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Research Article

Evaluation of white grain maize varieties for growth, yield and yield components

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ABSTRACT

Maize (*Zea mays* L.) is one of the most commonly cultivated crop after rice in Nepal. The present study was done to evaluate and recommend the best performing white maize genotypes in mid hill region of Nepal. This study was conducted at farmer field of Kavre, Nepal during the rainy season of 2019. Five white maize genotypes were evaluated in randomized complete block design with four replications where Deuti used as standard check. Ear and plant height of plant, days to 50% silking and tasseling, count of leaf above and below main cob, total number of leaf, cob length, cob diameter, kernel rows per cob, kernels count per row, thousand kernels weight, shelling and sterility percentage,stay green and grain yield parameters were observed. Deuti and DMH-7314 had good stay green and husk cover rating. Plant height (282.6 cm) and ear height (162.4 cm) was more in HB-008. Number of kernels per row was more in HB-008 (36.5) and HB-007 (36.5) and thousand kernel weights was more in DMH-7314 (386.3 g) followed by Deuti (353.9 g). DMH-7314 was late in tasseling (86 days) and silking (89days) but shelling percentage was the lowest in DMH-7314 (70.8) than other varieties. Analysis of variance revealed that genotype HB-008 (9.70 t/ha) had more yield as compared to standard check Deuti (7.80 t/ha). Thus genotype HB-008 perform better in mid hill region of Kavre, Nepal.

Keywords: Maize, Stay green, Grain Yield, Genotypes

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INTRODUCTION

Maize is a very high yielding potential than any other cereals and thus popularly known as the 'queen of cereals' (Dhaka *et al.*, 2010). It is being nutritionally an important crop, has multiple functions in the traditional farming system; being used as food and fuel for human beings and feed for livestock and poultry. It is second staple food crop of Nepal next to rice and it had the production of 2.71 million tons (t) which was cultivated in the area of 0.96 million hectare (ha) with average productivity of 2.84 t/ha in Nepal where as in Kavre district

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of Nepal it was cultivated in the area of 24643 ha with the production of 76590 tons with productivity of 3.11 t/ha (MoALD, 2020). Of the total production of hilly region, human consumption shares 86% maize production and in the context of terai region, 80% of maize production is used for making feed for animal and poultry (Gurung *et al*., 2011). The farm level maize yield was 2.55 t/ha is not satisfactory as compared to attainable yield (5.7 t/ha) in Nepal (MOAD, 2017; Karki *et al*., 2015). Maize production in the area suffers much from low fertility, low management, lack of improved varieties, and very severe infections of foliar diseases like turcicum leaf blight, high infestations of striga and stalk borers (Assefa, 1998). Compared to other countries, seed replacement rate of maize in Nepal is only 11.3% which is very low (Pokharel, 2013). Over the last decades, demand for the maize grain has been increased by 5% (Sapkota & Pokhrel, 2010). There are 114 feed industries in Nepal which played the vital role for making cattle and poultry feed and it is recorded that these feed industries produce around 0.5 million tons of feed every year. Bhattarai (2011) reported that of the total maize requirement in Nepal about 40-45% maize is being imported from India every year. Generally maize grain has two types of color i.e. white grain and yellow grain type. White grain type is especially preferred for the human consumption because of good palatable nature than that of yellow grain type and also it is given as cattle feeds in hilly parts of Nepal. White grain type maize is cultivated more in the high-hills and mid-hills region of Nepal. Similarly, yellow grain type is mostly used for making poultry feed because it gives good color to the egg shell of the poultry and it is also used for cattle and human consumption. Yellow grain type maize varieties are cultivated almost in all the regions of the Nepal. Varietal differences was observed in days to silking and tasseling, plant height, ear height, ear length and diameter, husk cover rating and grain yield of maize among fourteen early maize genotypes (Adhikari *et al*., 2018).Assessment of the maize varieties for morphological characters and grain yield is one of the crucial steps towards the development of crop varieties. Development of early maturing and high grain producing maize varieties are the prime importance in the selection of variety (Hussian *et al*., 2016). This research was performed to test the performance of white maize varieties for yield, yield attributes and other associated traits in the mill-hills region of Nepal.

