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Influence of age of seedling and varieties on dry matter, yield, quality and economics of transplanted *rabi* maize

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Abstract
Field experiment was conducted at College Agronomy Farm, B. A. College of Agriculture, Anand Agriculture University, Anand during 2015-2016 to study the influence of age of seedling and varieties on dry matter, yield, quality and economics of transplanted *rabi* maize. The experiment was consisted of two varieties *viz.,* Gujarat Maize 3 (GM 3) and High Quality Protein Maize (HQPM 1) and five age of seedling *viz.,* 14, 21, 28, 35 and 42 day old seedling. Results revealed that the highest dry matter accumulation (30.59 g plant^{-1}), dry root biomass (6.54 g plant^{-1}), grain (2447 kg ha^{-1}) and straw yield (3728 kg ha^{-1}.) were recorded under variety V_2 (HQPM 1). Protein content (11.53%) of grains was recorded significantly the highest under variety V_1 (GM 3). Among all the age of seedling, treatment A_5 recorded significantly the highest dry matter accumulation (31.25 g plant^{-1}) and lodging per cent (2.16) while treatment A_2 recorded significantly higher root length (cm), dry root biomass (g plant^{-1}), harvest index, protein content, grain yield (2963 kg ha^{-1}), straw yield (4210 kg ha^{-1}), net realization (Rs. 11094 ha^{-1}) and benefit cost ratio of 1.39 as compared to treatment A_5. Among all the treatment combinations, treatment combination V_2A_2 recorded significantly higher grain (3405 kg ha^{-1}), straw yield (4887 kg ha^{-1}), net realization (Rs. 26246 ha^{-1}) and benefit cost ratio (1.91) as compared to rest of the treatment combinations.

Keywords: Transplanted maize, age of seedling, variety, yield, quality, harvest index

Introduction
Globally, maize is known as queen of cereals because it has the highest genetic yield potential among the cereals. The productivity of maize is very high because of its C_4 nature, it is very efficient in converting solar energy into production of dry matter. The crop has high genetic yield potential hence, it is called miracle crop and "Queen of Cereals". Maize is primarily used as feed for livestock and poultry and a considerable portion of grains and green cobs is used for human consumption. The demand of maize is thus, rapidly increasing day by day in the India and even worldwide.

Maize is mainly sown directly through seed by using different methods of tillage and establishment. Ideal sowing time of *rabi* maize also lies in last week of October to mid November in Gujarat but during winters where fields are not remain vacant in time (till November). Delayed germination and plant growth receives a major setback due to late sowing of maize. Transplanting provides maximum stand establishment, early flowering, maximum biomass production and more grain yield as compared to direct seeding. Biswas (2008) [3] observed that maize transplanted at 14 and 21 days old seedling produced statistically similar grain yields. Therefore, transplanting of seedling may be an important area of study for maize cultivation considering the field duration and early plant establishment in Gujarat. Keeping the above facts, the present field experiment was carried out to know the influence of age of seedling and varieties on dry matter, yield, quality and economics of transplanted *rabi* maize.

Materials and Methods
A field experiment was conducted during *rabi* season of the year 2015-16 at College Agronomy Farm, Anand Agriculture University, Anand. The soil of the experiment field was loamy sand (Goradu) having 8.35 pH, 0.43 organic carbon, 217.42 kg/ha, available N, 45.72 kg/ha, available P_2O_5 and 256.69 kg/ha available K_2O. Average annual rainfall of 864.5 mm, which is realized entirely from the south-west monsoon currents. The maximum temperature ranged between 25.3 to 39.7 ˚C and minimum temperature ranged between 6.6 to 24.8 ˚C

