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Evaluation of Different Hybrid Maize Varieties on Yield and Agronomic Traits at Udayapur, Nepal

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ABSTRACT

A field experiment was set-up in the farmer field of Belaka Municipality, Udayapur to evaluate the growth, yield, and yield attributes of five maize varieties in a randomized complete block design which was replicated four times during the summer season of 2019. The soil texture of the experiment site was sandy loam and pH was moderately acidic in nature. Data on phenology, yield, and yield attributes of all maize varieties were recorded. The plant height of CP-858 was significantly taller and CP-808 had a smaller plant height than other varieties. CP-666 took longer days for tasseling but TX-369 is earlier in tasseling than other varieties. Statistically, there is no difference of varieties on-ear height and number of leaf below and above the main cob. Cob length and length diameter ratio were seen significantly more in CP-666 than other varieties. All the varieties had statistically similar cob diameter, number of rows per cob, thousand-grain weight, and shelling percentage but CP-666 produced significantly higher grain yield (11 t ha $^{-1}$) but TX-369, CP-808 N, CP-808 and CP-858 had statistically similar and lower grain yield than CP-666. Cluster analysis showed that the first cluster consists of four maize varieties; TX-369, CP-808, CP-666, CP-808 which represent 80% of the total varieties. So, CP-666 variety of maize was found better in many traits and grain yield based on these research findings.

INTRODUCTION

Maize (*Zea mays* L.) is one of the world's most important food crops and has been grown for more than 6000 years is South Asia. On the basis of volume of production, it is the world's first crop (1134.75 million tons) followed by wheat and rice and in the Asian region it is second crop (361.84 million tons) after rice. Of the total maize cultivated in the world, Asian region accounts for 34.16 % in the cultivated area and 31.89 % in the production. In the Nepal, it is cultivated in the area of 900288 ha with production of 2300121 tons having productivity of 2.56 t ha^{-1} (FAOSTAT 2017).

Maize is produced in three distinct agro-climatic zones within Nepal, the terai and inner terai (below 900m), the mid-hills (900-1800m) and the high-hills (above 1800m). The proportion of maize area consists of about 70% in mid-hills followed by 20% in terai and 10% in high-hills (Pathik 2002). The national average productivity of maize was 2.56 t ha^{-1} (FAOSTAT 2017), which is far below than the potential productivity of different hybrid maize varieties. In general hybrid maize has greater than 7 t ha^{-1} of productivity but the national average productivity is less than half of the productivity of any hybrid maize varieties. Poultry sector has huge demand for maize grain for making the feed for the poultry. Since hybrid maize has higher productivity and also due to the more market of maize grain, farmers are attracted towards the hybrid maize cultivation (Tripathi et al. 2016). Due to more yield advantages of hybrid maize than open pollinated varieties farmers are attracted towards cultivation of hybrid maize seed (Heisey et al. 1998). For the next two decades, the

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overall demand of maize has been estimated to grow up by 6-8% per annum because of the increased demand for food in the hills and for livestock feed in accessible areas in the terai and inner-terai (Pathik 2002). Of the total maize seed required for the cultivation, Nepal imports almost 20 % of seed (Adhikari 2014) and almost all those seeds are imported from India (Gurung et al. 2011). The grain yield from hybrid seed is 30-40% more than the open pollinated varieties (Koirala 2020).

Winter and summer are two main seasons for cultivation of maize in terai, inner-terai and mid hills of Nepal. Nowadays in eastern terai region of Nepal farmers are cultivating maize in the rainy season also. Different maize hybrids had been registered in Nepal for the general cultivation for terai, inner-terai, mid hills and high hills of Nepal. Few hybrids developed in Nepal from national research system and those released are not competitive. The performance of released cultivar is low as compared to commercial hybrids in grain yield and seed availability of those hybrids is almost negligible for general cultivation (Tripathi et al. 2016). Unavailability of competitive hybrid cultivars within the country and underdeveloped seed industries caused dependency over imported hybrid maize seed every year (Gurung et al. 2011). Hybrid maize seed marketing is flourishing every year but limited commercial hybrids are suited to cultivation owing to existing diverse agro-ecological regime of the country. The objective of this research is to find out the high yielding hybrid maize varieties and increase in the adoption of high yielding hybrid maize varieties for cultivation which have high production and productivity.

MATERIALS AND METHODS

Experimental location

A field experiment was conducted during summer season (February, 2019 to June, 2019) at farmer's field of Belaka Municipality, Udayapur, Nepal. The experimental site lies at 26.785206 North latitude and 87.037618 East longitudes.

