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Study on the Morpho-physiological Character of Four Quality Protein of Maize (Corn)

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Abstract

The experiment was conducted to find out the morpho-physiological variability in response to different sowing dates in four lines of Quality Protein Maize (QPM) in in the Field Laboratory of the Department of Crop Botany, Bangladesh Agricultural University, Mymensingh. The study was carried out with four lines of maize and two sowing dates, 15 November (T_1) and 15 December, ((T_2). Sowing date differed significantly in plant height, length of leaf blade, length of leaf sheath, leaf breadth, cob length, cob diameter, length of tassel, days to 50% tasselling, days to 50 % silking, days to maturity, number of cobs per plant, cob weight, number of grain per cob. 1000-seed weight, percent underdeveloped cob, total dry matter and grain yield, but did not differ in number of leaves and protein percent. The lines differed significantly among themselves in those characters except number of leaves per plant, length of leaf sheath, cob length, cob diameter, days to 50% tasselling, number of cobs per plants and number of grain per cob. The line Across 8666 (V_2) and (V_3) gave the highest grain yield 4.57 and 4.55 and the lowest from (V_4) lines 4.41 tons per hectare. The 15 November sowing time (T_1) gave the highest grain yield 4.86 tons per hectare. In case of interaction, the earlier planting time (T_1) showed better performance with all lines. On the other hand, the highest yield was found from combination of line V_2 and V_3 with earlier planting time (T_1).

Key words: Morpho-physiological Character, Maize and Protein Quality

Introduction

Maize (*Zea mays* L.) is one of the most important principal crops of the world. Maize ranks third, following wheat and rice, in the world production of cereal crops. The average yield of maize was 3.2 tons/ha compared to wheat (2.3 tons/ha) and rice cereals is due to its high response to better crop management originating from its superior physiological efficiency (Islam and Kaul, 1986) . It is a C_4 plant and that is why has high (3.02 tons/ha) (FAO, 1994). Higher yield of maize over other production potential for high photosynthetic capacity (Goldsworthy, 1984). Maize is a photo insensitive crop which can be planted at any time of the year. Maize uses nutrients more efficiently due to its deep rooting system and it is more tolerant to drought than rice and wheat. This allows maize grow well under low moisture conditions where rice or wheat may not grow so well. Moreover, maize uses available moisture to produced dry matter more efficiently than rice or wheat (Chrispeels and Sadara, 1977; House,1985). Grain yield potential of maize is almost double of rice or wheat. From the experimental station and farmer's field data and on the basis of available socio-economic surveys, it has been observed that maize yield may vary from 1 to 10 tons/ha in Bangladesh (ADAB, 1979; BARC, 1985; BARI, 1985; Mohammad, 1985). The fresh yield potential of maize makes the crop more profitable than any other cereal grown in the country. Bangladesh is predominantly a rice producing country. But production of rice is not sufficient enough to nourish her over growing population. In Bangladesh, maize covers an area, 8000 acres with a production of 3000 metric tons (BBS, 1994). Actually potential area for maize cultivation are much more higher than the present areas because of congenial environment for production. So, there is an ample scope for increasing maize production in this country. The increase in production per unit area of a crop is influenced by many factors; varieties, date of planting, number of plant population per unit area etc. are some of the very important ones. It needs much attention to find out the better variety and optimum date of planting for the maximum yield of maize. As maize is a photo insensitive crop, it can be cultivated round the year for its wider adaptability to the climate of Bangladesh. With this end in view the present piece of work was undertaken to find out the effects of different sowing dates on the morpho-physiological characters of four lines of quality protein maize (QPM).

Materials and Methods

The experiment was conducted at the Field Laboratory of the Department of Crop Botany, Bangladesh Agricultural University (BAU), Mymensingh. The experiment site is located at 20°N latitude and 91°E longitude, having an altitude of 8.3 m. The experimental plots were previously cropped with rice and wheat in the preceding kharif and robi seasons. After final land preparation on 1st November with cow dung at the rate of 5 t/ha. The land was finally prepared on the 15 November by repeated ploughing and laddering for planting maize. There were two factors of this experiment. Factor A: seeds of four lines of QPM (Quality Protein Maize were collected from Crop Botany Department, Bangladesh Agricultural University (BAU), Mymensingh and Factor B: two different planting times like 15 November (T_1) and 15 December (T_2) . These were the four Mexican lines of QPM. The QPM lines are called as- (1) V_1 = Poza Rica (1) 8763 , (2) V_2 = Across-8666, (3) V_3 = Across 8565 and (4) V_4 = Pooh 15Q.The experiment was fitted in the split plot design with lines in the main plot and time of sowing/planting in the sub plot with three replications. The size of the individua1l plot was 20 m^2 (5m × 4m). The first sowing was done on the 15 November in 12 plots. The hole was opened by a bamboo stick at a desired distance and one seed was placed in each hill.

