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Impact of Different Nutrient Management Practices on the Nutrient Dynamics of Wheat Crop in Western Uttar Pradesh, 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

The field experiment was conduct at Crop Research Center of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, (U.P.) during winter season of 2021-22 and 2022.The Experiment was laid out in Randomized Block Design with three replication and seven treatments i.e. T_1: Control, T_2: 100% NPK (150, 75, 60), T_3: 75% NPK+ FYM @ 7.5 t ha^{-1}, T_4: 75% NPK +

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Vermicompost @ 2.5 t ha^{-1}, T_5: 100% NPK + Paddy straw @ 2.0 t ha^{-1}, T_6: 100% NPK + Paddy straw @ 2.0 t ha^{-1} + Pusa Decomposer @ 20 lit. ha^{-1}, T_7: 100% NPK + Paddy straw @ 2.0 t ha^{-1} + Vermicompost @ 1.0 t ha^{-1}. Various growth and yield characteristics were observed and statistically analyzed. The absorption of wheat grain and straw as well as the nitrogen, phosphorus, and potassium content were greatly enhanced by the addition of 100% NPK + Paddy straw @ 2.0 t/ ha^{-1} + Vermicompost @ 1.0 t/ ha^{-1} over both years. The increased fertilizer levels resulted in a significant increase in the nutritional content and uptake in plants. The nutrient content and uptake in wheat grain and straw increased significantly over control plots when 100% NPK + Paddy straw @ 2.0 t/ha + Vermicompost @ 1.0 t/ha was applied, but it was on par with 100% NPK + Paddy straw @ 2.0 t/ha + Pusa Decomposer @ 20 lit./ha.

Keywords: Wheat; nutrient management; FYM; V.C; paddy straw; pusa decomposer.

1. INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most commonly produced crop and the most widely grown cereal in the world. In terms of both production and area, wheat is the most widely grown cereal in the world. The global area of wheat is around 218.28 million ha^{-1} [1]. The annual world-wide production of wheat is 761.9 million tonnes second after maize with an average productivity of 3395 kg ha^{-1} [2].

In terms of acreage and production, wheat is India's second-most significant staple food crop after rice, and it is important to the country's food and nutritional security [3].

About 30.23 million ha of wheat are farmed in India, producing 93.50 million tonnes with the productivity of 3093 kg ha-^{1}[4]. The risk of temperature affects wheat productivity. Therefore, production is higher in the western than in the eastern parts of the nation. In terms of production and area growth, Uttar Pradesh rank first in India [5]. Uttar Pradesh, Madhya Pradesh, Haryana, Punjab, Rajasthan, Bihar, Maharashtra, West Bengal, and other states in India are the main producers of wheat. Wheat was cultivated in Uttar Pradesh over an area of around 9.65 million ha, producing 26.87 million tonnes and yielding kg ha-^{1} [2].

Integrated nutrient management (INM) plays a significant role in maintaining wheat yield and production through improving the effectiveness of applied nutrients [6]. To maintain soil fertility and achieve the highest crop yield, balanced crop fertilization using organic and inorganic manures, such as farmyard manure, composts, vermicompost, crop residues, and biofertilizers, is necessary [7]. An integrated approach to maximizing the benefits from all potential sources of plant nutrients in order to keep soil fertility and plant nutrient delivery at an ideal level for maintaining the desired productivity [8].

It is equally necessary to establish and implement an integrated plant nutrient supply system that uses chemical fertilizers, organic manures, crop residues, and bio fertilizers at the proper times and with the appropriate methods [9].

Utilizing both organic and inorganic nitrogen sources together boosts field crop productivity and profitability while maintaining the soil's fertility [10].

For greater yield and healthy soil, organic manures, crop wastes, and vermicompost are required in addition to inorganic fertilizers. Inorganic fertilizers can be used with organic manures, crop wastes, and bio-fertilizers to increase soil health and hasten the efficiency of nutrient utilization. Combining mineral fertilizers with organic manures helped increase wheat productivity when compared to a system employing simply mineral fertilization [11].

