Plant Archives Vol. 25, Supplement 1, 2025 pp. 1250-1259 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.supplement-1.170

EVALUATION OF F_4 PROGENIES OF CHILLI (*CAPSICUM ANNUM* L.) FOR GROWTH, FLOWERING AND YIELD UNDER KOKAN CONDITION

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(Date of Receiving : 04-08-2024; Date of Acceptance : 25-10-2024)

ABSTRACT

An experiment was conducted to assess the F4 generation of chilli under the kokan conditions of Maharashtra, The experiment included 16 genotypes and was set up in RBD. The maximum plant heights of 37.5 cm, 40.54 cm, 56.44 cm, and 80.92 cm was recorded in the treatment T_3 (Pant C-3 x BC-28) at 30th, 60th, 90th and last day harvest, respectively. The treatment T_2 (Pant C-3 x Jwala) had the largest plant spread (22.96 cm, 36.29 cm, 50.7 cm, and 56.05 cm at 30th, 60th and 90th day after planting and at the time of the last harvest). In the treatment T7 (Jwala x BC-28), the bare minimum of days for the onset of flowering (32.4 days), 50% flowering (41.6 days), and fruit set (51.7 days) were noted. The Jwala x DPL-C-5 (T10) progeny had the highest fruit yield per plant (0.478 kg), fruit yield per hector (13.15 t/ha), and maximum fruit yield per plant (211.1 g). Therefore, Jwala x DPL-C-5 will be the best cultivar with a high yield in Maharashtra's Kokan climate.

***Keyword*:** Chilli, Genotypes, growth, yield, Maharashtra

Introduction

Among the many commercially grown vegetables in India, the chilli or hot pepper (*Capsicum annuum* va r. *annuum* L.) has emerged as one of the most significa nt, economically viable, and widely consumed vegetabl e crops farmed for both its red and green fruits as spice s (Barboza et al., 2022). It is a member of the Solanaceae family and is native to the countries of New Mexico, Guatemala, and Bulgaria in Latin America. In tropical nations like India, Mexico, Japan, Ethiopia, Uganda, Nigeria, Thailand, Turkey, Indonesia, China, and Pakistan, chillies are the widely consumed vegetables (Long An, 2015). India is the largest producer as well as consumer of chillies, and it is grown in almost every states. India has higher potential to boost its output of chillies in order to encourage exports (Suresh and Mathur., 2016). The species are grown in temperate climates as an annual, but they are especially productive in warm and dry climates (Hultquist, 2019).

Numerous varieties of chillies with a range of characteristics can be found in Maharastra's Konkan region. Regarding fruit size, form, and growth patterns, there is a significant amount of variation. However, no systematic research has been done so far regarding the selection and evaluation for suitable varieties.

Therefore, Chilli varieties cultivated in Konkan conditions must be assessed for great quality, yield, and growth performance as well as resistance to biotic and abiotic stress. The present experiment was conducted in the F4 progenies of chilies to examine the growth, flowering, and yield of chilli under kokan conditions in Maharashtra.

Material and Methods

Location and planting materials

The current study was conducted during the Rabi season of 2017 to 2018 at the Vegetable Improvement Scheme, Central Experiment Station, Wakawali, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri, Maharashtra, India. The experimental material for present study comprised of 16 progenies along with Konkan Kirti as a check variety. The details of the progenies were mentioned in **Table 1.** For planting, a basal dose of 150 kg N, 80 kg P_2O_5, and 100 kg K_2O per hectare was applied. At the time of transplanting, half of the nitrogen along with the full amount of phosphorus and potash were provided as a basal dose. The remaining half of the nitrogen was applied in two split doses, with the first dose after 30 days after transplanting and the second dose given 60 days after transplanting. Seedlings exhibiting uniform growth and good health were carefully chosen for planting.

Design of experiment

A 3.6 m × 2.4 m area was planted with seedlings at a spacing of 60 x 60 cm. After that, the plot received a thorough irrigation to keep the soil at the ideal moisture level. A randomised block design (RBD) was used to plan the experiment, and each treatment was replicated twice. In each replication, five plants were used to record observations for a variety of metrics, including growth observations, blooming characteristics, and yield parameters. The data were statistically analysis as per the procedure given by Panse and Sukhatme (1995).

Growth observations

Height of plant (cm) was recorded from the base just above the soil surface to top of the plant. The height was recorded at 30, 60, 90 days and at last harvesting stage after transplanting. Spread of plant (cm) recorded simultaneously with plant height at plant spread East- West and North- South directions at 30, 60, 90 days and at last harvest stage.

Duration

Number of days required for first flowering after transplanting in each progenies was recorded separately. Numbers of days taken from the date of transplanting to 50% plants started flowering in a plot were also recorded. Number of days taken from date of transplanting to the initiation of fruit set in each genotype was recorded separately.

Yield parameters

The weight (g) of five fruits was recorded separately from the selected plants with the help of weighing balance and average was worked out for each progenies. The numbers of fruits harvested from five randomly selected plants in each progenies collected during each pickings was counted and average fruits per plant was calculated. The fruit yield per plant (kg) from five randomly selected plants in each progenies was recorded during each picking counted and average fruit yield per plant calculated. The yield (t/ha) in green stage, weight was recorded in tonnes ha-1 under the progenies.

