Table 1. Overall performance of ACM 16

Name of the trial	Grain yield (kg/ha)	
	MDU 4 (ACM 16)	IR 20
State Seed Farm, Keelagudalur	5447 (127)	4418 (127)
Adaptive Research Trials	6894 (130)	6138 (138)
National Trial (AICRIP)	5304 (130)	4486 (135)*
Mean	5882	5014
% increase over IR 20	17.3	

* Mean yield of Jaya from AICRIP trials

Figures in parentheses indicate duration in days

germplasm as ACM 16. During 1985-86, this culture was tested under national trials (AICRIP) and during 1986-89, adaptive research trials (ART) were organised at the farmers holdings of Madurai, Dharmapuri and Salem Districts during *rabi* season.

RESULTS AND DISCUSSION

The distinguishing morphological characters of ACM 16 are: Habit erect tall; leaf sheath green; axil green; junction colourless; auricle colourless; ligule colourless; ligule shape acuminate; septum green; flag leaf green; lemma and palea green; apiculus green tip; awn absent; panicle compact and medium, stigma purple; husk colour yellow; length of grain 9.12; breadth of grain 2.26. grain L/B ratio 4.03; 1000 grain weight 22.87 g; length of kernel 8.8; breadth of kernel 2.1; kernal L/B ratio 4.3; rice grade medium slender; rice colour white; abdominal white absent.

The culture ACM 16 registered a mean grain yield of 5447 kg/ha under severe cold stress conditions at State Seed Farm, Keelagudalur in Cumbum valley of Madurai District, as against 4418 kg/ha recorded by the ruling IR 20. The yield increase was 18.9 per cent (Table 1).

In the ART conducted at the farmers holdings of Madurai, Dharmapuri and Salem Districts, ACM 16 recorded an average grain yield increase of 12.3 per cent over IR 20 (Table 1). In AICRIP trials, ACM 16 maintained its superiority over Jaya recording a mean grain yield of 5304 kg/ha as against Jaya (4468 kg/ha)

The culture ACM 16 could with stand cold stress during reproductive stage with low spikelet sterility (7.8%) as compared to IR 20 (13.7%). It is highly resistant to blast, sheathrot, grain disco loration and white backed planthopper and moderately resistant to brown spot and brown plant hopper. The grain is medium slender with white rice possessing good cooking quality.

ACM 16 was released as MDU 4 during 1991 for the cold stress affected areas of Madurai (Cumbum Valley), Dharmapuri and Salem Districts of Tamil Nadu.

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EFFECT OF PLANT ATTRIBUTES ON THE QUALITY CHARACTERISTICS IN CHILLI

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Abstract

Quality of chilli (*Capsicum annuum* L) is determined by its capsanthin content, capsaicin content, and ascorbic acid content. The relationship between the quality traits on the one hand and other characters on the other and the direct and indirect effects of other traits on quality traits were investigated. Ascorbic acid content, stem height upto 3rd internode length and fruit stalk weight showed not only positive correlation but also direct influence on the capsanthin content. Fruit length and fruit weight showed negative association with capsaicin content. Ascorbic acid content was found to be positively correlated with each of 1000 seed weight, fruit stalk weight, pedicel length, fruit length and capsanthin content and negatively correlated with number of fruits/plant. The direct effect of 1000 seed weight on ascorbic acid content was maximum.

Chilli (*Capsicum annuum* L.) is a very important vegetable crop and is used in the diet of both rich and poor all over the world. Economically, chilli is a good choice for greater income generation among the farming sector. Yield and quality plays an important role in increasing the income of the farmers. Quality of chillies is largely determined by its colour, pungency and ascorbic acid content. The major red colour is due to capsanthin, a carotenoid compound. Variability in capsanthin content has been reported by many workers. Colour in mature fruits is controlled by four different genes (y, c_1, c_2, c_l) with epistatic interactions (Hernandez and Smith, 1985; Shifriss and Pilovsky, 1992). The one attribute most typical of capsicums is pungency and must be considered one of the most important quality traits. Different combinations of capsaicinoids produce the different hotness characteristics (Bennet and Kirby, 1968). According to Navarro and Costa (1991), the higher the chlorophyll compounds in the fruit, the more the carotenoids pigment. Wide variability in capsaicin content of fruits had been reported by several workers. The third important quality is the ascorbic acid content (Vit-C). Quality is also affected by several other variables. Information on the characters which are related and which influence the quality traits is necessary to the breeders. Correlation and path coefficients provide useful information for the breeders and assist them to work on those specific traits which can directly or indirectly enhance the desired quality. Such studies in chilli are scanty. A study was therefore undertaken at the Indian Institute of Horticultural Research, Bangalore to find out the association between the quality characters on the one hand and other traits on the other and direct and indirect effects of other traits on each one of the quality traits with 73 genotypes available in the germplasm collection of the Institute.

