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Research Article

ASSESSMENT OF WHEAT THROUGH VARIETAL INVESTIGATION BASED ON YIELD ATTRIBUTING TRAITS IN PYUTHAN, NEPAL

Priti Devkota, *Sushil Awasthi, and Kriti Devkota

Agriculture and Forestry University, Nepal

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Abstract

A field experiment was conducted in Pyuthan, Nepal, from March to June 2024, to evaluate the performance of five wheat varieties (NL 1446, Sworgadwari, NL 1179, Khumal Shakti, and NL 1488) based on yield-attributing traits. The experiment followed a Randomized Complete Block Design (RCBD) with four replications. Data were collected on plant height, spike length, number of spike heads per square meter, number of grains per spike, grain weight per spike, thousand-grain weight (TGW), and total yield. Results revealed significant differences among the varieties. NL 1446 exhibited the highest yield (6.175 tons/ha) and superior performance in most yield-related traits, including plant height (104.05 cm), spike length (11.2 cm), and TGW (61.875 g). In contrast, Khumal Shakti had the shortest plant height (88.50 cm) and the lowest TGW (48.10 g). The number of grains per spike ranged from 36.70 (NL 1488) to 49.30 (Sworgadwari), while NL 1446 had the highest grain weight per spike (3.375 g). Sworgadwari and NL 1488 recorded the lowest yields of 3.650 and 3.550 tons/ha, respectively. The findings suggest that NL 1446 is the most promising variety for wheat production in Pyuthan due to its high yield and favorable agronomic traits, making it suitable for commercial cultivation.

Keywords: Wheat, Variety, Grain Yield, Production, and Trail.

INTRODUCTION

Wheat (*Triticumaestivum L.*), a globally important crop, is the most cultivated and consumed cereal worldwide. It is consumed by 35% of the world's population and contributes 20% of human calories and protein across the world (Poudel and Bhatta 2017). Wheat, a prominent staple crop occupies the third position after rice and maize in terms of production and the second position after rice in terms of consumption in Nepal (Pant *et al.,* 2023). Wheat cultivation extends from the Terai plains to the high-altitude mountain areas, with the consumption of wheat steadily increasing in recent times. Wheat cultivation is believed to have occurred since ancient times, especially in the Far and Mid-Western Hills of Nepal. The highest altitude differences in the world are seen in Nepal, where flat, Khet, and Bari regions with deep soils show how different wheat genotypes have adapted to different production conditions. Wheat is cultivated in 7,16,978 hectares of land and has a production of 2,144,568 Mt with an average productivity of 2.99 mt/ha in Nepal. It has contributed 5.6721% to AGDP (MoALD, 2023). Different agro ecological zones and environments with varying production potentials are used to grow wheat (Pandey *et al.,* 2017). Investing in crop research has significantly boosted productivity by developing new varieties and enhancing management practices. Varietal selection according to ecological conditions is one of the crucial points to get maximum production. In Nepal, wheat can be planted in spring which usually takes 120 days to mature, or in fall (winter) which takes 240 days to maturity (Krishi Diary,2080). Wheat is the major winter crop in Nepal including two major wheat production belts mid and high hills (600-2000 masl) and terai (<600 msal). It is grown in both rice-based and maize-based cropping systems but more than 80% of the wheat is grown in a rice-wheat pattern (Kandel *et al.,* 2018).

Corresponding Author:** ***Sushil Awasthi,
Agriculture and Forestry University, Nepal.

Being a country with different physiographic zones including hills, the development of wheat variety for hills is significant (Battese *et al.,* 2014). It is important to increase wheat yield and production in the country using appropriate variety. Developing high-yield crop varieties suited to the hilly terrain of Nepal is essential for meeting production demands and ensuring food security in the region. Modern varieties and improved farming practices greatly impact improved crop cultivation. Farmers gradually replaced their low-yielding traditional varieties with high-yielding ones, contributing most to the increased production and productivity (Prasai& Shrestha, 2015). The elevation of the Pyuthan District in Nepal ranges from 305 meters (1,000 feet) to 3,659 meters (12,001 feet) above sea level. It's a "hill" district located in Lumbini Province with district headquarters in Khalanga. Pyuthan covers an area of 1,309 square kilometers (505 square miles). It is situated at 28.1016595° North and 82.8532928° East. Pyuthan has a humid sub-tropical, dry weather climate (Agriculture Statistics and Annual Progress Report, 2080). The total area of wheat production in the Pyuthan district is 8,690 Ha and the total production is 24,959 metric tons with a productivity of 2.87 metric tons per hectare (MoALD, 2023). This study was conducted to evaluate the productivity of different varieties used in research and to estimate the yield potential of the varieties in Pyuthan, Nepal.

