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Determining the Effect of Integrated Nutrient Management on Growth and Yield of Barley (*Hordeum vulgare* L.) in Rajasthan, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted at experimental farm, Department of Agronomy, Faculty of Agriculture and Veterinary Sciences, Mewar University Gangrar, Chittorgarh (Rajasthan) during Rabi season of 2022-23 to effect of integrated nutrient management on growth and yield characters of barley variety "Rd-2036" was used in this study. The required quantities of fertilizers as per treatments were applied. The experiment was laid out in randomized block design with three replications consisting of nine treatments combinations. The increased yield parameter such as

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number of per siliqua, seed yield, stover yield harvest index was recorded with T_9 (Azotobacter + PSB + 30 kg ha^{-1} N through inorganic Fertilizer + 30 kg ha^{-1} N through poultry manure). The data revealed that the maximum plant height (97.05 ccm), total numbers of tillers (70.25) and yield attributes spike length (7.68 cm), number of grains/spike (44.96), grain yield (42.58 q/ha), straw yield (60.15 q/ha), biological yield (102.73 q/ha) and net return (53406.30 Rs/ha) was recorded with treatment T_5-75% RDF + PSB + Azotobacter.

Keywords: INM; barley; azotobacter; yield.

1. INTRODUCTION

"Barley (*Hordeum vulgare* L.) is the world´s fourth most important cereal crop after wheat, rice and maize and the most dependable crop in alkali soils and areas where frost or drought occurs. The major barley producing countries are China, Russia, Germany, USA, Canada, India, Turkey and Australia. The major use of barley grain is in brewing industries for manufacturing malt which is used to make beer, industrial alcohol, whisky, malt syrups, brandy, malted milk, vinegar and yeast. In India, barley is mainly grown in the northern plains and concentrates in the states of Rajasthan, Haryana, Punjab and western UP" [1,2,3].

"Nitrogen is universally deficient plant nutrient in most of the Indian soils. Nitrogen is an essential constituent of many compounds such as nucleotides, phospholipids, enzymes, hormones and vitamin etc. It governs to a considerable degree to the utilization of carbohydrates, potassium and other elements. Nitrogen being an essential constituent of protein nucleic acid and chlorophyll plays a major role in photosynthesis and chlorophyll synthesis" [4]. "Phosphorus is another important nutrient next to nitrogen. At present 49.3% of the Indian soils are under low category, 48.8% under medium and 1.9% under high category of P" [5].

"Over use of chemical fertilizers harms the biological power of soil, which must be prevented as all nutrient transformation are negotiated by soil micro flora. Organic matter is the source of energy to the soil micro flora and organic carbon content and it is considered to be index of the soil health. Organic materials are intrinsic and essential component of all soils and make the soil a living dynamic system. Organic matter serves as a reservoir of nutrients that are essential for plant growth" [1,2,3].

"Bio-fertilizers can play an important role in meeting the nutrient requirement of crops through biological nitrogen fixation (BNF), solubilization of insoluble forms of nutrients, stimulation of plant growth and decomposition of plant residues. Azotobacter is a free-living bacterium in non-legume crop and secretes some growth promoting substances. Azotobacter is reported to have beneficial effects on almost all the cereals crops" Tetarwal et al. [6].

"The vermicomposting is a rich source of macro and micronutrients, vitamins, enzymes, antibiotics and growth hormones. Apart from the balanced supply of nutrient it improves the fertilizer and water use efficiency even better than FYM" [7].

2. MATERIALS AND METHODS

A field experiment was conducted during Rabi season of 2022-23 at experimental farm, Department of Agronomy, Faculty of Agriculture and Veterinary Sciences, Mewar University Gangrar, Chittorgarh (Rajasthan). Soil of the experimental field was sandy loam in texture, saline in reaction with a pH value of 7.6, poor in organic carbon (0.16%), deficient in available zinc (0.48 ppm) and iron (1.2 ppm) low in available nitrogen (176 kg/ha) and phosphorus (20.2 kg/ha) but medium in available potassium (320 kg/ha). The experiment was laid out in randomized block design with three replications consisting of nine treatments *viz;* Control, 100% RDF, 75% RDF + Azotobacter, 75% RDF + PSB, 75% RDF + PSB + Azotobacter, 50% RDF + 2t FYM + Azotobacter, 50% RDF + 2t FYM + PSB, 50% RDF + 2t FYM + Azotobacter + PSB and 50% RDF + 1 t Vermicompost. The required quantities of fertilizers as per treatments were applied. The doses of NPK were applied in the form of urea, diammonium phosphate, murate of potash respectively.

