International Journal of Agricultural and Applied Sciences, June 2023, 4(1): 17-22
https://www.agetds.com/ijaas
ISSN: 2582-8053
https://doi.org/10.52804/ijaas2023.413

Research Article

Accessing the efficacy of different doses of phosphorus on growth and yield of spring maize (*Zea mays* L.) at Gulmi, Nepal

Shikha Sharma[1]*, Ananta Prakash Subedi[2], Bibek Budhathoki[1], Srijana Neupane[1] and Praju Ghimire[3]

*[*1]Faculty of Agriculture, Agriculture and Forestry University, Rampur, Chitwan, Nepal*
[2]Department of Agri-botany and Conservation Ecology, Agriculture and Forestry University, Rampur, Chitwan, Nepal,
[3]Faculty of Agriculture, College of Natural Resource Management, Puranchaur, Kaski, Nepal
Corresponding author e-mail: sajjsharma44@gmail.com
(**Received:** 28/11/2022; **Revised:** 19/03/2023; **Accepted:** 25/04/2023)

ABSTRACT

Phosphorus is one of the most important crop-limiting elements which plays a crucial role in the growth as well as the development of the plant. To meet the crop need and to obtain the efficiency of fertilizer they should be applied in appropriate doses. Thus, an experiment including six different doses of phosphorus as a treatment (0, 20, 40, 60, 80, and 100) kgha^{-1} was designed to identify the optimum dose of phosphorus for better growth and yield of spring maize. The study was carried out according to one factorial RCBD with four replications of six treatments at Satyawati rural municipality, Khaireni, Gulmi from February-June 2022. Maize seeds (Arun-2) treated with Bavistin were sown by maintaining a spacing of 75*25 cm^2. Different observations like biometrical, phenological as well as yield-attributing characters were recorded. The results showed that the different doses of phosphorus significantly affected the recorded parameters. The plant height was found highest (164.92cm) with 100kg P_2O_5 ha^{-1} which was statistically similar to the plant height (155.57cm) obtained at 80kg P_2O_5 ha^{-1}. The longest days to silking and tasseling were found at 0 kg P_2O_5 ha^{-1}. Likewise, cob length (23.05cm), number of grains per kernel (26.76), and shelling percentage (74.48%) were highest in plants with 100kg P_2O_5 ha^{-1}and number of kernel row per cob (15.19), number of grains per cob (406.22) [1] and grain yield (6203.29kg ha^{-1}) was highest in plants with 80 kg P_2O_5 ha^{-1}. The maximum harvest index percentage (38.13%) was obtained in 60 kg P_2O_5 ha^{-1}. There was no significant variation of treatment on thousand-grain weight. This research showed that the treatment of 80kg P_2O_5 ha^{-1} was found to boost the yield of maize by enhancing the growth and yield attributes of maize. Thus, for a better and improved yield of maize 80 kg P_2O_5 h^{-1} is recommended in Gulmi.
Keywords: Arun-2, Fertilizer dose, Yield parameters, Nutrients.

INTRODUCTION

In the global scenario, maize is the most important crop after rice. It is believed to be domesticated by the native people of Mexico about 9000 years ago (Matsuoka, et al., 2002) which has many domestic and industrial uses. Globally, its production area is about 197 million hectares and production is about 1,137 million tons (Erenstein, Jaleta, Sonder, Mottaleb, & Prasanna, 2022). United States of America, China, Brazil, Argentina, Ukraine, and India are the top countries for maize production with a production of 392,450,840 tons, 257,348,659 tons, 82,288,298 tons, 43,462,323 tons, 35,801,050 tons and 27,820,000 tons respectively.

