Study on Long-Term Fertility Experiment on Yield and Yield Attributes of Wheat at Parwanipur, Bara

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Abstract: A long-term fertility trial is continuously being conducted at Directorate of Agricultural Research, Madhesh Province, Parwanipur, Bara, Nepal since 1980. The experiment included two crops per year, rice (July–November) and wheat (December-April), with twelve treatments arranged in a randomized complete block design and three replications. As a continuity of the research, wheat was sown at Parwanipur during year 2021 and 2022 in an individual plot size of 6m length and 4 m width maintaining rows at 25 cm apart with seed rate of 120 kilograms per hectare (kg/ha). Early maturity of wheat crop was observed in treatment applied with 100:30:30 NPK kg/ha with residual $ZnSO_4$ from rice crop. Similarly, the same treatment applied with 100:30:30 NPK kg/ha with residual $ZnSO_4$ from rice crop resulted the highest yield among the treatments followed by the treatment consisting addition of 50 kg N per hectare on rice and residual FYM with 100:30:30 NPK kg/ha in both year of wheat cultivation. Hence, for wheat cultivation either application of inorganic fertilizer alone or application FYM only was not found sufficient to obtain stable higher yield, as crop responded to balanced used of fertilizer.

Keywords: Long-term fertility, Maturity, Wheat, Yield, Parwanipur

Introduction

Wheat (*Triticum aestivum* L.) is third most important cereal in Nepal after rice and maize in terms of cultivated area and production (MoALD, 2023). Rice and wheat are the most important food crops mostly grown in sequence in central terai in Nepal. Most of the land under the rice-wheat system, mostly in the terai plain, meets about 75% of the country's total food demand. Increasing the productivity of land through intensive cropping depletes nutrient reserves of the soil at a faster rate (DoARP, 2022).

Since soil is natural dynamic body acts as medium for growth and development of plants (Brady and Weil, 2004), soil fertility plays important role for keeping soil alive, hence, improvement in soil fertility is crucial for sustainable soil management and crop production (Khadka et al., 2017). Failure or success in crop production is highly dependent on proper management of soil fertility since plant obtain their nutrients mainly from soil (Ghodke et al., 2023) so there is necessity of balanced use of fertilizer. Soil organic matter plays important role in soil health by enhancing carbon storage and nutrient release (Spiegel et al., 2018; Singh et al., 2023). Cultivation of high yielding varieties after green revolution use of chemical fertilizers is gradually increased resulting a negative balance of major nutrients in soil (Singh et al., 2004). Increased use of imbalance fertilizers without considering the native soil fertility and declined trend in organic matter incorporation by farmers are some of possible factors affecting the crop productivity and soil fertility (DoARP, 2022).

The continuous cropping effect on the capacity of a system productivity and nutrient supply are generally evaluated through long-term experiments (LTEs) on soil fertility. Long-term experiment is valuable for evaluating the effects of continuous cropping on

the capacity of a system to sustain nutrient supply and the productivity. Long-term experiments are mean to sustainable agricultural management practices that maintains healthy basis to soil environment by capturing past data and provide early care system to meet future challenges (Bangre et al., 2023). Long term fertility experiment was started in 1980/81 to evaluate the effects of organic manure and inorganic fertilizers on crop yields as well as on soil properties and to study the effects of N with or without P and K in the long run under rice-wheat system. This paper discusses about effect of long term experiment on wheat yield and yield attributing characteristics.