Production Scenario in the World

Wheat, a cereal crop feeding millions of people worldwide, is a vital component in global food security. Wheat ranks as the second most widely cultivated grain globally in terms of both acreage and total production. During the 2023/24 period, global wheat production reached close to 785 million metric tons (m mt), experiencing a slight decrease of approximately four million tons from the previous year. In contrast, global wheat consumption rose to 796 m mt, reflecting an increase of five million tons compared to the prior year (Wheat Production in China, 2013-23). The largest wheat producer in the world is China with a production of 137.7 million metric tons, which is followed by India and Russia respectively (FAO, 2022)

Table 1. Top 10 wheat-producing countries of the world

S.N.	Country	Production (million tons)
1.	China	137.72
2.	India	107.7.4
3.	Russia	104.23
4.	USA	44.90
5.	Australia	36.23
6.	France	34.63
7.	Canada	34.33
8.	Pakistan	26.20
9.	Germany	22.58
10.	Ukraine	20.72

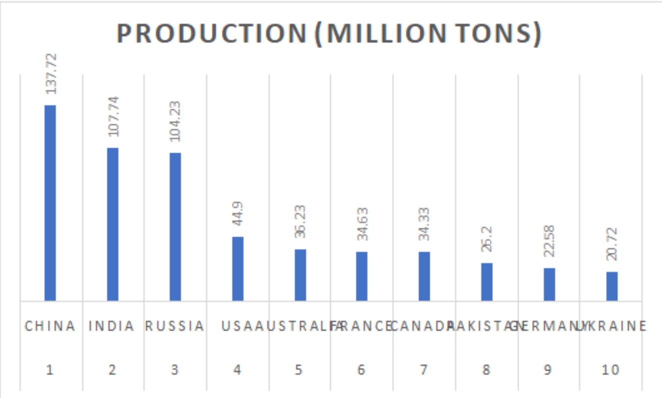

Figure 1. Top 10 wheat-producing countries of the world

Production in Nepal

Wheat is the third major cereal crop after rice and maize in Nepal and cultivated in around 716978 hectares and the average national productivity is 2.99 t/ha. It has contributed 5.6721 % to AGDP (MoALD, 2023). Wheat is grown from the terai to the high hills of Nepal. The Mid-hills and high hills represent 32% of the total production and 43% of the area. In Nepal, wheat can be grown from 60m up to 3,000m above sea level i.e. from warm subtropical to temperate climates(Pant *et al.,* 2023).

Table 2. Area, production, and yield of wheat in the last ten years (AD) in Nepal

Year (AD)	Area (ha)	Production (Mt)	Yield(ha/Mt)
2012/13	759,843	1,882,220	2.48
2013/14	754,474	1,883,147	2.5
2014/15	762,373	1,975,625	2.59
2015/16	745,823	1,736,849	2.33
2016/17	735,850	1,879,191	2.55
1017/18	706,843	1,949,001	2.76
2018/19	703,992	2,005,665	2.85
2019/20	707,505	2,185,289	3.09
2020/21	711,067	2,127,276	2.99
2021/22	716,978	2,144,568	2.99

Production in Pyuthan

Pyuthan is a mid-hilly district located in Lumbini province (Province no.5). Lumbini Province covers 533,072 mt of total production. The area under wheat cultivation, production, and productivity in 2021/22 was 8,690 ha, 24,959 metric tons, and 2.87 mtha−1, respectively in the Pyuthan district. (MoALD 2023).

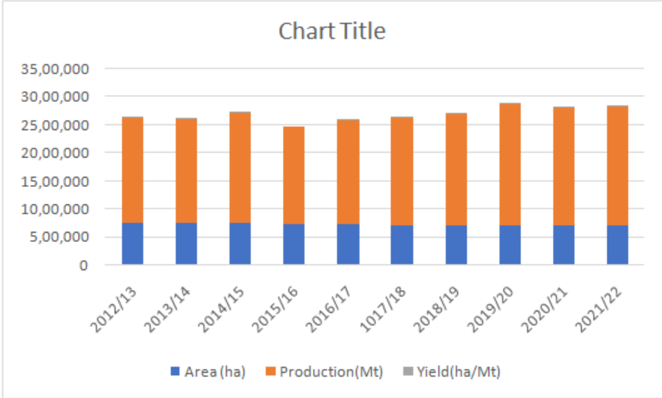

Figure 2. The trend analysis of Wheat Production in Nepal (2012-2022)

Table 3. Area, production, and yield of wheat in the last five years (BS) in Pyuthan

Year (BS)	Area (ha)	Production (mt)	Yield (mt/ha)
2074/75	8,577	25,431	2.97
2075/76	8,036	24,885	3.1
2076/77	7,951	23,693	2.98
2077/78	7,960	24,959	3.14
2078/79	8,690	24,959	2.87