In many developing countries, maize is considered a primary staple crop. In Nepal, maize is 2nd most essential crop in cultivated areas, with production and productivity contributing 9.5% to AGDP and 3.5% to GDP (KC, Karki, Shrestha, & Achhami, 2015) which is mainly grown for food, feed, and fodder as well as for industrial raw materials. The total maize production area is 9,79,776 ha with a production of 29,97,733 metric tons (MoALD, 2021). Among crop plants, maize has the highest production potential and has the most variation in its morphology. At present, the lower yield of maize in Nepal than that of other Asian countries may be probably due to a lack of quality seeds and proper use of inputs. The most important input in increasing agricultural productivity is Chemical fertilizer, according to Nepal's agriculture perspective plan and agriculture development strategy (Panta, 2019). Since, genotype, environment, and crop management influence yield, for better production fertilizer management is very crucial. Nitrogen is the foremost crucial fertilizer for maize production and after that, phosphorus is the most crop-limiting element in the majority of soil (Wojnowska, Panak, & Seikiewiez, 1995). Mainly in the hilly regions of Nepal, the majority of the soils lack soil-available phosphorus so, phosphorus could be a restrictive factor for Maize production (Shrestha, Amgain, & Aryal, 2016). Phosphorus plays a very important role in root growth and development as well as plant reproduction. Maize plants lacking phosphorus will results in stunted growth and limited development of the root system (Masood, et al., 2011) and also produce smaller ears with fewer kernels than normal (Sapkota, Shrestha, & Chalise, 2017). Another study by Baral, Adhikari, & Shrestha (2016) found the increased dose of phosphorus significantly reduces the days to 50% tasselling and silking. Besides this phosphorus application also increases the soil available P and K. Adequate phosphorus application results in quick quality vegetative growth and earlier maturity with quality grain. So, phosphorus application in an appropriate dose is crucial for better growth and yield of maize. Thus, the goal of the current study was to find the appropriate dose of phosphorus for better growth and yield of spring maize.

MATERIALS AND METHODS

Study area

This study was conducted to know how the growth and yield of spring maize were affected due to different doses of phosphorus at Satyawati rural municipality-6, Khaireni, Gulmi, from February to June 2022 located at Latitude: 28° 0' 55" north and Longitude: 83° 26' 21" east (Mapcarta, 2022).

Weather data

During the experiment period, average monthly weather data were recorded from February to June 2022. The average maximum and average minimum temperature for the cropping duration were 25.17˚C and 14.66˚C respectively. The maximum relative humidity for the cropping period was 52% and the minimum was 10.8% (Nasa Power, 2022).

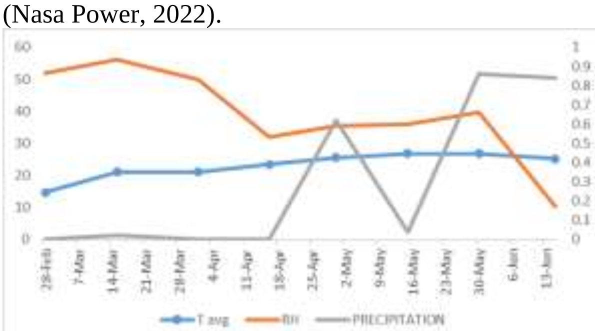

Figure 1: Weather data of experimental location, 2022, at Satyawoti-6, Khaireni, Gulmi

Variety details

Arun 2 variety of maize was used for the research. It is dwarf spring maize which was recommended in the Terai, Inner Terai, and lower hills that grows up to a height of 140cm to 200cm tall.

Experiment details

The experiment was carried out according to one factorial Randomized Complete Block Design (RCBD) including four replications of six treatments with each plot size 3 m *2.5 m (7.5 m^2) by maintaining the spacing of 75 cm*25 cm between the rows and plants respectively. For the routine test of soil, analysis of soil was done before conducting the research by taking samples randomly from each replication. Soil samples were collected from 0-15cm depth using the shovel and were dried, and made fine. A soil kit box was used for the analysis. The soil was sandy loam in texture which was identified by using the textural triangle method. PH was 6.7 which is best suited for maize. Nitrogen and Soil available phosphorus was medium meanwhile available potassium was low.