The seeds were sown in lines at 75 x 50 cm spacing. The seeds were placed at a depth of approximately 1 inch from the soil surface. Second planting was done on 15th December. After that, crop was taken care by following different intercultural operations like weeding, earthling up, following the same procedure. Irrigation etc. as necessary. Data from 10 randomly selected plants from the middle of each plot on individual plant basis were recorded in order to avoid boarder effect. Data were collected on plant height, leaves per plant, length of leaf blade (cm), length of leaf sheath, leaf breadth. Also days to 50% tasselling and days to 50% silking were counted. Also days were recorded for maturity and at that number of cobs per plant, length of tassel, cob length, cob diameter, cob weight, Grains per cob, 1000-seed weight, percent underdeveloped cobs, total dry matter, percent protein in grains and Grain yield (ton/ha). The protein was conducted by Micro Kjeldahl Method (AOAC, 1980). Means, analysis of variance and F-test and test of significant (Duncan's New Multiple range test) for mean values for each characters were done after Steel and Torrie (1960). Data on LAI, CGR and NAR were transformed by angular transformation during analysis of variance.

Results and Discussions

Mostly all the morpho-physiological characters were significantly different due to the influence of sowing dates under study.

Plant height

Plant height showed significant variation in lines, treatments and their interactions at 5%, 1% and 5% level of probability respectively. Results revealed from Table 1, column 2 that the best time for sowing of Quality protein maize was 15^{th} November when weather remains warm with maximum and minimum temperatures around 29 to 16^0C. Plant height declined significantly as the sowing was delayed beyond November. The plant heights were reduced by 141.02 cm with delayed sowing on 15^{th} December. V_1 {Poza Rica (1) 8763} was found to be superior to other three QPM lines and the plant height was 188.40c, whereas the lowest plant height was in V_4(Posh 15 Q) (1815.03 cm) and other two lines produced medium plant height. The interactions between lines and; treatments were found to be different beyond 5% level of significant. Among the interactions, both the V_2T_1 and V_1T_1 produced the highest plant height and they were found statistically identical. Lowest plant height was obtained by V_2T_2, although it did not vary significantly with V_3T_2 and V_1T_1. In second sowing (15 December) vegetative growth was retarded by long nights and short days. This observation was in full agreement with that of Martin *et al.* (1976), Lourenco and Carolino (1990) and Sandhu and Hundal (1991) who reported similar results in maize.

Number of leaves per plant

The mean values n number of leaves per plant are shown in Table 1, in column 3. From this table it was observed that the treatments, lines and the interactions between them did not produce any significant variation. Results revealed that the highest of leaves per plant was observe by T_1 (13.80) followed by T_2 (13.50). Lines were found in significant in number leaves per plant. However, the highest number of leaves per plant was attained by V_1 (13.73). All the interactions between treatments and lines, were found insignificant and they did not produce any variations in number of leaves per plant significantly. The results have shown that delayed sowing decreased in leaf number. This observation confirmed those of Lourenco and Carolino (1990).

Length of leaf blade

Length of blade showed highly significant variation in line, treatments and their interactions at 1% level of probability (Table 1, column 4). Treatment T_1 (85.76 cm) produced significantly longest leaf blade compared to T_2 (73.73 cm). As regards performance of lines, V_2 (Across 8666) gave the highest length of leaf blade (83.47 cm) followed by V_1 and V_4. The significantly lowest length of leaf blade (73.37 cm) was produced by V_3. All the interactions were highly significant at 1%level of probability. V_2T_1 showed the highest mean value (92.40 cm) and the lowest was 71.07 in V_3T_2. The delayed sowing (15 December) decreased the length of leaf blade. This observation was in close similarity with that of Martin *et al.* (1976) who reported a retarded vegetative growth during winter in maize.