3. RESULTS AND DISCUSSION

3.1 Growth Attributes

3.1.1 Yield attributes and yield

Data revealed at 30, 60, 90 DAS and at harvest that the effect of integrated nutrient management significantly influenced the plant height (Table 1 and Fig. 1.). The maximum plant height (29.56, 72.22, 93.15 and 97.05 cm) was recorded with the treatment T_5-75% RDF + PSB + Azotobacter. The minimum plant height was recorded T_1-Control treatment (21.14, 52.50, 74.85 and 78.36 cm), respectively. This result also supported by Chauhan et al. [8] and Singh et al*.* [9].

Data revealed at 30, 60, 90 DAS and at harvest that the effect of integrated nutrient management significantly influenced the number of total tillers (Table 1 and Fig. 2). The maximum total number of tillers (68.12, 78.96, 92.45 and 90.per m row length) was recorded with the treatment T_5-75% RDF + PSB + Azotobacter. The minimum total number of tillers was recorded T_1-Control treatment (52.45, 60.14, 68.14 and 66.36 per m row length), respectively. Similar findings also reported by Laghari et al*.* [10] and Dhaka et al*.* [11].

Table 1. Effect of integrated nutrient management on growth attributes of barley at different growth stages

Treatments	Plant height (cm)				Total number of tillers (m/row)			
	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest
T_1-Control	21.14	52.50	74.85	78.36	52.42	60.14	68.14	66.36
T_2-100% RDF	28.68	70.44	90.45	95.44	64.25	74.14	88.63	85.36
T_3-75% RDF + Azotobacter	26.78	69.47	88.45	92.77	60.12	71.25	82.85	81.36
T_4-75% RDF + PSB	26.44	67.85	87.89	90.65	58.36	70.96	82.36	79.36
T_5-75% RDF + PSB + Azotobacter	29.56	72.22	93.15	97.05	68.12	78.96	92.45	90.12
T_6-50% RDF + 2t FYM + Azotobacter	25.14	65.11	85.44	88.25	56.74	68.96	80.14	77.14
T_7-50% RDF + 2t FYM + PSB	24.66	62.96	83.47	86.36	55.66	66.35	78.35	75.36
T_8-50% RDF + 2t FYM + Azotobacter + PSB	28.12	69.35	89.69	93.47	62.14	73.14	86.47	84.36
T_9-50% RDF + 1t Vermicompost	23.25	62.52	83.02	85.45	54.33	65.96	77.85	74.15
SEm ±	0.40	0.75	1.14	1.22	2.02	2.13	3.08	2.70
CD at 5 %	1.19	2.26	3.39	3.65	6.06	6.32	9.36	8.10
CV%	7.45	7.98	9.85	9.15	7.88	93.75	10.45	9.33

Table 2. Effect of integrated nutrient management on yield attributes and yield of barley

Treatments	Number of effective tillers	Spike Length (cm)	Number of grains/ spike	Grain yield (q/ha)	Straw yield (q/ha)	Biological yield (q/ha)
T_1-Control	56.36	5.75	30.25	25.14	48.78	73.92
T_2-100% RDF	68.66	7.02	42.36	40.05	58.36	98.41
T_3-75% RDF + Azotobacter	64.25	6.85	37.66	37.36	53.69	91.05
T_4-75% RDF + PSB	63.36	6.8	35.36	35.47	52.12	87.59
T_5-75% RDF + PSB + Azotobacter	70.25	7.68	44.96	42.58	60.15	102.73
T_6-50% RDF + 2t FYM + Azotobacter	62.12	6.62	34.96	33.69	51.78	85.47
T_7-50% RDF + 2t FYM + PSB	60.02	6.55	33.85	30.14	50.36	80.5
T_8-50% RDF + 2t FYM + Azotobacter + PSB	66.15	6.92	40.36	39.36	54.36	93.72
T_9-50% RDF + 1t Vermicompost	59.30	6.52	32.22	28.36	49.66	78.02
SEm ±	1.36	0.22	1.20	2.34	1.29	3.72
CD at 5 %	3.95	0.68	3.61	6.98	3.86	11.12