MATERIALS AND METHODS

Plant materials

The five maize genotypes HB-007, HB-008, HB-008MX, Deuti and DMH-7314 were used for planting. Of those five varieties, first three varieties of HB series were received from Charoen Pokphand Seeds (India) Pvt. Ltd. and Deuti and DMH-7314 were produced by Nepal Agricultural Research Council, Nepal and Dhaanya Seeds Pvt. Ltd. respectively. Deuti was used as standard check because they were recommended for cultivation in that region. All those five varieties have white color grain.

Experimental site

This experiment was conducted at Bethanchowk of Kavre district of Nepal in the rainy season of 2019 where the research plot was located at Latitude 27°31'39.4" N and longitudes 85°29'35.5" E and the altitude of the experiment location was 1793 meter. The soil of the experiment field was slightly acidic and textural class was sandy loam in nature.

Experimental design and crop husbandry

Five maize varieties were planted in randomized complete block design (RCBD) with four replications. Individual plot size of $12m^2$ was used where the maize was planted at 60 cm row

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spacing and 25 cm plant spacing. Land was tilled and maize seeds were planted on 10 June 2019 with two seeds per spot. For the nutrient management nitrogen, phosphorus and potassium were applied at 150: 90: 90 kg/ha. The 2/3rd phosphorus and 4/5th potassium were incorporated during field preparation and remaining dose of phosphorus and potassium were applied at 40 days after sowing (DAS). Nitrogen was applied in two split equal doses, first at 40 DAS and second at tasseling stage at 80 DAS. 15 days after the sowing of seed thinning was carried out and plant population was maintained in each plot. Hand weeding was carried out at 20 DAS and earthing-up was done at 40 days after sowing of seeds. There was the problem of fall army worm (FAW) so for the effective control of FAW, Emamectin benzoate 5% SG was sprayed at 40 and 60 DAS. Since the maize was grown under rainfed system so no irrigation was done during the entire crop duration. Harvesting of crop was done on 11 November 2019.

Data recording and measurement

For recording data, ten sample plants were taken randomly from each plot and ear and plant height, leaf count below and above main cob, total numbers of leaf, cob diameter, cob length, sterility, kernel rows per cob, kernels count per rows were recorded. For determining the flowering, when 50% of the plant of the entire plot shows the tassel and silk then days count from the days of sowing to that days is considered as days to 50% tasseling and silking respectively. Cobs were harvested from sampled plants from each plot and moisture content of grain was determined and thousand kernel weight, shelling percentage. Grain yield (t/ha) at 15% moisture content was calculated using fresh ear weight with the help of the formula adopted by Carangal *et al.* (1971) and Shrestha *et al.* (2018) to adjust the grain yield (t/ha) at 15% moisture content.

Data analysis

The data recorded on different parameters from field were first tabulated and processing in Microsoft excel (MS- Excel, 2010). R-stat package was used for analysis of variance. The treatment means were subjected to Least Significant Difference (LSD) test at 5% level of significance (Gomez & Gomez, 1984; Shrestha, 2019).

RESULTS AND DISCUSSION

Stay green and husk cover

Varietal difference was observed in stay green of plant and husk cover of cob at the time of harvesting (Table 1).

Table 1: Varietal differences in stay green of plant and husk cover of cob at harvest

Varieties	Stay green[a]	Husk cover[b]
HB-007	1.0	5.0
HB-008	5.0	3.0
HB-008MX	3.0	5.0
Deuti	5.0	1.0
DMH-7314	9.0	1.0

[a]*Rating for staygreen (1= 0 % green leaf, 9 = 100 % green leaf)*

[b]*Rating for husk cover (1 = Husk tightly covers cob; 3 = Covers ear tip tightly; 5 = Expose tip loosely covers ear up to its tip; 7 = Grain exposed and husk leaves do not cover the ear; 9 = Poor husk cover tips clearly exposed)*

Stay green is the most important traits for the farmers because those having more greenness at the time of harvest are preferred for feeding the stalk of maize to the cattle. DMH-7314 had

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very much greenness than other varieties but HB-007 had more dried stalk at the time of harvest. Deuti and HB-008 are moderate in stay green at the time of harvesting.