Climate and soil

The experimental site lies in the subtropical humid climate belt of Nepal. The area has sub-humid type of weather conditions with cool winters, hot summers and distinct rainy season. The research was conducted during the summer season. The soil texture of the experiment site was sandy loam and pH was moderately acidic in nature.

Experimental details

The experiment was conducted in randomized complete block design with five treatments and four replications. Space of 1m was laid in between replications and 0.5m in between treatments. The size of individual plot was 4.8 m x 4m. Row to row spacing of 60 cm and plant to plant spacing of 25 cm was maintained during the time of planting. Five hybrid maize varieties viz. CP-666, CP-808, CP-808 N and CP-858 of Charoen Pokphand Seeds (India) Pvt. Ltd. and TX-369 of Shree Ram Bio Seeds (India) Pvt. Ltd. were used for planting.

Management practices

The crop was sown on 14th February 2019. At each spot two seeds were planted up to 4 to 5 cm deep. Thinning operation was carried out fifteen days after sowing to maintain required plant population. Nitrogen (N), phosphorus and potassium were applied at the rate of 150: 90: 90 kg ha^{-1}. Full dose of phosphorus and potassium were applied as basal dose at the time of field preparation. Nitrogen was applied in two split equal doses, first at knee height stage and second at tasseling stage. Since the crop was grown in the rainfed area so no any supplemental irrigation was done. Atrazine 50 % SC (soluble concentrates) herbicide was applied at the rate of 3 ml/L water on sowing day for weed control and earthing up was done at knee height stage on the day of first top dressing. Harvesting was done on 21 June 2019. Harvesting and threshing of cobs were done manually.

Parameters recorded and statistical analysis

Days to tasselling and silking were recorded when 50% of the plant population shows tassel and silk and number of days required to reach a particular stage was counted from the days of sowing. Ten randomly selected plants from the plot were taken at the time of harvest. Plant heights of selected plants were taken from ground level to the base of top most leaf. Ear heights of selected plant were taken from ground level to the base of main cob. From the selected plant, number of leaf below and above main cob were counted, diameter and length of cob, number of rows per ear, kernels per rows were recorded. Thousand grain weight and grain yield were recorded from net plot area and moisture was adjusted to 14% to compute the final grain yield. All the obtained recordings were entered into MS-Excel and further subjected to analysis of variance. R-stat package were used for data analysis. Obtained results were subjected to LSD for mean comparison at 5% level of significance with reference to Gomez and Gomez (1984). For the cluster analysis Minitab-14 software was used.

RESULTS AND DISCUSSION

Plant and ear height, flowering and number of leaf below and above main cob

Plant height of different varieties was significantly different but statistically there was no significant difference of varieties on ear height, number of leaf

Table 1. Varietal difference on plant and ear height, flowering and number of leaf below and above main cob.

Varieties	Plant height (cm)	Ear height (cm)	Days to tasseling	Days to silking	Number of leaf below main cob	Number of leaf above main cob
TX-369	212.25ab	100.25	69.25d	73.5	6.75	5.25
CP-858	221.5a	95	71.75ab	74	6.75	6.5
CP-808 N	212.5ab	100.5	70.25cd	73.75	7	6.25
CP-808	200.75c	91.75	71.25bc	74.5	6	6.5
CP-666	210.75b	97.5	73a	74	6.5	6
Grand mean	211.55	97	71.1	73.95	6.6	6.1
P(>F)	0.009**	NS	0.0002**	NS	NS	NS
LSD	9.938	10.188	1.29	0.848	0.8255	0.9126
CV (%)	3.117	6.969	1.2	0.76	8.2988	9.926

Note: *, **, Significant at the P < 0.05 and P < 0.01 levels, respectively. NS, non-significant; LSD, Least Significant Difference; CV, Coefficient of Variation.

Table 2. Varietal difference on cob length and diameter and number of kernels rows per cob, number of grain per rows and length diameter ratio.

