

Effect on growth and yield of barley (*Hordeumvulgare*L.) under different nutrient management practices

ABSTRACT

A field experiment was conducted during the *Rabi* season of the year 2022-2023 at the KVK Farm, Mahendergarh of CCS Haryana Agricultural University, Hisar during *Rabi* season 2022-23 with the objective to study the effect of different nutrient management practices on growth and yield of barley. The experiment containing eleven treatments viz. Control, 100% RDF (60 kg N + 30 kg P₂O₅ + 15 kg K₂O ha⁻¹, 100% RDF) + Azotobactor + PSB, 50% RDF + Azotobactor + PSB, 50% RDF + 50% RDN through Vermicompost, 50% RDF + 50% RDN through Vermicompost+ Azotobactor + PSB, 75% RDF + Azotobactor + PSB, 75% RDF + 25% RDN through Vermicompost, 75% RDF + 25% RDN through Vermicompost + Azotobactor + PSB, 100% RDN through vermicompost and 100% RDN through vermicompost + Azotobactor + PSB. All the growth and yield parameters increased significantly with 75% R.D.F + 25% N through Vermicompost. The growth characters like plant height (cm) and number of tillers/m² were significantly higher under 75% R.D.F + 25% N through Vermicompost + Azotobactor + PSB as compared to other nutrient combinations. The yield components like spike length (cm), number of grains spike⁻¹, grain yield (kg ha⁻¹) and straw yield (kg ha⁻¹) were significantly higher under 75% R.D.F + 25% N through Vermicompost+ Azotobactor + PSB. Harvest index and 1000-grain weight (g) were not influenced significantly due to different nutrient combinations. The nitrogen and protein content in grain were obtained higher with 75% R.D.F + 25% N through Vermicompost + Azotobactor + PSB which was significantly higher than rest of treatments. Thus, it can be concluded that a dose of 75% R.D.F + 25% N through Vermicompost + Azotobactor + PSB may be most suitable nutrient combination for achieving higher growth and yield of barley.

Keywords: Growth, Yield, Vermicompost, Biofertilizers

INTRODUCTION

Barley (*Hordeumvulgare* L.), also known as 'groats', with chromosome number 2n=14, is an edible annual grass in the family Poaceae, which is grown as a cereal grain crop. It is reported to have originated from western Asia or Ethiopia. It is the fourth largest grain crop produced globally after wheat, rice and corn. It is highly adaptable functional cereal crop that is produced in climates ranging from subarctic to subtropical. Barley is generally grown in areas with limited irrigation facilities and are affected with salt problems, as it can tolerate moisture and salt stress to a great extent (Yadav et al., 2003). Only 10% of barley is used as human food, while the remaining is used for brewing malt beverages, including beer and whiskey. However, the majority of the harvested barley is fed to animals. In India, barley is planted from October through November during the *Rabi* season, and it is

harvested from March through April. It is grown on an area of 6.84 lakh hectares with production of 1.99 million metric tonnes (Anonymous, 2021). The major states for barley production are Rajasthan, Uttar Pradesh and Madhya Pradesh. It is also cultivated for malting and brewing purposes in Haryana, Western U.P., Punjab and Rajasthan with relatively better management to get good grain quality (Gautam et al., 2021).

Rajasthan ranks first in barley production (935.75 thousand tonnes), followed by Uttar Pradesh (488.11 thousand tonnes) and Madhya Pradesh (47.98 thousand tonnes). Rajasthan had the maximum area under barley (269.75 thousand hectares) and contributed a share of 43 per cent to the total area and 54 per cent to the total production. The average crop productivity of barley was highest in Punjab (3777 kg ha⁻¹) followed by Rajasthan (3469 kg ha⁻¹), Haryana (3343 kg ha⁻¹), and Uttar Pradesh (3109 kg ha⁻¹) (Indiastat, 2020-21). Barley in Haryana is grown mainly in the South-Western zone with an area of 9.26 thousand hectares with production 30.96 thousand tonnes and average productivity 3343 kg ha⁻¹ (Indiastat, 2016-17).

