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Performance evaluation of quality protein maize genotypes across various maize production agro ecologies of Nepal

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ABSTRACT

To identify superior quality protein maize genotypes for grain yield under different agro climatic conditions of terai and hill districts in Nepal, the coordinated varietal trials (CVT) were conducted at Dailekh, Doti, Salyan, Lumle and Pakhribas in 2013 and Salyan, Pakhribas and Kabre in 2014 during summer season and coordinated farmer's field trials (CFFT) at Surkhet and Dailekh in 2013 and Salyan, Pakhribas and Khumaltar in 2014 during summer season. The experiment was carried out using randomized complete block design with three replications for CVT and CFFT. Across the locations and years the superior genotypes found under CVT were S01SIYQ, S01SIWQ-2 and Poshilo Makai-1 where as S99TLYQ-HG-AB, S99TLYQ-B and Poshilo Makai-1 were found superior genotypes under CFFT. The superior genotypes derived from CFFT will be promoted further for similar environments across the country.

INTRODUCTION

Maize is one of the most important staple food crops in Nepal where its area and productivity is 8.49 million hectare and 2.3 t/ha, respectively (MoAD, 2013). It contributes to about 25.02% in total for cereal production, 6.54% in AGDP and 3.15% in GDP (MoAD, 2013). It is also an important feed ingredient for poultry and livestock and hence the demand of quality protein maize (QPM) is increasing. In our country all varieties of maize released so far are normal type except Poshilo Makai-1. Cereal protein contains on average about 2% lysine which is less than one-half of the concentration recommended for human nutrition by Food and Agriculture Organization (FAO) of the United Nations (Prasanna *et al.*, 2001). Normal maize has poor nutritional value for monogastric animals such as humans and pigs because of reduced content of essential amino acids such as lysine and tryptophan. For humans, lysine is the most limiting amino acid followed by tryptophan in maize protein (Kies *et al.*, 1965). The biological value of QPM protein is about 80% that of milk which is about 90% and that of normal maize is only about 45% (FAO, 1992). QPM also provides better quality feed and fodder to poultry, cattle, swine, and fishmeal industries. The majority of hill farm families in Nepal are suffering from protein malnutrition as their major staple food is maize and cannot afford animal protein.

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The maize growing environments of Nepal is very diverse and varied along north to south parts of the country. It is the only crop which is adaptive to across different agro-ecological zones because of its great diversity (Ferdu *et al.*, 2002). The improved varieties give high and stable yields across environments where they are adapted (CIMMYT, 1991). The ability to develop high yielding stable cultivars is a primary focus in most breeding programs. The research on the development of quality protein maize varieties is not sufficient in Nepal. Therefore, these trials were conducted to identify superior quality protein maize genotypes in terms of grain production for hills of Nepal.

MATERIALS AND METHOD

Genotypes used

In CVT of 2013 and 2014, the genotypes used in trials were S00TLWQ-B S01SIWQ-2 CLEYAS99-SIWQ S00TLYQ-B S99TLWQ-B S03TLYQ-AB-01 S01SIYQ S03TLYQ-AB-2 Poshilo Makai-1 Farmer's Variety (Rampur Composite). In CFFT of 2013, the genotypes used in trials were S03TLYQ-AB-02, S03TLYQ-AB-01, S99TLYQ-B, S99TLYQ-HG-AB, Poshilo Makai 1 and Farmer's Variety (Rampur Composite). In CFFT of 2014, the genotypes used in trials were Obatampa, RampurSO3FQ-O2, S99TLYQ-HG-AB, S99TLYQ-B, Poshilo Makai-1 and Farmer's Variety (Rampur Composite)

Experimental design and cultural practices

The coordinated varietal trials (CVT) were conducted at Dailekh, Doti, Salyan, Lumle and Pakhribas in 2013 and Salyan, Pakhribas and Kabre in 2014 during summer season and coordinated farmer's field trials (CFFT) at Surkhet and Dailekh in 2013 and Salyan, Pakhribas and Khumaltar in 2014 during summer season. All trials were laid out in randomized complete block design with three replications in CVT and farmer's as replicate in CFFT with three replications and general agronomic practices were done in all trials. The individual plots was 4 rows of 3 m length i.e. 9 m^2 (3 m × 3 m) for CVT and 6 rows of 3 m length i. e. 13.5 m^2 (4.5 m × 3 m) for CFFT where genotypes were seeded at the standard seeding rate of 20 kg/ha. The net area harvested was 9m^2 for CVT and 13.5 m^2 for CFFT. The spaces between row to row and plant to plant were 75 and 25 cm. respectively. In all experiments, two seeds per hill were planted and thinned to single plant per hill after first weeding. Fertilizer was applied @ 120:60:40 kg/ha N:P_2O_5:K_2O, respectively for all the experiments. Half of N and full dose of P_2O_5 and K_2O were applied as basal dose. The remaining half of the N was applied in two splits at knee-high and pre-tasseling/silking stages. Other agronomic practices were carried out as per recommended.