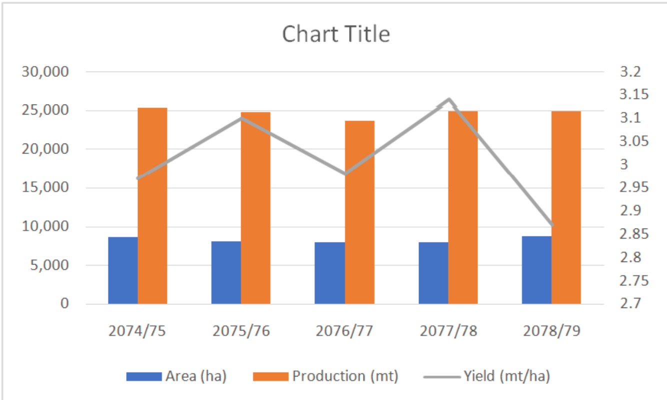

Figure 3. The trend analysis of wheat production of Pyuthan (2074-2079)

Wheat Yield attributing traits

Selection based on the plant's physical appearance or characteristics of its traits (phenotype) used to be considered an easy method and has been utilized extensively for the development of varieties (Joshi *et al.,* 2017). There was a significant variability among the genotypes for different traits including grain yield in wheat (Pant *et al.,* 2020). Grain yield of wheat is a complex trait and is affected by various components like; several tillers per meter square, number of grains/spikes, spike length, thousand grain weight (TGW), and days to maturity. This yield trait is affected by yield components (Pireivatlou *et al.,* 2011); therefore, yield and yield components could be considered and studied in breeding programs (Carew *et al.,* 2009). Grain yield is the result of genetic potential, environmental conditions, and agronomic practices. The grain yield of wheat varieties varied with the location due to varied environmental conditions (Yadav *et al.,* 2022). Growth stages and quantitative yield attributing parameters justified most of the variation in yield (80.2%) whereas the remaining is expected to be environmental and nutritional factors (Upadhyaya and Bhandari, 2022). The highly positive correlation of the number of tillers per meter square with grain yield shows that grain yield could be increased by increasing the number of tillers. Indirect selection for higher-grain-yielding genotypes could be done based on the number of tillers per square meter trait (Thapa *et al.,* 2022).

Wheat Varietal Investigation

Different agroecological zones and environments with varying production potentials are used to grow wheat (Pandey *et al.,* 2017). The best yield can be obtained with cool, moist weather during the major portion of the growing period followed by dry, warm weather to enable the grain to ripen properly. There is a limited potential area for expanding wheat cultivation, therefore, the focus should be on enhancing wheat productivity through improved cultivars (Chatrath *et al,* 2007). Varieties usually last 5 to 10 years before they become less productive due to new diseases. So, we need to keep creating new high-yielding varieties that resist diseases to replace the old ones and improve wheat farming continuously (Pant *et al.,* 2023). Improving varieties is an ongoing process. Thus, wheat improvement is accompanied by elevating the yield level and stabilizing the yield level attained. Tripathi 2014 highlighted the National Wheat Research Program (NWRP) must adopt certain strategies to strengthen the concept of developing location and product-specific varieties/technologies, for sustainable increase in wheat production and safeguarding the food security in the country. The hills have low productivity mainly because there aren't suitable high-yielding varieties, the seed distribution system is inefficient, irrigation is lacking, and there's insufficient resistance to diseases like leaf rust, yellow rust, and loose smut (Pant *et al.,* 2023). There is the existence of considerable genetic variability among the genotypes of wheat for yield and yield-related traits, which can further be exploited to improve wheat productivity (Semahegen *et al.,* 2020).

METHODOLOGY

Research Site Description

The research was conducted in the Pyuthan district of Nepal which represents the mid-hill region in Lumbini Provine (Province no.5) and has the potential for high wheat production. It covers an area of 1,309 square kilometers and is located at Latitude: 28.1032° North and Longitude: 82.8548° East. Khalanga is the district's administrative center. The research will be conducted in Khaprenkhola, Pyuthan as it is the major working site.

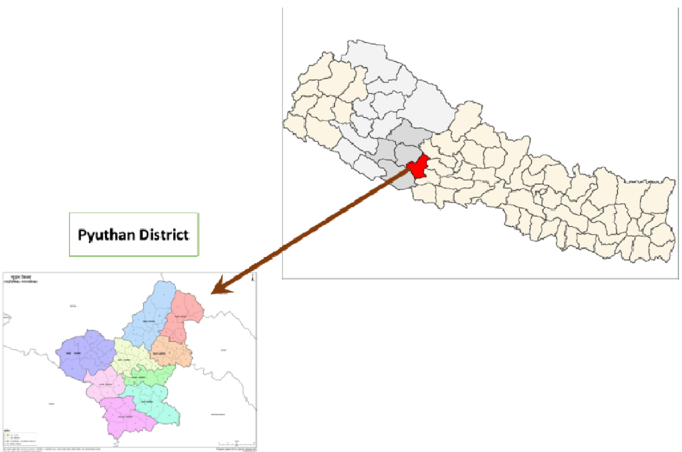

Figure 4. Map of Pyuthan District

Research Design

Research Period: The study was carried out from the Chaitra 2080 B.S. to the Ashar 2081 B.S.

