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Interactive effect of nitrogen and phosphorus in wheat varieties in effecting use efficiency and crop productivity

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Abstract

A field study on the "Interactive Effect of Nitrogen and Phosphorus in Wheat Varieties in Effecting Use Efficiency And Crop Productivity" was conducted during the rabi season (2022-23) at the research farm in Dehradun, Uttarakhand. The study looked at how nitrogen and phosphorus (N & P) treatments affected the height and dry matter weight of wheat plants. The tallest plants, reaching 90 cm, were found in HI 1544, while the smallest, measuring 73.50 cm, were found in HI 8663. The three locations with the tallest plants were GW 366 (86 cm), half dosage of P (91 cm), and HI 1544 (88.50 cm). Lok 1 (3.64 g) had the highest average dry matter weight per plant, followed by Narmada 14 (2.72 g), HI8713 (1.77 g), and NARMADA 14 (2.98 g). The highest dry matter weights were found in Lok1 (3.64 g/plant) and LOK1 (3.64 g/plant), while the lowest was found in HI8737 (1.06 g/plant). It was also important to consider how long it took a plant to mature; among the nutritional treatments, some kinds took between 100.5 (HI8663) and 135 days (Narmada 14) to do so, which is a considerable time. The rate of variation development was slowest in control plots, followed by treatments employing reduced nitrogen, reduced phosphatic, and normal NP doses. The two locations with the highest harvest indices were HI1563 (50.35%) and lok1 (37.78%). The control treatment (70.82%) and the lower phosphorus dose treatment (69.83%) had the highest nitrogen harvest indices, respectively. HI8663's NHI (70.40%) has the second-highest NHI (85.16%).

Keywords: Effect of nitrogen and phosphorus, crop productivity, use efficiency

Introduction

Triticum durum ($2n = 2x = 14$) and *Triticum aestivum* ($2n = 6x = 42$, AABBDD) are joined into the *Triticum* social affair of the Poaceae family. It is implied as the "Head of Oats" considering its level, power in movement, ampleness, and significance in the overall exchange food grains. It is the fundamental oat, ate as a staple food by 33% of the total people. There are different strategies to eat bread, including chapati, porci, atta, and semolina. India produces wheat on 30.55 million hectares, with a consequence of 107.17 million tons. Uttar Pradesh is the best district that is still a work in progress (9.35 million ha), followed by Uttarakhand (6.02 million ha), with anticipated consequences of 32.08 and 18.58 million tons, exclusively (USDA, FAS 2019; DES, MOA and FW India 2019-20). Is. After China, India is the world's second-most huge creator of wheat (FAO, 2020). As demonstrated by Guignard *et al.* (2017), manures are the essential driver of the "Green Uprising" that provoked the creation of separation in a nearby piece of the planet's surface. The critical pieces of cultivating configuration excrements and the fundamental rate-confining updates in most ordinary plans are nitrogen (N) and phosphorus (P). It has been settled that one centimeter of wheat grain should be delivered utilizing 2.26 kg of nitrogen and 0.40 kilogram of phosphorus.

Materials and Methods

Experimental Details

The trial was spread out in split plot plan with three replications. Every replication obliged 36 medicines including 3 nitrogen levels and 3 phosphorus levels in nine assortments. Supplement portion was in fundamental plot treatment while assortments were sub plot medicines.

