Phenological Studies on Parental Lines of Promising Maize Hybrids for their Seed Production Potentiality

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Authors Contribution

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Abstract

The field and laboratory experiments were conducted at ZARS, V. C. Farm, Mandya, during *kharif* 2020 to study the phenology of parental lines of promising maize hybrids for their seed production potentiality. The results revealed that mean sum of squares due to parental lines indicated significant differences for growth and yield parameters *viz.,* field emergence, plant height, cob length, cob weight, number of rows per cob, number kernels per row and seed yield per hectare and quality parameters *viz.,* hundred seed weight, seed germination, mean seedling length and seedling vigour index I and II. Among the parental lines MAI-729 has showed significantly higher cob weight (114.33 g), hundred seed weight (29.11 g), seed yield per hectare (45.71 q ha^{-1}) and seed vigour index-I and II (3550 and 7673, respectively). Therefore, MAI-729 line could be recommended for breeding and seed production programmes.

Keywords : Parental lines, Days to 50 per cent flowering, Seed yield, Quality

Maize (*Zea mays* L.) is one of the important versatile and staple cereal crops of the world and ranks next to wheat and rice. Maize has been an important cereal because of its great production potential and adaptability under wide range of environments. Maize occupies an important place in Indian economy, like rice, wheat and millets. Besides being a potential source of food for human being, it is also used for feeding cattle, poultry and industries for the production of starch, syrup, alcohol, acetic acid, lactic acid *etc*.

Globally, maize is cultivated on an area of 193.7 million hectares with production of 1147.7 million ton with productivity of 5750 kg ha^{-1} (FAO, 2020). In India, maize is grown over an area of 9.89 million hectares with a production of 31.65 million ton and productivity of 3199 kg ha^{-1}. In Karnataka, it is cultivated in an area of 1.34 million hectares with production of 3.98 million ton accounting the productivity of 3305 kg ha^{-1} (DES., 2021).

Maize is the only cereal crop which will be grown in various seasons and requires moderate climate for their growth. Being a C_4 plant, it is physiologically more efficient and has higher yield potential and wider adaptability over environmental conditions. The production and utilization potential of maize in the recent times is not only attracting the attention of research scientists, but also evolving major National and International Research thrusts, with a view to provide solutions to various problems of maize particularly in terms of poor genetic potential, low seed yield, poor adaptation to various agro ecologies and overall poor performance of some varieties. For achieving the successes of crop improvement programme not only depend on amount of genetic variability present in the population but also, it can be achieved through selection of genotypes based on phenological parameters *viz.,* days to 50 per cent tasseling and silking days to maturity, plant height, number of rows per cob, grain number per cob, seed yield traits and seed quality traits (germination, seedling length and seedling vigour index).

The study of phenology is one of the most important functions that determines the crop growth and development of any crop and is essential to acquire knowledge on the physiological response of the crop under different field conditions. The phenology of the crop is influenced by parameters like the crop genotype, nutrient, biotic, abiotic, yield potential and weather parameters (Chakravarthy and Jagannathan, 2014). Hence, study of phenological characters would make possible to selection of varieties for future breeding, propagation and production purpose.

Methodology

The experiment was laid out in randomized complete block design during *kharif* 2020 to study the crop growth, days to flowering, seed yield and quality in parental lines of promising maize hybrids with three replications at ZARS, V.C. Farm, Mandya and Department of Seed Science and Technology, UAS, GKVK, Bengaluru. Seeds of each parental lines were sown on a 3 m long row with an inter-plant spacing of 30 cm and an inter- row spacing of 60 cm. Normal agronomic practices were followed to raise the crop. The experiment consists of ten treatments (parental lines) *viz.* P_1: MAI 729, P_2: MAI 105, P_3: NAI 137, P_4: SKV 50, P_5: CAL 1443, P_6: CML 451, P_7: DH 388, P_8: DH 371, P_9: DH 376, P_{10}: DH 545. Observations on growth and yield attributes were recorded on five randomly selected plants from each plot during *kharif* 2020 season. Freshly harvested seeds of parental lines were collected and an observation on seed quality attributes was recorded as per the ISTA rules (ISTA., 2019).