Varieties	Cob length (cm)	Cob diameter (cm)	Number of kernels rows per cob	Number of kernels per row	Length diameter ratio
TX-369	18.875b	5.07	16.8	38.95c	3.72b
CP-858	19.2b	5.27	17.15	41.85b	3.64b
CP-808 N	19.2b	5.39	16	42.7b	3.57b
CP-808	19.3b	5.26	15.5	43.1ab	3.67b
CP-666	21.375a	5.21	17.1	44.75a	4.12a
Grand mean	19.59	5.24	16.51	42.27	3.74
P(>F)	0.00024**	NS	NS	0.00007**	0.01*
LSD	0.9254	0.34	1.33	1.825	0.3
CV (%)	3.13	4.315	5.38	2.869	5.43

Note: *, **, Significant at the P < 0.05 and P < 0.01 levels, respectively. NS, non-significant; LSD, Least Significant Difference; CV, Coefficient of Variation.

below and above main cob (Table 1). Plant height of CP-858 was taller and CP-808 had smaller plant height than other varieties. Koirala et al. (2001) also observed that in a research of national maize research program (NMRP) in summer maize trial the plant height of five maize varieties ranged from 201-235cm with the application of 150 N ha^{-1}. Hussain and Hassan (2014) and Sangoi and Salvador (1998) also reported highly significant differences among maize hybrids for plant height. Plant height is important traits for determining the lodging and grain yield of maize. Lower the plant height fosters less accumulation of photosynthate in the maize stover and play the vital role for translocation of produced photosynthate to the grain and gives the higher yield (Bastola et al. 2021). Similarly, varieties had highly significant effect on days to 50% tasseling but there is no any significant effect on days to silking (Table 1). CP-666 took longer days for tasseling but TX-369 is earlier in tasseling than others varieties in the test. Koirala et al. (2001) also observed that in a research conducted at Pakhribas of Nepal, the number of days for 50% silking ranged for 76-85 days after sowing in 34 hybrids excluding the local open pollinated variety. Akbar et al. (2008) and Kandel et al. (2017) also reported significant variation for days to silking among different maize hybrids. Due to earlier tasselling and silking, less number of days will be available for the crop growth by which less photosynthate will deposit in the grain and affect the grain yield which might be the reason for higher yield in the CP-666 and lower yield in TX-369 (Bastola et al. 2021).

Table 3. Varietal difference on thousand grain weight, shelling percentage and grain yield.

Varieties	Thousand grain weight (g)	Shelling percentage (%)	Grain yield (t ha^{-1})
TX-369	214.76	77.18	9.38b
CP-858	202.28	77.31	9.65b
CP-808 N	219.38	76.70	9.96ab
CP-808	212.87	78.63	9.46b
CP-666	216.09	80.14	11.00a
Grand mean	213.07	77.99	9.89
P(>F)	NS	NS	0.03*
LSD	26.67	3.17	1.06
CV (%)	8.3	2.69	7.13

Note: *, **, Significant at the P < 0.05 and P < 0.01 levels, respectively. NS, non-significant; LSD, Least Significant Difference; CV, Coefficient of Variation.

Cob length and diameter, number of kernels rows per cob, number of grain per rows and length diameter ratio

Varieties had significant difference on cob length, number of grains per row and length diameter ratio but cob diameter and number of kernels rows per cob had no difference within the varieties statistically (Table 2). Cob length was seen longer in CP-666 than other varieties but TX-369, CP-808, CP-808 N and CP-858 had statistically similar and shorter cob length than CP-666. Cob length is the most important traits for determining the yield of maize which might be the reason for higher grain yield of maize in CP-666. Maruthi and Rani (2015) also obtained highly significant differences in the cob length among different maize genotypes. Similarly, number of kernels per row was seen higher in CP-666 and lowest numbers of grains per row were seen in TX-369. Sesay et al. (2016) also observed highly significant differences among different hybrids for number of kernels per row. Longer cob length might be the reason for higher number of kernels per row in CP-666 than other varieties. Length diameter ratio was seen more in CP-666 than other varieties but TX-369, CP-808, CP-808 N and CP-858 had statistically similar and lower length diameter ratio than CP-666.

Thousand grain weight, shelling percentage and grain yield

Grain yield at the time of harvesting were significantly affected by the varieties but varieties had no difference on thousand grain weight and shelling percentage (Table 3). Although thousand grain weight and shelling percentage were statistically similar but higher shelling percentage were seen in CP-666. Shelling percentage plays the vital role for determining the yield of maize which might be reason for higher grain yield in CP-666 than other varieties. CP-666 had significantly higher grain yield but TX-369, CP-808, CP-808 N and CP-858 had statistically similar and lower grain yield than CP-666. Vashistha et al. (2013), Nayaka et al. (2015) and Khan et al. (2018) also reported highly significant differences among different maize genotypes for grain yield of maize. Higher cob length, more number of kernels per rows, more number of days for tassling and higher shelling percentage in CP-666 produced significantly higher grain yield in CP-666 than other varieties.

