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Research Article

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Effect of different doses of nitrogen of growth, yield and yield attributes of spring maize in Madichaur, Rolpa, Nepal

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ABSTRACT
The significantly highest plant height (198.06 cm) was measured for treatment 120 kg N/ha and the lowest plant height (162.6 cm) was measured for treatment 0 kg N/ha at 95 days after sowing. Likewise, significantly shortest period to tasseling (74.3 days) and silking (78.0 days) under the application of 120 kg N/ha but at par with treatment 90 kg N/ha (75.1 days) and (78.7days) respectively and longest period to tasseling (79.7 days) and silking (85.4 days) under the application of 0kg N/ha but at par with treatment 30 kg N/ha (78.7) and (84.6 days) respectively was obtained. Likewise, the highest grain yield (3.7 t/ha) was obtained for treatment 120 kg N /ha which was significantly higher than all other treatments but at par with treatment 90 kg N/ha (3.5 t/ha) and the lowest grain yield (1.5 t/ha) was obtained for treatment 0 kg N/ha which was significantly lower than all other treatments but at par with treatment 30 kg N/ha (1.8t/ha). Overall study shows that almost all parameters of spring maize increase significantly with the increasing dose of nitrogen up to 90kg/ha. But no significant difference was observed on yield and yield attributes while increasing the nitrogen dose from 90 to 120 kg/ha. Thus, for the optimum and sustainable production of spring maize, 90 kg N/ha can be used as a recommended dose in Madichaur, Rolpa.
Keywords: Spring maize, Doses, Nitrogen, Growth, Yield.

INTRODUCTION
Maize (*Zea mays)* cultivation is a way of life for most farmers in the hill of Nepal. About 55% of people in the hilly region considered maize as a principal staple food crop (Adhikary & Karki, 2014). Among the major cereal crops in Nepal, it ranks second in terms of area and production after rice. It is a traditional crop cultivated as a source of food, feed, fodder, and seed in Nepal. It is the most versatile cash crop, is also known as the `Queen of cereals ' as it has a very high yield potential than any other cereals and wider adaptability under varied agro-climatic regions.
The total production of maize is 2,555,847 metric tons which are planted in 954,158 ha of land (AITC, 2076). It contributes 3.15% to National GDP and 9.5% to AGDP (NMRP, 2016). The proportion of maize area consists of 72.28% in mid-hills followed by 18.95% in Terai and 8.76% in high hills (MOAD, 2015/16). The present yield of maize in Nepal is quite lower than that of other Asian countries. There is a wide gap between the attainable yield of maize (5.7 t/ha) and the actual yield of maize at the farm level (2.45 t/ha) (MOAD, 2015/16). One of the main factors for the low yield of maize is loss of soil fertility and improper use of fertilizer input. Chemical fertilizer especially nitrogen fertilizer is universally accepted as a key component for getting a high maize yield and expected economic return.
Optimum levels of nitrogen play a key role to achieve desirable crop growth and productivity. Generally knee-high and tasseling stages are critical stages of maize for nitrogen application. In the early growth stages, the rate of nitrogen uptake is slow in maize. But with the increment in growth nitrogen uptake also increases rapidly and reaches up to maximum before and after tasseling, where it is almost more than 4kg N/ha/day (FAO, 2006). So, nitrogen application in proper time and the proper dose is crucial for phenological and yield attributing characteristics of maize. The present study thus will be undertaken to study the effect of different doses of nitrogen on the growth, yield, and yield components of maize.

MATERIALS AND METHODS
The site of research was the Rolpa district. The research was carried out in Madichaur, Rolpa. This region falls under the zone for the production of maize by Prime Minister Agriculture Modernization Project. The experiment was conducted in Randomised Complete Block Design (RCBD) which was designed for field condition as present in our field. It is spring season maize

(Arun-2). Four replications of each treatment were done. Treatments lied perpendicular to replication.

A total of five treatments were done on different doses of nitrogen. 10 kg of FYM was applied in each plot during field preparation.

Table 1. Treatment combination used in the field during research

S. N.	Treatment	Treatment combinations (kg/ha)		
		Nitrogen	Phosphorus	Potassium
1	T1	0	40	40
2	T2	30	40	40
3	T3	60	40	40
4	T4	90	40	40
5	T5	120	40	40

The recommended dose of FYM @ 10 ton/ ha was applied 15 days before the sowing of seeds. Urea, SSP, and MOP were used as a source of fertilizers. The full dose of phosphorus and potassium was applied at the time of sowing. The half dose of N was used as basal dose for treatment T1, T2, T3, T4, and T5 respectively at the time of seed sowing. The remaining dose of N was split into 2 equal parts. 1/3th dose of N was side dressed at the knee-high stage (21st April 2020) and the remaining 1/3th was applied at the tasseling stage (26th May 2020).