Layout plan of the experimental field at Dehradun (T=Fertilizer dose, V = Varieties)

R1			R2			R3		
T ₂ V1	T ₂ V4	T ₂ V7	T ₃ V3	T ₃ V6	T ₃ V9	T ₄ V4	T ₄ V7	T ₄ V1
T ₂ V2	T ₂ V5	T ₂ V8	T ₃ V4	T ₃ V7	T ₃ V1	T ₄ V5	T ₄ V8	T ₄ V2
T ₂ V3	T ₂ V6	T ₂ V9	T ₃ V5	T ₃ V8	T ₃ V2	T ₄ V6	T ₄ V9	T ₄ V3
T ₁ V2	T ₁ V5	T ₁ V8	T ₄ V4	T ₄ V7	T ₄ V1	T ₃ V3	T ₃ V6	T ₃ V9
T ₁ V3	T ₁ V6	T ₁ V9	T ₄ V5	T ₄ V8	T ₄ V2	T ₃ V4	T ₃ V7	T ₃ V1
T ₁ V4	T ₁ V7	T ₁ V1	T ₄ V6	T ₄ V9	T ₄ V3	T ₃ V5	T ₃ V8	T ₃ V2
T ₃ V3	T ₃ V6	T ₃ V9	T ₂ V1	T ₂ V4	T ₂ V7	T ₁ V2	T ₁ V5	T ₁ V8
T ₃ V4	T ₃ V7	T ₃ V1	T ₂ V2	T ₂ V5	T ₂ V8	T ₁ V3	T ₁ V6	T ₁ V9
T ₃ V5	T ₃ V8	T ₃ V2	T ₂ V3	T ₂ V6	T ₂ V9	T ₁ V4	T ₁ V7	T ₁ V1
T ₄ V4	T ₄ V7	T ₄ V1	T ₁ V2	T ₁ V5	T ₁ V8	T ₄ V4	T ₄ V7	T ₄ V1
T ₄ V5	T ₄ V8	T ₄ V2	T ₁ V3	T ₁ V6	T ₁ V9	T ₄ V5	T ₄ V8	T ₄ V2
T ₄ V6	T ₄ V9	T ₄ V3	T ₁ V4	T ₁ V7	T ₁ V1	T ₄ V6	T ₄ V9	T ₄ V3

Land preparation

The evaluation was set up using a split plot design and three replications. In each replication, there were generally 36

drugs, including three nitrogen levels and three P levels with nine genotypes. The prescriptions were obviously separated independently in each replication.

Table 1: Details of experiment

1.	Design of experiment	Split plot design
2.	No. of replication	3
3.	No. of treatments (plots)	4
	Main plot	Fertilizer nutrient levels (4)
	Sub plot	Varieties (9)
4.	Net plot size	2m x 2m
5.	Gross plot size	2.5m x 2.5 m
6.	Row spacing	22.5 cm
7.	No. of rows per plot	9
8.	Crop	Wheat
9.	Plant population per plot	190
10.	Seed rate	100 kg ha ⁻¹
11.	Fertilizer dose (RDF)	120-60-40 kg ha ⁻¹ of N, P and K
12.	Date of sowing	25 November 2022

Main plot treatment details**Table 2:** Fertilizer nutrient levels (N&P dose): 4

Symbol	Treatment	Description
T ₁	Control	No fertilizers added
T ₂	100% (N + P + K)	120 kg/ha N + 60 kg/ha P ₂ O ₅ + 40 kg/ha K ₂ O
T ₃	50% N + 100% (P + K)	60kg/ha N + 60 kg/ha P ₂ O ₅ + 40 kg/ha K ₂ O
T ₄	100% (N + K) + 50% P	120 kg/ha N + 30 kg/ha P ₂ O ₅ + 40 kg/ha K ₂ O

Note: RDF @120:60:40 kg/ha of N, P₂O₅ and K₂O were supplied through Urea, SSP and MOP, respectively. 50% of N, 100% of P₂O₅ and 100% of K₂O of the respective treatments were applied as basal and rest 50% of the N dose was applied in two top dressings at 22 DAS and 45 DAS.