Results and Discussion

Growth and Yield Parameters

The results of phenology of parental lines of maize hybrids examined on field emergence were significant (Table 1). However, NAI-137 had significantly highest field emergence (90.50%) followed by MAI-729, MAI-105, SKVV-50, CAL-1443 and CML-451, while DH-376 had the lowest (65.00%). The ultimate test of seed vitality is field emergence. This variation in field emergence among parental lines could be attributed to their genetic makeup, as reported by Sharma *et al.* (2020) in maize.

Significant difference was observed among the parental lines for plant height at harvest. The plant

Table 1

Mean performance of parental lines of maize hybrids for their growth parameters

Parental lines	Field emergence (%)	Plant height (cm)	Days to 50 % tasseling	Days to 50 % silking	Days to maturity	Cob length (cm)
P_1 : MAI-729	85.27	152.33	55.00	57.00	102.00	13.36
P_2 : MAI-105	83.33	149.33	57.00	58.00	104.00	13.48
P_3 : NAI-137	90.50	151.00	56.00	58.00	106.00	11.89
P_4 : SKV-50	82.90	142.67	54.00	54.00	97.00	9.42
P_5 : CAL-1443	80.00	133.00	58.00	59.00	113.00	13.83
P_6 : CML-451	83.33	127.67	63.00	65.00	114.00	12.50
P_7 : DH-388	75.00	147.00	57.00	57.00	95.00	9.83
P_8 : DH-376	65.00	146.33	62.00	64.00	97.00	8.83
P_9 : DH-371	79.17	161.67	57.00	57.00	97.00	14.67
P_{10} : DH-545	70.00	137.00	57.00	57.00	108.00	10.17
Mean	79.45	144.80	57.60	58.60	103.30	11.80
SEm±	3.62	5.19	2.55	2.61	4.58	0.63
CD (P= 0.05)	10.84	15.57	NS	NS	NS	1.87

height ranged from 127.67 cm (CML-451) to 161.67 cm (DH-371) with a mean of 144.80 cm (Table 1). Significantly higher plant height was noticed in DH-371 followed by MAI-729, MAI-105, NAI-137, DH-388 and DH-376. The lowest plant height was found in CML-451. Plant height is an important trait because it is often associated with logging and lodging of plants under unfavorable situations. This variation may be attributed to their genetic background. Higher plant height may be attributable to earlier field emergence, which boosted the plant's resistance to heat and drought, resulting in higher plant height at harvest. The similar findings reported by Hidayat *et al.* (2008) and Manjunath *et al.* (2018) in maize.

Days to 50 per cent tasseling and silking did not differ significantly among parental lines (Table 1). However, SKV-50 had taken lesser days for flowering (54.00 and 54.00 days, respectively) and CML-451 has taken longer days to flowering (63.00 and 65.00 days, respectively). Furthermore, all the parental lines come under medium and late flowering groups as per the DUS guidelines. These parental populations were noted to be quite earlier than the checks and could be used as germplasm source in developing varieties with early maturity. Variability may be attributed to their differential genetic constitution and also due to speed of emergence, improved field stand and vigorous growth of plant. The above results are in line with previous findings of Hidayat *et al.* (2008) and Kiran and Channakeshava. (2017) in maize.

Non-significant difference was noticed for number of days taken to maturity among parental lines. CML-451 matured in 114 days while, CAL-1443 and DH-545 taken 113 and 108 days for maturation, respectively. The earliest maturation was noticed in DH-388 (Table 1). Flowering and maturity period are essential qualities that are typically taken into account before a variety is released for commercial use. Early flowering and maturity ensure the visible uniformity of a crop field which is always preferred by farmers. This might be due to better utilization nutrients and moisture among the parental lines populations. Similar results were also reported by Ibrahim and Mukhtar (2016) and Anil kumar (2018).