MATERIALS AND METHODS

The experiment was conduced at Institute Farm in randomised block design with three replications. Each plot comprised of single row, 3.60 m long with row to row and plant to plant spacings of 50 and 30 cm respectively. The seedlings obtained from raised seed beds were planted on 15 September 1980. A basal dose at 20 tonnes of FYM, 60 kg N, 80 kg P205 and 50 kg K20 and 20 kg Furadan/ha was given to the main field before planting. Top dressing was done with N at 30 kg/ha each time on 30 and 60 days after planting. Other agronomic practices like weeding, irrigation, plant protection etc. were carried out as per schedule. Observations were recorded on five randomly selected plant leaving two border plants on either side in each replication for each of the genotype for the characters namely dry fruit yield/plant (g), number of fruits/plant, fruit length (cm), pedicel length (cm), 50 fruit weight (g), 50 fruit stalk weight (g), stem height upto third internode (cm), 1000 seed weight (g), capsanthin content (per cent fruit dry weight basis), ascorbic acid content (mg/100 gm of green fruits) and capsaicin content (% of fruit dry weight). Pungency and ascorbic acid content were determined following the methods suggested by Harris and Ray (1935) and Palacio (1977) respectively. The capsanthin content was

Table 1. Direct (diagonal) and indirect effects of five component characters on the quality character, capsanthin content (%) in chilli

Character	Character					Total indirect effect	Total r 1/with
	X1	X2	X3	X4	X5		
X1	+0.0296 +32.4	-0.0341 -37.3	-0.0046 -5.0	-0.0201 -22.0	-0.0622 -68.1	-0.1210 -132.40	-0.0914 NS 100
X2	-0.0036 -1.00	+0.2824 +78.05	-0.0235 -6.49	+0.0369 +10.20	+0.0696 +19.24	+0.0794 +21.95	+0.3618** 100
X3	-0.0010 -2.05	-0.0479 -98.36	+0.1387 +284.8	+0.0201 +41.28	-0.0612 -125.67	-0.0900 -184.80	+0.0487 NS +100
X4	-0.0016 -0.38	+0.0274 +6.79	+0.0073 +180	+0.3802 +94.13	-0.0094 -2.34	+0.0237 +5.87	+0.4039** +100
X5	-0.0066 -2.24	+0.0718 +24.38	-0.0310 -10.53	-0.0132 -4.48	+0.2735 +92.87	+0.0210 +7.13	+0.2945* +100

Residual effect = 0.8122 * significant at P = 0.05 ** significant at P = 0.01 NS = not significant 1/= with capsanthin content (%)
Y = Capsanthin content X1 = Fruit yield/plant (g) X2 = Ascorbic acid content (mg/100 g) X3 = Capsaicin content (%)
X4 = Ht. upto 3rd internode length (cm) X5 = Fifty fruit stalk weight (g)
Figures underneath the effects indicate percentage values

Table 2. Direct (diagonal) and indirect effects of five characters on capsaicin content (%) in chilli

Character	Character					Total indirect effect	Total r 1j with
	X1	X2	X3	X4	X5		
X1	-0.0455	-0.0132	+0.0193	+0.0243	-0.0179	+0.0125	-0.033NS
	-137.9	-39.5	+58.0	+73.6	-54.2	+37.9	100
X2	+0.0041	+0.1442	-0.0579	-0.0185	-0.0232	-0.0955	+0.0487NS
	+8.4	+296.1	-118.9	-38.0	-47.6	-196.1	100
X3	+0.0055	+0.0522	-0.1601	-0.0507	-0.0165	-0.0095	-0.1696NS
	+3.2	+30.8	-94.4	-29.9	-9.7	-5.6	100
X4	+0.0072	+0.0175	-0.0532	-0.1527	-0.0743	-0.1028	-0.2555*
	+2.8	+6.9	-20.8	-59.8	-29.1	-40.2	100
X5	-0.0025	+0.0105	-0.0083	-0.0355	-0.3196	-0.0358	-0.3554**
	-0.7	+2.9	-2.3	-10.0	-89.9	-10.1	100

Residual effect = 0.9010 * significant at P = 0.05 ** significant at P = 0.01 NS = not significant r 1j = with capsanthin content (%)
Y = Capsanthin content X1 = Fruit yield/plant (g) X2 = Capsaicin content (%) X3 = Ascorbic acid content (mg/100 g)
X4 = Fruit length (cm) X5 = Fifty fruit stalk weight (g)
Figures underneath the effects indicate percentage values.

determined as outlined by Woodbury (1977). Correlation analysis i) between capsanthin content and each of the character namely fruit yield/plant, ascorbic acid content, capsaicin content, stem height upto third internode length and 50 fruit weight., ii) between capsaicin content and other characters and iii) between ascorbic acid content and other characters was done as outlined by Snedecor and Cochran (1967). Path analysis as suggested by Dewey and Lu (1959) was done to partition the correlation coefficients with components of direct and indirect effects considering quality characters as effect and other traits as causes.

