throughout the crop growth period, which supported better cell division and elongation processes essential for spike development. In contrast, the shortest spike length (5.12 cm) was noted under the control (T_1), likely due to nutrient deficiency, especially during the critical reproductive phase. These findings are in line with those reported by Singh *et al*. 2013, who also observed longer spikes under combined organic and inorganic nutrient applications compared to untreated plots.

Number of grain spikes⁻¹

The number of grain spikes-1 data is also shown to have been greatly impacted by INM treatments (Table 4 and Fig. 4). Grain spikes-1 (42) were highest under treatment T_4 [100% RDF + vermicompost @ 2.5 t ha^{-1} + *Azotobacter*] which was equivalent treatment T_3 [100% RDF + vermicompost @ 2.5 t ha-1 (39)] compared to other treatments. The treatment T_1 [Control] had the lowest number of grain spikes-1 with only 24 spikes per plant. This is because the plant absorbs fewer nutrients due to the lower soil nutrient availability which results in fewer spikes. This enhancement may be related to enhanced photosynthetic efficiency and improved nutrient translocation under INM. The addition of *Azotobacter* may have improved nitrogen fixation and growth-promoting activities, increasing the number of reproductive spikes. Abay and Tesfaye 2012 [1] and Fazily *et al*. 2021 [8], both observed similar findings.

Test weight (g)

The effect of various nutrient treatments on test weight (1000-grain weight) is presented in Table 4 and illustrated in Fig. 4. Although the variations among treatments were not statistically significant, test weight showed a positive response to integrated nutrient applications. The highest test weight (42.23 g) was recorded under treatment T_4 (100% RDF+ vermicompost @ 2.5 t ha^{-1} + *Azotobacter*) whereas the lowest value (36.15 g) was observed in the control (T_1). The modest improvement in test weight under integrated treatments could be attributed to better nutrient uptake, enhanced physiological functioning, and more effective grain filling during the reproductive stage. These results align with earlier findings reported by Kumar *et al*. 2014 [12] and Mutlu 2021 [19], who observed similar trends in barley when both organic and inorganic fertilizers were applied in combination.

Grain yield (q ha⁻1)

The data about grain yield (q ha^{-1}) determined by various integrated nutrient management practices is shown in Fig. 5 and Table 5. Treatment T_4 [100% RDF + vermicompost @ 2.5 t ha^{-1} + *Azotobacter*] produced 45.75 q ha^{-1} the highest grain yield among the treatments. This was significantly similar to treatment T3 [100% RDF + vermicompost @ 2.5 t ha-1 (42.46 q ha^{-1})] where RDF was applied in along with vermicompost and was found to be significantly better than the other treatments. During the investigation, the control treatment T_1 had the lowest grain production (28.43 q ha^{-1}).

The observed improvement in grain yield under integrated nutrient management (INM) treatments can be attributed to the consistent and balanced supply of nutrients from both organic and inorganic sources. *Azotobacter* contributes to enhanced nitrogen availability through biological nitrogen fixation and promotes better root development, while vermicompost improves soil physical properties, stimulates microbial activity and enhances nutrient retention and availability. These combined benefits foster favourable conditions for crop growth and productivity. The synergistic effect of integrating organic and chemical fertilizers has led to noticeable yield improvements which are in agreement with earlier findings reported by Nath *et al*. 2017 [20], Kundu *et al*. 2019 [15] and Das *et al*. 2021 [6], who documented similar positive responses in cereal crops across various agro-ecological zones.

Straw yield (q ha⁻¹)

Straw yield (q ha^{-1}) as influenced by different nutrient management practices is presented in Table 5 and Fig. 5. The maximum straw yield (67.29 q ha^{-1}) was recorded under treatment T_4 (100% RDF + vermicompost @ 2.5 t ha^{-1} + *Azotobacter*) which was higher than T_3 (63.08 q ha^{-1}) suggesting a beneficial effect of integrating biofertilizers with organic and inorganic sources. The lowest straw yield (38.12 q ha^{-1}) was observed in the control (T_1) likely due to limited nutrient availability. The improved straw yield under integrated treatments may be attributed to enhanced biomass accumulation resulting from better nutrient uptake, improved root growth and favourable soil conditions. *Azotobacter* likely contributed through biological nitrogen fixation and improved microbial activity, while vermicompost supported better soil structure, moisture retention and nutrient availability. These findings are supported by previous studies Saini *et al*. 2016, Yadav *et al*. 2019 [31, 32], Bhowmik *et al*. 2021 [4], which also reported that integrated nutrient management significantly enhanced straw yields in cereal crops.