The field was ploughed with a mini tiller 15 days before seed sowing to bring the soil under good tilth. In all experimental plots, the FYM @5 kg per plot area (7.5 m^2) was applied and mixed uniformly into the soil during the first land preparation. The amount of phosphatic fertilizer that is required for each treatment was calculated separately. As a basal dose, P_2O_5 @ 0 g, 33 g, 65.2 g, 98 g, 132 g, and 165 g per plot for treatments of 0, 20, 40, 60, 80, and 100 kg p ha^{-1}, respectively, full dose of recommended potassic fertilizer and half dose of nitrogen fertilizer were applied in all plots. Arun-2 Seeds treated with Bavistin were sowed with the help of Jab-planter after final land preparation. Sowing was done on 2nd March 2022. Later, at the knee-high stage and the tasselling stage, the remaining half of the nitrogen dose was applied in two equal portions. The first manual weeding and earthing up were done 40 days after sowing (DAS). After that second manual weeding was performed at 60 DAS. Harvesting was done on June 15, 2022, manually.

Observation recorded

A biometrical observation like plant height, and number of leaves; Phenological observation like days to 50% tasseling, days to 50% silking, yield attributing characteristics like shelling %, thousand-grain weight, cob length, number of kernel row per cob, number of kernels per row, number of kernels per cob, thousand-grain weight and grain yield were calculated. The formula used for calculating grain yield (kg ha^{-1}) has given below:

$$\text{Yield} = \frac{10000}{A * B} \times \frac{C \times R \times K \times TGW}{1000 \times 1000}$$

Where,
A = Row-to-Row spacing (m)
B = Plant-to-Plant spacing (m)
C = Number of cobs per plant
R = Number of rows per cob
K = Number of kernels per kernel row
TGW= Thousand grain weight (gm)

RESULTS AND DISCUSSION

Plant height

Table no. 1 shows the effect of different doses of phosphorus on plant height on different days after sowing. Plant height was found to be increased with increasing the dose of P_2O_5 from 0 kg ha^{-1} to 100 kg ha^{-1}. At 30DAS, maximum plant height (38.07cm) was obtained at 100 kg P_2O_5 ha^{-1} followed by plant height (36.57cm) and (34.5cm) obtained at 80 kg P_2O_5 ha^{-1} and 60kg P_2O_5 ha^{-1} respectively. Minimum plant height (28.14cm) was obtained at 0 kg P_2O_5 ha^{-1}.

At 45 DAS, the maximum plant height (105.86cm) obtained with 100kg P_2O_5 ha^{-1} was statistically similar to the plant height (101.02cm) obtained with 80 kg P_2O_5 ha^{-1} and the minimum plant height (72.04cm) obtained at 0 kg P_2O_5 ha^{-1}. At 60 DAS maximum plant height (158.64cm) was obtained with 100kg P_2O_5 ha^{-1} and minimum plant height (113.04cm) was obtained at 0kg P_2O_5 ha^{-1}. Finally at 75 DAS, similarly maximum plant height (164.93cm) was obtained at 100kg P_2O_5 ha^{-1} and minimum plant height (129.86cm) was obtained at 0kg P_2O_5 ha^{-1}. High phosphorus doses improve the root system and nutrient absorption which ultimately enhances plant growth. Phosphorus fertilization is used for a variety of physiological and metabolic processes, enhancing vegetative growth (Pal, et al., 2017).

Table 1. Effect of different doses of phosphorus on plant height of spring maize (Arun-2) at Khaireni, Gulmi, 2022

Treatment	Plant height(cm)			
	30 DAS	45 DAS	60 DAS	75 DAS
0 kg P_2O_5 ha^{-1}	28.14^{d}	72.04^{c}	113.04^{d}	129.86^{c}
20 kg P_2O_5 ha^{-1}	32.43^{c}	81.46^{bc}	120.50^{cd}	143.82^{bc}
40 kg P_2O_5 ha^{-1}	32.39^{c}	80.11^{bc}	127.50^{cd}	137.76^{bc}
60 kg P_2O_5 ha^{-1}	34.50^{bc}	87.11^{b}	138.57^{bc}	147.38^{abc}
80 kg P_2O_5 ha^{-1}	36.57^{ab}	101.02^{a}	154.82^{ab}	155.57^{ab}
100 kg P_2O_5 ha^{-1}	38.07^{a}	105.86^{a}	158.64^{a}	164.93^{a}
LSD(0.05)	3.47	13.59	19.40	18.49
SE_m(+-)	1.15	4.51	6.43	6.13
F-probability	***	***	***	*
CV,%	6.84	10.25	9.50	8.37
Grand mean	33.68	87.93	135.51	146.55

CV: coefficient of variation; DAS: days after sowing; NS: Non-significant; SE_m: standard error of the mean; *=significance level at 5% probability level, **= significance level at 1% probability level, ***= significance level at 0.1% probability level; LSD (0.05): Least significant difference at 5% level of significance same letter indicates the similar effect

Number of leaves per plant

There was no significant difference in the number of leaves per plant of maize due to different doses of phosphorus at different dates of observation (Table: 2).