Table 3: Sub plot treatment details nine varieties of wheat

S. No	Variety	Description
V1	HI 8663	<i>T. durum</i>
V2	HI 8737	<i>T. durum</i>
V3	HI 8713	<i>T. durum</i>
V4	HI 1563	<i>T. durum</i>
V5	HI 1544	<i>T. aestivum</i>
V6	HI 1531	<i>T. aestivum</i>
V7	GW 366	<i>T. aestivum</i>
V8	Lok 1	<i>T. aestivum</i>
V9	Narmada 14	<i>T. aestivum</i>

Application of fertilizers and crop management

In all treatments other than control, full-recommended P and K fertilizer dosages of 60 kg P₂O₅ and 40 kg K₂O per segment of land were treated as a basal in SSP and MOP

separately. N, P, and K were not present in the control plots (T₁). The prescribed amounts of N (120 kg ha⁻¹) and P (60 kg/ha) were applied to the normal piece treatment (T₂), however only roughly half of these levels were used to the experimental treatment (T₃). All of the excretions of N and just half of those of P were given to the T₄ therapy. Half of the applied N is represented as basal, despite the fact that the additional N was top wearing identical areas at 25 and 45 DAS, separately. The wheat crops were created using five water frameworks (5 cm) and one hand weeding at 30 DAS while adhering to accepted agronomic practices.

Result and Discussion**Plant height**

Between wheat and compost medication varieties, there were stark differences at the plant level. In general, the medications

were found to have a plant level that ranged from 65.50 cm (Hello 8737) to 91 cm (GW 366). The average plant level was greater in the typical portion of feces, followed by a reduction in the application of phosphatic manure, a reduction in the use of nitrogen fertilizer, and the least significant in control plots. The highest plant level among the courses of action with a full piece of N and P treatment was discovered in Hi 1544 (90 cm), while the lowest plant level was found in Hi 8663 (73.50

cm). HI1544 had the highest plant level among the assortments filled in a half-piece of N (88.50 cm), followed by GW 366 (86 cm), and in a half-piece of P by GW 366 (91 cm), followed by Hi 1544 (87 cm). In terms of the solutions as a whole, GW 366 (91 cm) had the highest plant level, followed by Hi 1544 (90 cm), and Great Greetings 8737 (65.50 cm) and Hi 8663 (67 cm) had the lowest plant levels.

Table 4: Effect of N & P doses on plant height (cm) of wheat varieties at flowering stage

	T ₁	T ₂	T ₃	T ₄	Mean A
HI8663	67.00	73.50	71.50	73.50	71.38
HI8737	65.50	75.00	73.00	73.50	71.75
HI8713	80.50	85.50	83.00	83.00	83.00
HI1563,	75.50	83.50	78.50	78.00	78.88
HI1544	85.00	90.00	88.50	87.00	87.63
HI1531	76.00	83.50	78.50	80.50	79.63
GW366	82.50	89.00	86.00	91.00	87.13
LOK1	82.50	87.50	83.50	85.00	84.63
NARMADA 14	80.00	87.50	83.00	84.50	83.75
Mean B	77.17	83.89	80.61	81.78	
Factors	C.D.		SE(d)		SE(m)
Factor(A)	0.37		0.11		0.08
Factor(B)	3.05		1.49		1.05
Factor(B)at same level of A	NS		2.98		0.24
Factor(A)at same level of B	NS		2.81		1.99

Dry matter weight per plant

Huge differences in dry matter weight were seen across all combinations of wheat and fertilizer agents during the vegetative stage. The intermediate dry matter weight of all the drugs, 1.06 g/plant (HI8737), was 3.64 g/plant (LOK1) (Table 5). The phosphatic fertilizer segment treatment, the nitrogen segment compost treatment, and the control plots had the lowest mean dry matter weight, whereas the optimal piece treatment had the highest mean dry matter weight. Among the mixtures filled in full piece of N and P treatment, Lok1 (3.64

g/plant) had the highest increased dry matter weight and HI1563 (1.62 g/plant) had the lowest increased dry matter weight. The collection filled with half part N fertilizer treatment revealed that HI8713 had the lowest dry matter weight (1.77 g/plant), while NARMADA 14 had the highest (2.72 g/plant) and Lok 1 had the highest (2.98 g/plant) in the collection filled with half part P fertilizer treatment. Lok1 (3.64 g/plant) and LOK1 (3.64 g/plant) had the highest significant dry matter weight of all the drugs, whereas HI8737 (1.06 g/plant) had the lowest significant dry matter weight.

