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Open Journal of Plant Science

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mail.plantscience@peertechz.com

ISSN: 2640-7906 DOI: https://dx.doi.org/10.17352/ojps

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Received: 20 December, 2018
Accepted: 29 December, 2018
Published: 31 December, 2018

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Research Article

Effect of sowing time and environmental variation on yield of differnt Maize varieties

Abstract

The primary factors those influenced yield potential of maize crop are genotypes, environment and interaction between them. Thus Evaluation of different maize varieties under different environmental condition helps to select the superior one in its yield potential among treatments. To verify this fact the field experiment was conducted during rainy season with three planting times, at Bako and Uke in 2016. Planting times were designed with 7 days interval among each planting time for each location. The first planting was done in may 25/ 2016 and in may 27/2016 for Uke and Bako respectively. The experiment was laid out in a Randomized Complete Block Design with three replications. Twenty maize varieties were planted in uniform spacing of 75x30 cm to understand the influence of sowing time, location and varieties on grain yield of maize, and to selected suitable variety. The analysis of variance showed that a significant (P<0.01) effects of panting times and varieties on grain yield of maize. The maize variety BHQPY 545 was superior in grain yield (10445 kg/ha) and number of cobs (87161 cob/ha) at both locations and at all planting times. However statistically similar grain yield (9616.3kg/ha) was also obtained in another maize variety BH 546. But BHQPY 545 performed well in all location with similar input and management. Therefore BHQPY 545 is the most suitable and productive variety under these locations. Although the results are one year experiment the variety performed well at two locations and number of cobs per plant is genetic factor. Thus BHQPY 545 variety should be grown at Bako and Uke to produce high yield.

Introduction

Maize (*Zea mays* L) is one the most important cereal crop having quick growing nature, high yield capacity and wider adaptability over a range of environmental conditions (Patel et al., 2017). The worldwide significance of maize as human food, animal feed and as raw materials for the manufacture of different industrial products is increasingly expressed. In Ethiopia maize is one of the most strategic crops for food security. It is grown every year in wide cultivated land in diverse agro ecologies for various uses of human beings.

Maize cultivars are grown in diverse agro-climate condition of different soil types, soil fertility levels, moisture levels, temperatures, planting time and management practices. All these factors constitute the growing environment for the crop varieties during production period [1].

Good planting date is one of the crucial factors that strongly influence crop production in rain fed agriculture. Particularly in many parts of Africa where the rainy season starts with some light showers followed by dry spells, can cause poor crop emergence or desiccate a young crop. Ethiopia is frequently portrayed as a drought-stricken country. Abnormally low and infrequent rainfall has been increasing the frequency and impact of droughts [2]. So it is important to adjust planting time to reduce such impacts. In addition, maize is C4 plant, its yield potential is depends on the photo period, the daily temperature (degree day) and optimum rainfall. Thus a difference in time of planting is related to different climatic conditions (rainfall, temperature and photoperiod) [3]. Maize grows well in the most varied conditions but the interaction between the environments and its genotype and variety is crucial to its production [4].

Grain yield is highly influenced by genotype and environment interaction [5]. Therefore evaluation of cultivars in multiple environments is essential [6]. Crop yield and quality are the result of the interaction between a genotype's potential expression and the environment, which is modified by agronomic management in order to meet the objectives of the farmer (Mariani et al., 2017). Therefore, much breeding and agronomic research has been designed to improve performance of crops under various agro climate conditions.