Table 3. Effect of integrated nutrient management on economics

Treatments	Cost of Cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C ratio
T_1-Control	16800	48186.25	31386.25	1.53
T_2-100% RDF	30250	81158.75	50908.75	1.59
T_3-75% RDF + Azotobacter	27859	75557.60	47698.60	1.58
T_4-75% RDF + PSB	25850	71964.45	46114.45	1.56
T_5-75% RDF + PSB + Azotobacter	32500	85906.30	53406.30	1.60
T_6-50% RDF + 2t FYM + Azotobacter	24600	68808.15	44208.15	1.55
T_7-50% RDF + 2t FYM + PSB	22100	62364.90	40264.90	1.54
T_8-50% RDF + 2t FYM + Azotobacter + PSB	29000	79161.60	50161.60	1.57
T_9-50% RDF + 1 t Vermicompost	21950	61580.00	39630.00	1.55

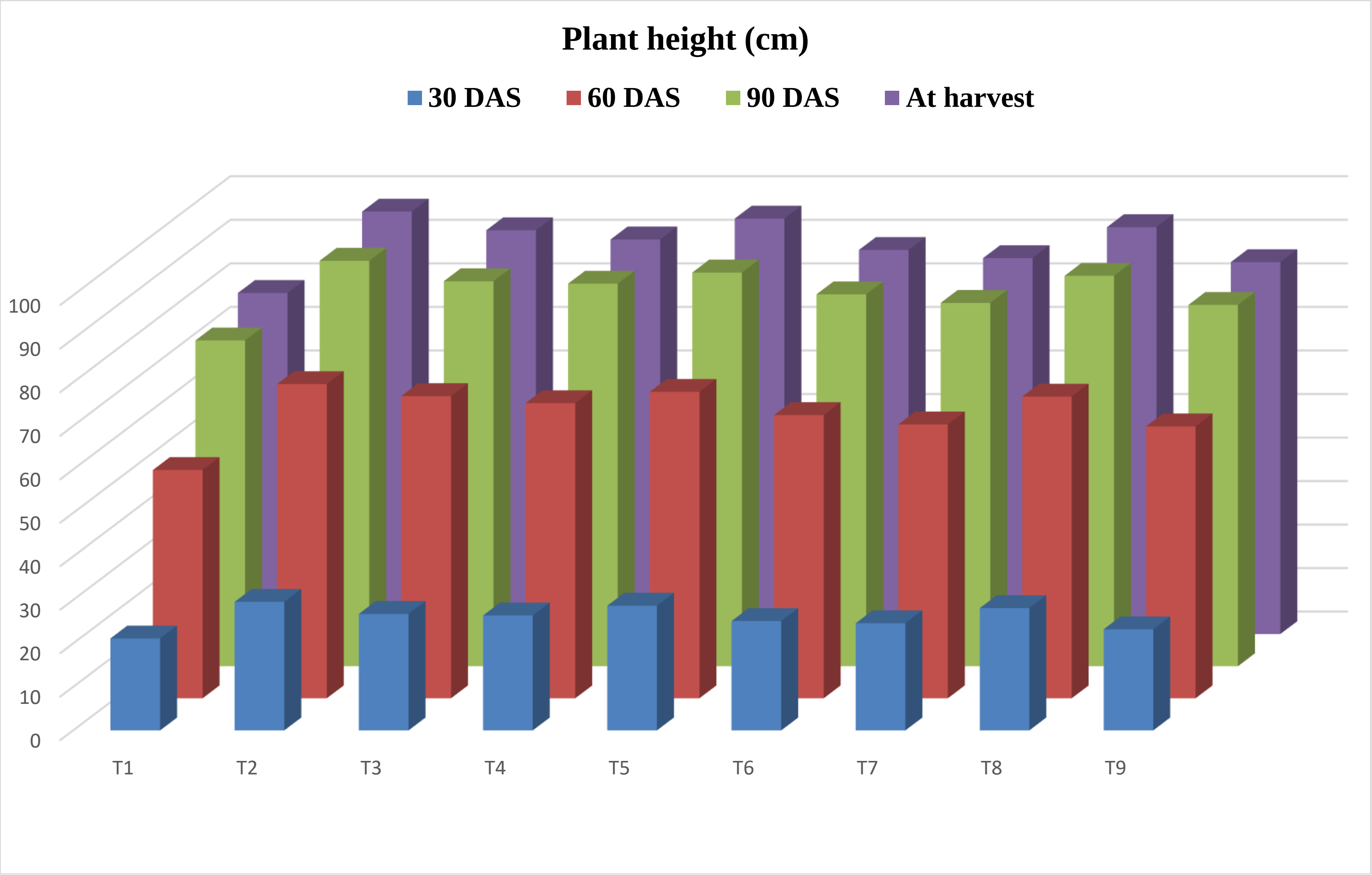

Fig. 1. Effect of integrated nutrient management on plant height of barley

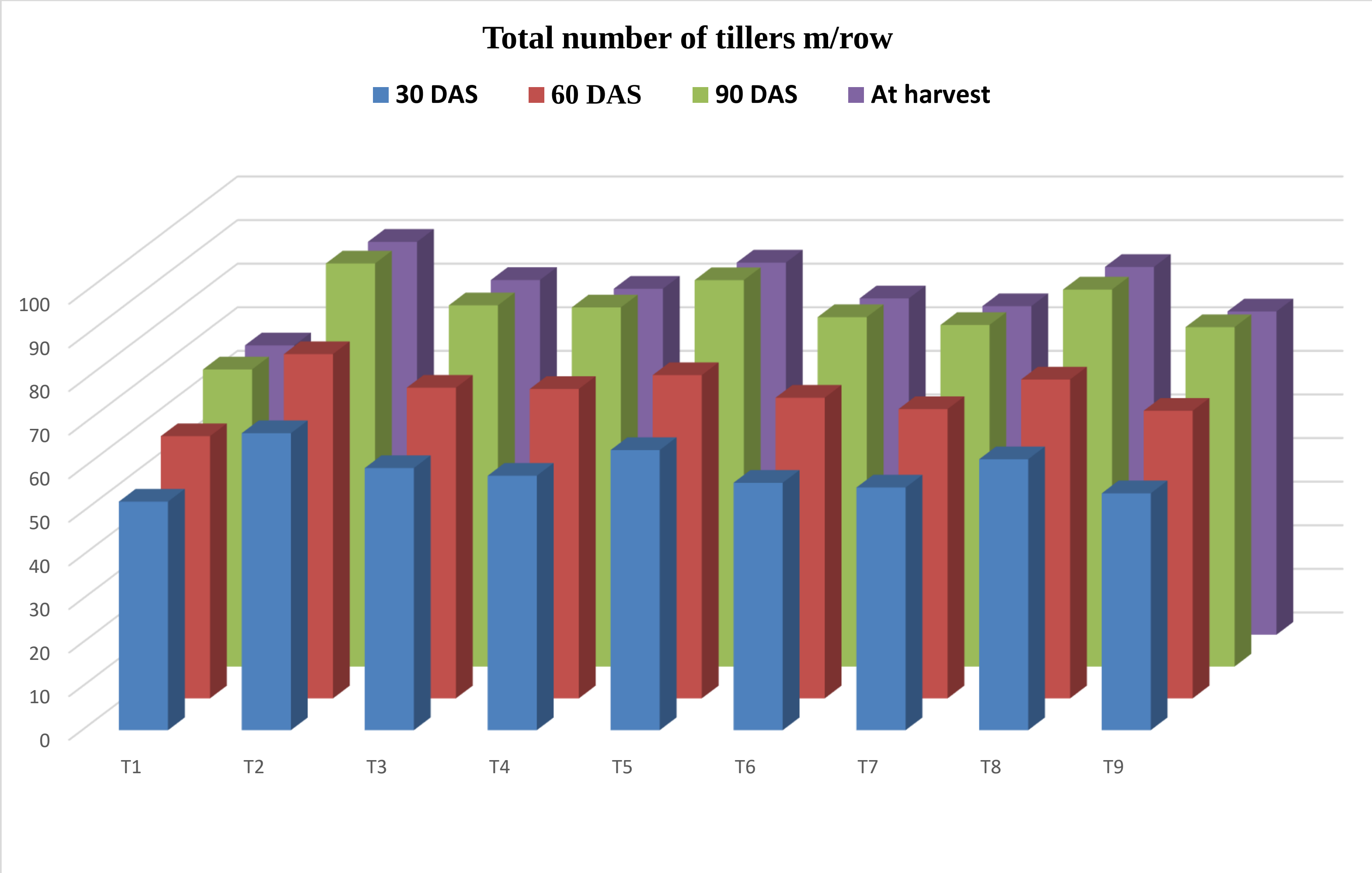

Fig. 2. Effect of integrated nutrient management on total number of tillers of barley