Table 5: Effect of N & P on Days to 50% flowering Days to 50% Flowering

Varieties name	T ₁	T ₂	T ₃	T ₄	Mean A
HI8663	70.50	65.50	62.50	66.50	66.25
HI8737	73.00	65.00	66.50	67.00	67.88
HI8713	74.00	66.00	67.50	68.00	68.88
HI1563	74.50	67.50	71.50	69.50	70.75
HI1544	73.50	64.00	66.50	64.50	67.13
HI1531	76.50	68.50	70.50	71.50	71.75
GW366	80.00	73.50	75.50	76.50	76.38
LOK1	78.50	71.50	75.50	73.50	74.75
NARMADA 14	71.50	65.00	66.50	66.50	67.38
Mean B	74.67	67.39	69.17	69.28	
Factors	C.D.		SE(d)		SE(m)
Factor (A)	1.85		0.56		0.40
Factor (B)	0.99		0.48		0.34
Factor (B) at same level of A	2.31		0.97		1.19
Factor (A) at same level of B	2.56		1.07		0.76

Days to maturity

In terms of collection and manure solutions, there were clear differences in the number of days left till progress. A few cultivars among the dietary remedies survived between 100.5 (HI8663) and 135 days (Narmada 14) (Table 6). Variety had a much better chance of growing in plots with control than in plots treated with reduced nitrogen content, reduced phosphatic fragment, and normal NP. In the whole piece N

and P treatment, Narmada 14 had the best development day count (125 days), however HI8663 had the lowest headway day count (100.5 days). When using a half-part of nitrogen compost, the assortment Narmada 14 took the longest (127 days), followed by Lok 1 (125.50 days), whereas when using a half-part of phosphorus compost, the Great Greetings 1531 took the longest (HI1531).

Harvest index

There were significant clusters in the Assemble list between the wheat strategy and feces remedies. The not-for-ever established Reap record range for all individuals is 20.94 (lok1) to 51.60% (HI1563). The Lessened Nitrogen Piece Treatment, the Decreased Phosphoric Part Treatment, and the Control Plots followed the Generally Common Section Treatment in terms of mean Collect rundown. In comprehensive calculations of N and P treatment, the mix HI1563 had the highest elevated collect record (50.35%),

whereas lok1 had the lowest (50.78%). The courses of action spread out in half-section N manure treatment yielded the best Gather report (51.60%), followed by HI8713 (50.57%) and HI1531 (49.95%) among the mixtures generated in half-section P fertilizer treatment. The drug that had the best Get record overall was HI1563 (51.60%), which used a smaller amount of N compost. It was followed by the conventional part-using HI1563 (50.35%), while the control plot's lok1 (20.94%) got the lowest Reap report.

Table 6: Effect of N & P on days to maturity of wheat genotypes Maturity days

	T ₁	T ₂	T ₃	T ₄	Mean A
HI8663	106.50	100.50	110.50	102.50	105.00
HI8737	110.50	105.50	105.50	109.50	107.75
HI8713	123.50	115.50	119.00	119.50	119.38
HI1563,	122.50	113.50	116.00	114.50	116.63
HI1544	118.00	116.00	116.50	116.50	116.75
HI1531	130.00	121.00	124.50	125.50	125.25
GW366	125.00	113.50	117.50	116.50	118.13
LOK1	128.50	121.50	125.50	122.50	124.50
NARMADA 14	135.00	125.00	127.50	125.00	128.13
Mean B	122.17	114.67	118.06	116.89	
Factors	C.D.		SE(d)		SE(m)
Factor(A)	1.51		0.46		0.32
Factor(B)	1.79		0.88		0.62
Factor(B)at same level of A	3.75		1.75		0.97
Factor(A)at same level of B	3.66		1.72		1.21