Another trait husk cover is also important to protect from bird damage and also to protect the water in entering the cob which protects the cob from damage especially in the rainy season. DMH-7314 and Deuti had good husk cover which protects the cob of maize but other three varieties are poor in husk cover.

Plant height, ear height and leaf number

There was significant difference of maize varieties on plant and ear height but number of leaf above and below main cob and total number of leaf on maize plant were not significantly affected by varieties (Table 2). HB-008 and Deuti had significantly taller plant height and DMH-7314 is shorter than other varieties. Pant height is the most important traits taken into consideration during breeding programs. Because of fertilizer responsive and resistant to lodging semi-dwarf type plant variety are selected. Muchie and Fentie (2016), and Hussain and Hassan (2014) also reported similar findings as in our trial in between different maize hybrids. Similarly, HB-008 had ear placement at taller level and HB-007 had cob at lower level from the ground than other varieties. Nayaka *et al.* (2015) also observed significant differences among maize varieties for height of ear. All the varieties had statistically similar number of leaf below and above main ear and total number of leaf.

Table 2: Varietal difference in plant and ear height and number of leaf

Varieties	Plant height (cm)	Ear height (cm)	Number of leaf above main cob	Number of leaf below main cob	Total number of leaf
HB-007	254.9^{bc}	140.0^{b}	6.0	7.7	13.7
HB-008	282.6^{a}	162.4^{a}	5.5	8.1	13.7
HB-008MX	270.9^{ab}	152.2^{ab}	6.1	8.1	14.1
Deuti	275.3^{a}	155^{ab}	6.2	8.5	14.7
DMH-7314	250.2^{c}	142.6^{b}	5.9	8.4	14.4
Grand mean	266.8	150.4	5.9	8.15	14.1
F-test	**	*	NS	NS	NS
$LSD_{0.05}$	16.3	17.2	0.5	0.7	0.9
CV, %	4.0	7.4	5.5	5.6	4.0
SEm (±)	7.5	7.9	0.2	0.32	0.4

*Note: ***, indicates significant at 0.1%, **, at 1% and *, at 5% probability whereas NS, non-significant. Treatments means followed by different letter (s) are significantly different using LSD ($p<0.05$).*

Yield attributes and moisture content of grain at harvest

Yield attributes and grain moisture at harvest were significantly affected by maize varieties (Table 3). All the varieties had statistically similar cob length but DMH-7314 had larger cob diameter and HB-007 had smaller cob diameter than other varieties. Cob diameter is also an important trait in determining the yield of maize grain. Maruthi and Rani (2015) also had difference in cob diameter among the maize varieties. Length : diameter ratio was observed more in HB-007 and HB-008MX and lowest in DMH-7314. All the varieties had statistically similar kernel rows per cob. Kernels count per rows was observed higher in HB-007 and HB-008 and lower was recorded in DMH-7314. Kandel *et al.* (2017), and Singh *et al.* (2013) also observed differences between maize in kernels count per row. Grain moisture content at the time of harvest was observed more in DMH-7314 but HB-007 had lowest moisture content than other varieties. Thousand kernel weight was observed significantly higher in DMH-7314

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and lowest was seen in HB-007 variety. Sesay *et al.* (2016), and Vashistha *et al.* (2013) also observed significant differences in genotypes of maize for thousand kernel weight.

Table 3: Varietal difference in yield attributes and grain moisture content at harvest

Varieties	Cob length (cm)	Cob diameter (cm)	Length: diameter ratio	Number of kernel rows per cob	Number of kernels per rows	Grain moisture content at harvest (%)	Thousand kernel weight
HB-007	17.5	4.3^{d}	4.1^{a}	13.1	36.5^{a}	31.5^{c}	248.2^{d}
HB-008	19.1	5.1^{ab}	3.8^{ab}	13.4	36.5^{a}	36.4^{b}	333.1^{bc}
HB-008MX	18.9	4.7^{c}	4.1^{a}	13	35.4^{ab}	34.7^{b}	293.8^{cd}
Deuti	18.4	4.9^{bc}	3.8^{ab}	12.9	33.2^{bc}	35.6^{b}	353.9^{ab}
DMH-7314	18.4	5.2^{a}	3.5^{b}	13.4	32.1^{c}	39.5^{a}	386.3^{a}
Grand mean	18.5	4.8	3.8	13.1	34.7	35.5	323.1
F-test	NS	***	*	NS	**	***	***
$LSD_{0.05}$	1.5	0.24	0.34	0.7	2.6	2.6	50.88
CV, %	5.3	3.3	5.9	3.5	4.9	4.8	10.2
SEm (±)	0.69	0.11	0.16	0.3	1.2	1.2	23.4