during the crop season. The experiment was consisted of 10 treatment combinations with two factors studied under factorial randomized block design with four replications. The factor one with two varieties (V_1: GM 3 and V_2: HQPM 1) and second factor with five different age of seedling (A_1: two weeks old seedling, A_2: three weeks old seedling, A_3: four weeks old seedling, A_4: five weeks old seedling and A_5: six weeks old seedling). The seedlings of both the variety were raised in the nursery. The plot was kept ready through tractor drawn cultivator for preparing nursery beds. The five beds of 4 m long and 2.5 m wide were prepared. 500 kg of FYM applied to the beds and beds were leveled perfectly. The seeds were sown in line keeping the 20 cm apart and covered with soil. The nursery was raised on different dates 09/11/2015, 16/11/2015, 23/11/2015, 30/11/2015 and 07/12/2015 as per the requirement of age of seedling i.e. two weeks, three weeks, four weeks, five weeks and six weeks old seedlings. The seedling of both the varieties GM 3 and HQPM 1 of different age were used for transplanting as per the treatments. The seedlings were transplanted as per the 60 cm × 20 cm spacing in each plot. The first light irrigation was given to the crop before transplanting for better establishment. One healthy seedling was transplanted at each hill. The maize crop was fertilized with recommended dose of fertilizer (120:60:00 kg N, P_2O_5 and 20 kg $ZnSO_4$ ha^{-1}). Total quantity of phosphorus, zinc and 50 per cent of the nitrogen was applied in the soil at the time of transplanting. At 25-30 DATP, top dressed 25 per cent of the nitrogen. The remaining 25 per cent nitrogen top dressed at 40-45 DATP. The N was supplied through urea and P was supplied through DAP while zinc was supplied through Zinc sulphate. In general, different weather parameters were favourable for plant growth during experimental period. The other package of practices was adopted to raise the crop as per the recommendations. In order to represent the plot five plants from each plot selected and labelled and all biometric observations was taken from selected plants. Protein content was measures with the help of Kjeldhal's method as suggested by Jackson (1973) [5]. All the costs formulated during the carrying out farm operation and other input costs were worked out the cost of cultivations for different treatments. Data on various observations during the experiment period was statistically analysed as per the standard procedure developed by Cochran and Cox (1957) [4].

Results and Discussion

Dry matter production is the net resultant effect of different plant metabolic processes. Variety V_2 (HQPM 1) and V_1 (GM 3) recorded significantly the highest and lowest dry matter accumulation (g $plant^{-1}$), respectively. These results are in corroborate with the findings of Adesina *et al*. (2014) [1]. Further, it was observed that age of seedling showed significant influence on dry matter accumulation (g $plant^{-1}$) recorded at 30 DATP wherein, treatment A_5 (Six weeks old seedling) recorded significantly the highest dry matter accumulation (g $plant^{-1}$), while treatment A_1 (Two weeks old seedling) recorded significantly the lowest dry matter accumulation (g $plant^{-1}$). The results are in accordance with the results of Kumar *et al*. (2014) [6]. Moreover, plants transplanted with lesser age seedling resulted in more LAI and root volume which contributed towards increased source-sink relationship within the plants with delayed maturity and resulted in more dry matter accumulation. Further, it was noticed that treatment A_3 (Four weeks old seedling), A_4 (Five weeks old seedling) and A_5 (Six weeks old seedling) statistically comparable with each other and found to be significantly superior over treatment A_1 and A_2 with respect to dry matter accumulation (g $plant^{-1}$).

Different varieties and age of seedling on root length (cm) measured at 30 DATP showed non-significant differences. The values of root length (cm) under treatments V_1 and V_2 were 11.25 and 11.90 at 30 DATP, respectively. Root length development was significantly faster under treatment A_2 (Three weeks old seedling) as compared to treatment A_5 (Six weeks old seedling), while treatment A_5 (Six weeks old seedling) recorded significantly the lowest root length (cm) at 30 DATP. The results support the findings of previous worker Adesina *et al*. (2014) [1]. Moreover, treatment A_1 (Two weeks old seedling), treatment A_2 (Three weeks old seedling), A_3 (Four weeks old seedling) and A_4 (Five weeks old seedling) remain at par with each other but found significantly superior over treatment A_5 (Six weeks old seedling).

Dry root biomass of maize recorded at 30 DATP was found to be significant due to different varieties. Variety V_2 (HQPM 1) registered significantly the highest dry root biomass (g $plant^{-1}$) while treatment V_1 (GM 3) recorded significantly the lowest dry root biomass (g $plant^{-1}$). The marked difference in total root dry matter production among different varieties was also noticed by Adesina *et al*. (2014) [1]. Age of seedling showed significant influence on dry root biomass (g $plant^{-1}$) recorded at 30 DATP wherein, treatment A_2 (Three weeks old seedling) recorded significantly higher dry root biomass (g $plant^{-1}$) as compared to rest of the treatment except treatment A_1 (Two weeks old seedling) and A_3 (Four weeks old seedling) wherein, the later treatment was not differed significantly from treatment A_4 (Five weeks old seedling). The lower root biomass under treatment A_5 might be due to inability of maize roots to regenerate after transplanting of six weeks old seedling resulted in reducing the root dry biomass. This result conforms to the results reported by Agbaje (1988) [2] that dry matter progressively decreases with delayed transplanting time.