Biological yield (q ha⁻¹)

The influence of integrated nutrient management practices on biological yield (q ha^{-1}) is illustrated in Table 5 and Fig. 5. Among the treatments T_4 (100% RDF + vermicompost @ t ha^{-1} + *Azotobacter*) recorded the highest biological yield (113.04 q ha^{-1}) which was statistically comparable to T_3 (100% RDF + vermicompost @ 2.5 t ha^{-1}) with 105.54 q ha^{-1}. Intermediate biological yields were obtained in T_6 (99.66 q ha^{-1}), T_5 (96.38 q ha^{-1}), T_7 (79.28 q ha^{-1}) and T_8 (85.13 q ha^{-1}). Treatment T_2 (100% RDF) resulted in a yield of 88.30 q ha^{-1}, whereas the control (T_1) recorded the lowest biological yield (66.55 q ha^{-1}). The enhanced yield in integrated treatments may be attributed to the synergistic effect of chemical fertilizers, vermicompost and *Azotobacter* which together improve nutrient supply, soil microbial activity and overall crop growth. The positive influence on yield-contributing traits such as spike length, number of effective tillers and grain count per spike also contributed to higher biomass production. These findings are in agreement with earlier studies by Singh *et al*. 2018 [28], Yadav *et al*. 2019 [31, 32] and Kumar *et al*. 2020 [13], who observed improved yield performance and biomass accumulation in cereals with the combined application of organic, inorganic and biofertilizers.

Harvest index (%)

The impact of different nutrient management practices on the harvest index is illustrated in Figure 5 and summarized in Table 5. The highest harvest index was recorded under the control treatment T_1 (42.71%) while the lowest was observed in T_6 (75% RDF + vermicompost @ 2.5 t ha^{-1} + *Azotobacter*) with 39.25%. Across treatments the harvest index ranged between 39% and 43% following the trend: $T_1 > T_8 > T_7 > T_4 > T_2 > T_3 > T_5 > T_6$. Although integrated treatments promoted better grain development and assimilate partitioning the relatively higher vegetative growth under these treatments may have resulted in a slight reduction in the harvest index. Nonetheless, the combined application of organic, inorganic and biofertilizer sources improved overall physiological efficiency and crop productivity. Verma *et al*. (2017) [29], Choudhary *et al*. (2020) [5] and Patel *et al*. (2021) [21] reported comparable findings which reinforce the significance of integrated nutrient management in maximizing cereal yield and harvest index.

Conclusion

The study demonstrated that integrated nutrient management (INM) significantly improved barley growth and yield under mid-hill conditions of Himachal Pradesh. The treatment T_4 (100% RDF + vermicompost @ 2.5 t ha^{-1} + *Azotobacter*) recorded the highest values for plant height, spike length, grain and straw yield. Enhanced nutrient supply, along with improved soil physical properties and boosted microbial activity, led to superior crop growth. INM treatments outperformed sole chemical fertilizer use in all major parameters. Thus, INM proves to be a sustainable and efficient strategy for improving barley productivity.

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Conflict of Interest

None of the above author has any conflict

Table- 1 Effect of integrated nutrient management on plant height (cm) of various stages of barley

Sr. No.	Treatment	Plant height (cm)				
		30 DAS	60 DAS	90 DAS	120 DAS	At harvest
T1	Control	7.67	30.84	70.15	76.87	80.15
T2	100% RDF	8.34	33.63	72.16	79.36	87.36
T3	100% RDF + vermicompost @ 2.5 t ha-1	12.78	43.15	84.37	94.65	102.57
T4	100% RDF + vermicompost @ 2.5 t ha- 1+ *Azotobacter*	13.56	46.60	85.75	96.48	105.80
T5	75% RDF + vermicompost @ 2.5 t ha-1	11.16	38.18	77.45	85.20	93.71
T6	75% RDF + vermicompost @ 2.5 t ha-1 + *Azotobacter*	12.57	41.58	78.12	87.12	96.68
T7	50% RDF + vermicompost @ 2.5 t ha-1	9.22	35.82	74.68	81.47	89.44
T8	50% RDF + vermicompost @ 2.5 t ha-1 + *Azotobacter*	9.97	36.21	76.58	83.17	91.59
SEm (±)		1.88	1.95	3.16	3.59	3.90
CD (P=1.0%)		NS	4.19	6.78	7.71	8.37