Days of silking and tasseling

Different doses of phosphorus have significantly influenced the days to 50% silking and 50% tasseling (Table 3). The maximum number of days to 50% tasseling (65.51 days) and days to 50% silking (67.98 days) were taken at the treatment 40 kg P_2O_5 ha^{-1} which was statistically similar to the treatment 0 kg P_2O_5 ha^{-1} and a minimum number of days to 50% tasseling (56.81days) and 50% silking (59.8days) was reported with treatment 100kg P_2O_5 which is statistically similar with treatment 80 kg P_2O_5 ha^{-1}. Lower days in silking and tasseling might be due to increased vegetative development along with root development which helps the plant to take up and utilize phosphorus quickly (Amanullah, Zakirullah, & Khalil, 2010). However, these findings are not in line with Khan et al. (2014) who found that different doses of P_2O_5 have no significant influence on days to 50% silking and 50% tasseling of maize.

Table 2. Effect of different doses of phosphorus on the number of leaves per plant of spring maize (Arun-2) at Khaireni, Gulmi, 2022

Treatment	Number of leaves per plant			
	30 DAS	45 DAS	60 DAS	75 DAS
0 kg P_2O_5 ha^{-1}	5.25	7.54	10.61	12.43
20 kg P_2O_5 ha^{-1}	5.07	7.57	10.54	12.39
40 kg P_2O_5 ha^{-1}	5.50	7.36	10.43	12.75
60 kg P_2O_5 ha^{-1}	5.57	7.57	10.61	12.75
80 kg P_2O_5 ha^{-1}	5.14	7.43	10.43	12.54
100 kg $P_2O_5ha^{-1}$	5.36	7.50	10.50	12.40
LSD(0.05)	0.45	0.48	0.42	0.76
SE_m(+-)	0.15	0.16	0.14	0.26
F-probability	NS	NS	NS	NS
CV,%	5.62	4.24	2.64	4.10
Grand mean	5.32	7.49	10.52	12.54

CV: coefficient of variation; DAS: days after sowing; NS:Non-significant; SE_m:standard error of the mean; *=significance level at 5% probability level, **= significance level at 1% probability level, ***= significance level at 0.1% probability level; LSD(0.05):Least significant difference at 5% level of significance same letter indicates the similar effect.

Table 3. Effect of different doses of phosphorus on days to silking and tasseling of spring maize(Arun-2) at Khaireni, Gulmi, 2022

Treatments	Days to tasseling	Days to silking
0 kg P_2O_5 ha^{-1}	64.24^{a}	67^{a}
20 kg P_2O_5 ha^{-1}	62.07^{ab}	64.95^{a}
40 kg P_2O_5 ha^{-1}	65.51^{a}	67.98^{a}
60 kg P_2O_5 ha^{-1}	62.41^{ab}	65.75^{a}
80 kg P_2O_5 ha^{-1}	58^{b}	64.57^{ab}
100 kg P_2O_5 ha^{-1}	56.81^{b}	59.85^{b}
LSD(0.05)	5.75	4.82
SE_m(+-)	1.91	1.56
F-probability	*	*
CV,%	6.20	4.92
Grand mean	61.51	65.02

CV: coefficient of variation; DAS: days after sowing; NS: Non-significant; SE_m: standard error of the mean; *=significance level at 5% probability level; LSD (0.05): Least significant difference at 5% level of significance same letter indicates the similar effect.