Cluster analysis

The critical examination of dendrogram reveled four clusters with minimum of 34.03 % similarity level in UPGMA Clustering (Figure 1). The cluster was divided into two clusters: Cluster 1 and Cluster 2 (Table 4). Cluster 1 consisted of four varieties TX-369, CP-808 N, CP-666, CP-808 which represent 80% of total varieties. Maize varieties of

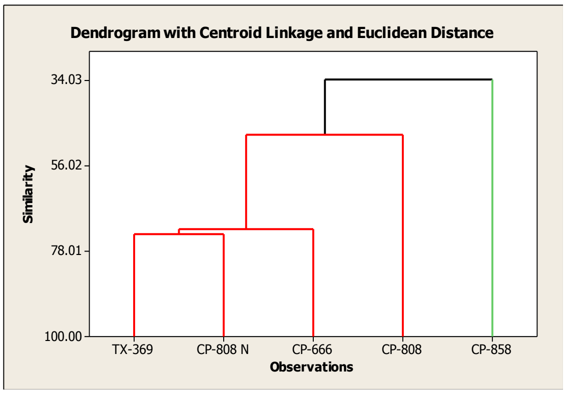

Figure1. Cluster analysis of the five maize varieties evaluated for different agronomic traits

Table 4. Mean of clustering of five maize varieties evaluated for different variables of maize.

Variables	Cluster1	Cluster2	Grand centroid
Days to tasseling	70.94	71.75	71.10
Days to silking	73.94	74.00	73.95
Plant height	209.06	221.50	211.55
Ear height	97.50	95.00	97.00
Number of leaf below main cob	6.56	6.75	6.60
Number of leaf above main cob	6.00	6.50	6.10
Cob length	19.69	19.20	19.59
Cob diameter	5.24	5.28	5.24
Rows per cob	16.35	17.15	16.51
Grains per row	42.38	41.85	42.27
Length diameter ratio	3.77	3.64	3.74
Thousand grain weight	215.78	202.28	213.08
Shelling percentage	78.16	77.31	77.99
Grain yield	9.95	9.65	9.89

this Cluster 1 had highest value for ear height, cob length, number of grain per row, length diameter ratio, thousand grain weight, shelling percentage and grain yield. Cluster 2 consisted of 1 maize variety CP-858, 20 % of total genotypes was characterized which had highest days to 50% tasseling, days to 50% silking, plant height, number of leaves below and above cob, number of row per cob. The genetic diversity among twenty maize inbred lines were studied for days to 50 % anthesis and silking, anthesis-silking interval, leaf firing, tassel blast, SPAD reading and leaf senescence, plant and ear height, leaf area index, ear per plant, cob length and diameter, number of kernel ear^{-1}, number of kernel row^{-1}, number of kernel row, silk receptivity, shelling percentage, thousand kernel weight and grain yield facilitates the selection of parents with diverse genetic background which is very essential for breeding program (Kandel et al. 2018). Cluster analysis help to minimize the plant pool making group of under study genotypes are an efficient tool during selection process (Mostafavi et al. 2011; Shrestha, 2016). Akteret *et al.*, (2009) also reported that cluster analysis is one of most powerful tool for selection of best variety or lines for a successful breeding program.

CONCLUSIONS

CP-666 took longer days for tasseling than other varieties. Cob length, number of grain per row, and length diameter ratio was significantly higher than other varieties. Due to good performance of CP-666 in many yield attributing traits grain yield was also higher in CP-666 than other varieties in test. Cluster analysis showed that first cluster consists of four maize varieties; TX-369, CP-808 N, CP-666, CP-808 which represent 80% of total varieties. These varieties have highest value for ear height, cob length, number of grain per row, length diameter ratio, thousand grain weight, shelling percentage and grain yield based on the cluster analysis. So, CP-666 variety was found good based on this research so multi-location and multi-year research can be conducted in mid-hills and terai regions to recommend the best performing variety in the mid-hills and terai regions of Nepal.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

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REFERENCES

Adhikari J. (2014) Seed sovereignty: Analysing the debate on hybrid seeds and GMOs and bringing about sustainability in agricultural development. Journal of Forest and Livelihood, 12(1): 33-46.

Akbar M. Shakoor M.S. Hussain A. Sarwar M. (2008) Evaluation of three way maize crosses through genetic variability, broad sense heritability, character association and path analysis. Journal of Agricultural Research (Pakistan), 46(1): 39 – 45.

Akter A. Hasan M.J. Paul A.K. Mutlib M.M. Hossain M.K. (2009) Selection of parent for improvement of restorer line in rice (Oryza Sativa L.). SAARC Journal of Agriculture, 7(2): 43-50.