To increase yield and quality parameters, integrated nutrient management (INM) is flexible approach to minimize the use of chemical fertilizers and at the same time, maximize their use efficiency and farmers' profit. INM refers to maintenance of soil fertility and plant nutrient supply to an ideal level for sustaining the desired crop productivity through the use of all possible sources of plant nutrients in an integrated manner. It involves a combination of fertilizers, organic manures and bio-fertilizers not only to sustain crop production, preserve soil health and biodiversity, but also helps in minimizing the cost of chemical fertilizers and improving crop performance and soil fertility by improving fertilizer use efficiency. The advantage of merging organic and inorganic sources of nutrients in INM has been proved superior to the use of each component separately (Shukla *et al.*, 2014). Also, integrated nutrient management significantly improves phenological and growth parameters, yield components and yield of barley (Dinka *et al.*, 2018).

Vermicomposting is a method of converting organic wastes into usable substrates. In this process, the digestive tracts of certain earthworm species (e.g., *Eiseniafetida*) are used to convert organic materials (usually wastes) into a stable, humus-like material known as vermicompost or worm castings. Vermicompost is a rich source of major and minor plant nutrients. On an average, it contains 3% N, 1% P₂O₅ and 1.5% K₂O. It serves as an excellent base for many beneficial free living and symbiotic microbes which improve the availability of nutrients to the plants (Das and Avasthe, 2018). Biofertilizers can be defined as biological products containing living microorganisms that, when applied to seed, plant surfaces, or soil, promote growth by several mechanisms such as increasing the supply of nutrients, increasing root biomass or root area and increasing nutrient uptake capacity of the plant (Vessey, 2003). Biofertilizers such as *Azotobacter*, an abiotic and free-living soil microbe, naturally fix atmospheric nitrogen in the rhizosphere, while the phosphate solubilizing bacteria (PSB)

play an important role in converting insoluble P (chemically fixed and applied) into soluble form resulting in higher crop yields (Gull *et al.*, 2004). Therefore, adoption of integrated plant nutrient supply (IPNS) and management strategies for enhancing soil quality, input use efficiency and crop productivity is extremely important for food and nutritional security in agriculture. The combined use of organic and inorganic sources of plant nutrient, therefore, not only pushes the production and quality of field crops, but also helps in maintaining the permanent fertility status of the soil (Sharma *et al.*, 2001).

MATERIALS AND METHODS

The present investigation entitled “Effect on growth and yield of barley (*Hordeum vulgare* L.) under different nutrient management practices” was conducted at the KVK Farm, Mahendergarh of CCS Haryana Agricultural University, Hisar during Rabi season 2022-23. The site is located at 27° 47° North latitude and 76°51 East longitude. It is situated at an average height of 262 m (859 feet) above sea level. The climate of Mahendergarh is tropical, semiarid and hot. It is mostly dry with very hot summer and cold winter except during the monsoon when moist air from the ocean penetrates in to the district. The experiment was conducted in Randomized Block Design having three replications with the eleven treatments viz., (T₁) Control, (T₂) 100% RDF, (T₃) 100% RDF + Azotobactor + PSB, (T₄) 50% RDF + Azotobactor + PSB, (T₅) 50% RDF + 50% RDN through Vermicompost, (T₆) 50% RDF + 50% RDN through Vermicompost+ Azotobactor + PSB, (T₇) 75% RDF + Azotobactor + PSB, (T₈) 75% RDF + 25% RDN through Vermicompost, (T₉) 75% RDF + 25% RDN through Vermicompost + Azotobactor + PSB, (T₁₀) 100% RDN through vermicompost and (T₁₁) 100% RDN through vermicompost + Azotobactor + PSB. The treatments were allocated to different plots at random in all the three replications using the random table. For this experiment observations were recorded on the growth parameter viz., Plant population/m², plant height (cm) and number of tillers/m² and yield attributes i.e Spike length (cm), Number of grains spike⁻¹, 1000-grain weight (g); Grain yield (q ha⁻¹), Straw yield (q ha⁻¹) and Harvest index (%). Barley variety 'BH 396' was sown on 4 November 2022 and the crop was harvested on 22 March 2023. All other operations were performed as per the recommendations for the crop.

RESULTS AND DISCUSSION

Growth attributes

Maximum plant height was recorded under 75% R.D.F + 25% N through vermicompost at all the crop growth stages which was mainly due to more availability of nitrogen and other essential nutrients due to higher mineralization rate of vermicompost compared to FYM. Similar results were also observed by Kakraliya *et al.* (2017). Maximum numbers of tillers were recorded under 75% R.D.F + 25% N through Vermicompost+ Azotobactor + PSB at 60 and 90 days after sowing and at maturity.

