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***Short Communication***

# Performance of newly developed cytoplasmic male sterile lines of cabbage (*Brassica oleracea* var. *capitata* L.) under mid- hill conditions of Himachal Pradesh

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**Abstract**

**The present investigation comprising of seventeen genotypes was carried out to evaluate the performance of newly developed cytoplasmic male sterile lines of cabbage for various quantitative traits. The analysis of variance revealed that mean squares due to genotypes were significant for all the traits, highlighting the presence of sufficient genetic variability among the CMS lines. Based on the *per se* performance with respect to marketable head yield and related traits, the best CMS line identified was II-105-CMS (231.48 q/ha) which was statistically at par with other two CMS lines namely II-M-CMS (215.92 q/ha) and III-105-CMS (210.37 q/ha). All these three CMS lines with respect to marketable head yield were also found quite promising in other important horticultural traits and from consumer's point of view.**

**Key words:** Cabbage, per se performance, genetic variability, CMS.

Cabbage (*Brassica oleracea* var. *capitata* L.) is one of the most economically important cole crops of *Brassicaceae* family, sharing a common chromosome number 2x=2n=18 (Bothmer *et al*. 1995). It has primarily originated from an ancestor *Brassica oleracea* var. *oleraceae* L. (syn. *sylvestris* L.), commonly known as wild cabbage and probably the Western Mediterranean region is considered as its primary center of origin (Ji *et al*. 2020). Cabbage is an important cash crop of mid and high hills of Himachal Pradesh and brings remunerative returns to farmers. In India, after Tamil Nadu (66.42 tonnes/ha), maximum productivity of cabbage (33.73 tonnes/ha) is found in Himachal Pradesh (Anonymous 2017). Being a highly cross pollinated crop, cabbage shows tremendous variability in the available germplasm for most of the traits. The success of crop improvement programmes relies heavily on genetic variability existing in the cultivated species either through natural processes or plant breeding for realizing higher economic yield. Therefore, the present study was undertaken to generate the extent of variation among different CMS lines for head yield and related traits in cabbage.

The experiment was conducted at Vegetable Research Farm, Department of Vegetable Science and Floriculture, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur during *Rabi* season, 2019-2020. The experimental material comprised of 17 diverse CMS lines developed at CSK HPKV, Palampur and trial was laid out in randomised block design with three replications at a spacing of 45 cm × 45 cm. Inter cultural operations were carried out as per the recommended package of practices. Five plants were randomly selected from each replication per genotype for recording various horticultural traits. The data of quantitative traits were statistically analysed as per methods lined out by Panse and Sukhatme (1984) for estimating the analysis of variance.

The analysis of variance revealed that mean squares due to genotypes were highly significant for all traits viz. days to harvest, plant spread, stalk length, number of non-wrapper leaves, gross weight, net head weight, polar and equatorial diameter of head, head shape index, head compactness and marketable head yield per plot, thereby highlighting the presence of

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sufficient variability in the existing genetic material (Table 1). Earlier workers namely, Sharma (2001), Thakur and Thakur (2002), Atter (2004), Atter *et al*. (2009) and Meena *et al*. (2009) had also reported significant variability in their respective cabbage material for different set of characters studied.

Earliness is extremely desirable character in all vegetables as the prevailing prices in the market are inevitably higher early in the season. With respect to days to harvest CMS line II-105-CMS took least number of days (92.99). Whereas, G7-S-CMS took maximum number of days (118.23). Various earlier workers namely, Sharma (2010) Singh *et al*. (2013) and Raygade (2015) had also noticed significant differences in days to harvest. Genotypes with minimum plant spread are desired in order to obtain higher yield per unit area. Plant spread ranged from 30.63 cm in E-1-3-1&2 to 39.84 cm in G7-M-CMS with overall general mean of 35.76 cm. CMS lines namely, 1-105-CMS (34.13 cm), III-M-CMS (33.54 cm), G7-S-CMS (34.09 cm) and GAP-S-CMS (32.29 cm) were found to be statistically at par with E-1-3-1&2. Shorter stalk length is preferred to have better plant stand. The stalk length varies from 2.06 cm in E-1-3-1&2 to 3.46 cm in II-105-CMS with an overall general mean of 2.76 cm. CMS lines viz. I-105-CMS (2.80 cm), I-S-CMS (2.59 cm), I-M-CMS (2.64 cm), II-M-CMS (2.73 cm), G7-S-CMS (2.61 cm), GAP-105-CMS (2.54 cm), GAP-S-CMS (2.38 cm), GAP-M-CMS (2.71 cm) and SC 2008-09 (2.08 cm) were statistically at par with E-1-3-1&2. Less number of non-wrapper leaves are desired in cabbage so as to obtain higher net head yield.Number of non-wrapper leaves ranged between 9.79 in GAP-S-CMS to 11.91 in I-M-CMS (Table 2). These results are in close conformity with the findings of Mishra *et al*. (2013) and Parkash and Verma (2004).