Results and Discussion

Plant height

The data presented in Table 2 is in relation to plant height of seventeen chilli progenies of F_4 generation revealed that the plant height at 30, 60, 90 days after transplanting and at last harvest varied significantly and illustrated graphically in Figure 1. The plant height at 30 days after transplanting (DAT) was significantly different with each other which were in the range of 10.43 cm to 37.35 cm. The highest plant height (37.35 cm) was recorded by T_3 (Pant C-3 x BC-28) which was at par with T_{10}, T_{14} and T_{16} while lowest plant height (10.43 cm) was recorded by T_1 (Pant C-3 x LCA-206). The mean for plant height at 30 DAT, was 22.65 cm. The plant height at 60 DAT was in the range of 38.32 cm to 54.79 cm with mean of 46.54 cm. At 60 DAT the significantly highest plant height (54.79 cm) was observed in the T_3 (Pant C-3 x BC-28). It was at par with treatment T_2, T_4, T_8, T_9, T_{12} and T_{14} while lowest plant height (38.32 cm) was recorded in the T_1 (Pant C-3 x LCA-206). The plant height at 90 DAT was in the range of 44.09 cm to 69.66 cm with mean of 56.44 cm. At 90 DAT, the highest plant height (69.66 cm) was observed in the T_3 (Pant C-3 x BC-28) and it was at par with T_2, T_4, T_8 and T_{14} while lowest plant height (44.09 cm) was recorded in the treatment T_1 (Pant C-3 x LCA-206). The plant height at last harvest was in the range of 48.29 cm to 80.92 cm with mean of 62.45 cm. At last harvest, the highest plant height (80.92 cm) was observed in T_3 (Pant C-3 x BC-28) progeny. It was at par with T_2 and T_8 while lowest plant height (48.29 cm) was recorded in the T_1 (Pant C-3 x LCA-206). The variation in the growth especially height might be governed by genetic factor which is

responsible for dwarfism (Wang and Bosland, 2006). Plant height is also related to prevailing agro-climate, season when the crop grown. These results are in accordance with the finding of Kumary and Rajamony (2004), Smitha and Basavaraja (2006).

Plant spread

Spread of plant is an important growth character in chilli. The yield of chilli crop depends upon the spread of plant (Sharma *et al*. (2015)). Data presented in Table 3 revealed that the spread of plant at 30 days after transplanting was in the range of 15.77 cm to 22.96 cm with mean of 18.31 cm. The maximum plant spread (22.96 cm) was observed in the treatment T_2 (Pant C-3 x Jwala) and it was at par with T_3, T_7 and T_{17}. The minimum plant spread (15.77 cm) was observed in the treatment T_6 (Jwala x LCA-206) and illustrated graphically in Figure 2. The spread of plant at 60 days after transplanting was in the range of 25.63 cm to 36.29 cm with mean of 30.86 cm. The maximum plant spread at 60 days after transplanting (36.29 cm) was observed in the treatment T_2 (Pant C-3 x Jwala) and it was at par with treatments T_4, T_5, T_9, T_{10}, T_{11}, T_{13}, T_{14}, T_{15}, T_{16} and T_{17}. The minimum plant spread (25.63 cm) was observed in the treatment T_6 (Jwala x LCA-206). The spread of plant at 90 days after transplanting was in the range of 31.67 cm to 50.7 cm with mean of 38.20 cm. The maximum plant spread at 90 days (50.7 cm) was observed in the treatment T_2 (Pant C-3 x Jwala). The minimum plant spread (31.67 cm) was observed in the treatment T_6 (Jwala x LCA-206). The spread of plant at last harvest was in the range of 34.70 cm to 56.05 cm with mean of 41.92 cm. The maximum plant spread at last harvest (56.05 cm) was observed in the treatment T_2 (Pant C-3 x Jwala) and it was at par with treatment of T_{17}. The minimum plant spread (34.70 cm) was observed in the treatment T_6 (Jwala x LCA-206). Initially, the plant spread was higher in T_3 and T_6 progenies but from 90 days after transplanting plant spread was higher in T_2 progeny indicating its extensiveness in spread at the later growth stage. The wide range of variation in the plant spread might be due to genetic character of that particular genotype and also the direct effect of soil and agro-climatic conditions and indirect effect of number of branches per plant (Smitha and Basavaraja, 2006). The variation in plant spread was also observed similarly by Nehru *et al*. (2003).

Flowering attributes

The data pertaining to the number of days to initiation of flowering, days to 50 per cent flowering and days to fruit set of F_4 generation chilli progenies is illustrated graphically in Figure 3. The days for initiation of flowering in chilli progeny ranged in between 32.4 to 54.4 days with mean of 42.17 days. Further, minimum days for initiation of flowering (32.4) were recorded in the T_7 (Jwala x BC-28) and it was at par with treatment of T_1, T_5, T_{10} and T_{14}. The maximum days (54.4) to initiation of flowering were observed in the variety Konkan Kirti (T_{17}) (Table 4). Such variation in the days to initiation of flowering might be due to moderately genetic factors of progenies, less influence by hormonal factors and environmental factors (Manju and Kumary, 2002).

It was noticed that the range for days to 50 per cent flowering in chilli progeny was 41.6 to 60.77 days with mean 51.21 days. The significantly maximum number of days to 50 per cent flowering (60.77) were observed in the variety Konkan Kirti (check) and while the minimum number of days (41.6) required for 50 per cent flowering in the treatment T_7 (Jwala x BC-28) and it was at par with T_1, T_2, T_9, T_{10} and T_{14} (Table 4). The variation in period required for 50 per cent flowering may be due to highly genetic make-up of genotypes, less environmental and vigour growth of crop (Smitha and Basavaraja, 2006; Farhad *et al*., 2008).

Fruit set

In the present study, the significant variation for days to fruit set was observed among the chilli progenies. However, it was in the range of 51.1 to 64.4 days with a mean of 54.57 days. Maximum days (64.4) for initiation of fruit set were noticed in the variety Konkan Kirti (T_{17}), while minimum days (51.1) in the treatment T_7 (Jwala x BC-28) and it was at par with T_1, T_5, T_7, T_8, T_9, T_{11}, T_{13}, T_{14} and T_{15}, it is illustrated graphically in Figure 3. The days required to fruit set depends on the initiation of flowering (reproductive phase) and might be governed by genetic behavior of the progeny and also influenced by the agro climate (Pramila *et al*., 2009; Phulari, 2012, Amit *et al.*, 2014).