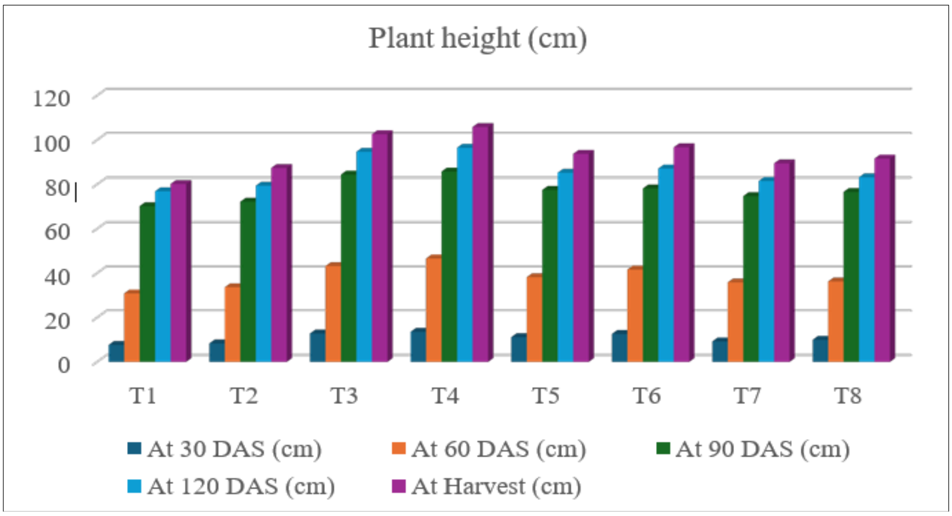

Fig 1: Effect of integrated nutrient management on plant height (cm) of various stages of barley

Table 2: Effect of integrated nutrient management on number of tillers (m-2) at 30, 60, 90 DAS and at harvest of barley

Sr. No.	Treatment	No. of tillers (m-2)				
		30 DAS	60 DAS	90 DAS	120 DAS	At harvest
T1	Control	70.47	104.86	150.33	180.82	173.87
T2	100% RDF	75.04	150.41	200.27	250.83	247.27
T3	100% RDF + vermicompost @ 2.5 t ha-1	97.52	176.20	264.45	293.51	287.50
T4	100% RDF + vermicompost @ 2.5 t ha-1+ *Azotobacter*	101.76	180.23	279.32	308.03	301.37
T5	75% RDF + vermicompost @ 2.5 t ha-1	89.86	164.12	235.46	260.05	257.82
T6	75% RDF + vermicompost @ 2.5 t ha-1 + *Azotobacter*	94.61	154.17	247.04	277.38	264.55
T7	50% RDF + vermicompost @ 2.5 t ha-1	81.38	157.81	210.06	243.07	240.61
T8	50% RDF + vermicompost @ 2.5 t ha-1 + *Azotobacter*	84.55	160.69	220.84	255.91	245.46
SEm (±)		14.33	6.95	12.30	10.77	11.03
CD (P=1.0 %)		NS	14.91	26.39	23.12	23.66

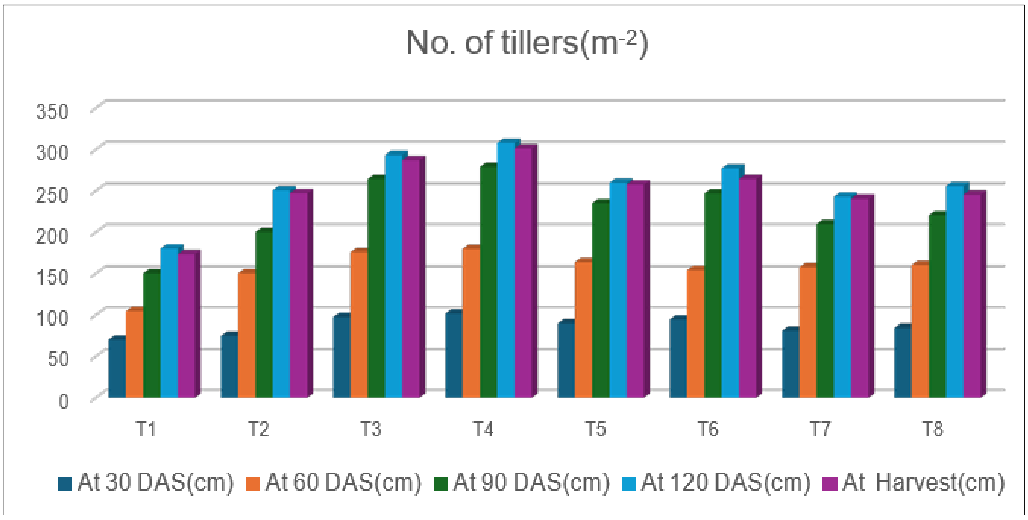

Fig 2: Effect of integrated nutrient management on number of tillers (m-2) at 30, 60, 90 DAS and at harvest of barley