Length of leaf sheath

Data on length of leaf sheath is presented in Table 1, in column 5. From this table, it was observed that the treatment T_1 and T_2 produced significant variations but the lines and the interactions between line and treatments did not produce any significant variation. Treatments produced significant variations in length of leaf sheath. Early sowing (15 November) was found better than late sowing (15 December) in respect of leaf sheath length. Early sowing (15 November) showed the highest length of leaf sheath (18.35 cm) and the late sowing (15 December) gave the lowest leaf sheath length (17.25 cm). Line effect was found insignificant in producing leaf sheath length. Interaction between lines and treatments were also found insignificant.. They did not produce any variation in leaf sheath length significantly. The variation in length of leaf sheath produced by T_1 (15 November) and T_2 (15 December) treatments have not been referenced with any work for non-availability of the relevant literature. However, from the study, it was revealed that the plants sown on 15 November produced the highest length of leaf sheath may be due to the favourable climatic factors, particularly the temperature.

Leaf breadth

Data on leaf breadth along with their mean values are presented in Table 1, in column 6. Both the treatments and the lines were found significant but the interactions of them were significant. From this table it was observed that T_1 produced the greatest leaf breadth (10.03 cm) compared to T_2 (9.49 cm) plants. As regards line performance, V_2 produced the highest leaf breadth

(10.3 cm) followed by V_1 and V_3. Line V_4 produced the lowest leaf breadth (9.50 cm). All the interactions between line and treatments were found insignificant and they did not give any significant variation in leaf breadth. The effect in leaf breadth produced by T_1 (15 November) and T_2 (15 December) treatments has not been referenced with any work for non-availability of the relevant literature. From the close observation of this work it was revealed that the T_1 plants gave the greatest leaf breadth than T_2 may be due to the favourable climatic factors particularly temperature.

Length of cob

The data on cob length are shown in Table 1, in column 7. The cob length was greatly influenced by the treatments. T_1 produced the significantly longest cob (21.48 cm) followed by T_2 (18.14 cm). Line did not produce any significant variation in cob length. Among the interactions between treatments and lines, line V_l and V_2 sown on 15 November produced the longest cob and they were found statistically identical. The second longest cob was obtained by V_3 and V_2 sown on the same time (15 November). But the same line (V_3) produced the smallest length of cob sown on 15 December (V_3T_2) and was found statistically identical to V_4T_2 and V_2T_2. 15 November sowing was found better producing maximum length of cob than 15 December sowing. Similar result was reported by Goldson (1963). The observation on cob length was in close similarity with that of Sandhu and Hundal (1991) who observed decreased cob length in delayed sowing.

Diameter of cob

The mean values of diameter of cob are shown in Table 1, in column 8. From this table was observed that the treatment alone produced significant variations but the line and the interactions between them did not produce any significant variation. It was found that the greatest diameter of cob was produced by T_1 (4.27 cm) followed by T_2 (3.58 cm). Lines were found insignificant in diameter of the cob. However, maximum diameter was attained by V_1 (4.08 cm). The variation in diameter of cob produced by T_l (15 November) and T_2 (15 December) treatments has not been referenced with any work for non-availability of the relevant literature.

Length of tassel

Data on length of tassel along with their mean values are presented in Table 1, in column 9. From the table it was observed that the treatments and the lines produced significant variations in length of tassel but the interactions of them did not produce any significant effect. It was observed that the treatment T_1 produced the highest length of tassel (30,35) and T_2 produced the second highest length (28.42 cm). Among the lines, produced statistically highest significant effect in length of tassel (29.83 cm) although it was statistically identical to V_3 (29.63). The lowest length of tassel was produced by the line V_1 (28.05 cm). The present observation on length of tassel was in close similarity with that of Martin *et al.* (1976).