Material and Methods

A long-term permanent plot experiment began in June 1980 at Directorate of Agricultural Research, Madhesh Province, Parwanipur, Bara (previously named Regional Agricultural Research station, Parwanipur) Nepal. The site is located l at 27°21′N and 84°53′E and 120 m above mean sea level. The mean monthly temperature ranges from a minimum of 8.5°C in January to a maximum of 34.5°C in May. The source of irrigation is groundwater pumped from 200-m-deep tube wells. The experiment included two crops per year, rice (July–November) and wheat (December-April), with 12 treatments arranged in a randomized complete block design with three replicates (Table 1). As a continuity of this permanent trial, wheat was sown at Parwanipur during year 2021 and 2022. Wheat was sown continuously in an individual plot size of 6m length and 4 m width maintaining rows at 25 cm apart with seed rate of 120 kilogram per hectare (kg/ha). All the P as $(NH_4)2HPO_4$, K as muriate of potash, and Zn and S as $ZnSO_4$ were applied as basal fertilizer. N was applied in two splits, 50% at sowing and the remaining 50% top dressed at 21-25 days after sowing (DAS) of wheat. Farmyard manure (FYM) was applied 4-7 days before sowing. Three irrigations mainly during crown root initiation (21 DAS), maximum tillering (55 DAS), and flowering (100 DAS) was applied. Crops were harvested manually 5 cm above the ground using sickles, and straw was removed from the field.

Data recording was done for the parameters days to heading (DH), days to maturity (DM), Tiller per squared meter (TILL), plant height in centimeters (PH), spike length in centimeters (SL), thousand grain weight in grams (TGW) and grain yield in kilograms per hectare (GY). These recorded parameters were analysed using statistical software Genstat discovery.

Table 1: Treatments of long-term soil fertility experiment

Treatments	Rice ($N:P_2O_5:K_2O$ kg/ha)	Wheat ($N:P_2O_5:K_2O$ kg/ha)
T_1	0:0:0	0:0:0
T_2	100:0:0	100:0:0
T_3	100:30:0	100:30:0
T_4	100:0:30	100:0:30
T_5	100:30:30	100:30:30
T_6	100:0:30	100:30:30
T_7	50:0:0	50:0:0
T_8	50:20:0	50:20:0
T_9	FYM @ 10 tons per hectare	FYM @ 10 tons per hectare
T_{10}	100:30:30 + 25 kg $ZnSO_4$ per hectare	100:30:30
T_{11}	50:0:0 + FYM 10 tons per hectare	100:30:30
T_{12}	50:0:0 + Chopped straw 10 tons per hectare	100:30:30

Results and Discussion

During year 2021, all the observed parameters except for tillers per square meter were significant among the treatments. Early maturity (102 days) of wheat crop was observed in treatment applied with 100:30:30 NPK kg/ha with residual $ZnSO_4$ from rice crop. The same treatment applied with 100:30:30 NPK kg/ha with residual $ZnSO_4$ from rice crop resulted the highest yield among the treatments (2578 kg/ha) followed by (2483 kg/ha) in the treatment consisting addition of 50 kg N per hectare on rice and residual FYM with 100:30:30 NPK kg/ha . The control plot without any nutrient supply still supported (354 kg/ha) wheat yield during 2021 (Table 2).

Table 2: Yield and yield attributes of wheat in long term fertility trial conducted at Parwanipur, Bara in 2021

Treatments	DH	DM	SL	PH	TWG	TILL	GY
1	73	108	5.8	58.80	32.21	184	354
2	74	108	8.0	66.47	29.03	171	487
3	71	105	10.2	76.00	29.65	188	1127
4	72	108	7.9	68.00	33.97	197	726
5	69	105	11.7	85.20	37.35	204	2393
6	68	104	11.2	84.40	38.93	204	2077
7	71	108	7.5	64.13	30.60	185	644
8	69	105	8.7	70.93	33.15	235	1211
9	72	105	8.6	72.80	36.73	190	1048
10	68	102	11.7	85.73	37.53	231	2483
11	68	103	11.8	87.20	39.57	210	2578
12	68	103	11.0	85.47	38.85	196	2137
Mean	70	105	9.5	75.43	34.80	200	1439
F-test	**	**	**	**	**	NS	**
Lsd(0.05)	1.626	1.259	1.258	6.255	3.342	-	393
CV(%)	1.4	0.8	7.8	4.9	5.7	13.2	9.2