RESULTS AND DISCUSSION

The correlation coefficients between each of the quality trait and other attributes are furnished below.

Capsanthin content

Capsanthin content showed high significant positive correlation with each of ascorbic acid content (0.3618) stem height 3rd internode length (0.4039) and fruit stalk weight (0.2945). In respect of the correlation coefficient between capsanthin content and fruit yield/plant (-0.0914), it was found that the direct effect of fruit yield/plant was appreciably positive and high (0.0296) and exerted strong indirect and negative influence via ascorbic acid content (-0.0341), capsaicin content (-0.0046), height upto 3rd internode length (0.0201) and 50 fruit stalk weight (-0.0622) on capsanthin content.

Fruit yield/plant, ascorbic acid content, capsaicin content, stem height upto 3rd internode length and 50 fruit stalk weight had high positive direct effect of 0.0296, 0.2824, 0.1387, 0.3802 and 0.2735 respectively on capsanthin content. The direct positive influence of stem height upto 3rd internode length through ascorbic acid content capsaicin content and indirect negative influence through 50 fruit stalk weight were appreciable. The results indicated that ascorbic acid content, stem height up to 3rd internode length and 50 fruit stalk weight were the major attributes contributing towards capsaicin content directly as well as indirectly via other components (Table 1)

Capsaicin content

Among the five characters namely fruit yield/plant, capsanthin content, ascorbic acid content, fruit length and 50 fruit weight, only two characters namely fruit length and 50 fruit weight were correlated negatively and significantly with capsaicin content (Table 2). The result of negative correlation between fruit length and capsaicin content is in agreement with Gomez and Mora (1991). All the correlation coefficients were partitioned into direct and indirect effects. It was observed that 50 fruit weight exerted the maximum direct negative effect on capsaicin content followed by ascorbic acid content. Other two attributes - fruit length and yield/plant - also had

Table 3. Direct (diagonal) and indirect effects of eight component characters on ascorbic acid content (mg/100 g) in chilli

Character	Character								Total indirect effect	Total r1 with
	X1	X2	X3	X4	X5	X6	X7	X8		
X1	-0.0260 -21.5	-0.0284 -23.5	+0.0023 1.9	-0.0824 -68.2	-0.0383 -31.7	-0.0031 -2.6	+0.0131 10.9	+0.0419 34.7	-0.0949 -78.5	-0.01209NS 100
X2	+0.0024 0.7	+0.3114 86.1	-0.0035 -1.0	+0.0204 5.6	+0.0292 8.1	+0.0156 4.3	-0.0171 -4.7	+0.0034 0.9	+0.0504 13.9	+0.3618** 100
X3	+0.0008 0.5	+0.0152 9.0	-0.0719 -42.4	-0.0260 -15.3	-0.0617 -36.4	-0.0054 -3.2	+0.0129 7.6	-0.0335 -19.8	-0.0977 -57.6	-0.1696NS 100
X4	-0.0612 -5.7	-0.0480 -17.0	-0.0141 -5.0	-0.1325 -46.9	-0.0816 -28.9	-0.0115 -4.0	0.0363 12.8	-0.0152 -5.3	-0.1503 -5.3	-0.2828** 100
X5	+0.0041 1.2	+0.0376 11.3	+0.0184 5.5	+0.0448 13.5	+0.2414 72.7	+0.0358 10.8	-0.0230 -6.8	-0.0271 -8.2	+0.906 27.3	+0.3320** 100
X6	+0.0012 0.4	+0.0711 25.6	+0.0057 2.1	+0.0224 8.1	+0.1269 45.8	+0.0682 24.6	-0.0138 -5.0	-0.0045 -1.6	+0.2090 75.4	+0.2772* 100
X7	+0.0059 2.3	+0.0917 36.0	+0.016 6.4	+0.0832 32.7	+0.0960 37.7	+0.0163 6.4	-0.0579 -22.8	+0.0032 1.3	+0.3124 122.8	+0.2545* 100
X8	-0.0041 -1.6	+0.0041 1.6	+0.0092 3.6	+0.0077 3.1	-0.0249 -9.8	-0.001 -0.5	-0.0007 -0.3	-0.2635 103.9	-0.0100 -3.9	+0.2535* 100