Variety:

Table 4. Name of variety used in research

S.N.	Variety
T1	Sworgadwari
T2	NL 1446
T3	NL 1179
T4	Khumal Shakti
T5	NL 1488

Experimental Design

The experiment was conducted using a single-factorial randomized complete block design (RCBD) with four replications. The replication factor was the wheat variety, and the total number of treatments corresponded to the five wheat varieties used in the research. In total, there were four replications and five treatments. The layout of the experiment involved assigning treatments in each replication using the lottery method to ensure randomness. The distance between plots was maintained at 0.5 meters, and the distance between adjacent blocks or replications was 1 meter. The total area of the experimental field was 16 m × 13 m, with each plot covering an area of 3 m × 2 m. Consequently, the experiment included a total of 20 plots, representing five treatments replicated four times each.

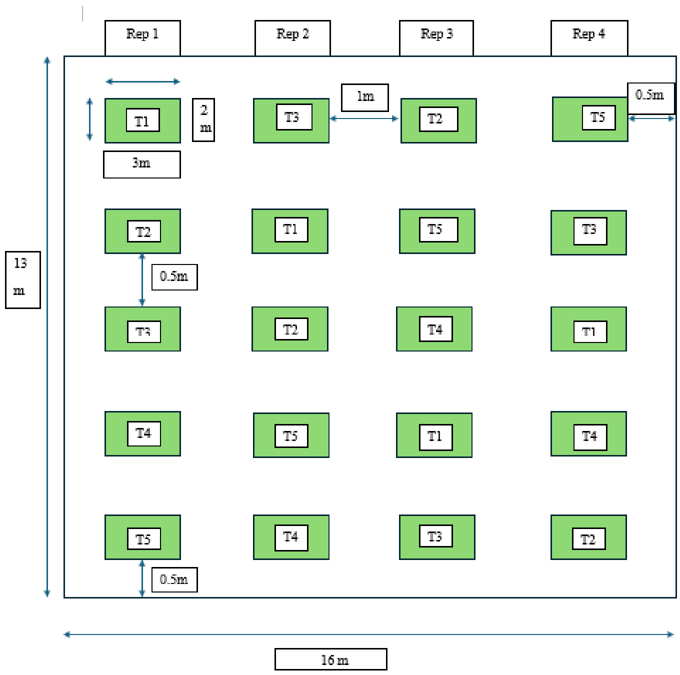

Figure 5. Layout of the Field

Sampling and Observation

Observation was taken for the following parameters

- *Spike length*

Length from the basal spikelet to the apical spikelet, excluding awns was measured as spike length and was taken from five sampled plants.

- *Plant height*

The plant height was measured from soil surface in cm up to tip of apical spikelet excluding awn of the main tiller using a meter scale at the time of harvesting.

- *Thousand Grain Weight (TGW)*

After harvesting and drying, 500 grains from each plot were counted and weighed (in gm) using electronic balance and multiplied by 2 to calculate the 1000 grain weight.

- *Number of Grain per spike*

Five spikes from randomly selected plants were hand threshed and number of grains was counted and averaged to obtain number of grains per spike.

- *Grain yield per spike*

The average of weight of grains from five sampled plants was taken as grain weight per spike.

- *Grain yield (kg/ha)*

Harvested crop from net plot was threshed using a plot thresher. The grain yield was recorded in kg/ha with adjustment for 12% grain moisture content.

Data Analysis

Data entry and processing was carried out using Microsoft Office Excel 2016. Analysis of variance (ANOVA) and mean estimation were done with the software- R Studio. The statistical significance (alpha) was declared at 5% level of probability.

RESULTS

Plant Height

The plant height of wheat varieties showed significant variation (F-probability < 0.001, LSD = 0.96 t/ha). NL 1179 exhibited the tallest plants with an average height of 106.50 cm, followed by NL 1488 (105.15 cm) and NL 1446 (104.05 cm). These three varieties were statistically similar in terms of height. In contrast, Khumal Shakti had the shortest plant height of 88.50 cm, while Sworgadwari was intermediate at 94.70 cm. The overall grand mean of plant height was 99.78 cm with a low coefficient of variation (CV = 2.06%). Plant height is a critical trait as it influences light interception and competition with weeds, but excessive height can increase the risk of lodging, especially in high-wind or rainfall-prone areas.