Optimizing of sowing date depend on the maturity stage is among the most important agronomic practices to increase

Citation: Golla B, Tadesse B, Chalsisa D, Bayisa E (2018) Effect of sowing time and environmental variation on yield of differnt Maize varieties. Open J Plant Sci 3(1): 041-045. DOI: http://dx.doi.org/10.17352/ojps.000014

crop production. High yielding varieties of maize are most sensitive to time of sowing; hence optimum time of sowing contributes more towards maize grain yield (Patel et al., 2017). It is therefore necessary to determine suitable planting time at different location to enhance productivity and production of maize in Ethiopia. Keeping this in view this study is designed with the following objective:

Objective

To identify the most suitable varieties and appropriate planting time for high yield of maize under different environments

Material and Methods

Twenty varieties (Table 1) were used for this experiment. The experiment was conducted at two locations (Bako and Uke) in 2016. The altitude of Bako is 1650 m. above sea level where as the altitude of Uke is 1200 above sea level. In both locations there was good rainfall distribution from May to November during 2016. Monthly rain fall distribution and relative humidity maximum temperature minimum temperature and mean temperature for Bako is indicted in the graphs 1,2 below.

Fertilizer: Nitrogen fertilizer in the form of urea (46% N) and NPS (19 %N, 38% P2O5, and 7 % S) fertilizers were used as a source of nitrogen and Phosphorus respectively

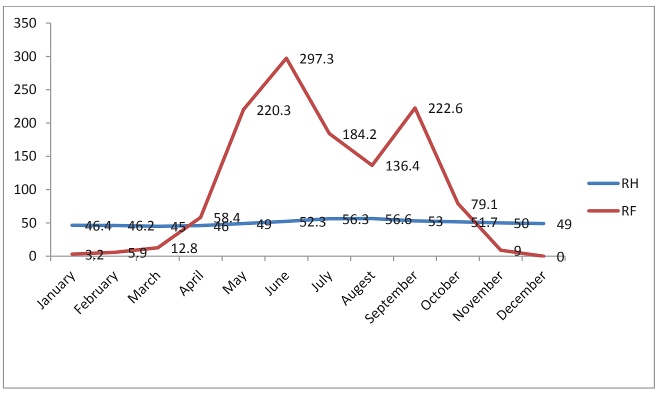
Treatments and experimental design

Three planting time were designed with 7 days interval among each other at both location. The first planting times were may 25/ 2016 and may 27/2016 for Uke and Bako

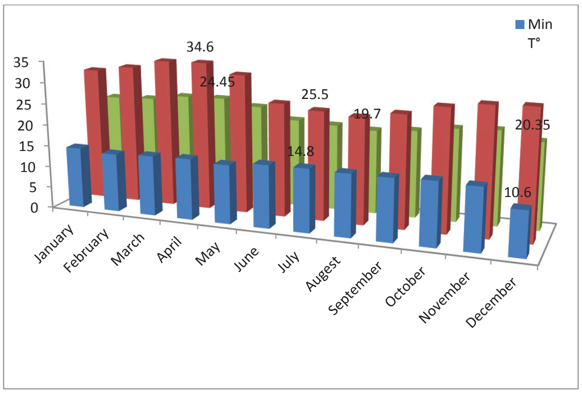
Table 1: Agro climate adaptation and yield potential of the selected maize varieties in Ethiopia.

No	Varieties	Area of adaptation		Yield (kg/ha)	
		Altitude (m)	Rain fall (mm)	On research field	On farm
1	BH660	1600-2400	1000-1500	9000-12000	6000-8000
2	BH540	1000-2000	1000-1200	8000-10000	5000-6500
3	BH543	1,000–2,000	1,000–1,200	8500–11000	5500–6500
4	BHQPY545	1,000–1,800	1,000–1,200	8000–9500	5500–6500
5	BH661	1,600–2,200	1,000–1,500	9500–12000	6500–8500
6	BH546	1000-2000	1000-1200	75000-9500	5500-6500
7	BH547	1000-2000	1000-1200	75000-9500	5500-6500
8	AMH760Q	1700-2600	1000-1200	9000-12000	6000-8000
9	AMH851(Jibat)	1,800– 2600	1,000– 1200	8000-12000	6000–8000
10	AMH854	No available data	No available data	No available data	No available data
11	AMH853	1800-2600	1000-1200	9000-12000	8000-9000
12	MH138Q	Low moisture stress	1000-1800	7500-8000	5500-6500
13	MH140	Low moisture stress	1000-1800	8500-9500	6500-7500
14	Melkasa-2	Low moisture stress	600-1000	5000–6500	4000–5000
15	Melkasa-4	Low moisture stress	600-1000	4000–5000	3500–4000
16	Melkasa-6Q	Low moisture stress	600-1000	4500–5500	3000–4000
17	Gibe-2	300–1,000	900–1,200	6500–7000	4500–5000
18	Morka	1,600–1,800	1,200–2,000	7000–9000	4000–6000
19	PHB30-G19 (Shone)	1000-2000	800-1200	7000-110000	6500-8000
20	P3812W (Limu)	No available data	No available data	No available data	No available data