Residual effect = 0.8267 * significant at P = 0.05 ** significant at P = 0.01 NS = not significant r1 = with capsanthin content (mg/100g)
Y = Ascorbic acid content (mg/g) X1 = Plant yield/plant (g) X2 = Capsanthin content (%) X3 = Capsaicin content (%)
X4 = Number of fruits/plant X5 = Fruit length (cm) X6 = Pedicel length (cm) X7 = Fifty fruit stalk weight (g)
X8 = One thousand seed weight (g)
Figures underneath the effects indicate percentage values

negative direct effects. Capsanthin content had substantial positive direct effect on capsaicin content. The result indicated that 50 fruit weight and fruit length contributed considerably high effect on capsaicin content due to maximum direct negative effect (-0.3196 and - 0.1527). On the basis of the present investigation, it appears that selection procedure based on 50 fruit weight coupled with fruit length may be used effectively to improve capsaicin content (%).

Ascorbic acid content

The correlation coefficient (0.3618) between capsanthin content and ascorbic and consists of 8 components, the relative contribution of which the direct effect of capsanthin content on ascorbic acid is high, implying an increase of 1% of capsanthin content resulted on the average an increase of 0.3114 units in ascorbic acid, other variables held constant. Though there is no correlation between capsaicin and ascorbic acid, the direct effect of capsaicin (0-0719) on ascorbic acid was quite sizable and negative. The number of fruits/plant and ascorbic acid were negatively correlated and also the direct effect of number of fruits/plant (0.1325) was high and negative. The indirect effect of number of fruits/plant via fruit length (-0.0816) and capsanthin content (0.0480) was negative and high. Fruit length and ascorbic acid content were highly positively correlated (r=0.3320) and the direct effect of fruit length on ascorbic acid was to the extent of 0.2414. Fruit length also indirectly influenced ascorbic acid content positively through plant yield/plant, capsanthin content, capsaicin content, number of fruits/plant and pedicel length and negatively through 50 fruit stalk weight and 1000 seed weight (Table 3).

Pedicel length and ascorbic acid were positively correlated (r=0.2772) and though the direct effect was 0.0682, its indirect effect via fruit length and number of fruits/plant were worth to be noted. The total correlation of fruit stalk weight with ascorbic acid was significant and positive but its direct effect (-0.0579) was negative and its indirect effects through other characters namely fruit length, number of fruits/plant, capsanthin content, capsaicin content, pedicel length, plant yield/plant and 1000 seed weight at varying magnitudes were high and finally made the correlation with ascorbic acid positive and significant. Thousand seed weight and ascorbic acid content were positively correlated and this was due to the direct effect of 1000 seed weight on ascorbic acid content. The indirect effect of 1000 seed weight via other characters were small and negligible.

The results revealed that the ascorbic acid content was positively correlated with each of 1000 seed weight, fruit stalk weight, pedicel length, fruit length, number of fruits/plant and capsanthin content and among the independent variables, the direct effect of 1000 seed weight was maximum followed by fruit length. The residual effect in the investigation was high due to the fact that many other independent variables like environmental factors and other plant traits (Reeves, 1987) not included in the study influenced the quality traits.

On the basis of present investigation, it appears that selection procedures i) based on stem height upto 3rd internode length, ascorbic acid content and fruit stalk weight may be used to improve the capsanthin content ; ii) based on fruit weight coupled with fruit length may be used to improve the capsaicin content and iii) based on capsaicin content, number of fruits/plant, fruit length and 1000 seed weight may be used to improve the ascorbic acid content.

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THE BEHAVIOUR OF ALTERED MALE STERILE LINES IN PEARL MILLET

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ABSTRACT

Five male sterile AxB combinations involving alternate B lines (81A x 3383B, 81A x pb 305 B, 3383A x 81B, pb 302A x pb 305B, pb 403A x pb 405B) were chosen and nine altered A lines were developed by transferring the genome of alternate B lines at 50 per cent and 75 per cent levels. Studies on the altered A lines indicated the possibility of altering the morphological expression of a A line by changing B lines. The differences between the original A lines and altered A lines were found to be significant. This may be due to the interaction of the genome of the alternate B line with the genome of original A line. For example, the altered A lines of 81A flowered earlier than the original A line and the difference was significant (81A x 3383B). The choice of appropriate b lines for altering A lines appeared to be very important. Transfer of genome from one B line to another A line at 50 per cent level appeared to be effective in improving the morphological expression and thus F1 sterile lines could be profitably utilised in developing three-way crosses.

KEY WORDS : Altered A lines, 50 and 75 per cent Transferred genome, F_1 male sterile line

Inbred male sterile lines because of their uniformity are found to be more susceptible to environmental variation and diseases. Further, some of the male sterile lines are sensitive to photoperiod and temperature (Rai and Witcombe,