Yield and yield attributing characters

Yield and yield attributing characters were found to be increased with increasing the dose of the phosphorus. The number of kernel rows per cob, number of grains per kernel, number of grains per cob, and grain yield were found to be maximum with 80 kg P_2O_5 ha^{-1} (6203.29kg ha^{-1}) which was statistically similar with 100kg P_2O_5 ha^{-1} (6033.20). Phosphorus at 0 kg ha-1 produced the fewest grains per cob (225.28) because phosphorus promotes healthy root development, which has a direct impact on plant performance as a whole. Masood et.al (2011) has also mentioned similar results.

Cob length

Different doses of phosphorus resulted in a significant variation in cob length (Table 4). There is a positive relationship between doses of phosphorus and ear length. The longest cob was produced with higher doses as reported by Amanullah, Zakirullah, & Khalil, (2010), this may be due to the rapid increase in vegetative character. The longest cob length (23.05cm) was found with 100kg P_2O_5 ha^{-1} which was statistically at par (22.11cm) with 80kg P_2O_5 ha^{-1} and the smallest cob (17.47cm) was found with 0kg P_2O_5 ha^{-1} followed by 17.90cm, 19.75cm & 20.10cm with 20 kg P_2O_5 ha^{-1}, 40 kg P_2O_5 ha^{-1} & 60 kg P_2O_5 ha^{-1} respectively.

Number of kernel rows per cob

There was a significant variation in the number of kernel rows row per cob due to different doses of phosphorus (Table 4). The number of kernel rows (15.19) was recorded as maximum with 80 kg P_2O_5 ha^{-1} which was statistically similar to 100 kg P_2O_5 ha^{-1} (14.93). Minimum kernel rows (11.04) were recorded with 0 kg P_2O_5 ha^{-1}. The consequence of a higher rate of P_2O_5 in more kernel rows per cob could be due to Phosphorus positive response to rapid growth of maize (Sadiq, et al., 2017).

Number of grains per kernel row

The number of grains per kernel row was found to be increased with increasing the dose of the phosphorus (Table 4). The maximum number of grains per kernel (26.78) was found in a plot with 100kg P_2O_5 ha^{-1} which was statistically similar (26.35) with 80kg P_2O_5 ha^{-1}. The minimum number of grains per kernel row (20.22) was found with 0kg P_2O_5 ha^{-1}.

Number of grains per cob

There was significant variation due to different doses of phosphorus in the number of grains per cob of maize (Table 4). The highest number of grains per cob was found with 80 kg P_2O_5 ha^{-1}. An increase in the number of grains per cob might be due to better flowering and fruiting enhanced by phosphorus (Alias , Usman, Ullah, & Warraich, 2003). The application of 0kg P_2O_5 ha^{-1} resulted in minimum number of grains per cob. The result is in accordance with Khan et.al (2014), who has stated the significant influence of NP application on the number of grains per cob.

Thousand-grain weight

The effect of different doses of phosphorus on thousand-grain weight was not significant (Table 4). However, the maximum thousand-grain weight of 282 g was found in plots with 60kg P_2O_5 ha^{-1} followed by 275 g with 80 kg P_2O_5 ha^{-1}. For estimating grain yield, thousand grain weight plays a crucial role. The lowest thousand-grain weight 253 g was obtained in a plot with 40 kg P_2O_5 ha^{-1} followed by 255 g with 0kg P_2O_5 ha^{-1}. The highest thousand-grain weight could be due to maximum assimilates being transmitted to grains as mentioned by Sadiq et.al (2017).

