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RESEARCH ARTICLE

Growth and yield performance of different varieties of maize in Eastern Terai of Nepal

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Abstract

The field research was conducted from February to June 2024 at farmer's field in maize zone, Sharnamati, Jhapa, Nepal with the objectives of evaluating different maize varieties in terms of yield and other agronomic traits and identifying promising farmers preferred maize varieties for eastern terai region of Nepal. Seven maize varieties collected from local agrovets were evaluated in Randomized Complete Block Design with three replications. Results showed that all the studied varieties differed significantly from each other in terms of plant height, number of leaves, yield traits and phenological traits except days to 50% silking. Arun-2 was seen inferior in all the growth and yield attributing parameters. Out of tested varieties, 900m gold has shown the best result among all the used varieties based on adaptability and yield (11.80 tons/ha). Hence, 900m gold can be recommended to the farmers in Eastern Terai of Nepal.

Keywords: Maize, yield, growth, variety

Introduction

Maize (*Zea mays* L.) is also known as the queen of cereals. It has characteristics of wide adaptability in the different ranges of growing conditions (Sharma *et al.,* 2018). But unlike the terai region, it's mostly grown on the hills, and the farms are smaller as well (Ghimire and Gyawali, 2023). The demand of maize is increasing with human population growth rate of 1.16% due to changing healthy diet habits of consumer from starch to protein rich food (Amgain *et al.,* 2018). In Nepal nearly 12-15% area and rest 85-88% is covered by hybrid maize and open pollinated varieties. Aggressive intervention of hybrid maize technology in terai and potential pocket of midhills could be one of the potential options to solve this problem of low yield (Koirala *et al.,* 2020). Most of the winter maize is used as raw materials for poultry feed industries which are produced in terai and inner terai districts. In Nepal, the productivity of maize is low as compared to other developed countries like France, USA, Canada, Argentina due to many factors that affect the maize productivity. One of the cropping strategies for food deficiency is the development of high potential maize varieties for normal planting season whereas yield gap can be reduced by cultivation of improved varieties (Kandel *et al.,* 2020). By 2020, in developing countries the demand for maize was expected to exceed demand for both wheat and rice. Over the 40 years, the world's total area under maize has increased by 40% and production has doubled. Hence, it can be said that maize is on the way of its increased popularity (Shariot-Ullah *et al.,* 2013). In Nepal, due to unavailability of hybrid maize, the majority of farmers are still growing open pollinated varieties in terai regions. Terai and inner terai regions of Nepal are highly potential for hybrid cultivation.

This hybrid maize variety could not be popular among the maize growers due to some reasons in seed production as per demand of consumer (Kunwar and Shrestha, 2014). The market's need for hybrid maize seed is clearly growing every year. Despite the country's many agro-ecological zones, only a few numbers of commercial hybrids are viable for cultivation, thus it's critical to locate hybrids that are appropriate for the climatic conditions in different locations. For all these, the study's primary goal was to evaluate the performance of different maize varieties and recognize the variety that would provide maize growers with the highest level of productivity (Manjunatha *et al.*, 2018). Maize is grown in all the ecological belt of Nepal from terai to high hills (Kandel *et al.,* 2021).Generally, hybrid maize has more than 7tons per ha productivity but in case of Nepal, the national productivity is less than the half of the productivity of any hybrid variety (2.56 tons/ha) (Bastola *et al.*, 2020).There are many problems that hinder the productivity of maize which may be biotic or abiotic but the main problem in long term production of maize is the changing global climate (Prasai *et al.,* 2015). The genetically improved varieties have better productivity across the climate and environment where they are adapted and some hybrid varieties are favorable for cultivating commercially because of diversified agroecological regions of the country. Therefore, it is important to identify the varieties that are suitable for different agroecological reasons (Shrestha *et al.,* 2015; Manjunatha *et al.,* 2018). Growth of hybrid maize cultivation can be considered as a viable option to meet the needs of industries and for food securities in hills of Nepal (Koirala *et al.*, 2020). In the present context, due to unavailability of suitable variety, farmers are getting low production. And because of low productivity, its wider adaptation is limited. Besides this, there are several biotic and abiotic factors that result in low productivity. Because of all these factors, the present study was planned and the findings of the study would be very vital to compare and identify the most suitable variety based on adaptability and yield performance.