Yield

In any crop improvement study, yield is the utmost important character. Breeders can improve any characters *viz*. quality attributes, morphological characters but cannot compromise with yield (Ukkud et al., 2007). Among all the observations studied in investigation, the yield attributes are important to judge the better yield potential of chilli genotypes. Data in relation to the yield contributing characters such as average fruit weight (g), number of fruits per plant, fruit yield per plant (kg), fruits yield per hectare (tonnes) are presented in Table 5, and data were varied significantly among all the 17 genotypes of chilli F_4 generation. The fruit weight of chilli varied between from 1.55 g to 3.40 g, with mean fruit weight of 2.27 g.

The maximum fruit weight (3.40 g) was observed in the progeny T_9 (Jwala x Pant C-3) and it was at par with T_{11} progeny. The minimum fruit weight (1.55 g) was observed in the treatment T_{16} (LCA-206 x Jwala) and illustrated graphically in Figure 4. Results showing variation of the fruit weight might be due to direct effect of genetic make-up of progenies and indirect effect of less environmental factors influence in Konkan region (Kumary and Rajamony, 2004; Tembhurne *et al*., 2008).

Number of fruits is one of the most important yield attributing characters (Amit et al., 2014). Some promising lines were found in present investigation and strengthen the selection. From the Table 5 it was observed that the maximum number of fruits per plant (211.1) was recorded in Jwala x DPL-C-5 progeny (T_{10}) and it was at par with T_4, T_5, T_7, T_{13}, T_{14} and T_{17}. While, minimum number of fruits (109.6) were found in Jwala x Pb Gucchedar progeny (T_8). The variation in average number of fruits per plant was in the range of 107.6 to 209.1 and mean number of fruits was 155.21 per plant. In Konkan Kirti variety, 173.53 fruits per plant were harvested and illustrated graphically in Figure 5. Variations in respect of number of fruits per plant in different genotypes might be due to fruit set percent (Todankar, 2014).

The maximum fruit yield per plant (0.478 kg) was observed in Jwala x DPL-C-5 progeny (T_{10}) and it was at par with T_1, T_2, T_4, T_6, T_7, T_{11}, T_{13}, T_{14} and T_{15}. While, minimum fruit yield per plant (0.235 kg) was observed in Jwala x Pb Gucchedar progeny (T_8). The range of fruit yield per plant was from 0.235 kg to 0.478 kg with mean (0.379 kg). In Konkan Kirti (Check) the yield was 0.347 kg plant^{-1} and illustrated graphically in Figure 6. The yield potential of the particular progeny is determined by its genetic potential, inheritance characters from their parents. The difference in fruit yield per plant may be due to fruit set percent, fruit length, diameter and weight of fruit showed highly positive direct effect on fruit yield per plant. This result variation was also recorded by kumary and Rajamony (2004), Smitha and Basavaraja (2006).

From the Table 5, it was noticed that the fruit yield per hectare varied from the 9.12 t/ha to 13.15 t/ha and average yield was noticed to 11.36 t/ha. Maximum fruit yield (13.15 t/ha) was observed in Jwala x DPL-C-5 progeny (T_{10}) and it was at par with T_1, T_2, T_4, T_5, T_6, T_7, T_9, T_{11}, T_{13}, T_{14} and T_{17}. while, the minimum fruit yield (9.12 t/ha) was observed in the Jwala x Pb Gucchedar progeny (T_8) and illustrated graphically in Figure 7. Variation of the fruit yield per hectare might be due to number of fruits per plant, fruit length and weight of fruits having direct positive correlation to yield and plant spread was reported by Smitha and Basavaraja (2006), Tembhurne *et al*. (2008).

Conclusion

The current results indicate significant variations in the yield and all yield attributing characteristics of F_4 progenies of chilli. Progenies such as Jwala x DPL-C-5, ACS-9818 x Pb Gucchedar, BC-28 x Pb Gucchedar, DPLC-5 x BC-28, K.Kirti x Jwala, and Konkan Kirti showed promising results in terms of higher yield per plant compared to the overall average in Konkan's agro-climatic conditions. As a result, these progenies should be selected for further investigation in the F_5 generation.

Table 1 : List of Genotypes and checks used in the study

Sr. No.	Treatment	Genotype
1	T_1	Pant C-3 x LCA-206
2	T_2	Pant C-3 x Jwala
3	T_3	Pant C-3 x BC-28
4	T_4	K.Kirti x Jwala
5	T_5	BC-28 x Pb Gucchedar
6	T_6	Jwala x LCA-206
7	T_7	Jwala x BC-28
8	T_8	Jwala x Pb Gucchedar
9	T_9	Jwala x Pant C-3
10	T_{10}	Jwala x DPL-C-5
11	T_{11}	ACS-9818 x Pb Gucchedar
12	T_{12}	ACS-9818 x BC-28
13	T_{13}	DPLC-5 x BC-28
14	T_{14}	DPL-C-5 x Pant C-3
15	T_{15}	DPL-C-5 x Pb Gucchedar
16	T_{16}	LCA-206 x Jwala
17	T_{17}	Konkan Kirti (C)

Table 2 : Height of plant at 30, 60, 90 days and last harvest days of selected F_4 chilli progenies.