Grain yield

The grain yield of maize as influenced by different doses of phosphorus is in the table (4). The data revealed that different doses of phosphorus significantly affected in grain yield as reported by Sadiq et.al (2017). An increment in dose of phosphorus up to 80kg P_2O_5 ha^{-1} has resulted in increased grain yield as maximum grain yield (6203.29 kg ha^{-1}) was obtained at 80kg P_2O_5 ha^{-1} followed by(6033.20 kg ha^{-1}) at 100kg P_2O_5 ha^{-1}. The lowest grain yield (3310.9kg ha^{-1}) was obtained at 0 kg P_2O_5 ha^{-1} followed by 3784.74 kg h^{-1} and 3831.18 kg ha^{-1} at 40 kg P_2O_5 ha^{-1} and 60 kg P_2O_5 ha^{-1} respectively. Masood et.al (2011) found significantly higher yields up to 100kg P_2O_5 ha^{-1}. Phosphorus application at the rate of 80kg ha^{-1} resulted in the highest number of rows per cob, the number of grains per cob, and thousand-grain weight which resulted in the highest grain yield at 80kg P_2O_5 ha^{-1}. Increasing Phosphorus above 80 kg ha^{-1} may be excessive, which has reduced the maize grain yield, indicating that the application of P_2O_5 in maize above 80 kg ha^{-1} is unreasonable in the mid-hill of Nepal. An adequate and ideal supply of P_2O_5 is linked to increased root growth, which encourages plants to inspect more of the soil's nutrients and moisture. Because of this, the grain yield with 0kg P_2O_5 ha^{-1} was the lowest because a lack of Phosphorus caused the plant's roots to grow more slowly, which had an adverse effect on the other physiological processes of those maize plants.

Harvest index

Different doses of phosphorus showed a significant effect on the harvest index of maize (Table 4). Phosphorus doses of 60 kg P_2O_5 ha^{-1}, 80kg P_2O_5 ha^{-1} had shown statistically similar harvest indexes i.e., 38.13 and 37.99 respectively, and the minimum harvest index was recorded at 0 kg P_2O_5 ha^{-1}. Better translocation of assimilates indicates a higher harvest index (Adhikari, Bhandari, Aryal, Mahato, & Shrestha, 2021). Alias, Usman, Ullah, & Warraich (2003) also reported a significant variation in the harvest index of maize due to different doses of phosphorus. However, Asim et.al (2017) and Iqbal & Chauhan (2003) reported a non-significant variation on the harvest index of maize due to different doses of phosphorus.

Shelling Percentage

Table 5 shows the effect of different dose of phosphorus on shelling percentage. Higher dose of phosphorus resulted in higher shelling percentages. Similar result was reported by Ali, Bakht, Shafi, Khan, & Shah (2002). Maximum shelling percentage (74.49%) was obtained with 100kg P_2O_5 ha^{-1} which was statistically similar at par with 80kg P_2O_5 ha^{-1}(73.05%) and the minimum shelling percentage (39.45%) was found with 0kg P_2O_5 ha^{-1}.

Table 4. Effect of different doses of phosphorus on yield attributes of spring maize (Arun-2) at Khaireni, Gulmi, 2022

Treatment	Cob length	Number of kernel row per cob	Number of grains per kernel row	Number of grains per cob	Thousand-grain weight (g)	Grain yield (kg ha^{-1})	Harvest index
0 kg P_2O_5 ha^{-1}	17.47^{c}	11.04^{b}	20.23^{b}	225.29^{b}	255.5^{a}	3310.98^{b}	29.19^{b}
20 kg P_2O_5 ha^{-1}	17.90^{c}	11.45^{b}	20.75^{b}	237.55^{b}	265.0^{a}	3831.18^{b}	29.37^{b}
40 kg P_2O_5 ha^{-1}	19.75^{bc}	11.72^{b}	22.90^{ab}	267.30^{b}	253.0^{a}	3784.74^{b}	32.73^{ab}
60 kg P_2O_5 ha^{-1}	20.10^{bc}	12.76^{ab}	23.35^{ab}	297.66^{b}	282.0^{a}	4500.77^{ab}	38.13^{a}
80 kg P_2O_5 ha^{-1}	22.11^{ab}	15.19^{a}	26.35^{a}	406.22^{a}	275.0^{a}	6203.29^{a}	37.99^{a}
100 kg P_2O_5 ha^{-1}	23.05^{a}	14.94^{a}	26.76^{a}	395.50^{a}	260.0^{a}	6033.20^{a}	32.73^{ab}
LSD(0.05)	2.93	2.84	3.99	19.79	38.10	974.14	6.56
SE_m(+-)	0.97	0.94	1.32	30.17	12.64	323.17	2.18
F-probability	**	*	*	**	NS	*	*
CV,%	9.70	14.68	11.32	19.79	9.54	14.01	12.85
Grand mean	20.06	12.84	23.39	304.92	265.08	4610.67	33.85

CV: coefficient of variation; DAS: days after sowing; NS: Non-significant; SE_m: standard error of mean; *=significance level at 5% probability level, **= significance level at 1% probability level; LSD (0.05): Least significant difference at 5% level of significance, same letter indicates the similar effect.