Days to 50% tasselling

The data on days to 50% tasselling are sown in table 3, in column 11. From this table it was found that the treatments and the interactions between treatments and lines produced statistically significant effect but the lines did not produce any variation in days to 50% tasselling. From this table it was observed that T_1 produced the highest days to tasselling (64.08 days) followed by T_2 (49.67 days). Among the interactions between treatments and lines, line V_1, V_2 and V_4 sown on 15 November produced the highest days to 50% tasselling and they were found statistically identical. The lowest days to 50% tasselling was obtained by V, sown on 15 November. But the line V_1 and V_3 produced the lowest, days to 50% tasselling sown on 15 December. It was found statistically identical to V_1T_7 and V_3T_2. These results confirmed those of Narwal *et al.* (1986) and Lourenco and Carolino (1990). This observation was also in close similarity with that of Sandhu and Hundal (1991) who reported the crop emerged 4-7 days earlier when was sown in the first week of December and came to tasselling 7-10 days earlier when was sown in the first to third week of November.

Days to 50% silking

The mean values on days to 50% silking are shown in Table 3, in column 12, From this table it was observed that the treatments, lines and interactions produced significant variations in days to 50% silking. T_1 produced the highest silking (68.67 days) compared to T_2 (55.60 days). As regards line performance, V_2 produced the highest days to 50% silking (63.17 days) followed by (62.17 days) and V (61.00 days). Line V_l produced the lowest days to silking (60.00 days) . Among the interactions between lines and treatments, line V_2 and V_1 sown on 15 November produced the highest days to 50% silking and they were found statistically identical (Fig. 3). The second highest days to silking was obtained by V_3 and V_4 sown on same time (15 November). But all the lines produced the lowest days to silking sown on 15 December and it was found statistically identical. It happened because after the seedling emergence the seedlings of early sowing (15 November) experienced cool temperature of 15°C for a longer period (5-8 weeks) than late sowing (3 weeks), which restricted the crop growth and thereby delayed the silking in the early sowing. These results were found similar with those o Narwal *et a1.* (1986) and Lourenco and Carolino (1990). Silking in all sowing occurred about a week after tasselling, owing to identical warm weather conditions during this period.

Days to maturity

Data on days to maturity are shown in Table 3, in column 13. From this table it was observed that the treatments, lines and the interactions between lines and treatments were statistically highly significant in days to maturity. Treatment T_1 required the highest days to maturity (108.67 days) while the T_2 required the lowest (95.33 days). Among the lines, V_2 required statistically highest significant effect in days to maturity (103.17) although it was statistically identical to V_4 (102.17).

The lowest maturity was required in V_3 (101.00). Interactions between lines and treatments, the highest days to maturity was required in V_2T_1 (110.00 days) although it was statistically identical to V_1T_1 (109.33) and V_3T_1 (108.22). The lowest days to maturity was required in V_1T_2 (94.00). Present study revealed that four lines of QPM took more days nor maturity in first sowing (15 November) than in second sowing (15 December) because of low temperature during this phase in second sowing, that was reported by Singh *et al.*(1990). QPM sown on 15 December, matured 13 days earlier than that sown on 15 November, because the former sowing took fewer days for tasselling and silking than the later. It may be due to the fact that after the seedlings emergence the seedlings of November sowing experienced cool temperature for a longer periods than the seedlings of 15 December sowing which might resulted in a delayed tasselling and silking. The result confirmed those of Narwal *et al.* (1986). Shaw and Thom (1951) also reported that interval from seedling emergence to tasselling determines the time of maize maturity.

Number of cobs per plant

The mean values on number of cobs per plant are shown in fable 3, in column 14. From this table it was observed that all the treatment, were found significant but the lines and the interactions between lines and treatments did not produce variation significantly. The highest number of cobs per plant was produced by T_1 (1.91) and the lowest was by T_2 (1.18). Lines did not produce any significant variation in number of cobs per plant. However, the highest number of cobs per plant was achieved by V_2 (1.57), followed by V_3 (1.55), V_4 (1.53) and V_1 (1.52). Interactions between lines and treatments, were found insignificant and they did not produce any variation in number of cobs per plant. From the present study it was observed that QPM sown on 15 November produced the highest number of cobs per plant due to optimum sowing conditions. Nayak *et al.* (1981) also reported that first fortnight of November produced maximum number of cobs per plant.