Sources (Worku et al.2012,Abate et al 2015)



Graph 1: Monthly rain fall destribution and relative humidity of Bako in 2016 croping season.



Graph 2: Monthly Mean Minimum, Mean maximum and Mean Temprature of Bako in 2016 croping season.

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respectively. All maize varieties were planted at 75cmx30cm spacing. The recommended rate of P fertilizer (100kg NPS) and half of the recommended of N fertilizer (100kg urea) was applied at sowing time and the remain half dose of urea (100 kg/ha) was applied 35 days after planting. The experiment was laid out as a randomized complete block design (RCBD) with three replications. The gross plot size was 4.5 m× 2.4 m (10.8 m^2) with row length of 2.4 m, but net plot size 3m × 2.4 m (7.2 m^2) was used for harvesting to minimize the border effects on the crop yields. The treatments were randomly assigned to the experimental unit within a block (replication). The blocks were separated by 1.5 m wide space.

Crop Data Collection: Data such as time of silking and tasseling, physiological maturing time, number of cobs and grain yield were collected and recorded for analysis.

Finally analyses of variances for the data recorded were conducted using the SAS version 9.3. Least significant difference (LSD) test at 5% probability was used for mean separation if the analysis of variance indicated the presence of significant treatment differences

Result and Discussion

The combination analysis of variance revealed a significant (P<0.01) effects of panting times, en and entries on grain yield of maize. However, location and the interaction of panting times and location were not significant.

The maize variety BHQPY 545 was superior in grain yield (10445 kg/ha) and number of cobs (87161 cob/ha) at both locations and at all planting times. Therefore BHQPY 545 is the most suitable and productive variety under these locations. Although some varieties showed significantly similar effect with this variety their yield performance is not consistence across location and planting times (Tables 2,3). [7] Reported that the maize varieties with stable mean yield across environments should be used to increase maize production [8,9].

Phenological parameters of maize

The analysis of variance revealed a significant (P<0.01) effects of locations, planting time entry and interaction among them on phenological parameters.

The highest days to attain 50% tasseling, silking and physiological maturity days were recorded on BH-660 BH 661 and Mork while the shortest day to attain 50% tasseling, silking and physiological maturity were observed on Melkasa6Q, Melkasa4 and Melkasa2 varieties. This clearly indicated that Melkasa6Q, Melkasa4 and Melkasa2 varieties were earlier seceded of their function of photosynthesis resulting reduction in their grain yield. On other hand BH-660 BH 661 and Mork capture solar radiation for longest time. But their proliferation is limited to one cob per plant (Table 4).