Reduction in number of tillers after 90 days of sowing may be due to mortality of shoots. Similar results have been reported by Sunag et al. (2021).

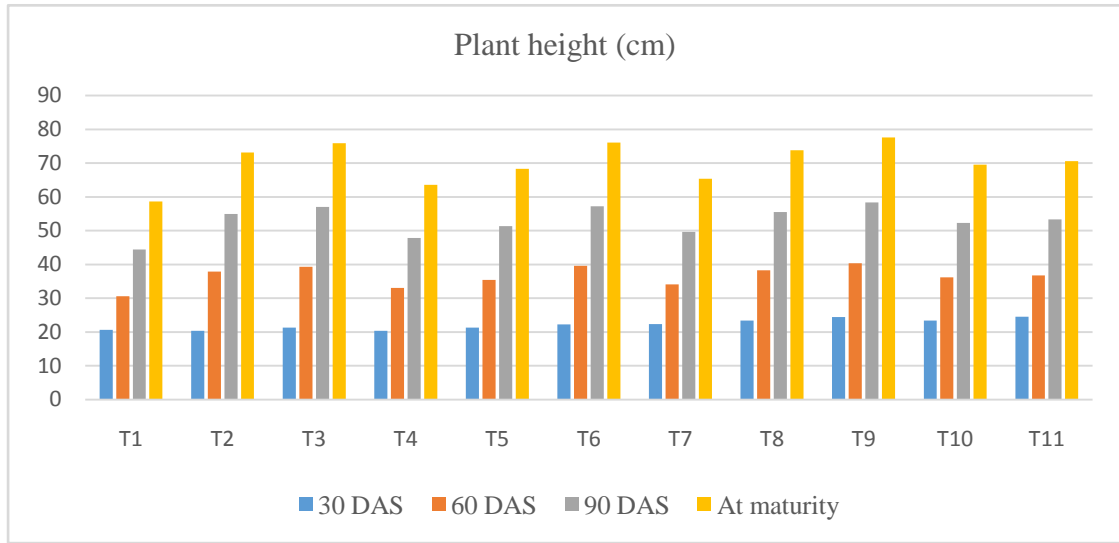


Figure 1: Effect of integrated nutrient management on plant height (cm) of barley

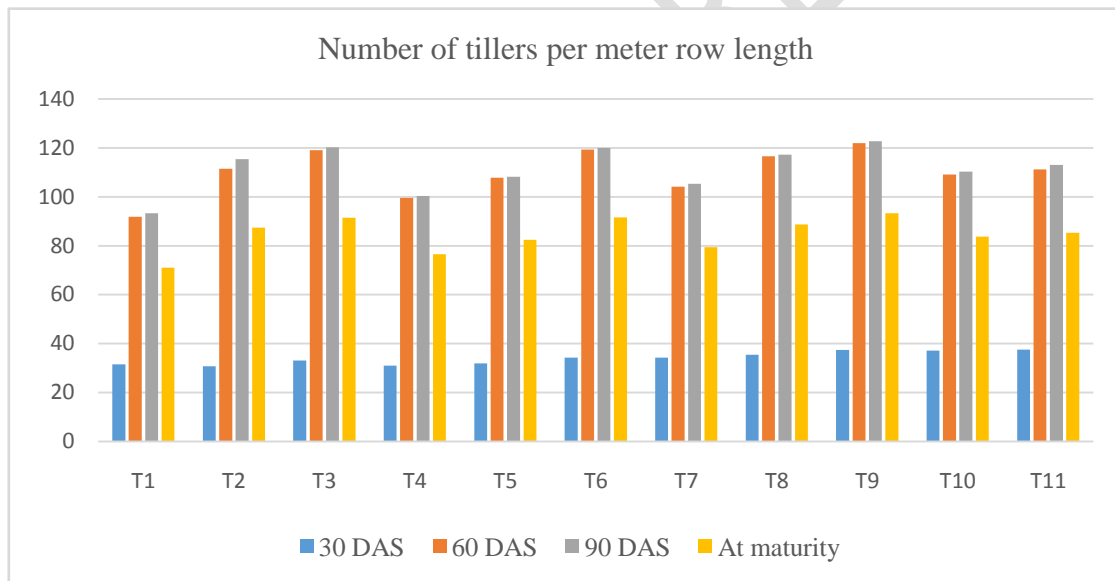


Figure 2: Effect of integrated nutrient management on number of tillers/mrl of barley