Measurement of growth attributes

Plant height:

In each plot, five plants were selected randomly and tagged except in the border rows. The height of the plant was measured with the help of scale and measuring tape from ground level up to the base of the fully opened flag leaf at 35, 65, and 95 DAS. And at last average data was calculated and expressed in cm.

Leaf number: The number of green or functional leaves of five sampled plants was counted at 35, 65, and 95 DAS. Lastly, average data was reported as thseveral leaves per plant.

Leaf area and leaf area index: Leaf area was measured from 3 randomly selected plants from each plot. The length and breadth of the leaf were recorded in a meter and applied in the formula to measure leaf area.

Leaf area = Leaf length x leaf breadth x K

K = Correction factor (0.776)

Similarly, the leaf area index was measured by given formulae.

LAI = Leaf area / Spacing

Harvest index:

The harvest in percentage was computed by dividing grain yield with the total dry matter yield as per the following formula:

$$\text{Harvest index (\%)} = \frac{\text{Economical yield (grain yield)}}{\text{Biological yield (grain yield + stover yield)}} x100$$

Statistical analysis

The data recorded on different parameters from the field were first tabulated in Microsoft Excel (MS- Excel). Then, Analysis of Variance (ANOVA) for all data was statistically analyzed using R- STUDIO - computer software package. The grain yield was analyzed in ANOVA of one factorial Randomized Complete Block Design (RCBD). All the analyzed data were subjected to Duncan's Multiple Range Test (DMRT) for mean comparison at a 5% level of significance.

RESULTS AND DISCUSSION

Biometrical observation

Plant height

The plant height at 35, 65, and 95 days after sowing (DAS) as influenced by different nitrogen treatments are presented in Table 3. The results indicated that increasing nitrogen level from 0 kg/ha to 120 kg/ha also increases the plant height of spring maize. At 35 DAS the highest plant height was measured for treatment (120 kg N/ha) i.e. 18.6cm, which was significantly higher than the other treatments but statistically similar with treatment (90 kg N/ha) i.e. 18.4 cm. The lowest plant height was measured for treatment (0 kg/ha) i.e., 11.9 cm which was significantly lower than all other treatments but statistically similar with treatment (30 kg N/ha) i.e. 12.3 cm.

At 65 DAS significantly highest plant height of 92.2 cm was measured for treatment (120 kg N/ha) and the lowest plant height of 80.1 cm was measured for treatment (0kg N/ha) which was statistically similar with treatment (30 kg/ha) i.e., 80.2 cm.

Table 2. Effect of different nitrogen treatments on plant height (cm) of spring maize

Treatments	35 DAS	65 DAS	95 DAS
1. 0 kg N/ha	11.9^{c}	80.1^{d}	162.66^{e}
2. 30 kg N/ha	12.3^{c}	80.2^{d}	173.94^{d}
3. 60 kg N/ha	15.4^{b}	84.7^{c}	183.60^{c}
4. 90 kg N/ha	18.4^{a}	91.6^{b}	192.28^{b}
5. 120 kg N/ha	18.6^{a}	92.2^{a}	198.06^{a}
LSD (=0.05)	0.399	0.545	3.089
Sem (±)	0.058	0.08	0.44
CV, %	1.69	0.412	1.101
Grand mean	15.31	85.7	182.10

Similarly, at 95 DAS, plant height significantly increases from top to bottom with an increment in doses of nitrogen. The highest plant height of 198.1 cm was measured for treatment (120 kg N/ha) which was significantly higher than all other treatments followed by treatment (90 kg N/ha) i.e., 192.28 cm, treatment (60 kg N/ha) i.e.,183.60 cm, treatment (30 kg N/ha) i.e. 173.94 cm and the lowest plant height 162.6 cm was for treatment (0kg N/ha) at 95 DAS. (Thakur, 1998), reported that increased plant height with the increasing level of nitrogen. (Yadav, 1990), also reported that the plant height significantly increased with the increasing level of nitrogen at all the growth stages. Being nitrogen as a constituent of chlorophyll and enzymes necessary for photosynthesis and vegetative growth, an extension of the stem, leaf thus increased plant height. (Diallo, 1997), reported that a decreased plant height under reduced levels of N fertility level might be due to the reduction in the growth of plants.