Lodging was not remarkably influenced due to different varieties, although the minor variations was noticed. With respect to age of seedling, treatment A_5 (Six weeks old seedling) recorded significantly higher value of lodging per cent as compared to rest of the treatment except treatment A_4 (Five weeks old seedling). However, significant variations in treatment A_1, A_2, A_3 and A_4 were not observed with respect to recording lodging per cent.

Harvest was not influenced due to different varieties, although the minor variation was noticed. The results are in close agreement with the results of Biswas (2008) [3] he also observed non-significant differences in harvest index among the maize varieties. Among all the treatments, treatment A_2 (Three weeks old seedling) recorded significantly the highest value of harvest index. In second line of the results, treatment A_1 (Two weeks old seedling) remained at par with treatment A_3, while later treatment was statistically comparable with treatment A_4 (Five weeks old seedling) and A_5 (Six weeks old seedling) with respect to harvest index. However, significantly lower value of harvest index was recorded under treatment A_5 (Six weeks old seedling) as compared to treatment A_1 (Two weeks old seedling) and A_2 (Three weeks old seedling). Harvest index increased significantly with increased age of seedling was also reported by Biswas (2008) [3].

Significantly maximum protein content was recorded in variety V_1 (GM 3) and lower protein content was recorded in variety V_2 (HQPM 1). The differences in the protein content of grains among maize varieties could be due to genetic

potential of varieties. Varieties V_1 and V_2 recorded protein content of 11.53 and 9.57 per cent, respectively. An examination of data mentioned in Table 1 revealed that different age of seedling showed their significant effect on protein content of maize grain. Treatment A_2 (Three weeks old seedling) recorded significantly higher protein content (11.06) of grain but was at par with treatment A_1 (Two weeks old seedling). Treatment A_1 and A_3 remain at par with each other with respect to protein content of grain but found significantly superior over treatment A_4 (Five weeks old seedling) and A_5 (Six weeks old seedling). Treatment A_5 (Six weeks old seedling) recorded significantly lower protein content (10.07).

Significant differences in grain and straw yield due to different varieties were observed. With respect to grain and straw yields, variety V_2 (HQPM 1) recorded significantly the highest grain yield of 2447 kg ha^{-1} and straw yield of 3728 kg ha^{-1}.Similar line of results was also reported by Mapfumo *et al.* (2007) [7] in pearl millet wherein, they noticed that variety PMV3 out yielded than PMV2 (Table 2). Significantly the highest grain yield (2963 kg ha^{-1}) was registered under treatment A_2 (Three weeks old seedling) while the lowest grain yield (1468 kg ha^{-1}) was recorded under A_5 (Six weeks old seedling) treatment. Similarly, A_2 treatment recorded significantly the highest straw yield (4210 kg ha^{-1}) while lower straw yield (2391 kg ha^{-1}) was observed under treatment A_5.

From the data presented in Table 2 revealed that maximum net realization of Rs. 10258 ha^{-1} with benefit cost ratio of 1.34 was registered under variety V_2 (HQPM 1) while, the lowest net realization Rs. 1324 ha^{-1} with benefit cost ratio of 1.05 was recorded under variety V_1 (GM 3). The highest net realization of ` 20058 ha^{-1} with benefit cost ratio of 1.76 was recorded under treatment A_2 (Three weeks old seedling) followed by treatment A_1 (Two weeks old seedling) with the net realization of Rs. 11418 ha^{-1} and benefit cost ratio of 1.43. The minimum net realization of Rs. 1755 ha^{-1} with benefit cost ratio of 1.07 was recorded under treatment A_4 (Five weeks old seedling). The results are in the conformity with the results reported by Kumar *et al*. (2014) [6]. They reported that 5 weeks old seedling fetched higher net returns and B:C ratio over 6 and 7 weeks old seedling. This might be due to higher productivity from plants which were transplanted with 5 weeks older seedling. However, treatment A_3 (Four weeks old seedling) was found to be superior over treatment A_4 and A_5 with respect to recording higher net realization of Rs. 7323 ha^{-1} with 1.28 BCR value. Treatment A_5 (Six weeks old seedling) recorded negative value of net realization.