Nitrogen harvest index

Procure record found revealed significant differences between combinations of wheat and feces treatments. The medicament that lowered phosphorus segmentation (69.83%) was followed by the treatment that most dramatically raised NHI (70.82%). Among the combinations, HI8663 (85.16%) had the combination with the greatest raised NHI. Following conventional part treatment, the two samples with the highest

NHI were HI1563 (70.47%) and HI8663 (70.40%).The nitrogen gather data's median range was between 55.77 (NARMADA 14) to 85.16% (HI8663).In the categories that made up half of the N excretion treatment, HI8663 had the most considerable nitrogen assemble list (75.94%), followed by HI8713 (74.31%). Under half a piece of P compost treatment, HI1563 (55.69%) had the least important Harvest document and HI8713 (81.28%) had the most important one.

Table 7: Effect of N & P on nitrogen harvest index of wheat genotypes

	T ₁	T ₂	T ₃	T ₄	Mean A
HI8663	85.16	70.40	75.94	75.52	76.75
HI8737	72.14	69.04	64.73	71.95	69.46
HI8713	73.04	68.50	74.31	81.28	74.28
HI1563,	71.94	70.47	72.51	55.69	67.65
HI1544	70.90	69.38	65.28	68.81	68.59
HI1531	74.73	66.23	71.63	75.68	72.06
GW366	69.32	67.01	67.38	60.48	66.05
LOK1	64.36	60.93	59.61	67.68	63.14
NARMADA 14	55.77	61.12	72.50	71.35	65.18
Mean B	70.82	67.01	69.32	69.83	
Factors	C.D.		SE(d)		SE(m)
Factor (A)	1.78		0.54		0.38
Factor (B)	1.62		0.79		0.56
Factor (B) at same level of A	3.47		1.58		1.15
Factor (A) at same level of B	3.48		1.59		1.12

Phosphorous content (%)

There were non-enormous differentiations saw in P% in grain of arrangements created under fertilizer drugs. The extent of P% in grain was found in the center between 0.069 (HI1531) to 0.151% (HI8663) among all of the drugs (Table 7). The mean P% in grain was higher in Normal part treatment followed by diminished phosphatic fertilizer segment treatment, lessened nitrogen segment excrement treatment and

lower in control plots. Among the combinations filled in full part of N and P treatment, the most raised P% in grain was found in HI8663 (0.151%) and the least P% in grain was found in HI1563 (0.125%). Among the groupings filled in half part of N manure treatment, the most raised P% in grain was seen in HI8713 (0.127%) followed by GW366 (0.126%) and among the arrangements filled in half piece of P, the most raised P% in grain was found in GW366 (0.133%) followed

by HI8737 (0.128%). Among all of the drugs, the most raised P% in grain was seen in HI8663 (0.151%) followed by HI1531 (0.145%) in customary part fertilizer treatment and least P% in grain was seen in HI1531 (0.069%) in control plot.

Harvest index

The P Assemble document range between 56.33(LOK1) to 77.96% (HI8713) in all of the medications among the fertilizer drugs, there were non-tremendous differences. At full piece of N and P treatment, the most raised P Harvest

document was found in HI1563 (73.50%) and the least P Assemble record was found in Lok1 (61.45%). At half part of N fertilizer treatment the most raised P Harvest list was seen in GW366 (76.55%) followed by Hi 1563 (76.34%) and among the arrangements filled in half piece of P, the hig\st P Gather record was found in HI8713(77.96%), followed by HI1531(75.61%). In control plots the most raised P Gather record was seen in HI8713 (77.22%) followed by HI1531 (73.55%). In all drugs, most negligible Gather document was seen in LOK1 (56.33%) in control.