Leaf number

The leaf number at 35, 65, and 95 days after sowing (DAS) as influenced by different nitrogen treatments are presented in Table 4. The results indicated that increasing nitrogen level from 0 kg/ha to 120 kg/ha significantly increases the leaf number of spring maize. At 35 and 65 DAS maximum leaf number (5.35 and 8.35) was measured for treatment 120 kg N/ha which was significantly higher than the other treatments and minimum leaf number (4.15 and 7.15) was measured for treatment 0 kg N/ha which was statistically similar with treatment 30 kg N/ha i.e., 4.23 and 7.24 respectively.

Similarly, at 95 DAS maximum leaf number was measured for treatment 120 kg N/ha i.e., 10.8 which was significantly higher than the other treatment but statistically similar with treatment 90 kg N/ha i.e. 10.1, and the minimum leaf number was measured for treatment 0 kg N/ha i.e. 9. (Thakur, 1998), found that increment of the amount of nitrogen applied results more leaf number. Leaf number significantly increased by both rate and application of nitrogen, (Hati, 1970).

Table 3. Effect of different nitrogen treatments on leaf number of spring maize

Treatments	35 DAS	65 DAS	95 DAS
1. 0 kg N/ha	4.15[d]	7.15[d]	9.0[c]
2. 30 kg N/ha	4.23[d]	7.24[d]	9.3[bc]
3. 60 kg N/ha	4.66[c]	7.66[c]	9.7[bc]
4. 90 kg N/ha	4.96[b]	7.96[b]	10.1[ab]
5. 120 kg N/ha	5.35[a]	8.35[a]	10.8[a]
LSD 0.05)	0.11	0.107	0.882
Sem (±)	0.016	0.015	0.128
CV, %	1.53	0.91	5.85
Grand mean	4.67	7.67	9.785

Phenological observation

Days to 50% tasseling

The result shows that the effect of nitrogen level on days to tasseling was significant. Significantly shortest period to tasseling (74.2 days) under the application of 120 kg N/ha and longest period to tasseling (79.7 days) under the application of 0kg N/ha which was at par with treatment 30 kg N/ha (78.7) were obtained. (Shrestha, 2015), found that a higher dose of nitrogen (200 kg N/ha) leads early tasseling in maize. (Dawadi, 2012), also reported that increasing nitrogen level from 120kg/ha to 200 kg/ha decreased the days to tasseling. The advance in days to tasseling with a higher level of nitrogen was due to quick growth.

Days to 50% silking

The result shows that the effect of nitrogen level on days to silking was significant. Significantly shortest period to tasseling (78.0 days) under the application of 120 kg N/ha which was at par with treatment 90 kg N/ha (78.7days) and longest period to tasseling (85.4 days) under the application of 0 kg N/ha which was at par with treatment 30 kg N/ha (84.6 days) were obtained. (Shrestha, 2015), found that a higher dose of nitrogen (200 kg N/ha) leads to early silking in maize. (Yadav, 1990), also found that earlier silking occurred due to a higher percentage of nitrogen applied.

Table 4. Effect of different nitrogen treatments on crop phenology of spring maize

Treatments	Days to 50% tasseling	Days to 50% silking
1. 0 kg N/ ha	79.7[a]	85.4[a]
2. 30 kg N/ha	78.7[a]	84.6[a]
3. 60 kg N/ha	76.3[b]	81.1[b]
4. 90 kg N/ha	75.2[bc]	78.7[c]
5.120 kg N/ha	74.2[c]	78.0[c]
LSD (=0.05)	1.20	1.77
Sem (±)	0.17	0.26
CV, %	1.01	1.41
Grand mean	76.8	81.57

Yield and Yield attributes

Cob length

The result shows that the ear length of maize was significantly influenced by different doses of nitrogen treatment. The longest ear girth was measured for treatment 120 kg N /ha i.e., 15.16 cm which was significantly higher than all other treatments but at par with treatment (90 kg/ha), and the shortest ear length was measured for treatment 0 kg N/ha i.e., 11.0 cm. (Pokhrel, 2006), reported the longest ear length (15.64 cm) with 210 kg N/ha. (Shrestha, 2015), also found that the application of a higher nitrogen dose (200 kg N/ha) gave the highest number of cob lengths 15.90 cm.

Cob girth

The result shows that non-significant differences were observed among the different doses of nitrogen treatment for the ear girth of maize. The ear girth varied from 12.81 to 13.44 cm.