Note: DH: days to heading, DM: days to maturity, Till: tiller/m^2, PH: plant height (cm), SL: spike length (cm), TGW: thousand grain wt. (g), GY: grain yield (kg/ha), ** -Highly significant, *- Significant and NS-non significant

During year 2022, all the observed parameters except for tillers per square meter were significant for the different treatments. Early maturity (106 days) of wheat crop was observed in treatment applied with 100:30:30 NPK kg/ha with residual $ZnSO_4$ from rice crop. Similarly, the same treatment applied with 100:30:30 NPK kg/ha with residual $ZnSO_4$ from rice crop resulted the highest yield among the treatments (2961 kg/ha) followed by (2938 kg/ha) in the treatment consisting addition of 50 kg N per hectare on rice and residual FYM with 100:30:30 NPK kg/ha. The control plot without any nutrient supply still supported 592 kg/ha wheat yield during 2022 (Table 3). Many researchers have reported significant impact on the amount of soil organic carbon, total nitrogen, and other essential nutrients by that integrated application (Bhardwaj et al., 2019; Padbhushan et al., 2021). Kabato et al. (2022) reported that 27.45% increase in wheat yield resulting from application of 75% recommended inorganic NP fertilizers combined with compost.

Table 3: Yield and yield attributes of wheat in long term fertility trial conducted at Parwanipur, Bara in 2022

Treatments	DH	DM	SL	PH	TWG	TILL	GY
T_1	77	112	7.1	68.5	34.5	189.3	592
T_2	77	109	9.0	72.9	29.8	192.7	631
T_3	75	107	11.5	81.9	22.1	211.0	805
T_4	77	111	8.3	70.5	34.3	215.0	857
T_5	73	108	12.8	94.9	36.5	268.0	2832
T_6	72	107	12.0	95.7	38.0	265.3	2879

T_7	76	112	8.7	76.5	32.2	205.0	942
T_8	74	108	12.1	88.5	32.0	201.3	1474
T_9	75	111	10.1	86.0	38.0	225.0	1019
T_{10}	72	106	12.7	94.9	39.1	308.3	2961
T_{11}	73	107	12.6	86.6	38.7	256.3	2938
T_{12}	72	107	12.7	96.2	39.0	303.7	2728
F test	**	**	**	**	**	**	**
CV %	0.8	1	5.3	6.5	5.3	11.2	11.7
LSD (0.05)	0.9514	1.92	0.9677	9.339	3.071	44.74	341.6
Grand mean	75	109	10.828	84.43	34.51	236.8	1721

Note: DH: days to heading, DM: days to maturity, Till: tiller/m^2, PH: plant height (cm), SL: spike length (cm), TGW: thousand grain wt. (g), GY: grain yield (kg/ha), ** -Highly significant, *- Significant and NS-non significant

Conclusions

Early maturity of wheat crop was observed in treatment applied with 100:30:30 NPK kg/ha with residual $ZnSO_4$ from rice crop. The same treatment applied with 100:30:30 NPK kg/ha with residual $ZnSO_4$ from rice crop resulted the highest yield among the treatments followed by the treatment consisting addition of 50 kg N per hectare on rice and residual FYM with 100:30:30 NPK kg/ha in both year of wheat cultivation. Kabato et al. (2022) reported that either inorganic fertilizer or organic fertilizer alone cannot sustainably improve productivity of wheat. Hence, for wheat cultivation either application of inorganic fertilizer alone or application FYM only was not found sufficient to obtain stable higher yield, as crop responded to balanced used of fertilizer.

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Authors' Contributions

M. K. Sah designed this research; M. K. Sah, B. Yonjan, P. Budhathoki and A. Chaudhary conducted the trial and recorded data; A. Chaudhary, R. D. Chaudhary and P. Shah wrote the final manuscript; and A. Mishra and P. Wagle revised the manuscript.

Conflict of Interest

The authors declare no conflicts of interest.

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