Materials and methods

The present study was carried out at farmer's field located in Jhapa Rural Municipality ward number 06 (26.50° N and 87.8696° E) in Nepal's eastern terai region. The study site was situated at an elevation of 113m above sea level. This place experiences a climate of high humidity, featuring chilly winters and scorching summers. The soil type of this area ranges from sandy loam to clay loam and has a pH value of approximately 6. For the experiment, Randomized Complete Block Design (RCBD) was used. In this experiment, 7 varieties were used as treatments which were replicated 3 times. The treatment details can be seen in table (1). These varieties were collected from nearby agrovets in Sharanamati. The size of experimental plots used in the study were 7.5meter squares in size (3 metres by 2.5 meters). The row-to-row distance was 60 centimeters whereas plant to plant distance was 25 centimeters. The distance between each block of plot was 1 meter, and the distance between each individual plot was 0.5 meter. The total number of plants in each plot was 50. For data collection, 10% of total plants (5 plants) in a plot were tagged as sample plants and data were collected from these samples. Centre five plants were used as sample plants. Plant height, number of leaves, days to 50% tasseling, days to 50% silking, anthesis silking interval, maturity days, cob length and diameter, number of kernel rows per ear, number of kernels per rows, 1000 kernel weight and grain yield were the parameters that were recorded from these sample plants. 180:60:60 kg NPK ha-1 was the dose of fertilizers used, where 1/3rd dose of N, full dose of P2O5 and K2O were applied during field preparation and remaining 2/3rd dose of N was applied at two equal split doses: 30 DAS and at 55 DAS (Krishi Diary, 2080).

All the collected data were recorded in MS Excel. For the analysis, R-Studio version 4.4.1 was used where the Duncan's Multiple Range Test was used to compare the mean values of different varieties at 0.05 level of significance.

Table 1: Treatment details of the varieties used in the present study

Sr. No	Treatment	Varieties
1	T1	Swarna
2	T2	Super King 4455
3	T3	Arun-2
4	T4	All rounder
5	T5	Rampur composite
6	T6	900 m gold
7	T7	TX369

Results and discussion

The objectives of the study was to evaluate the different maize varieties in terms of yield and other agronomic traits and identifying promising farmers preferred maize varieties for eastern terai region of Nepal. The results obtained are summarized below trait by trait.

Plant height

The overall mean plant height at 30 DAS across all varieties was 69.75cm. Although there was no significant difference at 30 DAS, it indicated that among the used variety in study, tx369 has shown the tallest height and 900mgold has shown shortest height at first data collection. Coming to plant height at 51 DAS, there was no any significant difference between the varieties. The overall mean plant height at 51 DAS across all varieties was 183.00cm. A significant difference was seen in plant height at 72 DAS. The overall mean plant height across all varieties was 242.51cm. Tx369 exhibited the tallest variety with 258.73 cm plant height, and Arun-2 was the shortest with 229.8cm plant height (Table 2). In the table mean followed by common letter(s) within column are non-significantly different at .05 based on DMRT. A significant difference was seen in terms of plant height during its final days where Arun-2 had the lowest plant height. Similar result is recorded by Thapa *et al.*, (2022) where Arun-2 has the shortest plant height among different varieties. Pokhrel *et al.*, (2013) also agreed the same suggesting that Arun-2 has the shortest height among other improved varieties.

Table 2: Plant height of different maize varieties at 30, 51 and 72 DAS at Sharnamati, Nepal

Treatment	30 DAS	51 DAS	72 DAS
Swarna	72.40	187.07	240.33^{bc}
Super king 4455	68.73	179.93	237.2^{bc}
Arun-2	67.60	187.33	229.8^{c}
All rounder	70.87	183.80	241.80^{bc}
Rampur composite	67.53	176.87	239.87^{bc}
900 m gold	67.27	179.60	249.87^{ab}
TX369	73.87	186.40	258.73^{a}
LSD (0.05)	18.92	33.35	16.06
SEM (±)	2.30	4.10	1.97
CV (%)	15.25	10.24	3.72
Grand mean	69.75	183.00	242.51
F-value	ns	ns	*

*** Significant at 0.001 level of significance, ** Significant at 0.01 level of significance and * Significant at 0.05 level of significant

Number of leaves

As like that of plant height, the number of leaves were also taken at 30, 51 and 72 DAS. No significant difference was seen at 30 and 51 DAS in terms of number of leaves, whereas significant differences were seen at 72 DAS. Though the number of leaves were not significant at 30 and 51 DAS, All-rounder and 900 m gold had the highest number of leaves respectively. At 72 DAS, 900m gold exhibited the maximum number of leaves with 14.33 leaves and Arun-2 exhibited the minimum number of leaves with 10.53 leaves (Table 3). In the table mean followed by common letter (s) within column are non-significantly different at .05 based on DMRT. Regarding total number of leaves in a plant of different maize varieties, no any recordings are made by different researchers. The reason that Arun-2 and Rampur composite have the lowest number of leaves as compared to other varieties is because of their height, as the number of leaves accumulated in a plant is directly proportional to its height and the height of these varieties were recorded the shortest.