The phenotypic character pertaining to cob length varied significantly among the parental lines (Table 1). It was found that higher cob length recorded in DH-371 (14.67cm) followed by MAI-729, MAI-105 and CAL-1443. Whereas the parental line DH-376 (8.83 cm) recorded lower cob length. The trait cob weight also differed significantly among the parental lines (Table 2 and Fig. 1). It was ranged from 54.27 grams (DH-376) to 114.33 grams (MAI-729) with a mean of 85.79 grams. However, higher cob weight recorded in MAI-729 followed by MAI-105 and DH-371 while, lowest cob weight was noticed in DH-376.

Significant differences were observed among parental lines of promising maize hybrids for number of rows per cob. The number of rows per cob ranged from 11.33 (DH-388 and DH-376) to 16.67 (CAL-1443) with a mean of 13.78. Similarly, the trait number of kernels per row also differed significantly among parental lines. The number of kernels per row was ranged from 16.33 (DH-376) to 23.94 (MAI-729) with a mean of 19.44 (Table 2).

Wietholter *et al.* (2008) concluded that, the traits contributed majorly to the classification of Brazilian corn landraces were plant height, ear insertion, female flowering, male flowering and kernel row number per ear, cob length and cob diameter. Though both qualitative and quantitative characters could be a better descriptive for grouping the maize genotypes, but high heritable traits are much useful in selection of inbreds for further breeding programme. Similar results were in line with Shashibhaskar (2015) in maize, Madhukeshwara and Sajjan (2015) in maize and Arjun *et al.* (2021) in white maize.

Seed yield per cob and seed yield per hectare showed significant differences among the parental lines of promising maize hybrids (Table 2). Among parental lines, MAI-729 lines showed highest seed yield per cob and seed yield per hectare (94.61 g and 45.71 q ha^{-1}, respectively) which was followed by MAI-105. Whereas lower seed yield per cob and

Table 2

Mean performance of parental lines of maize hybrids for yield parameters

Parental lines	Cob weight (g)	Number of rows per cob	Number of kernels per row	Seed yield per cob (g)	Seed yield (q ha^{-1})
P_1 : MAI-729	114.33	15.45	23.94	94.61	45.71
P_2 : MAI-105	113.44	16.58	20.67	90.08	43.37
P_3 : NAI-137	93.40	14.73	22.07	72.60	37.96
P_4 : SKV-50	71.33	12.72	16.39	58.72	28.94
P_5 : CAL-1443	80.67	16.67	21.00	66.33	30.96
P_6 : CML-451	86.67	14.67	17.33	69.67	33.54
P_7 : DH-388	63.60	11.33	16.67	53.33	24.63
P_8 : DH-376	54.27	11.33	16.33	43.00	17.89
P_9 : DH-371	106.82	12.67	23.00	90.00	38.25
P_{10} : DH-545	73.33	11.67	17.00	63.67	23.21
Mean	85.79	13.78	19.44	70.20	32.45
SEm±	3.96	0.62	1.37	3.39	1.66
CD(P= 0.05)	11.87	1.85	4.11	10.15	4.97

seed yield per hectare was recorded in DH-376 (43.00 g and 17.89 q ha^{-1}).

The variation in the yield potential is probably due to the diverse background of parental lines (Fig. 1). Positive and significant association of cob weight and hundred seed weight contribute to more seed yield. The significant positive correlation between seed yield to hundred seed weight and cob weight implies that the selection of these traits is important to improve the seed yield of the parental lines (Prasad and Shrestha, 2020). The above findings were in accordance with Daniel (2014) and Dhakal *et al.* (2017) in maize genotypes.