Table 3: Effect of integrated nutrient management on dry matter accumulation (g m-2) at 30, 60, 90 DAS and at harvest of barley

Sr. No	Treatment	Dry matter accumulation (g m-2)				
		30 DAS	60 DAS	90 DAS	120 DAS	At harvest
T1	Control	98.65	310.29	501.18	654.57	729.91
T2	100% RDF	105.05	332.47	536.42	695.23	880.23
T3	100% RDF + vermicompost @ 2.5 t h	146.28	461.85	650.54	862.73	1052.07
T4	100% RDF + vermicompost @ 2.5 t h 1+ *Azotobacter*	160.64	480.36	680.08	887.40	1075.71
T5	75% RDF + vermicompost @ 2.5 t ha-	125.80	404.67	604.10	780.66	980.66
T6	75% RDF + vermicompost @ 2.5 t ha-+ *Azotobacter*	141.91	429.44	627.34	806.85	1006.52
T7	50% RDF + vermicompost @ 2.5 t ha-	113.93	356.72	553.21	714.77	914.11
T8	50% RDF + vermicompost @ 2.5 t ha- + *Azotobacter*	118.37	380.37	575.53	748.47	948.80
SEm (±)		18.34	16.66	24.39	31.59	39.61
CD (P=1.0%)		NS	35.75	52.32	67.77	84.96

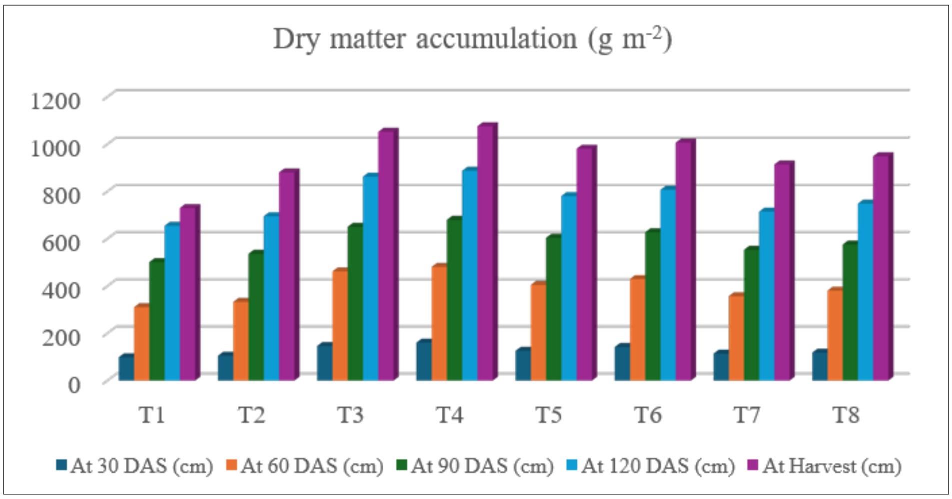

Fig 3: Effect of integrated nutrient management on dry matter accumulation (g m-2) at 30, 60, 90 DAT and at harvest of barley

Table 4: Effect of integrated nutrient management on yield attributes of barley

Sr. No.	Treatment	No. of effective tillers (m-2)	Spike Length (cm)	No. of grain spike-1	Test weight (g)
T1	Control	170.21	5.12	24	36.15
T2	100% RDF	242.85	6.24	28	38.47
T3	100% RDF + vermicompost @ 2.5 t ha-^{1}	285.37	7.41	39	41.26
T4	100% RDF + vermicompost @ 2.5 t ha-1+ *Azotobacter*	296.80	8.32	42	42.23
T5	75% RDF + vermicompost @ 2.5 t ha-^{1}	253.56	7.06	35	39.16
T6	75% RDF + vermicompost @ 2.5 t ha-1 + *Azotobacter*	261.23	7.09	37	40.54
T7	50% RDF + vermicompost @ 2.5 t ha-^{1}	237.65	6.68	31	37.25
T8	50% RDF + vermicompost @ 2.5 t ha-1 + *Azotobacter*	241.48	7.02	33	38.58
SEm±		11.06	0.43	1.46	2.00
CD (P=1.0%)		23.73	0.93	3.14	NS