Cob weight

The mean values on cob weight are shown in Table 3, in column 15. From the table it was observed that the treatments, lines and interactions were statistically significant in cob weights. T_l produced the highest cob weight (171.21 g) compared to T_2 plants (164.28 g). As regards line performance, $V_{,2}$ produced the highest cob weight (169.40 g) followed by V_1 (167.82 g). Line V_4 and V_3 produced the lowest cob weights 167.25 g and 166.52 g respectively and they were found statistically identical to V_2 and V_1. From all the interactions between lines and treatments, it was found that V_zT_1 produced the highest cob weight (172.60 g) followed by V_2T_1 (171.50 g), V_1T_1 (1970. 47 g) and V_4T_1 (170.27 g). The lowest cob weight was produced by V_3T_2 (160.43g). V_1T_2, V_2T_2 and V_4T_2 produced 165.17g, 167.30g and 164.23g, respectively. This observation was in full agreement with that of Nandal and Agarwal (1989) who observed decreased cob weight in delayed sowing.

Number of grains per cob

The mean values on the number of grains per cob are shown in Table 3, in column 16. From this table it was observed that the treatments and the interactions between treatments and lines were significant but the line did not produce any significant variation in number of grains per cob. Treatment T_1 produced the highest number of grains per cob (415.54) while T_2 produced the lowest (404.86). As regards lines, they did not produce any significant variation and they were found statistically insignificant in producing grains per cob. Among the interactions between the lines and treatments, highest number of grains per cob were produced by V_3T_1 (420.40) although it was statistically identical to V_1T_1, V_1T_2, V_2T_1 and V_4T_2. Lowest number of grains per cob were produced by V_3T_2 (393.30). Present observations revealed that the late sowing decreased crop growth rate during grain filling because of low radiation use efficiency and low incident radiation. Late sowing (15 December) affected grain yield by decreasing grain number per cob which was also reported by Cirilo *et al*. (1994) and Nandal and Agarwal (1989).

1000-seed weight

The mean values on 1000-seed weight are shown in Table 3, in column 17. From this table it was observed that the treatments, lines and interactions were produced significant variations in 1000-seed weight. T_2 produced the highest weight (290.56 g) compared to T_l plant (171.84 g). As regards line performance, V_1 produced the highest 1000-seed weight (313.45 g). The second highest 1000-seed weight was obtained by V_2 (290.60 g). Line V_4 produced the lowest 1000-seed weight (257.77g). Among the interactions between treatments and lines, it was found that V_1T_1 produced the highest 1000-seed weight (321x30 g)although it was statistically identical to V_1T_2 and V_2T_2. Lowest 1000-seed weight were produced by V_4T_1 (233.80 g). The treatments V_2T_I and V_4T_2 produced 278.83 g and 281.73 g 1000-seed weight respectively. V_3T_2 produced 272.53 g 1000-seed weight whereas produced 253.43 g. These results might be due to increased moisture content in second sowing. The grain moisture content at harvest period increased from the first to the last sowing. These results have conformity with the findings of Narwal *et al.* (1986), Kolcar and Vindenovic (1988), Lourenco and Carolino (1990) and Shumway and Cothren (1992).

Percent underdeveloped cob

Data on percent of underdeveloped cob are shown in Table 3, in column 18. From this table it was observed that treatments and lines were found significant but the interactions were found insignificant. T_1 plants produced the highest percent underdeveloped cob (4.77) compared to T_2 plants (4.13). As regards lanes performance, V_1 produced the highest percent of underdeveloped cobs (4.65%) followed by V_2 and V_3. Line V_4 produced the lowest percent underdeveloped cobs (4.35%). Among the interactions between treatments and line were found insignificant and they did not give any significant variation in percent underdeveloped cob.

Total dry matter

The mean values on total dry matter are shown in table 3, in column 19. From this table it was observed that it he treatments and lines produced significant variations but the interactions between them did not produce any significant variation. T_1 plants produced the highest total dry matter (1468.33 g/m^2) compared to T_2 plants (1280.25 g/m^2) which was statistically identical. As regards line performance, V_1 produced the highest total dry matter (1368.67 g/m^2) followed by V_2 (1382.50 g/m^2) and V_4 (1370.50 g/m$_2$). Line V_3 produced the lowest dry matter (1367.50 g/m^2). Among the interactions between treatments and lines, they were found insignificant and they did not give any significant variation in total dry matter. This observation was in full agreement with that of Cirilo and Andrade (1994 b) who reported decreased total dry matter yield with delayed sowing. Total dry matter was found decreasing with delaying sowing dates which was also reported by Sandhu Hundal (1991).