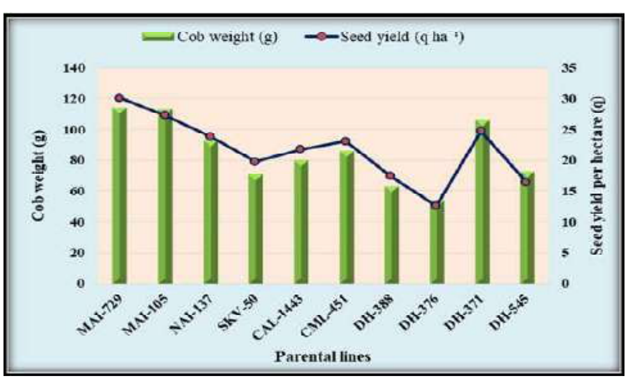

Fig. 1: Variation of cob weight (g) and seed yield (q ha^{-1}) in parental lines of maize hybrids

Seed Quality Parameters

Hundred seed weight is one of the important distinguishing features used by several scientists to differentiate several crop varieties. The study revealed that hundred seed weight was differed significantly among the parental lines (Table 3). Significantly higher hundred seed weight was observed in MAI-729 (29.11 g) followed by NAI-137, CAL-1443 and CML-451. Whereas lower hundred seed weight was observed in DH-376 (19.18 g). The variation among the parental lines might be due to inherent genotypic differential conditions that had existed during the crop growth, seed development and maturation stage. The genotypic variation in hundred seed weight may also be due to the reserved food material accumulated in the genotypes. Similar pattern of classification was reported earlier by Pinnisch *et al.* (2012) in maize and Bhusal *et al.* (2017) in sorghum.

Among the parental lines no significant differences were observed for seed germination percentage. The seed germination percentage ranged from 91.33 to 98.33 with a mean of 95.93 per cent (Table 3). However maximum seed germination percentage

TABLE 3

Mean performance of parental lines of maize hybrids for seed quality parameters

Parental lines	Hundred seed weight (g)	Germination (%)	Shoot length (cm)	Root length (cm)	Mean seedling length (cm)	Seedling dry weight (mg)	Seedling vigour Index-I	Seedling vigour Index-II	Electrical conductivity of seed leachate (μSm^{-1})
P_1 : MAI-729	29.11	98.33	17.07	19.03	36.10	78.03	3550	7673	188.00
P_2 : MAI-105	24.75	97.33	16.03	18.00	34.03	73.20	3313	7125	217.15
P_3 : NAI-137	27.63	97.67	16.56	18.41	34.97	74.60	3415	7286	198.14
P_4 : SKV-50	22.71	96.00	14.60	16.86	31.46	65.72	3020	6309	231.71
P_5 : CAL-1443	27.54	97.00	16.20	18.11	34.31	67.00	3338	6499	219.59
P_6 : CML-451	28.12	97.00	16.34	18.28	34.62	76.40	3358	7411	244.84
P_7 : DH-388	21.46	94.33	14.80	15.67	30.47	64.28	2874	6064	277.33
P_8 : DH-376	19.18	91.33	13.16	16.35	29.52	63.12	2696	5765	317.33
P_9 : DH-371	24.72	96.00	15.47	17.21	32.68	73.28	3137	7035	239.83
P_{10} : DH-545	20.60	94.33	13.76	16.46	30.22	63.60	2851	6000	295.49
Mean	24.58	95.93	15.40	17.44	32.84	69.92	3154	6717	242.94
SEm±	0.67	1.89	0.42	0.47	0.63	1.66	84.44	161.54	5.54
CD(P=0.05)	1.97	NS	1.23	1.38	1.84	4.90	249.09	476.55	16.33

was observed in MAI-729 (98.33%) and minimum seed germination percentage was observed in DH-376 (91.33%). This is due to increase in activity of enzymes such as amylase, protease and lipase which have great role in breakdown of macromolecules for growth and development of embryo that ultimately resulted in higher seedling emergence. Similar findings were reported by Hidayat *et al.* (2008) and Manjunatha *et al.* (2018) in maize genotypes.

Significant differences were observed among the parental lines of promising maize hybrids for shoot, root and mean seedling length (Table 3). The results showed that highest shoot, root and mean seedling length was recorded in MAI-729 (17.07, 19.03 and 36.10 cm, respectively) which was followed by NAI-137, CAL-1443 and CML-451. Whereas lowest shoot, root and mean seedling length was recorded in DH-376 (13.16, 16.35 and 29.52 cm, respectively).