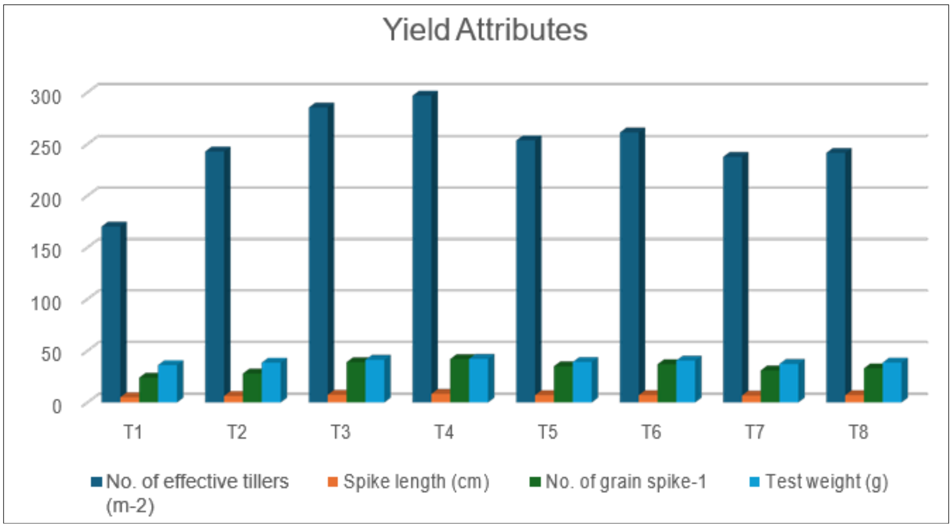

Fig 4: Effect of integrated nutrient management on yield attributes of barley

Table 5: Effect of integrated nutrient management on grain yield (q ha-1), straw yield (q ha-1), biological yield (q ha-1) and harvest index (%) of barley

Sr. No.	Treatment	Grain yield (q ha-1)	Straw yield (q ha-1)	Biological yield (q ha-1)	Harvest Index (%)
T1	Control	28.43	38.12	66.55	42.71
T2	100% RDF	35.54	52.76	88.30	40.24
T3	100% RDF + vermicompost @ 2.5 t ha-1	42.46	63.08	105.54	40.23
T4	100% RDF + vermicompost @ 2.5 t ha-1+ *Azotobacter*	45.75	67.29	113.04	40.47
T5	75% RDF + vermicompost @ 2.5 t ha-1	38.11	58.27	96.38	39.54
T6	75% RDF + vermicompost @ 2.5 t ha-1 + *Azotobacter*	39.16	60.80	99.96	39.25
T7	50% RDF + vermicompost @ 2.5 t ha-1	32.87	46.41	79.28	41.46
T8	50% RDF + vermicompost @ 2.5 t ha-1 + *Azotobacter*	35.54	52.76	85.13	42.06
SEm±		2.08	2.57	4.36	2.46
CD (P=1.0%)		4.46	5.52	9.36	NS

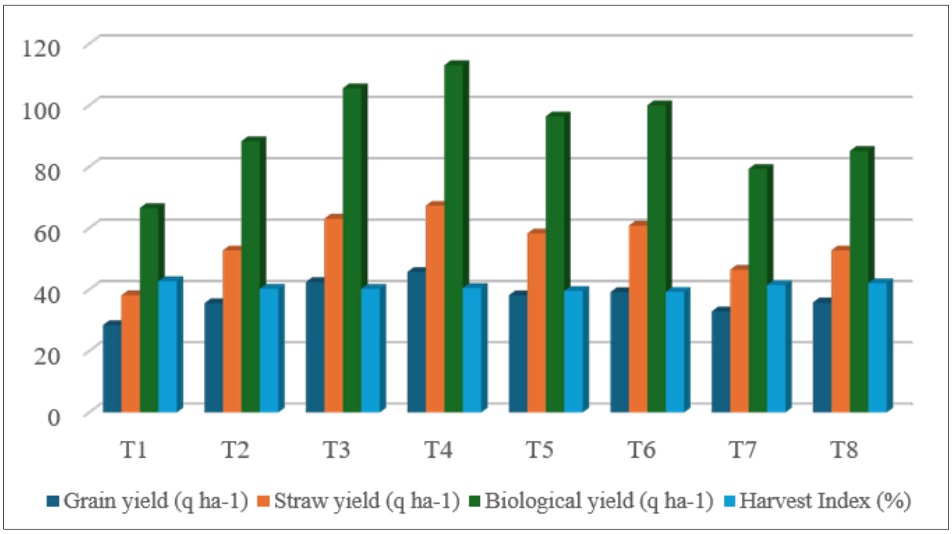

Fig 5: Effect of integrated nutrient management on grain yield (q ha-1), straw yield (q ha-1), biological yield (q ha-1) and harvest index (%) of barley

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