Table 5. Plant height of wheat influenced by variety in Pyuthan, Nepal 2024

Treatment	Plant Height(cm)
NL 1446	104.05 ^{a}
Sworgadwari	94.70 ^{b}
NL 1179	106.50 ^{a}
Khumal Shakti	88.50 ^{c}
NL 1488	105.15 ^{a}
LSD (0.05)	3.18
SEm (±)	1.03
F-probability	<0.001
CV%	2.06
Grand Mean	99.78

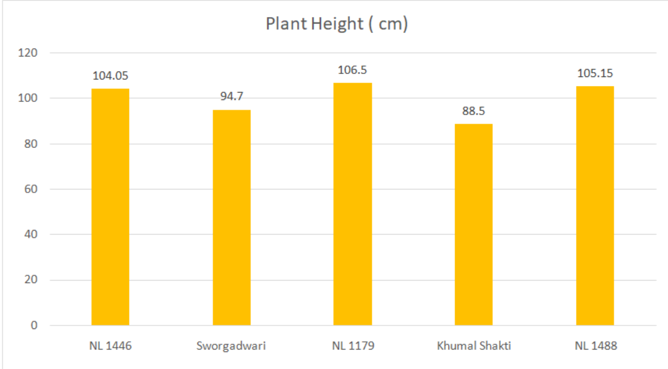

Figure 6. Plant height of wheat influenced by variety

Note: SEm: Standard error of the mean, LSD: least significant difference, CV: Coefficient of variation, values with same letters on the column are not significantly different at 5%DMRT (Duncan Multiple Range Test) and figure in parenthesis indicate square root transformation

Spike Length

Spike length also varied significantly among the varieties (F-probability < 0.001, LSD = 0.96 t/ha). NL 1446 had the longest spike with an average length of 11.2 cm, which was significantly higher than other varieties. Sworgadwari (9.1 cm), Khumal Shakti (9.05 cm), and NL 1488 (9.215 cm) had intermediate spike lengths, while NL 1179 had the shortest spike length of 8.03 cm. The grand mean spike length was 9.32 cm with a coefficient of variation of 6%, suggesting moderate variability among the varieties. Spike length is directly associated with the number of grains a spike can accommodate, making it an important trait for overall yield potential.

Table 6. Spike Length of wheat influenced by variety in Pyuthan, Nepal 2024

Treatment	Spike Length
NL 1446	11.2 ^{a}
S	9.1 ^{b}
NL 1179	8.03 ^{c}
KS	9.05 ^{b}
NL 1488	9.215 ^{b}
LSD (0.05)	0.863
SEm (±)	0.28
F-probability	<0.001
CV%	6
Grand Mean	9.32

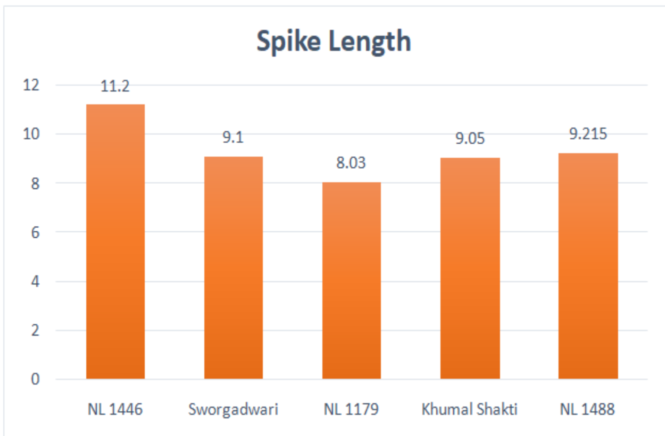

Figure 7. Spike Length of wheat influenced by variety

Note: SEm: Standard error of the mean, LSD: least significant difference, CV: Coefficient of variation, values with same letters on the column are not significantly different at 5%DMRT (Duncan Multiple Range Test) and figure in parenthesis indicate square root transformation.

Spikes Head per meter square

The number of spike heads per square meter, reflecting the density of spikes in the field, showed significant variation among the varieties (F-probability < 0.01, LSD = 18.50). Khumal Shakti had the highest number of spike heads at 107.00 spikes/m², followed by NL 1446 (100.25 spikes/m²). These varieties demonstrated higher productivity in terms of tiller formation and spike development. On the other hand, Sworgadwari and NL 1488 had significantly fewer spike heads per square meter, at 74.75 and 77.75 spikes/m², respectively. The grand mean for this trait was 90.65 spikes/m² with a CV of 13.24%, indicating a higher level of variability likely influenced by environmental factors such as soil quality or moisture availability. Higher spike head density generally correlates with increased grain production.

Table 7. Influence of variety on Spike Head per meter square

Treatment	Spike Head/m^2
NL 1446	100.25 ^{a}
S	74.75 ^{b}
NL 1179	93.50 ^{ab}
KS	107.00 ^{a}
NL 1488	77.75 ^{bc}
LSD (0.05)	18.50
SEm (±)	6
F-probability	<0.01
CV%	13.24
Grand Mean	90.65