Table 5. Effect of different doses of phosphorus on shelling percentages of spring maize (Arun-2) at Khaireni, Gulmi, 2022

Treatments	Shelling %
0 kg P_2O_5 ha^{-1}	39.45^{c}
20 kg P_2O_5 ha^{-1}	40.03^{c}
40 kg P_2O_5 ha^{-1}	52.58^{c}
60 kg P_2O_5 ha^{-1}	56.37^{bc}
80 kg P_2O_5 ha^{-1}	73.05^{ab}
100 kg P_2O_5 ha^{-1}	74.49^{a}
LSD(0.05)	17.75
Grand mean	56

CONCLUSION

From this study, it was found that different doses of phosphorus affected the growth and yield of spring maize. The plant height, cob length, number of grains per kernel, and shelling percentage were highest in plants with 100 kg P_2O_5 ha^{-1}, while the number of kernel rows per cob, number of grains per cob, and grain yield were highest with 80 kg P_2O_5 ha^{-1}. Thus, for better growth along with the increment in yield of maize phosphorus at the dose of 80 kg is recommended as this dose has enhanced the growth and yield parameters of spring maize. However, for more accurate and considerable results multi location trials can be conducted as well as further research should be conducted in different seasons to validate these findings.

CONFLICT OF INTEREST

The author here declares that there is no conflict of interest in the publication of this article.

ACKNOWLEDGEMENT

The author would like to acknowledge Prime Minister Agriculture Modernization Project (PMAMP), Agriculture and Forestry University for funding this research project.

REFERENCES

Adhikari, K., Bhandari, S., Aryal, K., Mahato, M., & Shrestha, J. 2021. Effect of different level of nitrogen on growth and yield of hybrid maize (Zea mays L.) varieties. *Journal of Agriculture and Natural Resources*, ***4*** (2), 48-62. doi:https://doi.org/10.3126/janr.v4i2.33656

Ali, J., Bakht, J., Shafi, M., Khan, S., & Shah, W. A. 2002. Effect of various levels of N and P on yield and yield components of Maize. *Journal of Agronomy*, ***1***(1), 12-14. doi:10.3923/ja.2002.12.14

Alias, A., Usman, M., Ullah, E., & Warraich, E. A. 2003. Effects of different phosphorus levels on the growth and yield of two cultivars of maize (Zea mays L.). *International Journal of Agriculture and Biology*, *5*(4), 632-634. Retrieved from http://www.ijab.org/

Amanullah, Zakirullah, M., & Khalil, S. K. 2010. Timing and Rate of Phosphorus Application Influence Maize Phenology, Yield and Profitability in Northwest Pakistan. *International Journal of Plant Production*, 281-292. doi:10.21608/eajbsh.2010.17014

Asim, M., Hussain, Q., Ali, A., Farooq, S., Khan , R., & Ali Shah, S. A. 2017. Responses of maize to different levels and sources of phosphorus application. *pure and applied biology*, ***6***(3), 1030-1036. doi:https://www.researchgate.net/deref/http%3A%2F%2Fdx.doi.org%2F10.19045%2Fbspab.2017.600109

Baral, B. R., Adhikari, P., & Shrestha, J. 2016. Productivity and economics of hybrid maize (Zea mays L.) under different Fertilizer doses in the Inner terai region of nepal. *Journal of Agrisearch*, ***3***(1), 14-15. doi:http://dx.doi.org/10.21921/jas.v3i1.11401

Erenstein, O., Jaleta, M., Sonder, K., Mottaleb, K., & Prasanna, B. 2022. Global maize production,consumption and trade: trends and

R&D implications. *Food Security*. doi:httpps://doi.org/10.1007/s12571-022-01288-7

Iqbal, R. M., & Chauhan, H. Q. 2003. Effect of Phosphorus levels on yield components,grain yield and harvest index of two maize varieties. *Asian Journal of Plant Sciences*, ***2***, 800-803. doi:https://dx.doi.org/10.3923/ajps.2003.800.803