Table 8: Effect of N and P on phosphorus harvesting index of wheat genotypes

	T ₁	T ₂	T ₃	T ₄	Mean A
HI8663	69.86	66.78	66.61	69.61	68.21
HI8737	70.41	67.73	66.34	71.81	69.07
HI8713	77.22	71.21	70.29	77.96	74.17
HI1563,	72.84	73.50	76.34	61.29	70.99
HI1544	65.23	71.32	68.31	62.68	66.88
HI1531	73.55	69.42	69.43	75.61	72.00
GW366	71.18	68.26	76.55	63.05	69.76
LOK1	56.33	61.45	67.21	65.63	62.65
NARMADA 14	60.31	64.45	72.30	66.11	65.79
Mean B	68.55	68.23	70.37	68.19	
Factors	C.D.		SE(d)		SE(m)
Factor(A)	NS		0.54		0.38
Factor(B)	5.47		2.68		1.89
Factor(B)at same level of A	NS		5.35		1.15
Factor(A)at same level of B	NS		5.07		3.59

4.18 Physio-chemical parameters of soil after harvesting of crop.

There were slight differences in the soil pH, EC, and OC among all the compost medicines in the continuous review. These were consistent with earlier revelations. Different nitrogen levels had no effect on the soil's pH, EC, or OC

condition. It's plausible that the obvious differences in soil N and P capabilities between the treated and control plots are a direct result of the extraordinary improvements in the soil. Additionally, dietary status may have benefited from the broadened plant root biomass that was filled in organized plots.

Table 9: Physio chemical parameters of soil after harvesting of crop

Fertilizer Dose	pH	EC (dS/cm)	O.C. (%)	N(kg/ha)	P(kg/ha)	K(kg/ha)
T ₁	8.03	0.17	0.53	172.10	9.60	322.20
T ₂	8.04	0.16	0.51	202.10	13.20	361.80
T ₃	8.02	0.16	0.49	187.50	12.70	357.60
T ₄	8.04	0.16	0.53	198.10	11.20	358.80
C.D.	N/A	N/A	N/A	2.58	2.54	N/A

Summary and Conclusions

The audit examined the effects of applying nitrogen and phosphorus to wheat, including how these nutrients affected the plant's height, leaf location, biomass, grain yield, chlorophyll content, SPAD regard, nitrogen content in grain and straw, agronomic use efficiency by N, nitrogen gathering record, photosynthetic rate, hard and fast phosphorus take-up, clear phosphorus recovery, phosphorus gathering document, and reduced days to half blossoming. The wheat genotype Good Tidings 1544 had a greater mean plant level than HI8663, which had a lower mean plant level. Whatever the reason, GW366 cultivars grown in both sub-optimal P section and excellent nitrogen circumstances showed taller plants. The results showed that wheat genotype Hi 1544 had the most significant mean leaf district and wheat genotype HI8663 had a lower mean plant level. The data also showed that when traditional nitrogen and phosphorus planning was applied, the wheat genotype GW366 had the greatest mean leaf location. The maximum grain yield was also a result of the HI8713

grouping's significant nitrogen and phosphorus uptake. The four enhancement medications T₂ (N, P, and K) outperformed all nine of the wheat collections in terms of yield credits, grain yield, and other usage adequacy characteristics. The most significant mean PHI was found in HI8713. There were no appreciable differences between the manure treatments in terms of the soil's pH, electrical conductivity, or potassium status. The soil's nitrogen status grew from 172.2 to 202.3 kg/ha, whereas open phosphorus went from 9.5 to 13.1 kg/ha. In completely pre-planned plots, the potassium level of the soil did not change much.

Credit authorship contribution statement

Shalini Kumari, Priya Rawat, Satendra Kumar: Conceptualisation; Methodology; Data curation; Writing-original draft. Poonam Gusain, Prerna Gupta, Minnu Sasi Manisha Phaugat: Review & editing; Validation; Supervision.

Declaration of Competing Interest

The authors say they have no competing interests.

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