2. MATERIALS AND METHODS

The field experiment was conduct at Crop Research Center of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, (U.P.) during winter season of 2021-22 and 2022 to study the Impact of Different Nutrient Management Practices on Nutrient Content and Their Uptake by Wheat Crop in Western Uttar Pradesh. The Experiment was laid out in Randomized Block Design with three replication and seven treatments i.e. T_1: Control, T_2: 100% NPK (150, 75, 60), T_3: 75% NPK+ FYM @ 7.5 t ha^{-1}, T_4: 75% NPK + Vermicompost @ 2.5 t ha^{-1}, T_5: 100% NPK + Paddy straw @ 2.0 t ha^{-1}, T_6: 100% NPK + Paddy straw @ 2.0 t ha^{-1} + Pusa Decomposer @ 20 lit. Ha-^{1}, T_7: 100% NPK +

Paddy straw @ 2.0 t ha^{-1} + Vermicompost @ 1.0 t ha^{-1}.

Meerut is situated at 29°4' N latitude and 77°46' E longitude at an altitude of 237 m above the mean sea level. The Crop Research Centre is located 2 km away to the west of the Meerut highway and connected by pucca link road.

To evaluate the treatment effect, various observation were recorded. Recommended dose P_2O_5, K_2O through NPK grade 12:32:16 were applied at the time of sowing while 50 percent nitrogen was applied as basal and rest 50 percent in two equal splits at 30 and 60 DAS stage through urea. Required quantity of vermicompost and FYM as per treatments was also applied before sowing. Certified treated seed of wheat DBW-187 was used for experiment. With a seed rate of 100 kg ha-1, sowing was carried out manually behind a country plough .For optimal seed placement in the furrow after planting, planking was carried out.

3. RESULTS AND DISCUSSION

3.1 Nutrient Studies

3.1.1 Nitrogen content (%) in grain and straw

The nitrogen content (%) in wheat grain and straw are presented in Table 1 and depicted in Fig 1. Application of different nutrient management approaches significantly affected the nitrogen content in grain as well as straw during both of year's study. It indicates that maximum nitrogen content (1.892 and 1.905 %) in grain was found with treatment T_7 (100% NPK + Paddy straw @ 2.0 t ha^{-1} + Vermicompost @ 1.0 t ha^{-1}) which is at par T_6 and T_5 while lowest N content in grain (1.521 and 1.532 %) was found with T_1 (control) during 2021-22 & 2022-23, respectively. Maximum N content in straw (0.433 and 0.446 %) was found with T_7 which is at par with T_6 and lowest N content in straw (0.264 and 0.272 %) was found with control treatment during both the years.

The application of FYM, VC, and paddy straw may have increased the activity of soil microorganisms and led to higher populations of fungi, bacteria, and actinomycetes along with higher activity of soil enzymes, which in turn stimulated plant growth and as a result, the nutrient content and uptake in grain and straw were enhanced [12].

3.1.2 Nitrogen uptake (kg/ha) in grain and straw

The data pertaining nitrogen uptake by grain and straw of wheat are presented in Table 1 and depicted in Fig. 1. Nitrogen uptake was more during 2022-23 in both grains as well as in straw. The uptake of nitrogen in grain and straw increased significantly due to different nutrient management approaches during both years.

During both the years, the maximum N uptake in grains (94.17 and 95.73 kg/ha) was recorded with T_7 (100% NPK + Paddy straw @ 2.0 t ha^{-1} + Vermicompost @ 1.0 t ha^{-1}) whereas minimum N uptake in grains (30.67 and 31.17 kg/ha) was recorded with control plot. The maximum N uptake in straw (27.87 and 28.97 kg/ha) was recorded with T_7 (100% NPK + Paddy straw @ 2.0 t ha^{-1} + Vermicompost @ 1.0 t ha^{-1}) whereas minimum N uptake in straw (8.37 and 8.67 kg/ha) was recorded with control plot during both the years.

3.1.3 Total N uptake (kg/ha) by crop

The data regarding to total nitrogen uptake (kg/ha) by wheat crop are presented in Table 1 and depicted in Fig. 1. Total uptake of N increased significantly due to different nutrient management approaches during both years. It is indicated that highest total uptake of nitrogen (122.04 and 124.70 kg/ha) by wheat crop was recorded with the treatments T_7 (100% NPK + Paddy straw @ 2.0 t ha^{-1} + Vermicompost @ 1.0 t ha^{-1}) which is significantly higher than rest of the treatments during both years while lowest total N uptake (39.04 and 39.84 kg/ha) by crop was found with T_1 (control) during both years.