Sr. No.	Progenies	Plant height (cm)			
		30 DAT	60 DAT	90 DAT	At last harvest
T_1	Pant C-3 x LCA-206	10.43	38.32	44.09	48.29
T_2	Pant C-3 x Jwala	27.71	50.02	63.51	72.05
T_3	Pant C-3 x BC-28	37.35	54.79	69.66	80.92
T_4	K.Kirti x Jwala	27.74	50.47	63.14	67.32
T_5	BC-28 x Pb Gucchedar	29.48	46.26	54.12	59.69
T_6	Jwala x LCA-206	13.26	43.20	48.49	54.04
T_7	Jwala x BC-28	11.24	41.66	48.21	52.66
T_8	Jwala x Pb Gucchedar	14.46	53.95	66.61	73.90
T_9	Jwala x Pant C-3	12.36	50.59	59.32	65.85
T_{10}	Jwala x DPL-C-5	35.83	44.23	49.31	54.41
T_{11}	ACS-9818 x Pb Gucchedar	13.24	46.55	59.05	64.76
T_{12}	ACS-9818 x BC-28	14.74	51.32	58.52	63.05
T_{13}	DPLC-5 x BC-28	15.75	41.72	55.62	61.47
T_{14}	DPL-C-5 x Pant C-3	36.14	51.31	61.82	69.42
T_{15}	DPL-C-5 x Pb Gucchedar	33.29	42.82	51.76	57.36
T_{16}	LCA-206 x Jwala	33.84	41.84	55.56	59.31
T_{17}	Konkan Kirti (C)	18.26	42.28	50.70	57.27
	Mean	**22.65**	**46.54**	**56.44**	**62.45**
	Result	**SIG**	**SIG**	**SIG**	**SIG**
	S.Em±	**2.140**	**2.711**	**2.807**	**3.308**
	CD at (5%)	**6.417**	**8.130**	**8.417**	**9.920**

Table 3 : Plant spread at 30, 60, 90 days and at last harvest of F_4 chilli progenies

Sr. No.	Progenies	Plant spread (cm)			
		30 DAT	60 DAT	90 DAT	At last harvest
T_1	Pant C-3 x LCA-206	18.73	27.24	33.39	37.51
T_2	Pant C-3 x Jwala	22.96	36.29	50.7	56.05
T_3	Pant C-3 x BC-28	19.93	29.15	38.35	44.28
T_4	K.Kirti x Jwala	18.48	31.52	41.6	45.37
T_5	BC-28 x Pb Gucchedar	17.05	31.32	39.39	42.51
T_6	Jwala x LCA-206	15.77	25.63	31.67	34.70
T_7	Jwala x BC-28	21.19	28.40	33.65	36.35
T_8	Jwala x Pb Gucchedar	16.00	29.27	35.49	39.50
T_9	Jwala x Pant C-3	16.06	31.20	37.70	41.47
T_{10}	Jwala x DPL-C-5	19.00	30.65	36.18	38.82
T_{11}	ACS-9818 x Pb Gucchedar	18.38	30.80	38.72	42.00
T_{12}	ACS-9818 x BC-28	17.23	26.54	33.10	36.08
T_{13}	DPLC-5 x BC-28	16.28	33.60	40.80	44.77
T_{14}	DPL-C-5 x Pant C-3	17.76	36.07	41.24	43.82
T_{15}	DPL-C-5 x Pb Gucchedar	17.79	31.12	36.17	38.96
T_{16}	LCA-206 x Jwala	15.85	30.90	37.01	40.30
T_{17}	Konkan Kirti (C)	20.27	35.00	44.37	50.30
	Mean	**18.31**	**30.86**	**38.20**	**41.92**
	Result	**SIG**	**SIG**	**SIG**	**SIG**
	S.Em±	**1.115**	**1.920**	**2.021**	**2.578**
	CD at (5%)	**3.343**	**5.757**	**6.060**	**7.730**

Table 4 : Flowering attributes of F_4 chilli progenies

Sr. No.	Progenies	Days to initiation of flowering	Days to 50 per cent flowering	Days to fruit Set
T_1	Pant C-3 x LCA-206	33.7	45.8	52.5
T_2	Pant C-3 x Jwala	42.2	54.7	56.9
T_3	Pant C-3 x BC-28	41.8	45.7	55.4
T_4	K.Kirti x Jwala	52.2	59.4	56.1
T_5	BC-28 x Pb Gucchedar	36	49.5	55.1
T_6	Jwala x LCA-206	48.1	57.7	55.4
T_7	Jwala x BC-28	32.4	41.6	50.6
T_8	Jwala x Pb Gucchedar	47.0	53.5	51.4
T_9	Jwala x Pant C-3	39.0	48.2	52.5
T_{10}	Jwala x DPL-C-5	34.9	45.4	51.1
T_{11}	ACS-9818 x Pb Gucchedar	41.8	49.4	52.7
T_{12}	ACS-9818 x BC-28	42.9	51.9	55.8
T_{13}	DPLC-5 x BC-28	49.8	55.8	54.9
T_{14}	DPL-C-5 x Pant C-3	32.6	43.5	51.5
T_{15}	DPL-C-5 x Pb Gucchedar	38.2	49.0	53.5
T_{16}	LCA-206 x Jwala	50.0	58.8	57.9
T_{17}	Konkan Kirti (C)	54.4	60.77	64.4
	Mean	**42.17**	**51.21**	**54.57**
	Result	**SIG**	**SIG**	**SIG**
	S.Em±	**1.739**	**2.413**	**1.338**
	CD at (5%)	**5.215**	**7.236**	**4.012**