Protein percent

Data on protein percent (in grain) are shown in table 3, in column 20. From this table it was observed that treatments did not produce any significant variation but the lines and interactions were found statistically significant in protein percent of grain. As regards line performance, V_4 produced the highest protein percent (12.71). The lowest protein percent was found in V_3 (8.55) which was statistically identical to V_2 (11.37) and V_1 (9.71). Among the interactions between treatments and lines,V_4T_1 and V_4T_2 produced the highest protein percent and they were found statistically identical. The second highest protein percent was obtained by V_2T_1 and V_2T_2. The lowest protein percent was observed by V_3T_2 (8.51) and V_3T_1 (8.58) and it was found statistically identical to V_1T_1 and V_1T_2. From the present study, it was observed that sowing date did not effect on percent of protein in grain. These results confirmed the findings of Shumway and Cothren (1992).

Grain yield (tons/ha)

The mean values on grain yield are shown in Table 2, in column 21. From this table it was observed that the treatments, lines and the interactions produced significant effects in grain yield. The grain yield was greatly influenced by the sowing dates. T_1 produced the significantly highest grain yield (4.86 tons/ha) followed by T_2 (4.02 tons/ha). Line also produced significant variation in grain yield. V_2 produced the highest grain yield (4.57 tons/ha) followed by V_3 (4.55 tons/ha) and V_1 (4.47 tons/ha). The lowest grain yield was obtained by V_4 (4.41 tons/ha). Among the interactions between lines and treatments, $V_{3,}$ V_2 and V_4 sown on 15 November produced the highest grain yield and they were found statistically identical. The second highest grain yield was obtained by V_l sown on the, same time (15 November). But the same line V_l produced the lowest grain yield sown on 15 December (V_1T_2) and it was found statistically identical to V_2T_2, V_3T_2 and V_4T_2. This present observation was in close similarity with that Nayak *et al.* (1981) who reported that the first fortnight of November was optimum time of sowing in winter maize for achieving highest grain yield as well as stoves.

Conclusion

Two treatments (sowing dates) had greater influence on grain ;field (ton/ha). Grain yield was decreased with T_2 (4,02 ton/ha)whereas in T_1 it was 4.86 ton/ha. V_2 (4.57 ton/ha) recorded the highest grain yield followed by V_3 (4.55 ton/ha) and V_4 (4.41 ton/ha)and the lowest was in V_1 (4.47 ton/ha). The mean values for the interactions V_1T_1, V_2T_1, V_3T_1 and V_4T_1 were 4.47, 5.08, 5.09 and 4.82 ton/ha respectively, while the interactions, V_1T_2, V_2T_2, V_3T_2 and V_4T_2 were 3.98, 4.06, 4.01 and 4.00 ton/ha, respectively. The earlier planting time 15 November (T_1) showed the best performance compared to late planting time 15 December (T2). Line V2 and V3 showed the highest yield where there was no significantly different. But these Two lines are better compared to rest two lines. Earlier planting showed better performance with V2 and V3 regarding yield. Finally it can be concluded that line V3 can be followed with earlier planting. In the present study it was observed clearly that the morpho-physiological characters of maize (QPM) were influenced greatly by sowing dates. From this observation, it may be concluded that in maize, the early sowing (15 November) was the best time compared to sowing on 15 December.