N, P, and K content and their uptake in wheat were significantly increased with higher fertilizer doses at levels ranging from 50 to 75% NPK (Goyal, 2002). Due to higher availability of these nutrients, which led to a higher biomass yield, the uptake of N, P, and K increased as the supply of NPK to the crops gradually increased [13]. Faujdar and Sharma [14] and Bejbaruha et al. [15] reported findings that were similar.

Table 1. Effect of different nutrient management approaches on N content (%), N uptake and total N uptake (kg ha^{-1}) in grain and straw of wheat

Treatment		N content in grain (%)		N content in straw (%)		N uptake in grain (kg ha^{-1})		N uptake in straw (kg ha^{-1})		Total N uptake (kg ha^{-1})	
		2021-22	2022-23	2021-22	2022-23	2021-22	2022-23	2021-22	2022-23	2021-22	2022-23
T_1	Control	1.521	1.532	0.264	0.272	30.67	31.17	8.37	8.67	39.04	39.84
T_2	100% NPK	1.714	1.726	0.341	0.351	72.29	73.13	20.74	21.48	93.03	94.61
T_3	75% NPK+ FYM @ 7.5 t ha^{-1}	1.738	1.750	0.328	0.338	75.09	76.33	20.09	20.76	95.18	97.09
T_4	75% NPK + Vermicompost @ 2.5 t ha^{-1}	1.761	1.773	0.366	0.377	77.07	78.33	22.46	23.35	99.53	101.68
T_5	100% NPK + Paddy straw @ 2.0 t ha^{-1}	1.813	1.826	0.382	0.393	80.87	82.20	23.84	24.78	104.71	106.97
T_6	100% NPK + Paddy straw @ 2.0 t ha^{-1} + Pusa Decomposer @ 20 lit. ha^{-1}	1.847	1.860	0.417	0.429	83.72	85.08	26.08	27.24	109.80	112.32
T_7	100% NPK + Paddy straw @ 2.0 t ha^{-1} + Vermicompost @ 1.0 t ha^{-1}	1.892	1.905	0.433	0.446	94.17	95.73	27.87	28.97	122.04	124.70
	SEm (±)	0.034	0.037	0.012	0.013	1.81	1.96	0.55	0.54	2.34	2.53
	C.D. (P=0.05)	0.106	0.115	0.036	0.040	5.59	6.03	1.69	1.68	7.21	7.78