Table 5 : Yield and yield attributing parameters of F_4 chilli progenies

Sr. No.	Progenies	Avg. green fruit weight (g)	Number of fruits per plant	Green fruit yield per plant (kg)	Green fruit yield (t/ha)
T_1	Pant C-3 x LCA-206	1.86	146.8	0.412	11.32
T_2	Pant C-3 x Jwala	2.54	136.5	0.416	11.45
T_3	Pant C-3 x BC-28	2.51	118.3	0.35	9.61
T_4	K.Kirti x Jwala	1.91	198.1	0.444	12.2
T_5	BC-28 x Pb Gucchedar	2.44	173.8	0.256	12.96
T_6	Jwala x LCA-206	2.19	159	0.413	11.35
T_7	Jwala x BC-28	2.30	163.9	0.432	11.88
T_8	Jwala x Pb Gucchedar	2.17	109.6	0.235	9.12
T_9	Jwala x Pant C-3	3.40	134.3	0.249	11.5
T_{10}	Jwala x DPL-C-5	1.95	211.1	0.478	13.15
T_{11}	ACS-9818 x Pb Gucchedar	2.85	159.8	0.468	12.89
T_{12}	ACS-9818 x BC-28	2.29	113.6	0.336	9.25
T_{13}	DPLC-5 x BC-28	2.22	179.5	0.446	12.28
T_{14}	DPL-C-5 x Pant C-3	1.63	173.1	0.416	11.45
T_{15}	DPL-C-5 x Pb Gucchedar	2.16	146.6	0.391	10.76
T_{16}	LCA-206 x Jwala	1.55	141.1	0.351	9.645
T_{17}	Konkan Kirti (C)	2.58	173.53	0.347	12.37
	Mean	**2.27**	**155.21**	**0.379**	**11.36**
	Result	**SIG**	**SIG**	**SIG**	**SIG**
	S.Em±	**0.189**	**16.92**	**0.034**	**0.75**
	CD at (5%)	**0.566**	**50.75**	**0.104**	**2.24**

