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Effect of fertilizer and biofertilizer management on growth parameters of barley (*Hordeum vulgare* L.)

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Abstract

The experiment "Effect of fertilizer and biofertilizer management on growth, yield and economics of barley (*Hordeum vulgare* L.)" was conducted at the Agricultural Research Farm, Faculty of Agricultural Sciences and Allied Industries, Rama University, Kanpur, during the rabi season of 2025-26. Ten treatments comprising various levels of Recommended Dose of Fertilizers (RDF), organic manure (Vermicompost), and biofertilizer (PSB) were evaluated in a Randomized Block Design with three replications. The results indicated that the application of 100% RDF + Vermicompost + PSB (T₁₀) significantly improved all growth parameters. Treatment T₁₀ recorded the maximum plant height at harvest (109.53 cm), number of tillers per m² row length at 60 DAS (142.83), leaf area index at 60 DAS (4.77), and dry matter accumulation at harvest (355.39 g m⁻² row length). Additionally, it reduced the days to 50% flowering (61.50 days) and maturity (108.96 days). It is concluded that integrating chemical fertilizers with organic and biological sources promotes vigorous vegetative growth in barley.

Keywords: Barley, Biofertilizer, vermicompost, PSB, growth parameters

Introduction

Barley (*Hordeum vulgare* L.), a member of the grass family, is one of the world's first cultivated grain crops and currently ranks as the fourth most important cereal globally, following wheat, rice, and maize (Kant *et al.*, 2016) [2]. Highly versatile and hardy, barley thrives across temperate, tropical, and subtropical regions and exhibits strong resilience to adverse agroclimatic conditions such as drought, salinity, and alkalinity. Globally, barley production stands at 142.64 million tonnes across an area of 46.90 million hectares (ICAR-IIWBR, 2023). In India, the crop covers 0.62 million hectares, producing approximately 1.69 million tonnes with an average productivity of 2733 kg/ha (ICAR-IIWBR, 2023). Rajasthan is the leading producer in the country, accounting for over 55% of the area and 56% of national production, yielding 0.94 million tonnes at a productivity rate of 2815 kg/ha (ICAR-IIWBR, 2023; DA&FW, 2025).

Achieving the desired grain quality and maximizing yield requires meticulous fertilizer management. Optimizing growth parameters such as biomass accumulation, cellular development, and photosynthetic efficiency relies heavily on the synchronized application of major macronutrient (Marschner, 1995) [4]. As the most crucial nutrient for plant development, nitrogen is a core component of protoplasm and chlorophyll. It directly influences vegetative growth parameters and photosynthetic capacity, driving the activity of every living cell. Essential for plant metabolism and biochemical processes, phosphorus facilitates energy transfer and storage (via ADP and ATP) and is a vital constituent of DNA and RNA, directly impacting cell division and genetic transmission. Potassium regulates cellular osmotic pressure and cell membrane potential, ensuring the proper hydration of the protoplasm. It also activates enzymes necessary for protein synthesis, aids in carbohydrate translocation, and bolsters the plant's resistance against fungal and bacterial diseases (Wang *et al.*, 2023) [12].

To sustainably harness potential yields and improve soil fertility, the integration of biofertilizers has emerged as a vital agronomic practice. Biofertilizers introduce live or latent efficient microbial strains that accelerate nutrient cycling and produce plant growth promoting (PGP) substances (Singh *et al.*, 2025) [8]. Key microbial agents include: Free-living soil microbes that bind

atmospheric nitrogen, converting it into a form accessible to the plant roots, thereby supporting sustained vegetative growth. These bacteria convert applied and naturally occurring insoluble soil phosphates into available forms, directly enhancing root development and overall crop yields (Sun *et al.*, 2026) ^[10].

Materials and Methods

The experiment was carried out at the Agricultural Research Farm, Rama University, Kanpur, Uttar Pradesh, during the rabi season of 2025-26. The soil of the experimental site was sandy loam in texture, low in available nitrogen, medium in available phosphorus and potassium, and slightly alkaline in reaction (pH 8.18). The barley variety DWRB-160 was sown at a seed rate of 100 kg/ha.