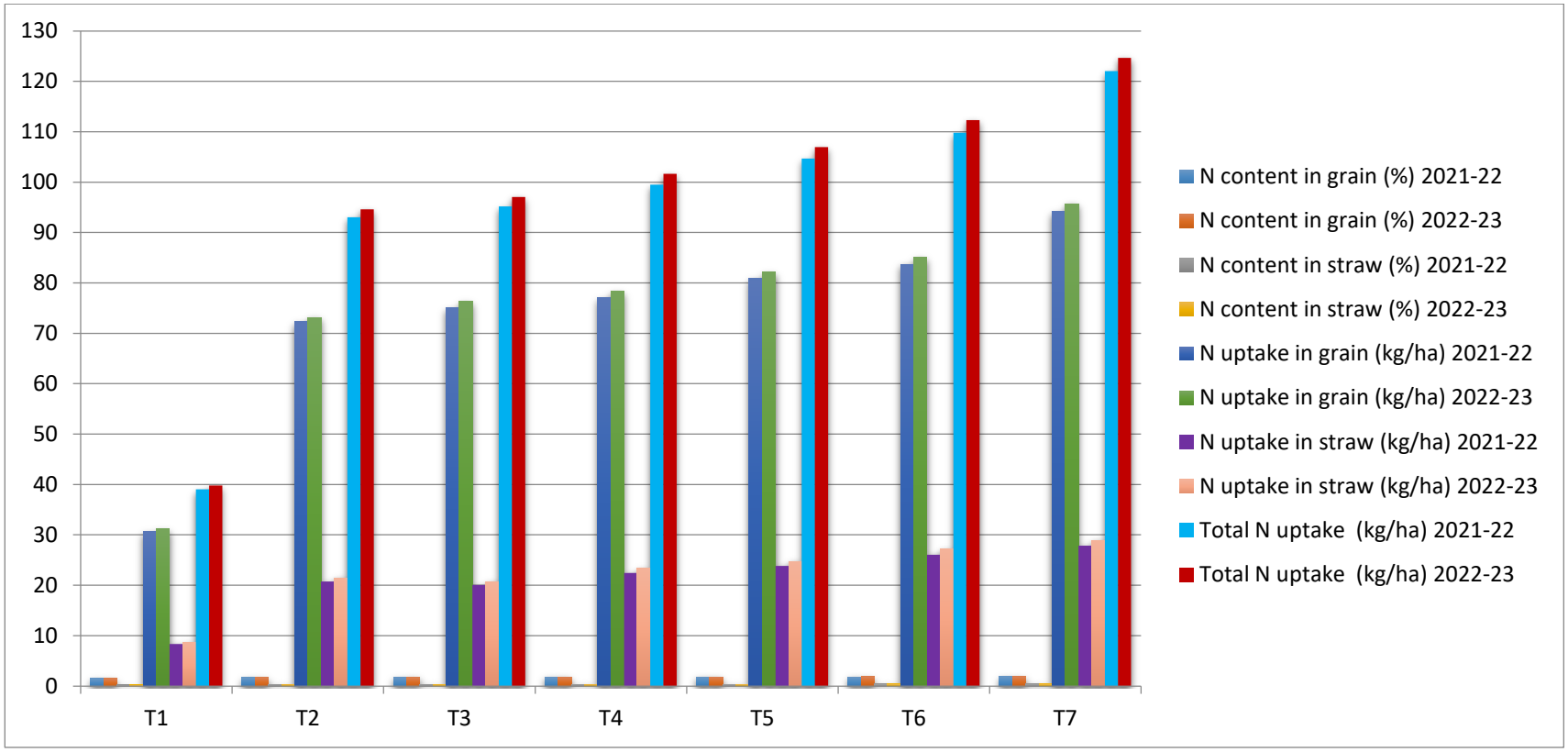

Fig. 1. Effect of different nutrient management approaches on N content (%), N uptake and Total N uptake (kg ha^{-1}) in grain and straw of wheat

3.1.4 Phosphorus content (%) in grain and straw

The data related to the phosphorus content (%) in wheat grain and straw are presented in Table 2 and depicted in Fig. 2. Application of different nutrient management approaches significantly affected the P content in grain as well as straw during both of year's study. It is indicated that maximum P content (0.391 and 0.398 %) in grain was found with treatment T_7 (100% NPK + Paddy straw @ 2.0 t ha^{-1} + Vermicompost @ 1.0 t ha^{-1}) during 2021-22 & 2022-23, respectively while lowest P content in grain (0.272 and 0.277 %) was found with T_1 (control) during both the years.

Maximum P content in straw (0.137 and 0.139 %) was found with T_7 which was at par with T_6, T_5, T_4, and T_2 while lowest P content in straw (0.097 and 0.098 %) was found in control treatment during both the years.

3.1.5 Phosphorus uptake (kg/ha) in grain and straw

Phosphorus uptake was more during 2022-23 in both grains as well as in straw. The uptake of phosphorus in grain and straw increased significantly due to different nutrient management approaches during both years.

During both the years, the maximum P uptake in grains (19.88 and 20.42 kg/ha) was recorded with T_7 (100% NPK + Paddy straw @ 2.0 t ha^{-1} + Vermicompost @ 1.0 t ha^{-1}) whereas minimum P uptake in grains (5.49 and 5.63 kg/ha) was recorded with control plot.

The maximum P uptake in straw (8.82 and 9.02 kg/ha) was recorded with T_7 (100% NPK + Paddy straw @ 2.0 t ha^{-1} + Vermicompost @ 1.0 t ha^{-1}) which is at par with T_6 whereas minimum P uptake in straw (3.08 and 3.13 kg/ha) was recorded with control plot during both the years. The data pertaining phosphorus uptake by grain and straw of wheat are presented in Table 2 and depicted in Fig. 2.