Conclusion

Maize grain yield is highly affected by genotype and planting times. Planting time is also varied depends on agro ecologies. Maximum grain yield (191086 kg) was obtained when the maize varieties planted in June 3/2016 at Bako agro ecological condition. However, in case of another location (Uke)

Table 2: Effect of planting time on number of cobs and grain yield of various maize varieties at two locations and three planting times

Entry	Bako						Uke					
	1st planting		2nd planting		3rd planting		1st planting		2nd planting		3rd planting	
	NC	GY/kg/ha	NC	GY/kg/ha	NC	GY/kg/ha	NC	GY/kg/ha	NC	GY/kg/ha	NC	GY/kg/ha
Shone (1)	48889FG	9855.6AB	50370E	8997CDE	40000D	5020.8D	47407CD	10588.2A	45926DE	9634AB	45926E	8904.3ABCDEF
LIMU (2)	62222BCD	11003.4A	68148BC	10764ABC	45926BCD	6656.9ABCD	45926D	7958DE	47407CDE	8877ABCD	50370CDE	10393.3AB
BH-660 (3)	51852EFG	9121.4ABC	59259CDE	10160BCD	41481CD	5107.4D	48889CD	8733CBD	48889CDE	8793ABCD	59259C	9631.8ABCD
BH-540 (4)	53333DEFG	9591.1AB	53333DE	10482ABCD	47407BCD	6692.2ABCD	51852CD	8520CD	44444E	8168ABCDE	45926E	8043CDEFGH
BH-543 (5)	62222BCD	9885AB	59259CDE	10065CD	47407BCD	6504.2ABCD	50370CD	9058.4ABCD	50370CDE	8452ABCDE	51852CDE	9681.5ABCD
BHQPY -545 (6)	94815A	11038.3A	94815A	12368A	74074A	7777.4A	85926A	10505AB	85926A	10293A	87407A	10689.9A
AMH760 Q (7)	57778CDEF	8433.9BC	65185BCD	9859CD	50370BC	6075.6ABCD	51852CD	9100.6ABCD	45926DE	8074ABCDE	47407DE	7949EDFGH
MH851(GIBAT) (8)	51852EFG	7961.7BC	57778CDE	8452DEF	48889BCD	5836BCD	53333BCD	7993.1DE	47407CDE	6777CDE	45926E	7558FGH
AMH853 (9)	48889FG	8741.9BC	50370E	9096CDE	45926BCD	6134.9ABCD	47407CD	8376CD	44444E	7355BCDE	45926E	7561.1FGH
MH138 Q (10)	69630B	9538.8AB	68148BC	9111CDE	50370BC	5681.3CD	57778BC	8053.3CDE	54815BC	7744BCDE	59259C	7744.6EFGH
MH-140 (11)	59259CDE	9834.9AB	66667BC	10731ABC	50370BC	7519.5AB	50370CD	8982ABCD	47407CDE	8064ABCDE	47407DE	8684.4BCDEFG
BH-661 (12)	56296CDEF	9384.4AB	56296CDE	9654CD	47407BCD	6241.3ABCD	48889CD	8953.5ABCD	45926DE	8089ABCDE	47407DE	7645.7FGH
BH-546 (13)	69630B	10968.3A	77037B	12188AB	45926BCD	5783.6CD	53333BCD	9848.8ABC	50370CDE	9005ABCD	57778CD	9904.2ABC
BH-547 (14)	44444F	8869.6BC	48889E	10090CD	47407BCD	6228.7ABCD	44444D	8890.8ABCD	44444E	9154ABC	45926E	8795.3BCDEF
AMH-854 (15)	50370EFG	8321.4BC	66667BC	9471CD	44444BCD	5524.9CD	50370CD	8540.7CD	44444E	7548BCDE	45926E	7768.1EFGH
GIBE-2 (16)	65185BC	9666AB	63704BCD	8516DEF	53333B	7124.1ABC	53333BCD	8197.1CD	60741B	9446AB	72593B	9601.8ABCDE
MORKA (17)	54815CEF	8330.5BC	59259CDE	8694CDEF	45926BCD	5248.4D	53333BCD	8316.1CD	47407CDE	7509BCDE	54815CDE	6864.9GH
MELKASSA 2 (18)	54815DEF	8071.3BC	59259CDE	8621DEF	51852B	6435.9ABCD	54815BCD	7544.8DE	53333BCD	8222ABCDE	47407DE	7241.4FGH
MELKASA-4 (19)	62222BCD	8236.5BC	57778CDE	6705F	51852B	5056.8D	50370CD	6380.5DE	48889CDE	6600DE	47407DE	6263H
MELKASSA 6Q (20)	54815DEF	7315.1C	60741CDE	7062EF	50370BC	5272.7D	63704B	7463.2DE	48889CDE	6148E	56296CDE	6654.7H
LSD (0.05)	9949.4	1982.8	12685	2091.7	10364	1734.9	10644	1809.4	7571.8	2486.8	10862	1890
CV%	10.26	13.03	12.35	13.03	12.79	17.22	12.11	12.73	9.09	18.35	12.373	15.65