The experiment was laid out in a Randomized Block Design (RBD) with 10 treatments and 3 replications. The treatments were: T₁ (Control), T₂ (50% RDF), T₃ (50% RDF + Vermicompost), T₄ (50% RDF + Vermicompost + PSB), T₅ (75% RDF), T₆ (75% RDF + Vermicompost), T₇ (75% RDF + Vermicompost + PSB), T₈ (100% RDF), T₉ (100% RDF + Vermicompost), and T₁₀ (100% RDF + Vermicompost + PSB). Biometric observations for growth parameters like plant height, number of tillers m⁻², leaf area index (LAI), and dry matter accumulation were recorded at 30, 60, 90 DAS, and at harvest.

Results and Discussion

Plant height (cm)

Plant height was significantly enhanced by nutrient treatments across all growth intervals, with treatment T₁₀ (100% RDF + Vermicompost + PSB) consistently recording the maximum heights: 27.45 cm at 30 DAS, 59.68 cm at 60 DAS, 81.58 cm at 90 DAS, and 109.53 cm at harvest. Treatments T₉ and T₈ closely followed, reaching 106.93 cm and 104.76 cm at harvest, respectively. Conversely, the T₁ (Control) treatment consistently exhibited the shortest plants at every stage, culminating at 82.58 cm at harvest. This increase is attributed to the stimulation of root and shoot growth and cellular elongation through continuous mineral supply. The findings are consistent with the results of Khan *et al.* (2016) ^[3], Yadav *et al.* (2017) ^[13] and Singh *et al.* (2018) ^[9].

Number of tillers m⁻² row length

The number of tillers reached its peak at 60 DAS, after which a decline was observed at 90 DAS and at harvest due to physiological tiller mortality. The maximum number of tillers m⁻² was recorded in T₁₀ (100% RDF + Vermicompost + PSB), achieving 142.83 at 60 DAS and maintaining a high of 111.83 at harvest. The T₁ (Control) treatment consistently exhibited the lowest tiller count across all stages, with 94.50 at 60 DAS and 64.66 at harvest. These findings align with the results of Tejalben *et al.* (2017) ^[11] and Rathwa *et al.* (2018) ^[6].

Leaf Area Index (LAI)

LAI increased significantly up to 60 DAS before declining due to crop senescence. Treatment T₁₀ achieved the highest LAI at 60 DAS (4.77), followed closely by T₉ (4.56). The minimum LAI was consistently observed in the control group (3.15 at 60 DAS). The integrated approach enhanced vegetative growth and canopy architecture. The integrated application of organic and inorganic fertilizers significantly increases the Leaf Area Index (LAI) of barley by providing a continuous, balanced nutrient supply that accelerates early leaf expansion and delays senescence. This synergistic nutrient management optimizes the crop's photosynthetic canopy architecture, leading to superior dry matter

accumulation compared to using either fertilizer source alone. The findings are consistent with the results of Singh *et al.* (2018) ^[9].

Dry matter accumulation (g m⁻² row length)

Dry matter accumulation was maximized across all growth intervals under treatment T₁₀, which recorded 355.39 g m⁻² at harvest. Treatments T₉ and T₈ closely followed with harvest accumulations of 351.74 g and 348.67 g, respectively. The T₁ (Control) treatment exhibited the poorest performance, terminating with 296.58 g m⁻² at harvest. The combination of vermicompost, PSB, and chemical fertilizers stimulated vegetative growth, leaf area expansion, and net photosynthetic rate. The findings are consistent with the results of Singh *et al.* (2011) ^[7], Patel *et al.* (2018) ^[5] and Singh *et al.* (2018) ^[9].

Number of days to 50% flowering and maturity

Integrated nutrient management significantly accelerated the crop's phenological development, with treatment T₁₀ achieving the earliest 50% flowering at 61.50 days and the earliest maturity at 108.96 days. The maximum duration for both parameters was consistently observed in the T₁ (Control), taking 78.53 days to reach 50% flowering and 126.50 days to mature. These findings align with the results of Dwivedi *et al.* (2014) ^[1] and Khan *et al.* (2016) ^[3].

Conclusion

The study demonstrates that integrating chemical fertilizers with organic and biological sources promotes vigorous vegetative growth in barley. The application of 100% RDF + Vermicompost + PSB (T₁₀) emerged as the best practice, significantly boosting plant height, tillering, LAI, dry matter accumulation, and ensuring early phenological development.

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