Mean seedling dry weight was differed significantly among the parental lines (Table 3). Higher mean seedling dry weight was observed in MAI-729 (78.03 mg) which was followed by MAI-105, NAI-137 and CML-451 and lower seedling dry weight was observed in DH-376 (63.12 mg).

Among the parental lines significant differences were observed for seedling vigour index I and II (Table 3 and Fig. 2). Significantly higher seedling vigour index-I and II was recorded in MAI-729 (3550 and 7673, respectively) and lower seedling vigour index-I and II was recorded in DH-376 (2696 and 5765, respectively).

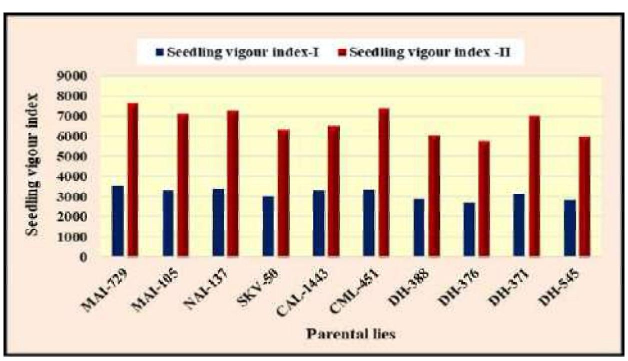

Fig. 2 : Variation of seedling vigour index-I and II in parental lines of maize hybrids

Significant variation was found among parental lines for seed quality parameters *viz.,* shoot, root and mean seedling length, seedling dry weight and seed vigour index except germination percentage. Variation among the parental lines might be due to accumulation reserve food material *viz.* carbohydrates, protein and soluble sugars that existed during seed formation, development and maturation stage. The mean seedling length, seedling dry weight and seedling vigour index were all positively correlated with hundred seed weight. Similar findings were reported by Ahammad *et al.* (2014), Anil Kumar (2018) and Vijay Lakshmi and Siddaraju (2021) in maize.

Electrical conductivity of seed leachate was differed significantly among the parental lines of promising maize hybrids (Table 3). The results revealed that MAI-729 recorded significantly lower electrical conductivity of seed leachate (188.00 μSm^{-1}) and higher electrical conductivity of seed leachate was recorded in DH-376 (317.33 μSm^{-1}). The reduction in the value of electrical conductivity of seed leachate with diversity of parental lines or genotypes may be because of critical maintains of structural integrity and cell membranes permeability. The results were in accordance with the findings of Kiran and Channakeshava (2018) and Omar *et al.* (2022) in maize.

Based on the above experimental results, it can be inferred that MAI-729 is the better performer among the parental lines in terms of growth, higher seed yield and good quality aspects. Therefore, it was suggested that study of phenological characters would be most supporter for selection of parental lines in breeding and seed production programmes.

References

Ahammad, K. U., Rahman, M. M. and Ali. M. R., 2014, Effect of hydropriming method on maize (*Zea mays* L.) seedling emergence. *Bangladesh J. Agric. Res.,* **39** (1) : 143 - 150.

Anil Kumar, G. S., 2018, Staggering and optimization of planting ratios to maximize the seed yield and quality of single cross hybrid maize MAH-14-5 (*Zea mays* L.).

M. Sc. Thesis, Univ. Agric. Sci., Bangalore, Karnataka, India.

Arjun, B., Ankit, S., Pandey, U., Mausami, R., Manoj, K. and Shrestha, J., 2021, Evaluation of white grain maize varieties for growth, yield and yield components. *J. Agric. Natural Res.,* **4** (1) : 265 - 272.

Bhusal, N., Pahuja, S. K. Akshay Kumar, V., Srivastava, A. and Ravi Kumar, 2017, Morphological characterization of forage sorghum genotypes for its various DUS traits. *J. Appl & Natural Sci.,* **9** (2) : 912 - 919.

Chakravarthy, K. S. and Jagannathan, R., 2014, Phenological studies on five maize hybrids under higher nitrogen levels in western zone of Tamil Nadu. *Madras Agric. J.,* **101** (7 - 9) : 235 - 238.