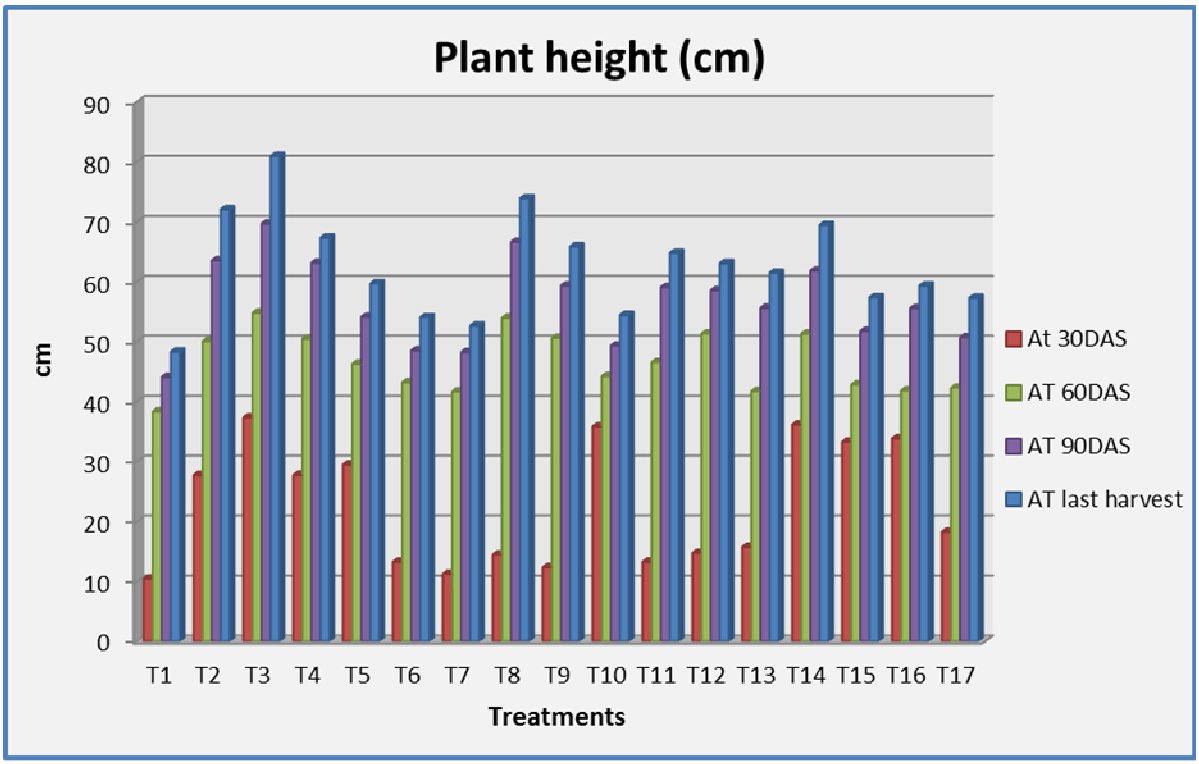

Fig. 1: Plant height (cm) at 30, 60, 90 and last harvest of F_4 chilli progenies

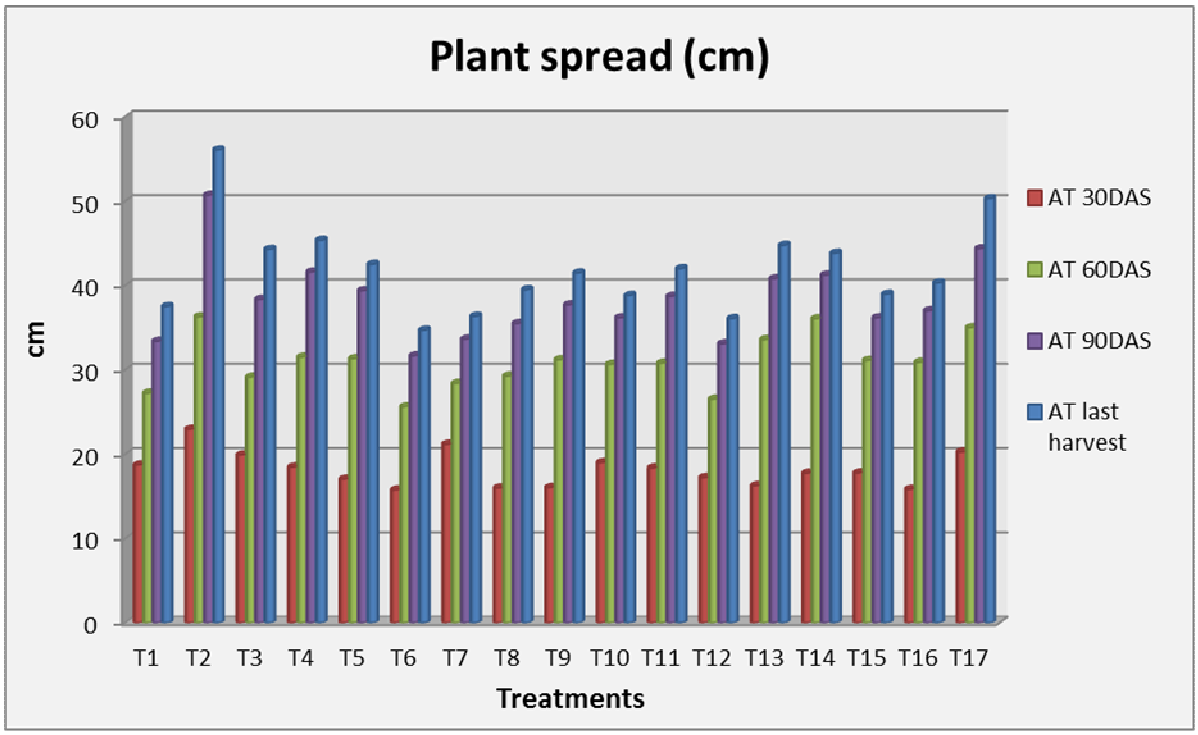

Fig. 2: Plant spread (cm) at 30, 60, 90 and last harvest of F_4 chilli progenies