3.1.6 Total P uptake (kg/ha) by crop

The data regarding to total phosphorus uptake (kg/ha) by wheat crop are presented in Table 2 and depicted in Fig. 2. Total uptake of P increased significantly due to different nutrient management approaches during both years. It is indicated that highest total uptake of phosphorus (28.70 and 29.43 kg/ha) by wheat crop was recorded with the treatments T_7 (100% NPK + Paddy straw @ 2.0 t ha^{-1} + Vermicompost @ 1.0 t ha^{-1}) which is significantly higher than rest of the treatments during both years while lowest total P uptake (8.56 and 8.76 kg/ha) by crop was found with T_1 (control) during both years. The addition of FYM, VC, and paddy straw may have boosted soil microbial activity, which in turn encouraged plant development, enhancing the nutrient content and absorption in grain and straw. [12].

3.2 Potassium Content (%), its Uptake (kg/ha) and Total K Uptake (kg/ha) by Crop

3.2.1 Potassium content (%) in grain and straw

The data related to the potassium content (%) in wheat grain and straw are presented in Table 3 and depicted in Fig. 3.The application of different nutrient management approaches significantly affected the K content in grain as well as straw during both of year's study. It is indicated that maximum K content (0.427 and 0.428 %) in grain was found with treatment T_7 (100% NPK + Paddy straw @ 2.0 t ha^{-1} + Vermicompost @ 1.0 t ha^{-1}) which is at par with T_6, T_5, T_4, T_3, and T_2 during 2021-22 & 2022-23, respectively while lowest K content in grain (0.312 and 0.315 %) was found with T_1 (control) during both the years.

Maximum K content in straw (1.617 and 1.638 %) was found with T_7 which is at par with T_6, T_5, T_4, T_3 and T_2 while lowest K content in straw (1.337 and 1.355 %) was found with control treatment during both the years.

3.2.2 Potassium uptake (kg/ha) in grain and straw

The data pertaining potassium uptake by grain and straw of wheat are presented in Table 3 and depicted in Fig. 3. Potassium uptake was more during 2022-23 in both grains as well as in straw. The uptake of potassium in grain and straw increased significantly due to different nutrient management approaches during both years.

During both the years, the maximum K uptake in grains (21.71 and 22.16 kg/ha) was recorded with T_7 (100% NPK + Paddy straw @ 2.0 t ha^{-1} + Vermicompost @ 1.0 t ha^{-1}) whereas minimum K uptake in grains (6.29 and 6.42 kg/ha) was recorded with control plot.

Table 2. Effect of different nutrient management approaches on P content (%), P uptake and total P uptake (kg ha^{-1}) in grain and straw of wheat

Treatment		P content in grain (%)		P content in straw (%)		P uptake in grain (kg ha^{-1})		P uptake in straw (kg ha^{-1})		Total P uptake (kg ha^{-1})	
		2021-22	2022-23	2021-22	2022-23	2021-22	2022-23	2021-22	2022-23	2021-22	2022-23
T_1	Control	0.272	0.277	0.097	0.098	5.49	5.63	3.08	3.13	8.56	8.76
T_2	100% NPK	0.334	0.340	0.124	0.126	14.09	14.40	7.54	7.68	21.63	22.08
T_3	75% NPK+ FYM @ 7.5 t ha^{-1}	0.327	0.333	0.119	0.121	14.13	14.51	7.29	7.41	21.42	21.92
T_4	75% NPK + Vermicompost @ 2.5 t ha^{-1}	0.341	0.347	0.126	0.128	14.93	15.32	7.74	7.91	22.66	23.23
T_5	100% NPK + Paddy straw @ 2.0 t ha^{-1}	0.352	0.358	0.131	0.133	15.70	16.12	8.18	8.36	23.88	24.48
T_6	100% NPK + Paddy straw @ 2.0 t ha^{-1} + Pusa Decomposer @ 20 lit. ha^{-1}	0.374	0.380	0.133	0.135	16.95	17.40	8.32	8.55	25.27	25.95
T_7	100% NPK + Paddy straw @ 2.0 t ha^{-1} + Vermicompost @ 1.0 t ha^{-1}	0.391	0.398	0.137	0.139	19.88	20.42	8.82	9.02	28.70	29.43
	SEm (±)	0.007	0.010	0.005	0.005	0.38	0.36	0.18	0.20	0.57	0.55
	C.D. (P=0.05)	0.021	0.030	0.014	0.016	1.16	1.12	0.56	0.61	1.75	1.70