Number of kernel rows per ear

The result shows that a number of kernel rows per cob was significantly influenced by different doses of nitrogen. The shifting from 0 kg N/ha to 120 kg N/ha showed an increase in the number of kernel rows per cob. Significantly highest number of kernel rows per cob (11.88) was measured for treatment 120 kg N/ha and the lowest number of kernel rows per cob (10.35) was measured for treatment (0 kg/ha). (Dawadi, 2012) , reported that there was a trend of increasing number of kernel rows/ear with increasing doses of nitrogen application

No of kernels per row

The result shows that a number of kernels per row was significantly influenced by different doses of nitrogen treatment. The highest kernel/row (24.6) was obtained for the application of 120 kg N/ha which was significantly higher than all other treatments and the lowest kernel/row (14.9) was obtained for the application of 0 kg N/ha which was statistically at par with the application of 30 kg N/ha (15.2). (Dawadi, 2012) , reported that there was a trend of increasing the number of kernels per row with increasing doses of nitrogen application.

Thousand grain weight (TGW)

The result shows that the TGW of maize was significantly influenced by different doses of nitrogen treatment. The highest thousand grain weight (272.2 gm) under application of 120 kg N/ha which was significantly higher than all other treatment but at par with TGW (268.4 gm) under application of 90kg/ha and lowest thousand-grain weight (232.6 gm) under application of 0 kg N/ha which was statistically similar at par with TGW (234.5 gm) under application of 30 kg N/ha were obtained. (Shrestha, 2015), found that the application of a higher nitrogen dose gave the greatest test weight.

Table 5. Effect of different nitrogen treatments on yield attributing characters of spring maize

Treatments	Ear length (cm)	Ear girth (cm)	No. of kernel row per cob	No. of kernel per row	1000 grain weight(gm)
1. 0 kg N/ha	11.00[d]	4.08	10.35[d]	14.9[d]	232.6[c]
2. 30 kg N/ha	11.34[cd]	4.05	10.55[cd]	15.2[d]	234.5[c]
3. 60 kg N/ha	12.77b[c]	4.15	10.83[c]	17.0[c]	248.4[b]
4. 90 kg N/ha	13.92[ab]	4.20	11.43[b]	21.3[b]	268.4[a]
5.120 kg N/ha	15.16[a]	4.28	11.88[a]	24.6[a]	272.2[a]
LSD (=0.05)	1.68	Ns	0.037	0.897	4.25
Sem (±)	0.244	0.031	0.141	0.13	0.62
CV, %	8.49	3.36	1. 811	3.13	1.09
Grand mean	12.84	4.15	11.005	18.58	251.22

Grain yield

The result of mean data indicated that the variation in grain yield (t/ha) due to the influence of different doses of nitrogen was found to be significant. The highest grain yield (3.7 t/ha) was produced under the application 120 kg N/ha which was significantly higher than all other treatments but at par with treatment 90 kg N/ha (3.5 t/ha) and the lowest grain yield (1.5 t/ha) was produced under the application of 0 kg N/ha which was significantly lower than all other treatments but at par with treatment 30 kg N/ha (1.8 t/ha). (Singh D. R., 2000), indicated that grain yield increased with the increase in nitrogen level from 0-200 kg/ha. (Ullah, 2007), also reported the increased grain yield with increasing nitrogen levels. Application of nitrogen up to a certain limit enhances the growth and productivity of maize. It can be explained that plants cannot achieve required amount of nutrients from the soil because of the underdose of fertilization. On the other hand, plants cannot utilize the nutrients over the required dose (Sherchan et al., 2007).

Stover yield

The result of mean data indicated that the variation in biological yield (t/ha) due to the influence of different doses of nitrogen was found to be significant. The highest biological yield (5.0 t/ha) was produced under the application 120 kg N /ha which was significantly higher than all other treatments but statistically similar with treatment 90 kg N/ha (4.8 t/ha) and the lowest stover yield (3.4 t/ha) was produced under the application of 0 kg N/ha which was significantly lower than all other treatments but statistically similar with treatment 0 kg N/ha (3.6 t/ha). (Singh D. R., 2000), indicated that stover yield increased with the increase in nitrogen level from 0-200 kg/ha. (Ullah, 2007), also reported that the increased stover yield with increasing nitrogen levels.

Harvest index

The result of mean data indicated that the variation in harvest index due to the influence of different doses of nitrogen was found to be significant. The highest harvest index (43%) was found under the application 120 kg N /ha which was significantly higher than all other treatments but statistically similar with treatment 90 kg N/ha (42%) and the lowest harvest index (30%) was found under the application of 0 kg N/ha which was significantly lower than all other treatments but at par with treatment 30 kg N/ha (33%).