Table 3: Number of leaves of different maize varieties at 30, 51 and 72 DAS

Treatment	30 DAS	51 DAS	72 DAS
Swarna	7.27	12.73	12.8^{bc}
Super king 4455	7.27	12.13	12.07^{cd}
Arun-2	6.80	11.267	10.53^{e}
All rounder	7.53	12.67	13.47^{ab}
Rampur composite	7.20	11.07	11.4d^{e}
900 m gold	7.20	13.06	14.33^{a}
TX369	7.33	12.8	12.93^{bc}
LSD (0.05)	1.37	1.78	1.08
SEM (±)	0.20	0.22	0.10
CV (%)	10.68	8.19	4.84
Grand mean	7.23	12.25	12.50
F-value	ns	ns	***

*** Significant at 0.001 level of significance, ** Significant at 0.01 level of significance and * Significant at 0.05 level of significant

Phenological traits

The study's finding indicated that there was significant difference in anthesis days as Arun-2 exhibited the earliest anthesis achieving anthesis just in 60 days after sowing. All the varieties except Arun-2 were at par meaning there was not significant difference between those varieties except Arun-2. It took about 66.10 days to 50% anthesis in an average. Regarding the days to 50% silking, the varieties were not statistically significant. However, Arun-2 exhibited the earliest silking at 65 days as like that of days to 50% anthesis. However, the average days to 50% silking was 69.62days. Anthesis silking interval, which is the time gap between tasseling and silking, showed significant variability among the varieties. Regarding anthesis and silking interval, the average ASI was 3.33 days. Arun-2 exhibited the maximum interval of 5 days whereas all rounder and 900 m gold had the shortest ASI days of 2.33 days (Table 4). Mean followed by common letter(s) within column are non-significantly different at .05 based on DMRT. Arun-2 was seen bearing its flower early as compared to others varieties but the research by Thapa *et al.*, (2022) has different result where P3553 flowered its tassel early. Same is the condition with Prasai *et al.*, (2015). Regarding silking days, no any significant differences were seen but according to the research by Prasai *et al.*, (2015), farmer's variety took the shortest days to silk 50% of the plants. Pokhrel *et al.*, (2013) also suggested that Arun-2 did not have the shortest silking days.

Similarly regarding Anthesis Silking Interval, Arun-2 and Rampur Composite had the longest ASI days as compared to other varieties. But the research by Prasai et al. (2015) did not record the same as ours. The reason for the different result (tasseling, silking and ASI) is because of the differences in varieties used. Arun-2 took the shortest days to mature as compared to others. This is due to the fact that it takes the shortest days to flower its tassel as compared to others. The maturity days of maize depends up on the days to flower the tassels. It is directly proportional to tasseling days. This can be observed from the table 4 in the result section. In terms of days to maturity, All-rounder and 900 m gold took the longest days to mature whereas Arun-2 took the shortest days to mature. TX369 was behind All-rounder and 900 m gold. Swarna, Super king 4455 and TX369 were at par. But Rampur Composite was also at par with Swarna and Super king 4455 and also with Arun-2.

Table 4: Phenological traits and days to maturity of different maize varieties

Treatment	Days to 50% anthesis	Days to 50% silking	Anthesis silking interval	Days to maturity
Swarna	66.33^{a}	69	2.67^{bc}	99^{bc}
Super king 4455	67^{a}	70.67	3.67^{abc}	99.33^{bc}
Arun-2	60^{b}	65	5^{a}	93.67^{d}
All rounder	68.67^{a}	71	2.33^{c}	105^{a}
Rampur composite	67.33^{a}	72	4.67^{ab}	95.33^{cd}
900 m gold	67.67^{a}	70	2.33^{c}	103.67^{a}
TX369	67.8^{a}	71.11	3.31^{bc}	99.86^{b}
LSD (0.05)	4.02	4.77	1.91	3.96
SEM (±)	0.50	0.60	0.20	0.50
CV (%)	3.42	3.85	32.29	2.24
Grand mean	66.10	69.62	3.33	99.38
F-value	*	ns	*	***