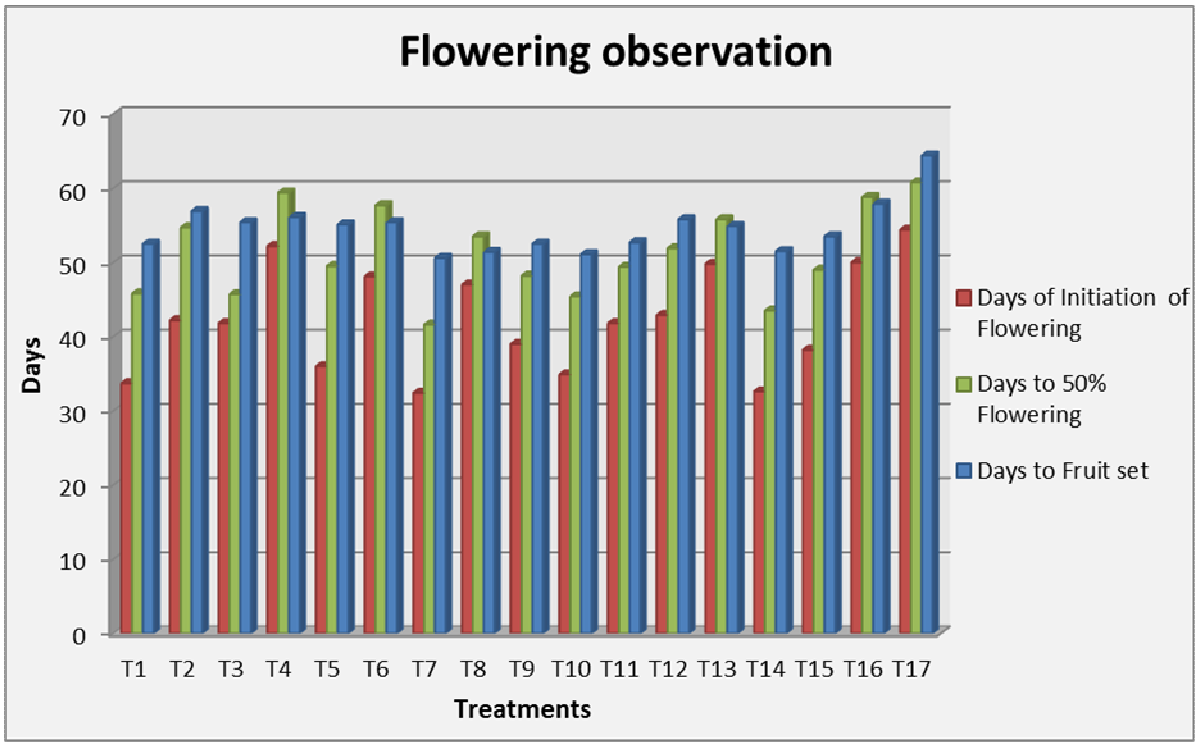

Fig. 3: Flowering observations of F_4 chilli progenies

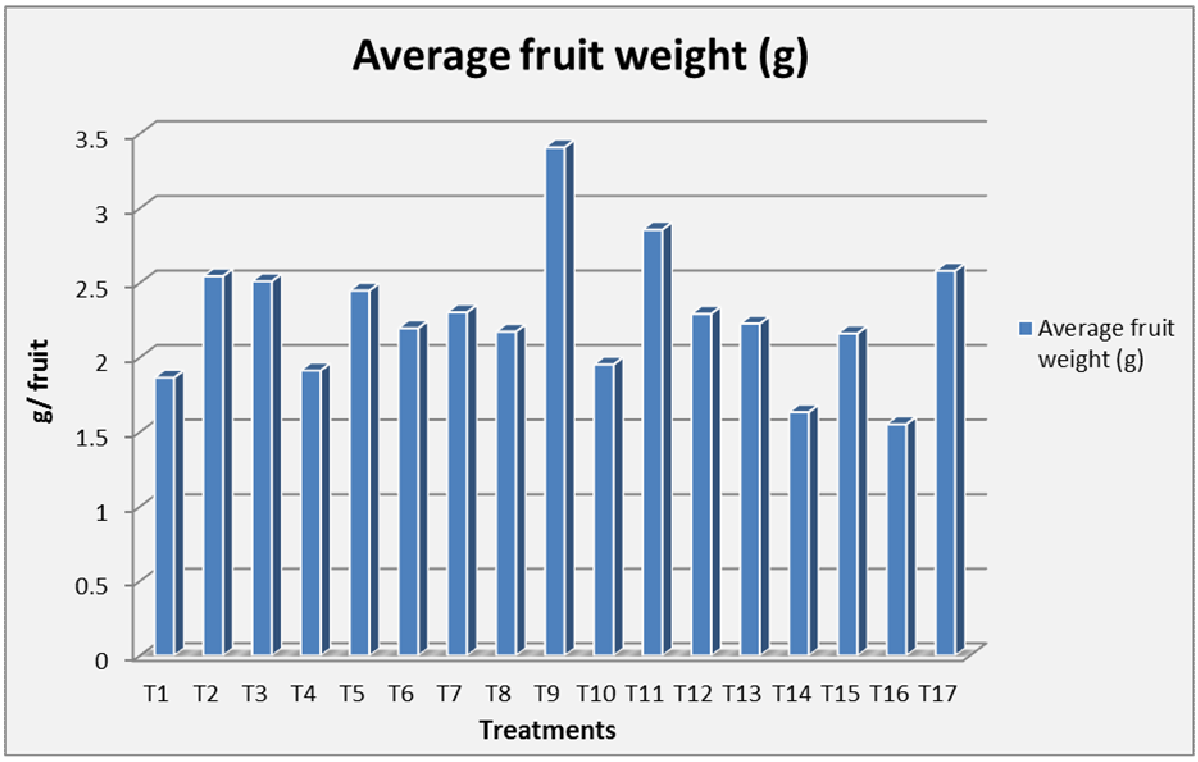

Fig. 4: Average fruit weight (g) of F_4 chilli progenies

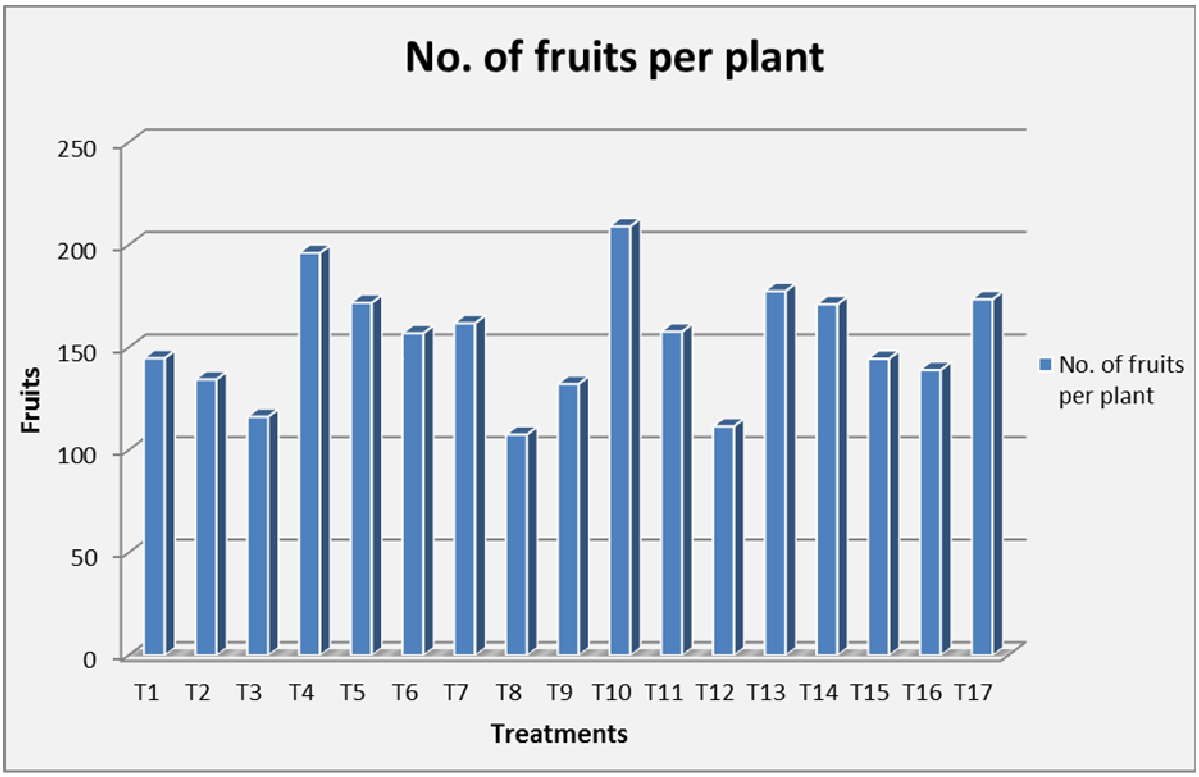

Fig.5: Number of fruits per plant of F_4 chilli progenies