Table 6. Effect of different nitrogen treatments on yield of spring maize

Treatments	Grain yield(t/ha)	Stover yield (t/ha)	Harvest Index (%)
1. 0 kg N/ha	1.5[c]	3.4[c]	30[b]
2. 30 kg N/ha	1.8[c]	3.6[c]	33[b]
3. 60 kg N/ha	2.6[b]	4.0[b]	39[a]
4. 90 kg N/ha	3.5[a]	4.8[a]	42[a]
5. 120 kg N/ha	3.7[a]	5.0[a]	43[a]
LSD (=0.05)	0.29	0.27	3.39
Sem (±)	0.043	0.039	0.49
CV, %	7.34	4.23	5.89
Grand mean	2.61	4.17	37.4

Relationship between yield and yield attributes of maize

Relationship between grain yield and cob length

There is found to be strong and significant positive relationship between the grain yield and cob length, r (18) = 0.84, p<0.001 which signifies that there is an increase in grain yield with an increase in cob length of maize.

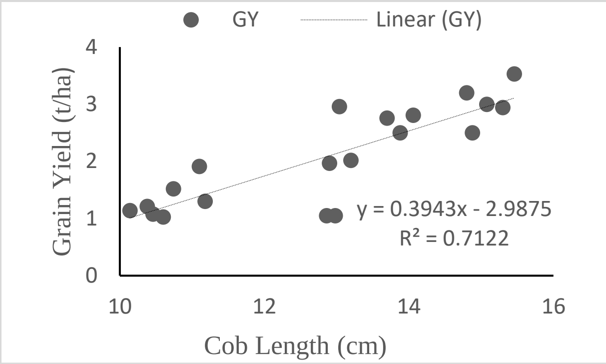

Figure 2. Relationship between grain yield and cob length of spring maize

Relationship between grain yield and cob girth

There is found to be a strong and significant positive relationship between the grain yield and cob girth, r (18) = 0.51, p<0.05 which signifies that there is an increase in grain yield with an increase in cob girth of maize.

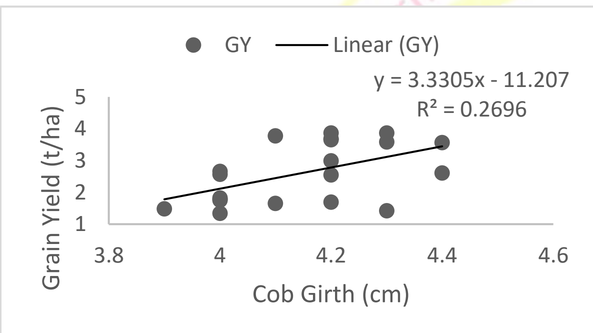

Figure 3. Relationship between grain yield and cob girth of spring maize

Relationship between grain yield with the number of kernel rows per cob

There is found to be a strong and significant positive relationship between the grain yield and the number of kernel rows per cob, r (18) = 0.93, p<0.001 which signifies that there is an increase in grain yield with an increase in a number of kernel rows per cob of maize.

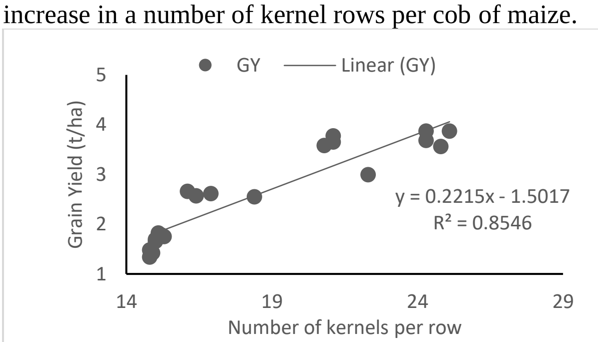

Figure 4. Relationship between grain yield and number of kernel rows per cob of spring maize

Relationship between grain yield and number of kernels per row

There is found to be a strong and significant positive relationship between the grain yield and number of kernels per row, r (18) = 0.9, p<0.001 which signifies that there is an increase in grain yield with an increase in a number of kernels per row.

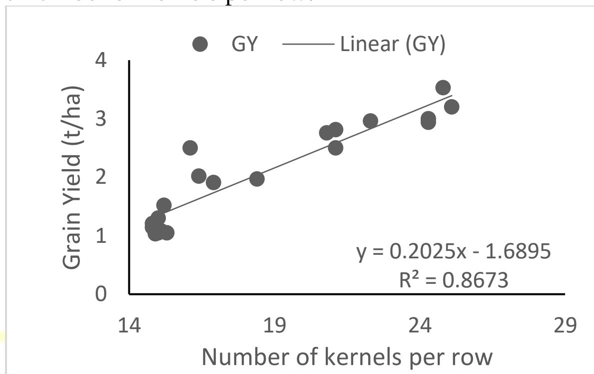

Figure 5. Relationship between grain yield and number of kernels per row of spring maize

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