Bastola A. Soti A. Pandey U. Rana M. Kandel M. Shrestha, J. (2021) Evaluation of white grain maize varieties for growth, yield and yield components**.** Journal of Agriculture and Natural Resources, 4(1), 265-272.

FAOSTAT. (2017) On-line database URL: http://www.fao.org/faostat/en/#data/QC [Accessed 17 May, 2020].

Gomez K.A. Gomez A.A. (1984) Statistical procedures for agricultural research. John Wiley & Sons, New York.

Gurung D.B. Upadhyay S.R. Pandey BR. Pokhrel B.B. Kshetri J.B. (2011) Hybrid maize seed production: A new initiative for reliable and sustainable hybrid maize seed supply in Nepal. Agriculture Development Journal, 8(1): 1-8.

Heisey P.W. Morris M.L. Byerlee D. Lopez-Pereira M.A. (1998) Economics of hybrid maize adoption. In Morris M.A. (ed.). Maize seed industries in developing countries. Boulder, Colorado, Lynne Reinner.

Hussain M.A. Hassan Z.A. (2014) Genetic variability, heritability and correlation studied for yield and yield components in maize hybrids. Sarhad Journal of Agriculture, 30(4): 472 – 478.

Kandel M. Ghimire S.K. Ojha B.R. Shrestha J. (2017) Analysis of genetic diversity among the maize inbred lines (*Zea mays* L.) under heat stress condition. Journal of Maize Research and Development, 3(1): 86-97.

Kandel M. Ojha B.R. Ghimire S.K. Shrestha J. (2018) Cluster analysis among the maize inbred lines (Zea mays L.) under heat stress condition. International Journal of Global Science Research, *5*(1): 677-684.

Khan M.U. Shah S.M.A. Rahman H. Iqbal A. Aslam E. (2018) Evaluation of maize hybrids for yield and maturity traits. Sarhad Journal of Agriculture, 35(1): 7-12.

Koirala K.B. Gurung D.B. Pokharel B.B. (2001) A review on hybrid maize research in Nepal. Rajbhandari N.P. Ransom J.K. Adhikari K. Palmer A.F.E. (eds), Sustainable maize production systems for Nepal: Proceedings of a Maize Symposium held, 3-5 December, 2001 Kathmandu, Nepal. Kathmandu: NARC and CIMMYT, p.38-45

Koirala K.B. (2020) Maize research for food, feed, and nutritional security in Nepal. Bhandari D. Upreti H.K. Shrestha R. Tripathi J.J. Shrestha H.K. Mishra K.K. Joshi B.K. Ansari A.R. Tripathi B.P. Badya S. Shrestha J. Tripathi M. Paneru P. (eds.), Proceedings of the 29th Summer Crops Workshop 17-18 June 2018, Regional Agricultural Research Station, Lumle, Kaski, Nepal. Nepal Agricultural Research Council, p.7-19.

Maruthi R.T. Rani K.J. (2015) Genetic variability, heritability and genetic advance estimates in maize (Zea mays L.) inbred lines. Journal of Applied and Natural Science, 7 (1): 149 -154.

Mostafavi K. Shoahosseini M. Geive H.S. (2011) Multivariate analysis of variation among traits of corn hybrids traits under drought stress. International Journal of Agricultural Sciences, 1:416-422.

Nayaka M.P. Lambani N. Marker S. (2015) Genetic variability and heritability studies in maize. International Journal of Tropical Agriculture, 33(3): 1987-1990.

Pathik D.S. (2002) Maize Research achivements and constraints. Sustainable maize production systems for Nepal (No. 631.536. CIMMYT).

Sangoi L.U.I.S. Salvador R.J. (1998) Influence of plant height and of leaf number on maize production at high plant densities. Pesquisa Agropecuária Brasileira, 33(3): 297-306.

Sesay S. Ojo D.K. Ariyo O.J. Meseka S. (2016) Genetic variability, heritability and genetic advance studies in topcross and three-way cross maize (Zea mays L) hybrid. Maydica, 61-2016: 1-7.

Shrestha J. (2016) Cluster analysis of maize inbred lines. Journal of Nepal Agricultural Research Council, 2: 33-36.

Tripathi M.P. Shrestha J. Gurung D.B. (2016) Performance evaluation of commercial maize hybrids across diverse Terai environments during the winter season in Nepal. Journal of Maize Research and Development, 2(1): 1-12.

Vashistha A. Dixit N.N. Sharma S.K. Marker S. (2013) Studies on heritability and genetic advance estimates in maize genotypes. Bioscience Discovery, 4(2): 165-168.