Yield attributes and yield

The number of grains spike⁻¹ was affected by various treatments. The maximum number of grains spike⁻¹ was recorded under 75% R.D.F and 25% N through Vermicompost + Azotobactor + PSB in comparison to other treatments. The number of grains spike⁻¹ determined primarily by the amount of nutrient observed and secondary by the amount of carbohydrate produced at the time of spikelets differentiation. Maximum length of spike was recorded with 75% R.D.F and 25% N through Vermicompost + Azotobactor + PSB was significantly superior over rest of the treatment. The lowest

value of yield attributing characters were obtained under T₁ treatment because plants were subjected to utilize the least amount of available nitrogen which resulted into reduced translocation of photosynthesis from source to sink. The results are in line with those of Devi *et al.* (2011). The yield was recorded significantly higher under 75% R.D.F + 25% N through vermicompost + Azotobactor + PSB as compared to other treatments. This might be due to adequate nitrogen availability which contributed to increase dry matter accumulation. Better vegetative growth coupled with high yield attributes resulted into higher grain yield due to higher availability of macro, micronutrients and plant growth promoters present in the vermicompost. Reduced nutrient supply as in case of rest of the treatment, recorded lowest yield due to both poor growth and yield attributes. The results are in conformity with Singh *et al.* (2018) and Dhakal *et al.* (2016). Maximum straw yield was recorded under 75% R.D.F and 25% N through Vermicompost + Azotobactor + PSB. This may be probably due to higher density of tiller and increased rate of dry matter production per unit area as a result of better performance of vegetative growth caused due to efficient assimilation and absorption of nutrients from the soil during entire period of growth. From the present investigation it has been concluded that treatment with integration of 75% RDF + 25% RDN through vermicompost + Azotobactor+ PSB (T₉) performed best in case of plant height, number of tillers per meter row length, spike length, number of grains per spike, grain yield, straw yield and biological yield and the minimum success was obtained in control. While the data obtained was found non-significant with plant population per meter row length, test weight and harvest index. Treatment with integration of 100% RDF + Azotobactor+ PSB has more P and K in soil after harvest.