*** Significant at 0.001 level of significance, ** Significant at 0.01 level of significance and * Significant at 0.05 level of significant

Yield and yield attributing traits

All of the yield and yield attributing parameters (ear length, ear diameter, number of lines per ear, number of grains per line, ear weight and yield) showed significant differences except for 1000 grain weight. Super king 4455 had the longest ear whereas Arun-2 and Rampur composite had the shortest ear length. 900 m gold had the girthiest ear and Arun-2 had the least girth. TX369 and 900 m gold had the greatest number of kernel rows per ear whereas Rampur composite and Arun-2 had the lowest. Similarly, regarding number of kernels per row, 900 m gold was superior and Arun-2 and Rampur composite were inferior. Ear weight was highest in 900 m gold and all-rounder, which were also at par with TX369 and Super King 4455. Rampur composite and Arun-2 had the lowest ear weight. Regarding grain yield, Rampur composite and Arun-2 differ significantly with other five maize varieties which were at par, meaning that, there was not any significant difference between those five varieties (Swarna, Super king 4455, All-rounder, 900 m gold and TX369) (Table 5). Mean followed by common letter(s) within column are non-significantly different at .05 based on DMRT. Regarding cob length, cob diameter, number of kernel rows per ear and number of kernels per row, a thousand kernel weight and grain yield, Arun-2 was seen inferior among all other varieties. Similar observations were recorded by Pokhrel *et al.*, (2019) while working with maize crop.

Though there were not any significant differences Arun-2 and Rampur Composite, Arun-2 was even inferior to Rampur Composite. Similar results are seen in all the above-mentioned traits by Thapa *et al.*, (2022) in their research. Prasai *et al.*, (2015) revealed quite different findings where Arun-2 did not have low yield. This is because of the fact that the varieties used by Prasai *et al.*, (2015) does not match entirely with ours and they have used quite out-dated varieties, where most of the varieties in our research is high yielding and some of them are from India as well because of the influence of Indian market as the border is quite close to the research location.

Table 5: Yield and yield attributing parameters of different maize varieties

Treatment	Ear length (cm)	Ear girth (cm)	Number of kernels row per ear	Number of kernels per row	Ear weight (kg)	1000 grain weight (kg)	Yield (mt/ha)
Swarna	18.63^{ab}	4.84^{c}	14.93^{b}	34.2^{ab}	0.21^{b}	0.33	10.59^{a}
Super king 4455	19.02^{a}	5.07^{ab}	15.47^{ab}	33.87^{b}	0.23^{ab}	0.35	11.09^{a}
Arun-2	16.24^{c}	4.15^{e}	13.07^{c}	26.73^{c}	0.12^{c}	0.31	6.15^{b}
All rounder	18.47^{ab}	5.04^{ab}	15.87^{ab}	37.07^{ab}	0.25^{a}	0.34	11.67^{a}
Rampur composite	16.24^{c}	4.51^{d}	13.33^{c}	29.13^{c}	0.15^{c}	0.31	7.06^{b}
900 m gold	17.32^{bc}	5.14^{a}	16.53^{a}	37.6^{a}	0.24^{a}	0.31	11.80^{a}
TX369	17.81^{ab}	4.89^{bc}	16.53^{a}	34.86^{ab}	0.23^{ab}	0.33	11.44^{a}
LSD 0.05	1.50	0.17	1.26	3.19	0.02	0.03	1.28
SE(m)	0.20	0.02	0.15	0.40	0.00	0.00	0.20
CV%	4.76	1.99	4.69	5.37	6.55	5.22	7.21
Grand mean	17.68	4.81	15.10	33.35	0.20	0.32	9.98
F-value	**	***	***	***	***	ns	***

*** Significant at 0.001 level of significance, ** Significant at 0.01 level of significance and * Significant at 0.05 level of significant

In conclusion the study showed that the examined maize varieties have a significant level of genetic diversity. The best varieties, appropriate for widespread cultivation, are those that regularly generate high yields. But in comparison, 900m gold is found to be high yielding and effective variety for farmers in Nepal's terai region for productivity and high earning. Therefore, 900m gold can be considered as the best variety in terms of yield and adaptability and can be promoted as a promising variety adaptable to the area.

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