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Table 3: Mean performance of various maize varieties at three planting time and two locations.

Entry	NC			GY/kg/ha		
	Bako	Uke	Combine	Bako	Uke	Combine
Shone (1)	46420J	46420GHI	46420GF	7957.6DEF	9708.9AB	8833.3BECD
LIMU (2)	58766BCDE	47901FGHI	53333ED	9474.6ABC	9076.2BC	9275.4BC
BH-660 (3)	50864GHIJ	52346CDEF	51605EDF	8129.6DEF	9052.6BC	8591.1FBECD
BH-540 (4)	51358FGHIJ	47407FGHI	49383EGF	8921.9CBD	8243.8CDE	8582.8FBECD
BH-543 (5)	56296EDEFG	50864DEFGH	53580ED	8818CBDE	9063.9BC	8941BECD
BHQPY -545 (6)	87901A	86420A	87161A	10394.7A	10495.8A	10445.2A
AMH760 Q (7)	57778CBDEF	48395EFGHI	53086ED	8122.8DEF	8374.6BCDE	8248.7FGECD
MH851(GIBAT) (8)	52839EFGHIJ	48889EFGHI	50864EGDF	7416.4FGH	7442.7EFG	7429.6GHI
AMH853 (9)	48395HIJ	45926HI	47160GF	7990.9DEF	7764.2EF	7877.5FGE
MH138 Q (10)	62716BC	57284BC	60000CB	8110.5DEF	7847.2DEF	7978.9FGED
MH-140 (11)	58765CBDE	48395EFGHI	53580ED	9361.9ABC	8576.9BCDE	8969.4BCD
BH-661 (12)	53333EFGHI	47407FGHI	50370EGF	8426.6CDEF	8229.6CDE	8328.1FGECD
BH-546 (13)	64197B	53827CDE	59012CB	9646.5AB	9586AB	9616.3AB
BH-547 (14)	46913IJ	44938I	45926G	8396.1CDEF	8946.7BCD	8671.4FBECD
AMH-854 (15)	53827EFGH	46913FGHI	50370EGF	7772.3DEFG	7952.2CDE	7862.3FGE
GIBE-2 (16)	60741BCD	62222B	61481B	8435.4CDEF	9081.5BC	8758.5FBECD
MORKA (17)	53333EFGHI	51852CDEFG	52592ED	7424.4FGH	7563.2EFG	7493.8GHI
MELKASSA 2 (18)	55308DEFG	51852CDEFG	53580ED	7709.2EFG	7669.3EF	7689.3FGH
MELKASA-4 (19)	57284CDEFG	48889EFGHI	53086ED	6666GH	6414.5G	6540.3I
MELKASSA 6Q (20)	55309DEFG	56296CD	55802CD	6550H	6755.3FG	6652.7HI
LSD (0.05)	6749.2	5498.4	5207.8	1157.3	1160.2	1081
CV%	12.77	11.23	14.59	14.96	14.81	19.76

Where NC = Number of Cob and GY/kg/ha = grain Yield /kilo gram per hectare.

Table 4: Effect of planting time and environmental variation on phenological parameters of various maize varieties.