*Note: ***, indicates significant at 0.1%, **, at 1% and *, at 5% probability whereas NS, non-significant. Treatments means followed by different letter (s) are significantly different using LSD (p<0.05).*

Flowering, sterility and shelling percentage and grain yield

Days to 50% silking and tasseling and shelling percentage and grain yield were significantly affected by the varieties in the experiment (Table 4). DMH-7314 was significantly late in tasseling and silking but earlier tasseling and silking were observed in HB-007.Munchie and Fentie (2016), and Vashistha *et al.* (2013) also reported significant dissimilarities among maize hybrids for days to tasseling. Number of silking days plays very vital role in determining the maturity of maize crop. Muchie and Fentie (2016), and Akbar *et al.* (2008) also recorded significant variation in maize hybrids for days to silking.

Table 4: Varietal difference in flowering, sterility and shelling percentage and grain yield of maize

Varieties	Days to 50% tasseling	Days to 50% silking	Sterility percentage	Shelling percentage	Grain yield (t/ha)
HB-007	78.25^{d}	80.75^{d}	15.9	76.3^{a}	6.1^{c}
HB-008	84.00^{b}	87.25^{b}	12.6	76.7^{a}	9.7^{a}
HB-008MX	81.25^{c}	84.25^{c}	15.8	77.2^{a}	7.5^{b}
Deuti	82.75^{c}	85.00^{c}	11.7	76.4^{a}	7.8^{b}
DMH-7314	85.50^{a}	88.75^{a}	13.6	70.8^{b}	7.5^{b}
Grand mean	82.35	85.20	13.9	75.5	7.7
F-test	***	***	NS	**	***
$LSD_{0.05}$	1.4	1.6	5.5	3.1	0.86
CV(%)	1.1	1.3	25.7	2.7	7.3
SEm (±)	0.65	0.75	2.5	1.5	0.4

*Note: ***, indicates significant at 0.1%, **, at 1% and *, at 5% probability whereas NS, non-significant. Treatments means followed by different letter (s) are significantly different using LSD (p<0.05).*

All the varieties had similar sterility percentage. Lowest shelling percentage was observed in DMH-7314 and highest was observed in HB-008MX which was statistically similar with HB-008, Deuti and HB-007. Kandel *et al.* (2017) also recorded significant differences in shelling percentage among different maize genotypes.

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Grain yield was obtained highest from HB-008 which was followed by Deuti, DMH-7314 and HB-008MX. The lowest grain yield was produced from HB-007. Prasai *et al.* (2015), Shrestha (2016), and Hussain *et al.* (2004) also found highly significant differences in maize varieties for grain yield.

CONCLUSION

The present study was aimed at analyzing the variability present among the maize genotypes using yield and yield attributing traits. Genotypes namely Deuti and DMH-7314 had good husk cover so they had no any cob damage by rain and bird than other varieties. All varieties had similar number of leaf. Thousand kernel weight and kernels count per row were more in DMH-7314 and HB-008 respectively. DMH-7314 was late in flowering and shelling percentage was lower in the same variety. HB-008 produced higher grain yield which was followed by Deuti. Deuti being developed in Nepal also showed good performance so HB-008 can be recommended for the cultivation in Bethanchowk of Kavre district of Nepal.

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Authors' contribution

A. Bastola conceived the idea, designed the experiment, analyzed the data and wrote the manuscript, A. Soti oversees the research as entomologist and assist in data collection, U. Pandey helped during field layout and planting, M. Rana oversees the research as soil scientist and helped in final data entry in the excel sheet, M. Kandel and J. Shrestha helped in data analysis. All authors read and approved the final version of the manuscript.

Conflict of interest

This manuscript is original and free from any plagiarism, and has not been published before and is not currently being considered for publication elsewhere. There is no conflict of interest associated with this publication.

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