Daniel, T., 2014, Evaluation of improved maize genotypes for grain yield and yield components in Chilga district, North Western Ethiopia. *Int. J. Sci. Res.,* **3** (10) : 1362-1364.

Dhakal, B., Keshav, P. S., Joshi, B. P. and Jiban, S., 2017, Evaluation of early maize genotypes for grain yield and agro morphological traits. *J. Maize Res. Develop.,* **3** (1) : 67 - 76.

Directorate of Economics and Statistics (DES), Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare. Retrieved March, 2021, from https://www.india.gov.in/official-website-directorate-economics-and-statistics

Food and Agriculture Organization (FAO), FAOSTAT: Suite of Food Security Indicators. Retrieved July 2020, from https://www.fao.org/faostat/en/#data/FS

Hidayat, U. R., Sajid, A., Syed, M. A. S., Syed, S. S., Naveed, U. R., Amin, I. K., Hussain, I. and Fehmida, A., 2008, Diversity for morphological and maturity traits in maize populations from upper dir. *Sarhad J. Agric.,* **24** (3) : 2007 - 2011.

Ibrahim, A. K. and Mukhtar, Y., 2016, Evaluation of the performance of maize genotypes (*Zea mays* L.) for yield and other agronomic traits. *Bayero J. Pune and Appl. Sci.,* **9** (2) : 61 - 65.

International Rules for Seed Testing (ISTA). Retrieved January 1, 2019, from https://doi.org/10.15258/istarules.2019.F

Kiran, S. P. and Channakeshava, B. C., 2017, Influence of seed treatments and foliar spray on crop growth and seed yield in maize hybrid (*Zea mays* L.) - Hema. *Mysore J. Agric. Sci.,* **51** (3) : 644 - 649.

Madhukeshwara, B. P. and Sajjan, A., 2015, Morphometric characterization of maize hybrids and their parents using dus guidelines. *I-scholar,* **6** (2) : 178 - 182.

Manjunatha, B., Niranjana, K. and Jagadesh, G. B., 2018, Performance evaluation of maize hybrids (*Zea mays* L.). *Int. J. Curr. Microbiol. App. Sci.,* **7** (11) : 1198 - 1203.

Omar, S., Tarnawa, A., Kende, Z., Ghani, R. A., Kassai, M. K. and Jolankai, M., 2022, Germination characteristics of different maize inbred hybrids and their parental lines. *Cereal Res. Communi.,* pp. : 1 - 8.

Pinnisch, R., Mowers, R., Trumpy, H., Walejko, R. and Bush, D., 2012, Evaluation of maize (*Zea mays* L.) inbred lines for yield component traits and kernel morphology. *Maydica,* **57** (2) : 1 - 5.

Prasad, K. B. and Shrestha, K., 2020, Performance evaluation of maize hybrids in inner-plains of Nepal. *Heliyon.,* **6** : 1 - 6.

Sharma, V., Bhushan, A., Deepak, K., Mishra, S. and Kumar., R., 2020, Single cross hybrid of QPM maize seed production as influenced by row ratio and spacing in north western Himalayan region. *Int. J. Curr. Microbiol. App. Sci.,* **9** (8) : 1491 - 1496.

Shashibhaskar, M. S., 2015, Investigation on seed production techonology for single cross maize hybrids (*Zea mays* L.). *Ph.D. Thesis,* Univ. Agric. Sci., Bangalore, Karnataka, India.

Vijayalakshmi, N. and Siddaraju, R., 2021, Optimization of spacing and mother plant nutrition on growth potential of parental lines of maize hybrid MAH-14-5. *The Pharma Innovation J.,* **10** (4) : 581 - 586.

Wietholter, P., Melo Sereno, M. J., De Freitas Terra, T., Silva, D. A. E., Delmar, S. and Barbosa, J., 2008, Genetic variability in corn landraces from Southern Brazil. *Maydica*, **53** (2) : 151 - 159.