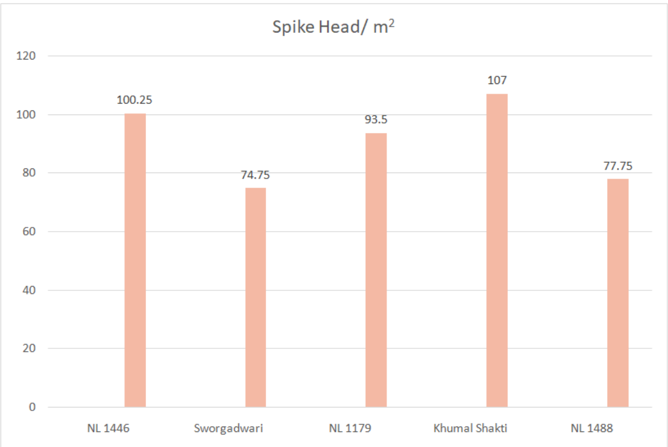

Figure 8. Spike head per m^2 of different variety of wheat

Note: SEm: Standard error of mean, LSD: least significant difference, CV: Coefficient of variation, values with same letters on column are not significantly different at 5%DMRT (Duncan Multiple Range Test) and figure in parenthesis indicate square root transformation

Number of Grains per spike

Significant differences were observed in the number of grains per spike across the wheat varieties (F-probability < 0.001, LSD = 3.9). Sworgadwari produced the highest number of grains per spike at 49.30, closely followed by NL 1446 (48.15 grains/spike) and Khumal Shakti (46.45 grains/spike). NL 1179 produced a moderate number of grains with 41.95 grains/spike, while NL 1488 had the lowest grain count at 36.70 grains/spike, which could limit its yield potential. The grand mean across all varieties was 44.51 grains/spike, with a CV of 5.7%, indicating low variability in this trait. The number of grains per spike is a critical yield component, directly influencing the grain output per plant.

Table 8.: Influence of variety on the number of grains per spike

Treatment	Grain/Spike
NL 1446	48.15 ^{a}
S	49.30 ^{a}
NL 1179	41.95 ^{b}
KS	46.45 ^{a}
NL 1488	36.70 ^{c}
LSD (0.05)	3.9
SEm (±)	1.27
F-probability	<0.001
CV%	5.7
Grand Mean	44.51

Note: SEm: Standard error of the mean, LSD: least significant difference, CV: Coefficient of variation, values with same letters on the column are not significantly different at 5%DMRT (Duncan Multiple Range Test) and figure in parenthesis indicate square root transformation

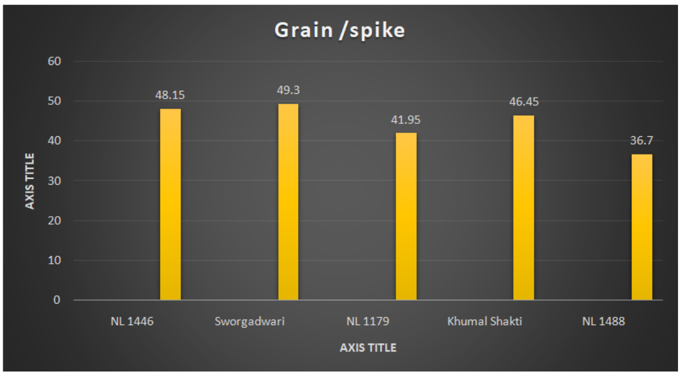

Figure 9. No of grain per spike for different variety of wheat

Grain weight per spike

Grain weight per spike, a key factor in determining overall yield, also varied significantly among the varieties (F-probability < 0.001, LSD = 0.265 g). NL 1446 had the highest grain weight per spike at 3.375 g, followed by NL 1179 (2.850 g) and Khumal Shakti (2.600 g). Sworgadwari and NL 1488 had significantly lower grain weights per spike at 2.250 g and 2.100 g, respectively. The grand mean for this trait was 2.635 g, with a CV of 6.51%, indicating moderate consistency. Heavier grain weight per spike is advantageous for yield potential, as it directly contributes to higher grain mass.

Table 9. Influence of varieties on Grain weight/ Spike of wheat

Treatment	Grain Weight/Spike
NL 1446	3.375 ^{a}
S	2.250 ^{c}
NL 1179	2.850 ^{b}
KS	2.600 ^{b}
NL 1488	2.100 ^{c}
LSD (0.05)	0.265
SEm (±)	0.086
F-probability	<0.001
CV%	6.51%
Grand Mean	2.635

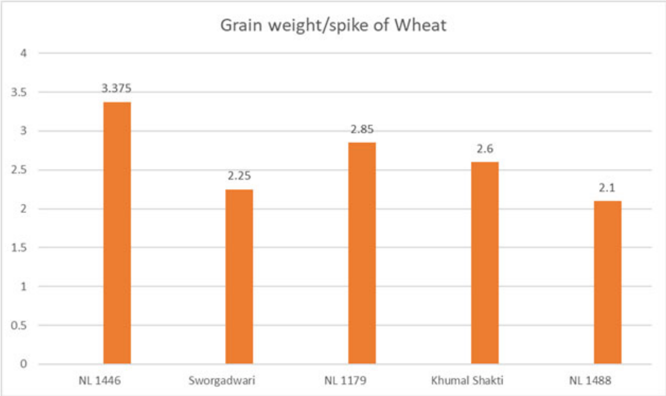

Figure 10. Gain weight per spike of different variety of wheat

Note: TGW= Thousand Grain Weight SEm: Standard error of mean, LSD: least significant difference, CV: Coefficient of variation, values with same letters on column are not significantly different at 5%DMRT (Duncan Multiple Range Test) and figure in parenthesis indicate square root transformation