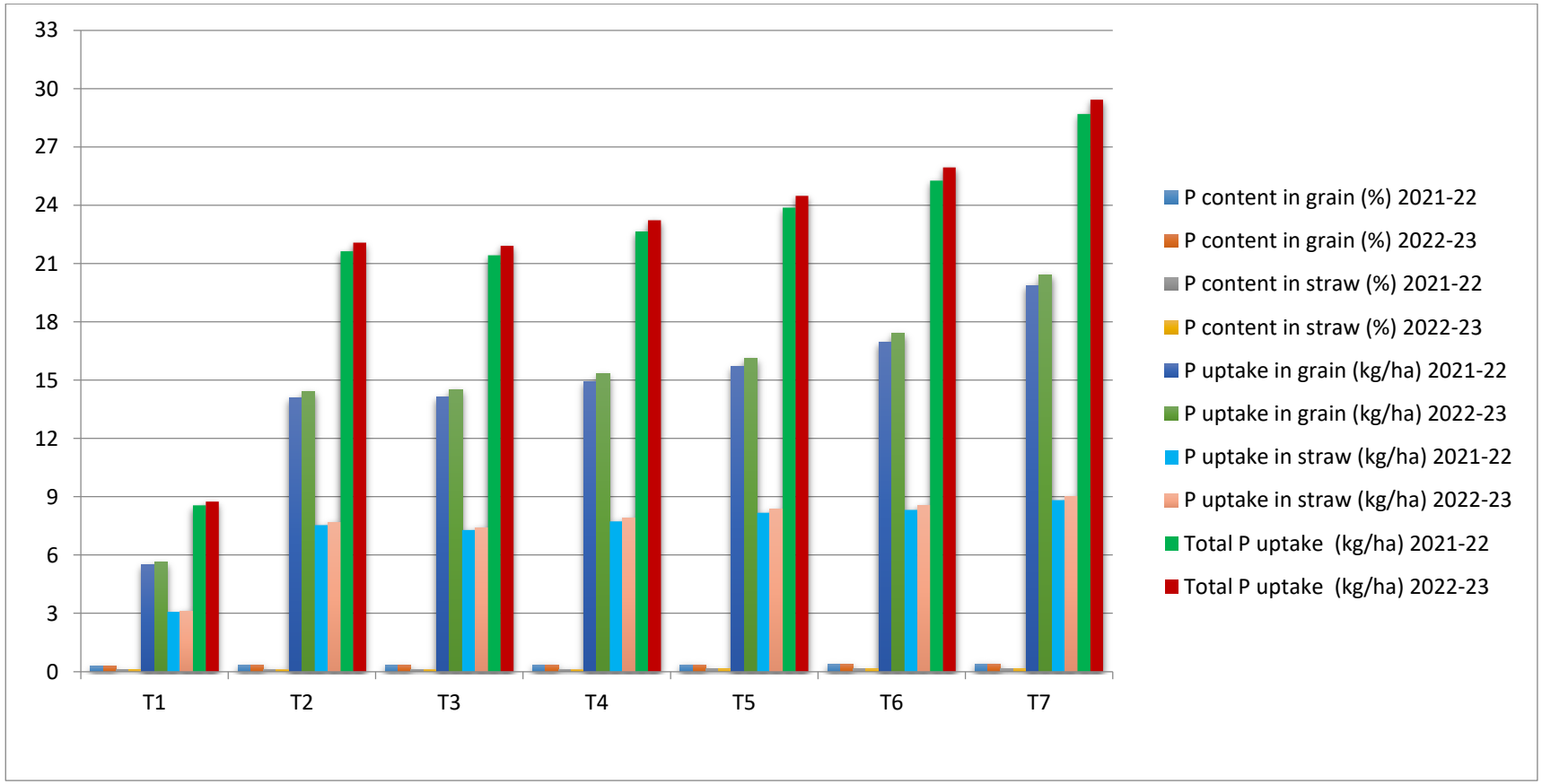

Fig. 2. Effect of different nutrient management approaches on P content (%), P uptake and Total P uptake (kg ha^{-1}) in grain and straw of wheat