Field Measurements

Plant height, ear height, tasseling and silking day were recoreded. Grain yield (kg/ha) at 15% moisture content was calculated using fresh ear weight with the help of the below formula:

$$\text{Grain yield } \left(\frac{\text{kg}}{\text{ha}}\right) = \frac{\text{F.W.}\left(\frac{\text{kg}}{\text{plot}}\right)(100-\text{moisture},\%)\text{x S x 10,000}}{85 \text{ x Harvested area}(m^2)}$$

Where,

F.W. = Fresh weight of ear in kg per plot at harvest Moisture (%) = Grain moisture content at harvest 85= Required moisture percentage 15%
S= Shelling co-efficient (0.80)
Harvested area= net harvested plot size, m^2

Statistical Analysis

The statistical analysis of the data was done using computer software MSTATC version 1.2 (Freed, 1990) applying 5% level of significance.

RESULTS AND DISCUSSION

The findings of CVT in 2013 summer season showed that at Dailekh, Doti, Salyan, Lumle and Pakhribas the combined analysis across location revealed that all the tested genotypes were highly significant for grain yield, significant for ear height and non significant for plant height. The highest grain yield was obtained by Farmer's Variety (5135 kg/ha) followed by S01SIYQ (5086 kg/ha), Poshilo Makai-1 (4997 kg/ha) and S01SIWQ-2 (4893 kg/ha). The S00TLWQ-B had highest plant height (178.5 cm) while Poshilo Makai-1 had lowest plant height (177.9 cm). Maximum value of ear height was shown by Poshilo Makai-1 (97.9 cm), while minimum value was recorded in S00TLYQ-B (84.1 cm). The genotype × location interaction was non significant for plant height, significant for ear height and highly significant for grain yield. The highly significant G × E interaction indicated that genotypes under different environments behaved differently for the expression of characters of interest. It means a particular variety may not exhibit the same phenotypic performance under different environments or different varieties may respond differently to a specific environment.

The findings of CFFT in 2013 summer season showed that at Surkhet and Dailekh the combined analysis across location revealed that all the tested genotypes were highly significant for tasseling day, silking day, ear height and non significant for grain yield. The highest grain yield was produced by Poshilo Makai-1 (3266 kg/ha) followed by S99TLYQ-HG-AB (3094 kg/ha) and Farmer's variety (3066 kg/ha) and S99TLYQ-B (3036 kg/ha). Farmer's variety had highest ear height (125 cm) while S03TLYQ-AB-02had lowest plant height (95.7 cm). Maximum value of plant height was shown by Farmer's Variety (237 cm), while minimum value was recorded in S03TLYQ-AB-02 (193.5 cm). There was variation in tasseling day; the highest in Poshilo Makai-1 (55.33 day) and lowest in Farmer's variety (52 day). Similarly highest value of silking was given by S99TLYQ-B (58.11 day) and lowest value in Farmer's variety (54.44 day). There was highly significant G × E interaction for tasseling and silking, significant for plant height and non significant for ear height and grain yield.

The highly significant G × E interactions indicated that genotypes performance was inconsistent across testing locations and need to be tested in several locations in order to select stable genotypes.

Table 1. Combined analysis of genotypes for agronomic traits under CVT at Dailekh, Doti, Salyan, Lumle and Pakhribas in 2013 summer season

SN	Genotype	Plant height (cm)	Ear height (cm)	Grain yield (kg/ha)
1	S00TLWQ-B	178.5	91	3958
2	S01SIWQ-2	173.2	86.1	4893
3	CLEYAS99-SIWQ	175.8	87	4725
4	S00TLYQ-B	160.8	84.1	3694
5	S99TLWQ-B	164.7	97.2	4391
6	S03TLYQ-AB-01	179.9	93	4546
7	S01SIYQ	172.6	88.6	5086
8	S03TLYQ-AB-2	174.1	86.1	4835
9	Posilo Makai-1	177.9	97.9	4997
10	Farmer's Variety (Rampur Composite)	179	87.9	5135
F-test,	Genotype	0.652	0.026	<.001
	Location	<.001	<.001	<.001
	Genotype × Location	0.129	0.01	<.001
$LSD_{0.05}$		36.52	38.11	2001.5
CV%		10.5	21.6	21.5

Table 2. Combined analysis of genotypes for agronomic traits under CFFT at Surkhet and Dailekh in 2013 summer season

SN	Genotype	Tasseling day	Silking day	Plant height (cm)	Ear height (cm)	Grain yield (kg/ha)
1	S03TLYQ-AB-02	52.78	56.11	193.5	95.7	2999
2	S03TLYQ-AB-01	54.44	56.89	211.4	107.5	2955
3	S99TLYQ-B	54.44	58.11	228.5	122.1	3036
4	S99TLYQ-HG-AB	55.11	57.44	222.6	114.7	3094
5	Poshilo Makai 1	55.33	57.78	226.5	114.5	3266
6	Farmer's Variety (Rampur Composite)	52	54.44	237	125	3066
F-test	Genotype	<.001	<.001	<.001	<.001	0.770
	Location	<.001	<.001	<.001	<.001	<.001
	Genotype × Location	<.001	<.001	0.039	0.214	0.934
$LSD_{0.05}$	Genotype	1.288	1.238	13.04	9.889	435
	Location	0.7886	0.7581	7.984	6.056	266.4
CV%		2.5	2.28	6.21	9.15	14.85

The results of CVT in 2014 summer season showed that at Salyan, Pakhribas and Kabre the combined analysis across location revealed that all the tested genotypes were highly significant for grain yield, tasseling day, silking day, ear height and significant for plant height. The highest grain yield was obtained by Farmer's variety (4185 kg/ha) followed by S01SIYQ (3645 kg/ha), S01SIWQ-2 (3302 kg/ha) and Poshilo Makai-1 (3275 kg/ha).