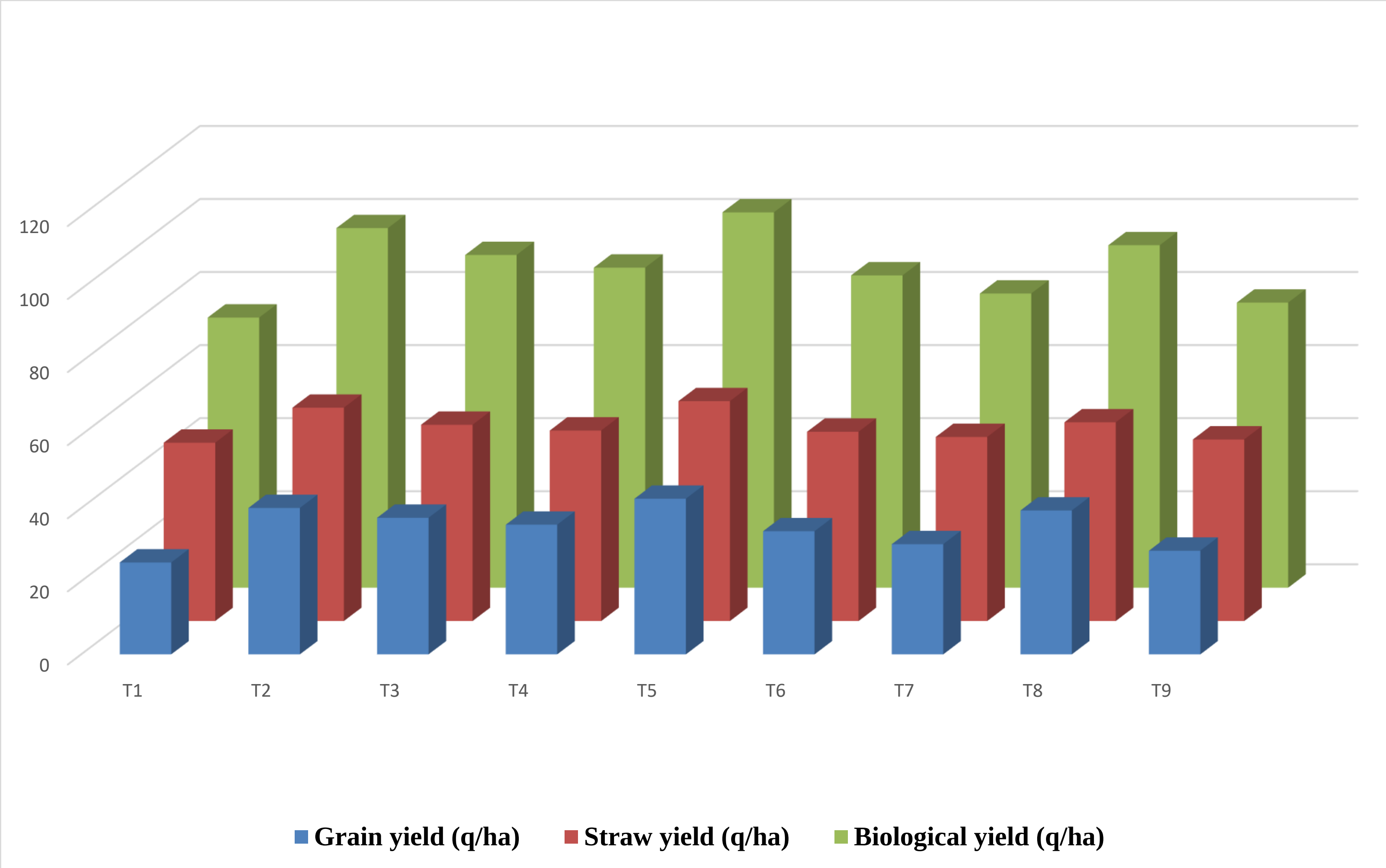

Fig. 3. Effect of integrated nutrient management on yield of barley

Data revealed that the effect of integrated nutrient management significantly influenced the spike length (Table 2). The maximum spike length (7.68 cm) was recorded with the treatment T_5-75% RDF + PSB + Azotobacter. The minimum spike length (Table 2) was recorded T_1-Control treatment (6.92 cm). Data revealed that the effect of integrated nutrient management significantly influenced the number of grains/spike (Table 2). The maximum number of grains/spike (44.96) was recorded with the treatment T_5-75% RDF + PSB + Azotobacter. The minimum number of grains/spike was recorded T_1-Control treatment (30.25). This findings also confirmed by Roy and Singh [12] and Mubarak and Singh [13].

Data showed integrated nutrient management had a considerable impact on grain output (Table 2 and Fig. 3). The treatment T_5-75% RDF + PSB + Azotobacter produced the highest grain yield (42.58 q/ha), The minimum grain yield was recorded T_1-Control treatment (25.14 q/ha). The treatment T_5-75% RDF + PSB + Azotobacter produced the highest straw yield (60.15 q/ha). The minimum straw yield was recorded T_1-Control treatment (48.78 q/ha). The treatment T_5-75% RDF + PSB + Azotobacter produced the highest biological yield (102.73 q/ha). The minimum biological yield was recorded T_1-Control treatment (73.92 q/ha). Similar result also reported by Bhakher et al. [14] and Tiwari et al. [15].

3.2 Economics Variability

Cost of cultivation fixed cost (for all treatments) is included in this chapter. Cultivation expenses for every therapy. For any treatment combination, the total cost of cultivation consists of the gross return and grain and straw yield (q ha^{-1}). Following post-harvest observation, the economic viability of each treatment was calculated to determine the cost of cultivation, gross profit, return, net profit, and benefit cost ratio for the barley crop. The benefit cost ratio and treatment economics statistics have been calculated and are shown in Table 3, correspondingly.

Notes pertaining to economics are provided in Table 3 When compared to other treatment combinations, treatment T_5-75% RDF + PSB + Azotobacter had the highest gross return (85906.30 Rs/ha), net return (50908.75 Rs/ha), and benefit-cost ratio (1.59). The economic analysis demonstrates barley cultivation's great promise. Similar result also confirmed by Malik (2017) and Kumar et al. (2021).

4. CONCLUSION

On the one-year experimentation the application of T_5-75% RDF + PSB + Azotobacter found to be most suitable to get maximum crop yield. However, the application of 75% recommended dose of fertilizer also found to be most suitable dose for good crop yield and economically superior.

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

Authors have declared that no competing interests exist.

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