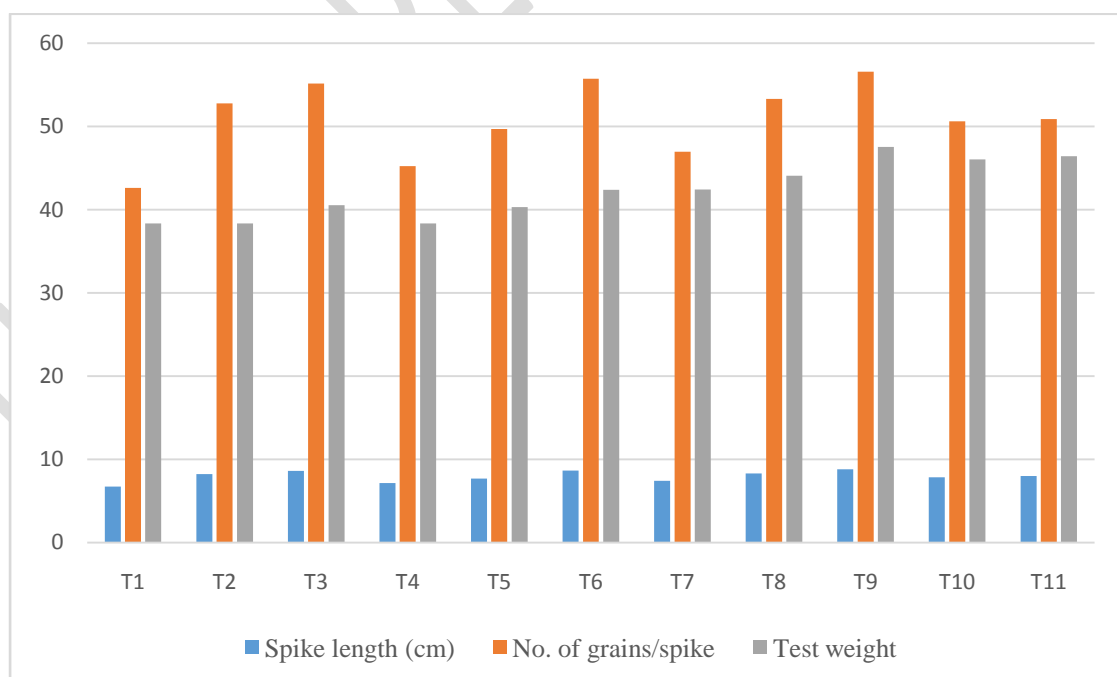


Figure 3 Effect of integrated nutrient management practices on yield attributes of barley

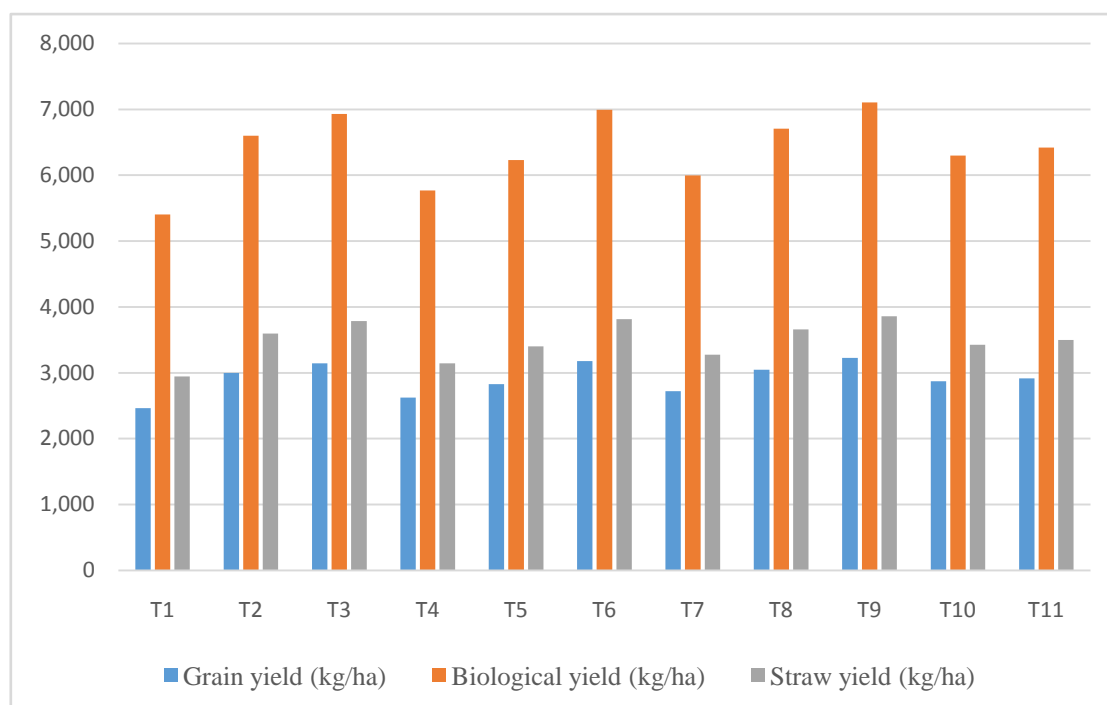


Figure 4: Effect of integrated nutrient management practices on yield and harvest index of barley

CONCLUSION

The results of this study indicated that integrated nutrient management significantly improved growth and yield of barley. Based on one year study, it can be concluded that plant height and number of tillers were highest in treatment T₉ followed by treatment T₆ and T₃. Among various combinations of chemical fertilizer, vermicompost, *Azotobactor* and PSB highest spike length (cm), number of grains spike-1, grain yield (kg ha⁻¹) and straw yield was recorded in treatment T₉ followed by treatment T₆ and T₃. Overall Integrated Nutrient Management treatment resulted in higher growth and yield.