Farmer's variety had highest plant height (258.2 cm) while CELEYA S99-SIWQ had lowest plant height (203.8 cm). Maximum value of ear height was shown by Farmer's Variety

(150.9 cm), while minimum value was recorded in CELEYA S99-SIWQ (108 cm). There was variation in tasseling day; the highest in S00TLWQ-B (66.17 day) and lowest in Farmer's variety (61.33 day). Similarly highest value of silking was given by CELEYA S99-

SIWQ (69.17 day) and lowest value in Farmer's variety (64.5 day). There was highly significant G × E interaction for tasseling, silking, ear height, grain yield and significant for plant height. The highly significant G × E interactions indicated that genotypes performance was inconsistent across testing locations and need to be tested in several locations in order to select stable genotypes.

Table 3. Combined analysis of genotypes for agronomic traits under CVT at Salyan, Pakhribas and Kabre in 2014 summer season

SN	Genotype	Tasseling day	Silking day	Plant height (cm)	Ear height (cm)	Grain yield (kg/ha)
1	S00TLWQ-B	66.17	69	237	128.8	1068
2	S01SIWQ-2	64.5	68	223.1	113.8	3302
3	CELEYA S99-SIWQ	66.5	69.17	203.8	108	1098
4	S00TLYQ-B	63.67	66.5	210.1	114.2	3195
5	S99TLWQ-B	63.67	66.83	218.5	119.9	2757
6	S03TLYQ-AB-01	65.17	69	223.2	113.2	2945
7	S01SIYQ	66.5	69.33	236.2	127.8	3645
8	S03TLYQ-AB-02	65.33	68.17	211.1	113.8	2669
9	Poshilo Makai-1	65.67	68.67	221.2	111.5	3275
10	Farmer's Variety (Rampur Composite)	61.33	64.5	258.2	150.9	4185
	Genotype	0.002	0.002	0.018	<.001	<.001
F-test,	Location	<.001	<.001	<.001	<.001	<.001
	Genotype × Location	<.001	<.001	0.55	0.003	<.001
$LSD_{0.05}$		3.247	3.887	3.887	1952	113.3
CV%		2.4	2.8	2.8	7.9	19.3

The findings of CFFT in 2014 summer season showed that at Salyan, Pakhribas and Khumaltar the combined analysis across location revealed that all the tested genotypes were significant for grain yield, plant height and ear height. The highest grain yield was obtained by Farmer's Variety (6651 kg/ha) followed by Poshilo Makai-1 (5970 kg/ha), S99TLYQ-HG-AB (5753 kg/ha) and S99TLYQ-B (5166 kg/ha). Farmer's variety had highest plant height

(258.2 cm) while S99TLYQ-HG-AB had lowest plant height (223.6 cm). Maximum value of ear height was shown by Farmer's Variety (143.8 cm), while minimum value was recorded in S99TLYQ-

B (113.9). The genotype × location interaction was non significant for grain yield, plant height and ear height.

Table 4. Combined analysis of genotypes for agronomic traits under CFFT at Salyan, Pakhribas and Khumaltar in 2014 summer season

SN	Genotype	Plant height (cm)	Ear height (cm)	Grain yield (kg/ha)
1	Obatampa	235.4	121.7	3925
2	RampurSO3FQ-O2	224.6	114.3	5141
3	S99TLYQ-HG-AB	223.6	116.8	5753
4	S99TLYQ-B	226.8	113.9	5166
5	Poshilo Makai-1	225	116.4	5970
6	Farmer's Variety (Rampur Composite)	258.2	143.8	6651
F-test	Genotype	0.003	0.004	0.044
	Location	0.007	0.015	0.003
	Genotype × Location	0.447	0.454	0.668
$LSD_{0.05}$	Genotype	18.33	15.67	1659
	Location	12.96	11.08	1173
CV%		8.23	13.49	31.82

CONCLUSION

- Selection of high yielding QPM genotypes for a particular location is the most important task in QPM development program.
- In CVT, S01SIYQ, S01SIWQ-2 and Poshilo Makai-1 were found high yielding genotypes across years and locations.
- In CFFT, S99TLYQ-HG-AB, S99TLYQ-B and Poshilo Makai-1 were found superior for grain yield genotypes across years and locations.
- Superior varieties in CVT should be further tested in CFFT and superior varieties in CFFT should be forwarded for release and be recommended to farmers of hill districts of Nepal for general cultivation

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