Table 3. Effect of different nutrient management approaches on K content (%), K uptake and Total K uptake (kg ha^{-1}) in grain and straw of wheat

Treatment		K content in grain (%)		K content in straw (%)		K uptake in grain (kg ha^{-1})		K uptake in straw (kg ha^{-1})		Total K uptake (kg ha^{-1})	
		2021-22	2022-23	2021-22	2022-23	2021-22	2022-23	2021-22	2022-23	2021-22	2022-23
T_1	Control	0.312	0.315	1.337	1.355	6.29	6.42	42.41	43.19	48.70	49.61
T_2	100% NPK	0.407	0.412	1.512	1.532	17.17	17.44	91.97	93.69	109.14	111.13
T_3	75% NPK+ FYM @ 7.5 t ha^{-1}	0.413	0.418	1.541	1.561	17.85	18.21	94.42	95.94	112.26	114.15
T_4	75% NPK + Vermicompost @ 2.5 t ha^{-1}	0.414	0.419	1.548	1.568	18.12	18.49	95.03	97.16	113.15	115.65
T_5	100% NPK + Paddy straw @ 2.0 t ha^{-1}	0.419	0.424	1.553	1.573	18.69	19.07	96.92	99.09	115.61	118.16
T_6	100% NPK + Paddy straw @ 2.0 t ha^{-1} + Pusa Decomposer @ 20 lit. ha^{-1}	0.423	0.428	1.561	1.582	19.17	19.56	97.66	100.32	116.83	119.88
T_7	100% NPK + Paddy straw @ 2.0 t ha^{-1} + Vermicompost @ 1.0 t ha^{-1}	0.427	0.432	1.617	1.638	21.71	22.16	104.10	106.42	125.82	128.58
	SEm (±)	0.010	0.009	0.046	0.047	0.42	0.46	2.37	2.27	2.65	2.88
	C.D. (P=0.05)	0.031	0.028	0.140	0.144	1.31	1.42	7.30	7.00	8.17	8.86