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UNDER PEER REVIEW

Table1. Effect of different nutrient management practices on plant height (cm) and on number of tillers/mrl of barley

Treatments	Plant height (cm)				Number of tillers/mrl			
	30 DAS	60 DAS	90 DAS	At maturity	30 DAS	60 DAS	90 DAS	At maturity
T ₁ :Control	20.67	30.64	44.40	58.65	31.53	91.82	93.24	71.04
T ₂ : 100% RDF (60 kg N ha ⁻¹ , 30 kg P ₂ O ₅ ha ⁻¹ and 15 kg K ₂ O ha ⁻¹)	20.33	37.94	54.98	73.13	30.77	111.54	115.46	87.44
T ₃ : 100% RDF + <i>Azotobactor</i> + PSB	21.35	39.34	57.03	75.85	33.14	119.13	120.26	91.49
T ₄ : 50% RDF + <i>Azotobactor</i> + PSB	20.33	33.02	47.81	63.59	31.01	99.59	100.40	76.50
T ₅ : 50% RDF + 50% RDN through Vermicompost	21.35	35.41	51.31	68.27	31.86	107.76	108.26	82.46
T ₆ : 50% RDF + 50% RDN through Vermicompost + <i>Azotobactor</i> + PSB	22.30	39.58	57.22	76.10	34.22	119.37	120.00	91.63
T ₇ : 75% RDF + <i>Azotobactor</i> + PSB	22.37	34.06	49.60	65.39	34.25	104.17	105.37	79.37
T ₈ : 75% RDF + 25% RDN through Vermicompost	23.38	38.30	55.51	73.83	35.46	116.57	117.26	88.71
T ₉ : 75% RDF + 25% RDN through Vermicompost + <i>Azotobactor</i> + PSB	24.40	40.37	58.32	77.57	37.47	121.94	122.70	93.31
T ₁₀ : 100% RDN through vermicompost	23.38	36.16	52.32	69.58	37.10	109.09	110.36	83.71
T ₁₁ : 100% RDN through vermicompost+ <i>Azotobactor</i> + PSB	24.50	36.78	53.30	70.59	37.59	111.26	113.05	85.29
SEm±	1.218	0.54	0.77	1.04	1.71	0.97	1.66	1.12
C.D. at 5%	NS	1.61	2.28	3.09	NS	2.89	4.94	3.33

Table 2. Effect of different nutrient management practices on yield attributes, yield and harvest index of barley

Treatments	Spike length (cm)	No. of grains/spike	Test weight (g)	Grain yield (kg/ha)	Biological yield (kg/ha)	Straw yield (kg/ha)	Harvest index (%)
T ₁ : Control	6.73	42.62	38.03	2,463	5,406	2,943	45.57
T ₂ : 100% RDF (60 kg N ha ⁻¹ , 30 kg P ₂ O ₅ ha ⁻¹ and 15 kg K ₂ O ha ⁻¹)	8.25	52.78	39.81	2,999	6,598	3,599	45.45
T ₃ : 100% RDF + <i>Azotobactor</i> + PSB	8.60	55.14	40.25	3,143	6,930	3,787	45.35
T ₄ : 50% RDF + <i>Azotobactor</i> + PSB	7.17	45.23	38.55	2,625	5,770	3,146	45.48
T ₅ : 50% RDF + 50% RDN through Vermicompost	7.70	49.68	39.77	2,828	6,232	3,404	45.38
T ₆ : 50% RDF + 50% RDN through Vermicompost + <i>Azotobactor</i> + PSB	8.66	55.72	40.07	3,180	6,996	3,817	45.45
T ₇ : 75% RDF + <i>Azotobactor</i> + PSB	7.44	46.98	39.81	2,722	5,996	3,274	45.40
T ₈ : 75% RDF + 25% RDN through Vermicompost	8.32	53.29	41.94	3,049	6,709	3,659	45.45
T ₉ : 75% RDF + 25% RDN through Vermicompost + <i>Azotobactor</i> + PSB	8.82	56.58	42.49	3,226	7,107	3,859	45.40
T ₁₀ : 100% RDN through vermicompost	7.85	50.60	39.07	2,871	6,297	3,425	45.60
T ₁₁ : 100% RDN through vermicompost+ <i>Azotobactor</i> + PSB	7.99	50.88	39.71	2,918	6,418	3,500	45.47
SEm±	0.12	0.95	1.04	39.7	92.2	53.03	0.08
C.D. at 5%	0.37	2.83	NS	118	274	158	NS