Thousand Grain Weight

The Thousand Grain Weight (TGW) varied significantly among the wheat varieties (F-probability < 0.001, LSD = 1.51 g). NL 1446 had the highest TGW at 61.875 g, indicating larger and heavier grains. Sworgadwari (58.90 g) and NL 1179 (58.375 g) also had relatively high TGW values. In contrast, Khumal Shakti had the lowest TGW at 48.100 g, significantly lower than all other varieties. The grand mean TGW was 56.13 g with a very low CV of 1.75%, suggesting that this trait is stable and not greatly influenced by environmental factors. Larger grains are typically preferred for both yield and marketability, making TGW an important indicator of grain quality.

Table 10. Influence of wheat genotypes on TGW

Treatment	TGW
NL 1446	61.875 ^{a}
S	58.900 ^{b}
NL 1179	58.375 ^{b}
KS	48.100 ^{d}
NL 1488	53.400 ^{c}
LSD (0.05)	1.51
SEm (±)	0.492
F-probability	<0.001
CV%	1.75
Grand Mean	56.13

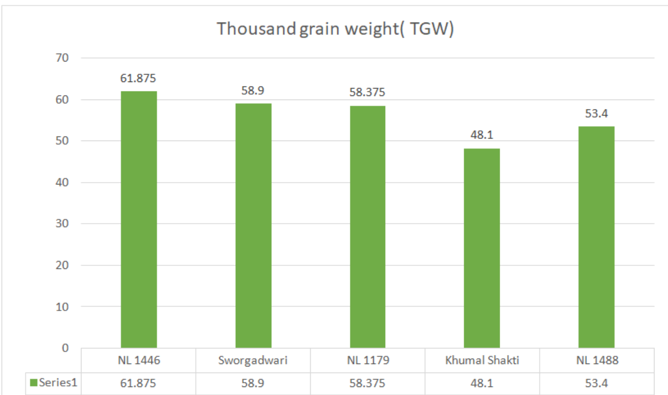

Figure 11. Thousand gain weight of different variety of wheat

Note: TGW= Thousand Grain Weight SEm: Standard error of mean, LSD: least significant difference, CV: Coefficient of variation, values with same letters on column are not significantly different at 5%DMRT (Duncan Multiple Range Test) and figure in parenthesis indicate square root transformation

Grain Yield

The total grain yield showed significant variation among the varieties (F-probability < 0.001, LSD = 0.96 t/ha). NL 1446 produced the highest yield of 6.175 tons/ha, making it the most productive variety in the study. NL 1179 followed with a yield of 4.775 tons/ha, while Sworgadwari (3.650 tons/ha) and NL 1488 (3.550 tons/ha) had the lowest yields. Khumal Shakti also had a lower yield at 4.100 tons/ha. The grand mean yield was 4.45 tons/ha, with a CV of 13.98%, indicating that environmental factors or management practices may have caused some variability in yield. Yield is the most critical trait for farmers, as it represents the economic output of wheat cultivation. The high yield of NL 1446 highlights its potential for commercial production in Pyuthan, Nepal.

Table 11. Influence of varieties on yield of wheat

Treatment	Total Yield(ton/ha)
NL 1446	6.175 ^{a}
S	3.650 ^{c}
NL 1179	4.775 ^{b}
KS	4.100 ^{bc}
NL 1488	3.550 ^{c}
LSD (0.05)	0.96
SEm (±)	0.31
F-probability	<0.001
CV%	13.98
Grand Mean	4.45

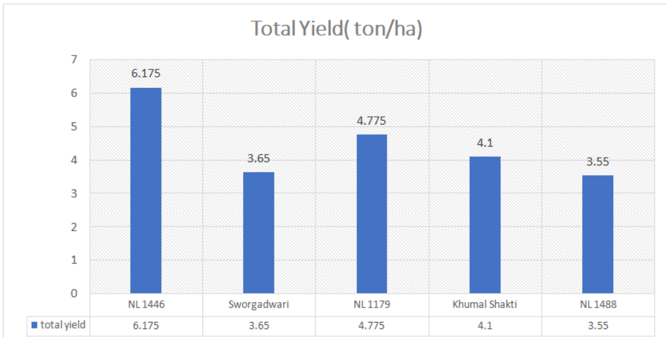

Figure 12. Total yield of different variety of wheat

Note: SEm: Standard error of the mean, LSD: least significant difference, CV: Coefficient of variation, values with same letters on the column are not significantly different at 5%DMRT (Duncan Multiple Range Test) and figure in parenthesis indicate square root transformation