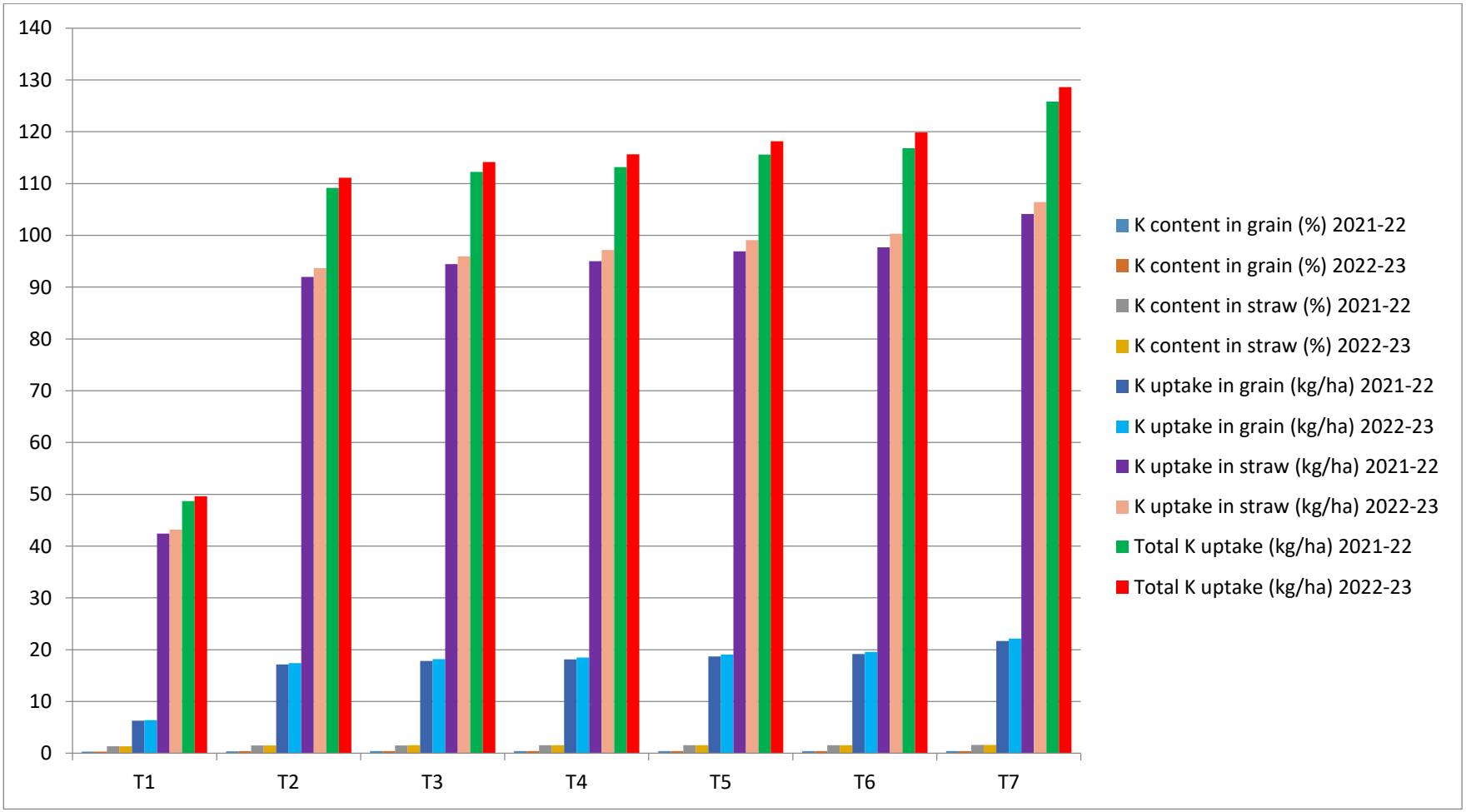

Fig. 3. Effect of different nutrient management approaches on K content (%), K uptake and Total K uptake (kg ha^{-1}) in grain and straw of wheat

The maximum K uptake in straw (104.10 kg/ha) was recorded with T_7 (100% NPK + Paddy straw @ 2.0 t ha^{-1} + Vermicompost @ 1.0 t ha^{-1}) which is at par with T_6 and T_5 whereas minimum K uptake in straw (42.41 kg/ha) was recorded with control plot during 2021-22.

During 2022-23, the maximum K uptake in straw (106.42 kg/ha) was recorded with T_7 (100% NPK + Paddy straw @ 2.0 t ha^{-1} + Vermicompost @ 1.0 t ha^{-1}) which is at par with T_6 while minimum K uptake in straw (43.19 kg/ha) was recorded with control plot.

3.2.3 Total K uptake (kg/ha) by crop

The data regarding to total potassium uptake (kg/ha) by wheat crop are presented in Table 3 and depicted in Fig. 3. Total uptake of K increased significantly due to different nutrient management approaches during both years. It is indicated that highest total uptake of potassium (125.82 and 128.58 kg/ha) by wheat crop was recorded with the treatments T_7 (100% NPK + Paddy straw @ 2.0 t ha^{-1} + Vermicompost @ 1.0 t ha^{-1}) which is significantly higher than rest of the treatments during both years while lowest total K uptake (48.70 and 49.61 kg/ha) by crop was found with T_1 (control) in 2021-22 and 2022-23, respectively. The N, P, and K content and their uptake in wheat were significantly increased with higher fertilizer doses at levels ranging from 50 to 75% NPK [16]. Due to higher availability of these nutrients, which led to a higher biomass yield, the uptake of N, P, and K increased as the supply of NPK to the crops gradually increased [13]. Similar finding was reported by Faujdar and Sharma [14] and Bejbaruha et al. [15]. Due to improved soil characteristics that allowed for better absorption of water and nutrients from both applied and native sources, the simultaneous use of organic manures and chemical fertilizers increased N, P, and K concentration and uptake [17,18]. Numerous workers have also documented an increase in nutrient uptake with integrated usage of FYM and fertilizers [19-21].

4. CONCLUSION

It is concluded that for greater yield and healthy soil, organic manures, crop wastes, and vermicompost are required in addition to inorganic fertilizers. Inorganic fertilizers can be used with organic manures, crop wastes, and bio-fertilizers to increase soil health and hasten the efficiency of nutrient utilization.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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