Table 1. Growth Characteristics of four QPM lines of Maize

Characters	Plant height (cm)	Number of leaves/plant (no)	Length of leaf blade (cm)	Length of leaf sheath (cm)	Leaf breadth (cm)	Cob length (cm)	Cob diameter (cm)	Length of tassel
1	2	3	4	5	6	7	8	9
Treatments								
T_1	231.96 a	13.80 a	85.76 a	18.35 a	10.03 a	21.48 a	42.27 a	30.35 a
T_2	141.02 b	13.50 a	73.73 b	17.25 b	9.49 b	18.14 b	3.58 d	28.42 b
Line								
V_1	188.40 a	13.73	81.50 b	17.81	9.59 bc	20.33	4.08	28.80 b
V_2	186.96 ab	13.59	83.47 a	17.83	10.03 a	19.68	3.98	29.83 a
V_3	185.57 b	13.60	73.37 c	17.78	9.94 ab	19.13	3.92	29.63 a
V_4	185.03 b	13.67	80.65 b	17.76	9.50 c	20.10	3.71	29.30 ab
Interaction								
(T x V)								
V_1T_1	234.30 a	13.77	91.03 a	18.30	9.73	22.23 a	4.47	29.77
V_1T_2	142.50 c	13.70	71.97 de	17.33	9.45	18.43 c	3.70	27.73
V_2T_1	234.50 a	13.80	92.40 a	18.40	10.33	20.87 b	4.45	30.73
V_2T_2	139.40 c	13.36	74.53 cde	17.27	9.72	18.50 c	3.50	28.92
V_3T_1	229.50 b	13.86	75.67 cd	18.33	10.28	20.63 b	4.14	30.50
V_3T_2	141.60 c	13.33	71.07 e	17.23	9.60	17.63 c	3.70	28.77
V_4T_1	229.50 b	13.73	83.93 b	18.37	9.80	22.20 a	4.03	30.43
V_4T_2	140.60 c	13.60	77.37 c	17.16	9.20	18.00 c	3.40	28.16

Table 2. Flowering and Yield Quality of four QPM lines of Maize

Characters	Days to 50% tasselling (days)	Days to 50% silking (days)	Days to maturity (days)	Number of cobs/plant (no)	Cob weight (g)	Number of grain/cob (no.)	1000-seed weight (g)	Percent underdeveloped cob (%)	Total dry matter (g/m^2)	Protein percent in grain	Grain yield (tons./ha)
10	11	12	13	14	15	16	17	18	19	20	21
Treatments											
T_1	64.08 a	68.67 a	108.67 a	1.91 a	171.21 a	514.54 a	271.84 b	4.77 a	1468.33 a	10.60	4.86 a
T_2	49.67 b	55.60 b	95.33 b	1.18 b	164.28 b	404.86 b	290.56 a	4.13 b	1280.25 b	10.57	4.02 b
Line											
V_1	57.17	60.00 b	101.67 b	1.52	167.82 ab	412.00	313.45 a	4.65 a	1386.67 a	9.71 c	4.47 b
V_2	57.00	63.17 a	103.17 a	1.57	169.40 a	412.77	290.60 b	4.40 b	1382.50 a	11.37 b	4.57 a
V_3	56.17	61.00 ab	101.00 b	1.55	166.52 b	406.85	262.98 c	4.40 b	1367.50 b	8.55 d	4.55 a
V_4	57.17	62.17 ab	102.17 ab	1.53	167.25 b	409.18	257.77 c	4.35 b	1370.50 ab	12.71 a	4.41 ab
Interaction											
(T x V)											
V_1T_1	65.00 a	69.33 a	109.33 a	1.83	170.47 b	414.37 a	321.30 a	4.97	1501.67	9.72 c	4.47 b
V_1T_2	49.33 c	54.67 c	94.00 d	1.20	165.17 d	409.63 a	305.60 ab	4.33	1271.67	9.70 c	3.98 c
V_2T_1	64.00 ab	70.00 a	110.00 a	1.93	171.50 ab	420.30 a	278.83 bcd	4.80	1447.33	11.39 b	5.08 a
V_2T_2	50.00 c	56.33 c	96.33 c	1.20	167.30 c	405.23 ab	302.37 abc	4.00	1286.67	11.36 b	4.06 c
V_3T_1	63.00 b	67.00 b	107.00 b	1.97	172.60 a	420.40 a	253.43 de	4.70	1430.00	8.58 d	5.09 a
V_3T_2	49.33 c	55.00 c	95.00 cd	1.13	160.43 e	393.30 b	272.53 cd	4.10	1285.00	8.51. d	4.01 c
V_4T_1	64.33 ab	68.33 ab	108.33 ab	1.90	170.27 b	407.10 ab	233.80 e	4.60	1463.00	12.74 a	4.82 a
V_4T_2	50.00	56.00 c	96.00 c	1.17	164.23 d	411.27 a	281.73 bcd	4.10	1277.667	12.67 a	4.00 c

In a column, the values followed by common letters are not significantly different at 5% level of significance.

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