Entry	Tasseling days			Silking days			Maturity days		
	Bako	Uke	Combine	Bako	Uke	Combine	Bako	Uke	Combine
Shone (1)	77.22ef	67.56ef	72.4def	79.78def	68.44gh	74.1cde	157.22bc	146.56cd	151.89cd
LIMU (2)	77.11ef	69.67bcd	73.4Cde	78.44efg	70.11ef	74.3cde	154.67de	142.56e	148.61e
BH-660 (3)	85.11a	73.33a	79.2a	86.33a	74.11a	80.2a	160.22a	150.22a	155.22a
BH-540 (4)	78.33de	68.33de	73.3Cde	76.33ghi	68.67fgh	72.5efg	155.67cd	148.00bc	151.83cd
BH-543 (5)	81.00c	70.00bc	75.5b	82.78bcd	70.67cde	76.7b	155.89cd	150.00ab	152.94bc
BHQPY -545 (6)	78.44de	68.44cde	73.4Cd	80.11def	69.11efg	74.6cd	153.44def	142.22e	147.83e
AMH760 Q (7)	80.33c	70.78b	75.6b	82.44cd	72.11bc	77.3b	152.67efg	151.00a	151.83cd
MH851(GIBAT) (8)	74.89h	66.44fgh	70.7g	75.89ghij	67.67ghi	71.8fgh	154.67de	146.11cd	150.39
AMH853 (9)	71.22i	65.89gh	68.6h	72.44kl	66.22i	69.3ij	143.78i	139.22f	141.50g
MH138 Q (10)	75.56gh	66.89efgh	71.2fg	77.22efg	68.44gh	72.8def	149.11h	138.00f	143.55f
MH-140 (11)	75.67gh	66.56fgh	71.1fg	76.78fgh	67.33hi	72.1fg	154.44de	142.33e	148.39e
BH-661 (12)	83.44b	73.11a	78.3a	85.67abc	74.33a	80a	157.33bc	149.56ab	154.00ab
BH-546 (13)	81.00c	70.44b	75.7b	82.22d	71.78cd	77b	155.22cd	145.78d	150.50d
BH-547 (14)	78.89d	69.78bcd	74.3bc	80.44de	70.22def	75.3b	150.78gh	146.22cd	148.50e
AMH-854 (15)	72.00i	65.33h	68.7h	73.56hijk	66.33i	69.9hij	145.67i	138.11f	141.89g
GIBE-2 (16)	76.44fg	67.44efg	71.9efg	73.11ijk	68.00gh	70.6hij	151.56fgh	144.89d	148.22e
MORKA (17)	83.78ab	74.00a	78.9a	86.11ab	73.44ab	79.8a	158.44ab	150.22a	154.33ab
MELKASSA 2 (18)	71.67i	63.33i	67.5h	72.78jk	64.00j	68.4jk	144.67i	137.67f	141.17g
MELKASA-4 (19)	69.44J	61.67j	65.6l	70.78kl	62.44jk	66.6jk	140.44j	135.11g	137.78h
MELKASSA 6Q (20)	68.11j	60.78j	64.4l	69.22l	61.44k	65.3l	138.00j	135.33g	136.67h
LS	1.44	1.57	1.06	3.44	1.61	1.88	2.48	2.17	1.66
CV	2	2.47	2.23	4.71	2.52	3.91	1.75	1.61	1.71

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the maximum grain yield (172003kg) was obtained in the first planting time, may 25/2016.

The maize variety BHQPY 545 was superior in grain yield and number of cobs compared to all other varieties at both locations and at all planting times though statistically similar result was obtained on variety BH 546. Therefore BHQPY 545 is the most suitable and productive variety under these locations. Although the results are one year experiment the variety performs well at two locations and at three planting times. The crucial factor that enable the variety BHQPY 545 to be superior over other varieties is its ability to caries two or more than two cobs per plan. Number of cobs per plant is genetic factor which is seldom affected by environments. Thus BHQPY 545 variety should be grown in the first week of June at Bako and in the first days of the last week of May at Uke to produce high yield.

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