Interaction effect

Significantly higher grain yield (3405 kg ha^{-1}) was recorded under treatment combination V_2A_2 (HQPM 1 + Three weeks old seedling) and found to be significantly superior over rest of treatment combinations (Table 3). Treatment combinations V_2A_1 (HQPM 1 + Two weeks old seedling), V_1A_2 (GM 3 + Three weeks old seedling) and V_2A_3 (HQPM 1 + Four weeks old seedling) showed almost comparable effects and recorded significantly higher grain yield as compared to rest of the treatment combinations. Significantly lower grain yield was observed under treatment combination V_1A_5 (GM 3 + Six weeks old seedling) as compared to rest of the treatment combinations barring treatment combinations V_1A_4 (GM 3 + Five weeks old seedling), V_2A_5 (HQPM 1 + Six weeks old seedling) and V_1A_3 (GM 3 + Four weeks old seedling).

Among different treatment combinations, significantly the highest straw yield (4887 kg ha^{-1}) was recorded under treatment combination V_2A_2 (HQPM 1 + Three weeks old seedling). Significantly lower straw yield was observed under treatment combination V_1A_5 (GM 3 +Six weeks old seedling) as compared to rest of the treatment combinations barring treatment combination V_1A_4 (GM 3 + Five weeks old seedling).

Table 1: Dry matter, root biomass and protein content as influenced by different maize varieties and age of seedling

Treatment	Dry matter accumulation (g plant^{-1}) 30 DATP	Root length (cm) 30 DATP	Dry root biomass (g plant^{-1}) 30 DATP	Lodging (%) 40 DATP	Protein Content (%)	Harvest Index (%)
Varieties (V)						
V_1: GM 3	21.65	11.25	5.80	1.62 (2.15)	11.53	36.80
V_2: HQPM 1	30.59	11.90	6.54	1.48 (1.43)	9.57	0.220
S.Em.+	0.72	0.26	0.20	0.13	0.07	NS
C. D. at 5%	2.08	NS	0.57	NS	0.20	37.34
Age of seedling (A)						
A_1: Two weeks	16.29	12.25	6.58	1.22 (0.64)	11.53	37.62
A_2: Three weeks	24.73	12.38	7.01	1.30 (0.98)	48.65	38.47
A_3: Four weeks	28.33	11.50	6.31	1.34 (0.99)	47.94	36.91
A_4: Five weeks	30.01	11.75	5.83	1.73 (2.36)	47.83	36.35
A_5: Six weeks	31.25	10.00	5.13	2.16 (4.00)	47.53	36.01
S.Em. ±	1.13	0.41	0.31	0.21	0.38	0.35
C. D. at 5%	3.28	1.19	0.91	0.61	0.11	1.01
Interaction V x A	NS	NS	NS	NS	0.32	NS
C.V. (%)	12.25	10.03	14.36	38.33	2.96	2.65

*Figures in the parentheses are original values. All Figures are subjected to transformed values to square root ($\sqrt{x + 1}$).

Table 2: Yields and economics as influenced by different maize varieties and age of seedling

Treatment	Grain yield (kg ha^{-1})	Straw Yield (kg ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Gross realization (Rs. ha^{-1})	Net realization (Rs. ha^{-1})	BCR
Varieties (V)						
V_1: GM 3	1844	2778	26811	28135	1324	1.05
V_2: HQPM 1	2447	3728	29596	39854	10258	1.34
S.Em.+	42	63	-	-	-	-
C. D. at 5%	121	183	-	-	-	-
Age of seedling (A)						
A_1: Two weeks	2402	3573	26484	37902	11418	1.43
A_2: Three weeks	2963	4210	26484	46542	20058	1.76
A_3: Four weeks	2129	3268	26484	33807	7323	1.28
A_4: Five weeks	1766	2822	26484	28239	1755	1.07
A_5: Six weeks	1468	2391	26484	23484	-3000	0.89
S.Em. ±	67	99	-	-	-	-
C. D. at 5%	191	284	-	-	-	-
Interaction V x A	Sig.	Sig.	-	-	-	-
C.V. (%)	8.46	8.85	-	-	-	-

Table 3: Grain and straw yields as influenced by interaction effect of different varieties and age of seedling

Yields (kg ha^{-1})										
	Grain	**Straw**	**Grain**	**Straw**	**Grain**	**Straw**	**Grain**	**Straw**	**Grain**	**Straw**
Treatments	**A_1**		**A_2**		**A_3**		**A_4**		**A_5**	
V_1	2169	3259	2521	3533	1691	2620	1427	2282	1310	2094
V_2	2635	3887	3405	4887	2466	3817	2104	3363	1627	2687
	Grain				Straw					
S. Em. ±	93				141					
C. D. at 5%	269				408					
C. V. %	8.46				8.85					

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