DISCUSSION

Grain Yield per Hectare

Grain yield is the most critical trait in wheat cultivation and is influenced by several yield-contributing factors such as plant height, spike length, number of spike heads per square meter, grain weight, and thousand-grain weight. In this study, NL 1446 had the highest grain yield of 6.175 tons/ha, followed by NL 1179 (4.775 tons/ha). The varieties Sworgadwari (3.650

tons/ha) and NL 1488 (3.550 tons/ha) recorded the lowest yields. These results suggest that NL 1446 has superior agronomic performance compared to the other varieties. Grain yield is often the primary focus of breeding programs as it directly affects farmers' profitability. Several studies (Pandey *et al.,* 2017; Thapa *et al.,* 2022) have reported significant variation in wheat yield across different genotypes. The mean wheat yield obtained in this study, 4.45 tons/ha, is higher than the national average yield for wheat in Nepal, which ranges from 2.3 to 2.59 tons/ha (Bhatta *et al.,* 2020; Gairhe *et al.,* 2017). This suggests that the varieties used in this trial, especially NL 1446, have a higher yield potential than the commonly grown varieties in Nepal.

Reproductive Traits

The reproductive traits measured, including number of grains per spike, grain weight per spike, and number of spike heads per square meter, showed significant variation among the genotypes. Sworgadwari had the highest number of grains per spike (49.30 grains/spike), followed closely by NL 1446 (48.15 grains/spike). However, NL 1488 produced significantly fewer grains (36.70 grains/spike), which likely contributed to its lower yield. The number of grains per spike is a crucial yield-determining trait. Previous studies (Ali *et al.,* 2021; Ikram-ul-Haq *et al.,* 2022) have demonstrated that genotypes with higher grain counts generally yield more grain per unit area. The results of this study support this, with the highest-yielding variety, NL 1446, also having one of the highest grain counts per spike. In terms of spike head density, Khumal Shakti showed the highest number of spike heads per square meter (107.00 spikes/m²), followed by NL 1446 (100.25 spikes/m²). The number of spike heads per unit area is directly correlated with yield potential, as more spike heads usually mean a higher number of grains per unit area. These results are consistent with studies by Malik et al. (2021) and Liu et al. (2023), who found significant differences in spike head density among wheat genotypes.

Plant Architectural Traits

Plant height and spike length are key architectural traits that can influence both yield and the plant's ability to compete with weeds and resist lodging. In this study, NL 1179 was the tallest variety, reaching an average height of 106.50 cm, while Khumal Shakti was the shortest at 88.50 cm. Taller plants like NL 1179 may capture more light and produce more biomass, which could contribute to higher grain yields. However, excessive plant height can increase the risk of lodging, especially under adverse weather conditions. Previous research (Ikram-ul-Haq *et al.,* 2022; Molero& Reynolds, 2020) has shown that plant height is an important trait in wheat breeding, as it influences both yield and structural stability. In this study, the plant height across varieties was relatively consistent, with a low CV of 2.06%, indicating that this trait is largely controlled by genetics rather than environmental factors.

Grain weight per spike and thousand grain weight (TGW)

Grain weight per spike and thousand-grain weight (TGW) are important traits contributing to the final yield. In this study, NL 1446 had the highest grain weight per spike (3.375 g), while NL 1488 (2.100 g) and Sworgadwari (2.250 g) had the lowest. These differences in grain weight could explain the variations in yield across the varieties.

Thousand-grain weight (TGW) is an indicator of grain size and weight, which are important for both yield and marketability. NL 1446 had the highest TGW (61.875 g), while Khumal Shakti had the lowest (48.10 g). The relatively low coefficient of variation for TGW (CV = 1.75%) suggests that this trait is stable across different environmental conditions, as noted in previous studies (Ali *et al.,* 2021; Ikram-ul-Haq *et al.,* 2022). TGW is often used as a selection criterion in breeding programs aiming to improve both yield and grain quality.

Spike Length

Spike length is another important agronomic trait, influencing the number of grains per spike and, consequently, the yield. In this study, NL 1446 had the longest spike (11.2 cm), while NL 1179 had the shortest (8.03 cm). However, spike length was not as strongly correlated with yield as other traits like the number of grains per spike or grain weight per spike. This is consistent with findings from other studies (Khyber *et al.,* 2019; Ali *et al.,* 2021), which showed that while spike length can contribute to yield, its effect is often overshadowed by other factors such as grain number and weight.

Conclusion

In conclusion, NL 1446 is the most suitable wheat variety for cultivation in Pyuthan, owing to its high yield and favorable agronomic traits. Its high TGW, longer spikes, and higher grain weight per spike make it ideal for maximizing wheat production in the region. NL 1179 and Khumal Shakti offer moderate potential, while Sworgadwari and NL 1488 are less suited for large-scale cultivation under similar conditions. Selecting high-yielding varieties like NL 1446 could significantly enhance wheat productivity in Pyuthan and similar agro-climatic regions. Further research is recommended to assess these varieties under different environmental conditions and management practices to ensure wider adaptability and yield stability.

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