KC, G., Karki, T. B., Shrestha, J., & Achhami, B. B. 2015. Status and prospects of maize research in Nepal. *Journal of Maize Research and Development*, ***1***(1), 1-9. doi:10.5281/zenodo.34284

Khan, F., Khan, S., Shah, F., Shah, F., Hussain, S., Saqib , A., & Ashfaq, A. 2014. Effect of different levels of nitrogen and phosphorus on the phenology and yield of maize varieties. *American Journal of Plant Sciences*, ***5***, 2582-2590. doi:http://dx.doi.org/10.4236/ajps.2014.517272

Mapcarta. 2022. *Mapcarta, The Open Map*. Retrieved September 2022, from http://www.mapcarta.com/map

Masood, T., Gul, R., Munsif, F., Jalal, F., Hussian, Z., Noreen, N., . . . Khan, H. 2011. Effect of different phosphorus levels on yield and yield components of maize. *Sarhad Journal of Agriculture*, ***27***, 167-170. Retrieved from https://www.researchgate.net/publication/268011160

Matsuoka, Y., Vigouroux, Y., Goodman, M. M., Sanchez G., J., Buckler, E., & Doebley, J. 2002. A single domestication for maize shown by multilocus microsatellite genotyping. *Proceedings of the National Academy of Sciences of the United States of America*, ***99***(9), 6080-6084. doi:10.1073/pnas.052125199

MoALD. 2021. *Statistical information of nepalese agriculture*. Kathmandu, Nepal: Ministry of Agricultural and Livestock Development, Monitoring, Evaluation and Stastistics Division, Agri Stastistics Section.

Nasa Power. 2022. *Nasa power-Prediction of worldwide energy resources*. Retrieved from power.larc.nasa.gov/data-access-viewer/.

Pal, B., Hirpara, D., Vora, V., Vekaria, P., Sutaria, G., Akbari, K., & Verma, H. 2017. Effect of Nitrogen and Phosphorus on Yield and Yield Attributes of Maize in south Saurashtra, India. *International Journal of Current Microbiology and Applied sciences*, ***6***, 1945-1949. doi:https://doi.org/10.20456/ijcmas.2017.603.221

Panta, H. 2019. Policy review and strategies for fertilizer supply system management in Nepal. *Agricultural Extension Journal*, ***3***(9), 1-9. Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3668754

Sadiq, G., Khan, A. A., Inamullah, Rab, A., Fayyaz, H., Naz, G., . . . Khattak, W. A. 2017. Impact of phosphorus and potassium levels on yield and yield components of maize. *Pure and Applied Biology*, ***6***(3), 1071-1078. doi:https://www.researchgate.net/deref/http%3A%2F%2Fdx.doi.org%2F10.19045%2Fbspab.2017.600114

Sapkota, A., Shrestha, R. K., & Chalise, D. R. 2017. Response of maize to the soil application of nitrogen and phosphorus fertilizers. *International Journal Of Applied Science and Biotechnology*, ***5***(4), 537-541. doi:https://doi.org/10.3126/ijasbt.v5i4.18777

Shrestha, R. K., Amgain, l. P., & Aryal, S. 2016. Assessing the effect of phosphorus application on early growth of maize at Sundarbajar, Lamjung ,Nepal. *Journal of Maize Research and Development*, ***2***(1), 117-122. doi:https://doi.org/10.3126/jmrd.v2i1.16222

Wojnowska, T., Panak, H., & Seikiewiez, S. 1995. Reaction of winter oil seed rape to increasing levels of nitrogen fertilizer application under condition of Ketizyn Chernozem. *Rosling oleiste*, ***16***, 173-180.

Citation: Shikha Sharma*, Ananta Prakash Subedi, Bibek Budhathoki, Srijana Neupane and Praju Ghimire 2023. Accessing the efficacy of different doses of phosphorous on growth and yield of spring maize (*Zea mays* L.) at Gulmi, Nepal. *International Journal of Agricultural and Applied Sciences*, 4(1): 12-16. https://doi.org/10.52804/ijaas2023.413