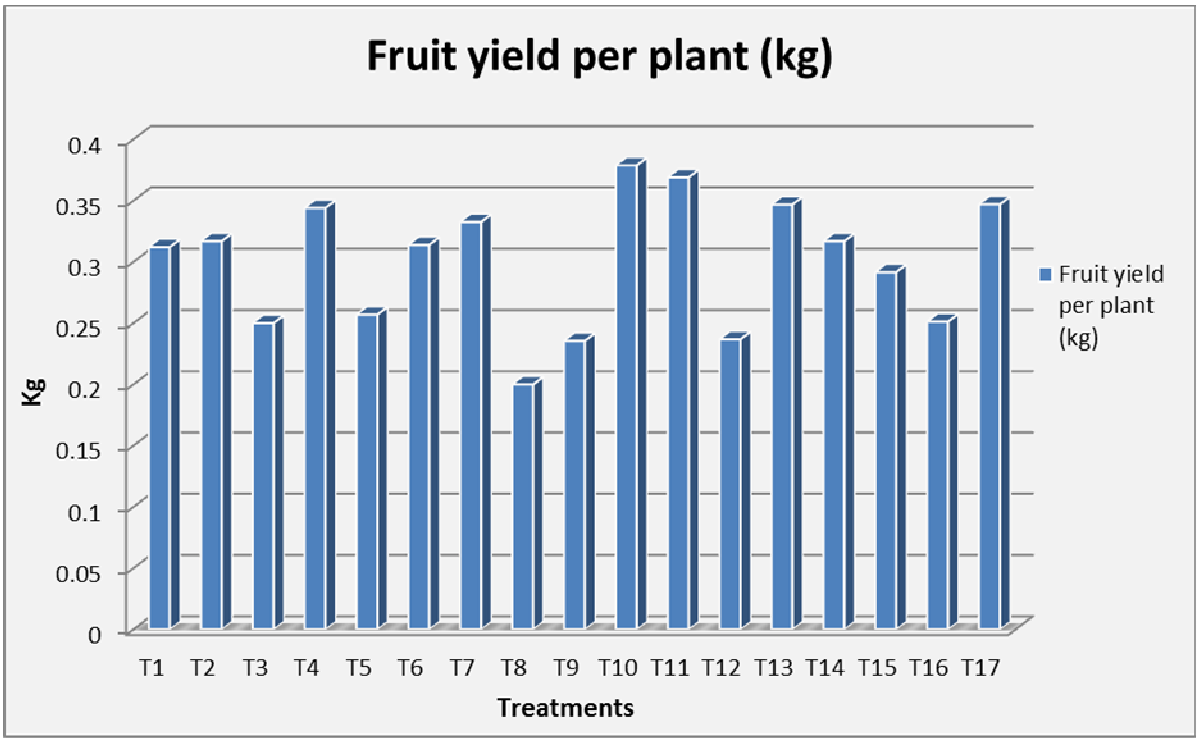

Fig. 6: Fruit yield per plant (kg) of F_4 chilli progenies

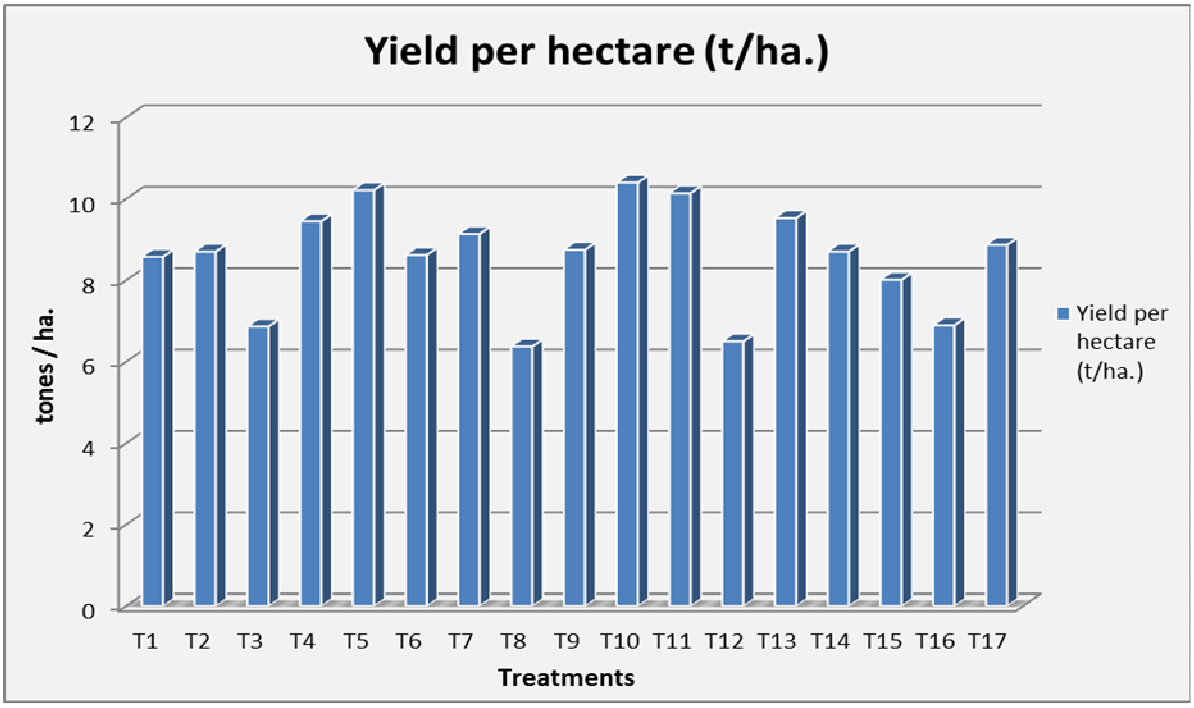

Fig. 7: Yield per hectare (t/ha.) of F_4 chilli progenies

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