Gross weight, net head weight, polar diameter, equatorial diameter, head shape index, head compactness and marketable head yield are the important traits which reflects the yield potential of a particular genotype. Gross weight was found maximum in I-105-CMS (993.00 g) which was statistically at par with I-M-CMS (981.34 g) and was minimum in SC 2008-09 (544.34 g). Net head weight ranged between 266.00 g in SC 2008-09 to 646.00g in II-105-CMS. Maximum net weight of head was recorded in II-105-CMS and was significantly superior with respect to other CMS lines. The highest polar diameter was recorded in III-M-CMS (12.96 cm) and the lowest of 10.16 cm was recorded in SC 2008-09. Lines viz. I-105-CMS (12.92 cm) and GAP-S-

**Table 1. Analysis of variance (mean sum of squares) for quantitative traits in cabbage (*Brassica oleracea* var. *capitata* L.)**

| Source of variation | | Mean squares due to | | |
|---|---|---|---|---|
| | | Replication | Genotypes | Error |
| **Traits** | **df** | **2** | **48** | **96** |
| Days to harvest | | 2.18 | 180.27* | 2.19 |
| Plant spread (cm) | | 0.34 | 26.35* | 2.32 |
| Stalk length (cm) | | 0.17 | 0.84* | 0.11 |
| Number of non-wrapper leaves | | 6.31 | 2.87* | 0.80 |
| Gross weight (g) | | 911.53 | 63973.21* | 59.64 |
| Net head weight (g) | | 133.19 | 39047.99* | 39.32 |
| Polar diameter (cm) | | 0.06 | 1.63* | 0.05 |
| Equatorial diameter (cm) | | 0.03 | 2.10* | 0.04 |
| Head shape index | | 0.00 | 0.008* | 0.002 |
| Head compactness ($g/cm^3$) | | 2.12 | 83.92* | 0.65 |
| Marketable head yield per plot (kg) | | 0.05 | 5.42* | 0.21 |

*Significant at 5% level

**Table 2. Mean performance of cabbage (*Brassica oleracea* var. *capitata* L.) for various quantitative traits during *rabi* season 2019-2020**

| Genotypes | Days to harvest | Plant spread (cm) | Stalk length (cm) | Number of non-wrapper leaves | Gross weight (g) | Net head weight (g) | Polar diameter (cm) | Equato-rial diameter (cm) | Head shape index | Head compact-ness ($g/cm^3$) | Marke-table head yield (q/ha) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| I-105-CMS | 103.93 | 34.13 | 2.80 | 11.25 | 993.00 | 541.67 | 12.92 | 12.56 | 1.03 | 26.21 | 187.41 |
| I-S-CMS | 102.99 | 34.82 | 2.59 | 11.04 | 933.00 | 488.34 | 12.26 | 11.28 | 1.09 | 30.00 | 187.77 |
| I-M-CMS | 106.42 | 36.53 | 2.64 | 11.91 | 981.34 | 468.00 | 11.26 | 11.04 | 1.02 | 33.78 | 179.26 |
| II-105-CMS | 92.99 | 36.38 | 3.46 | 10.28 | 958.00 | 646.00 | 11.88 | 12.96 | 0.92 | 33.78 | 231.48 |
| II-S-CMS | 105.47 | 39.90 | 3.01 | 10.27 | 849.67 | 393.00 | 11.28 | 11.52 | 0.98 | 26.57 | 121.48 |
| II-M-CMS | 105.2 | 37.90 | 2.73 | 11.21 | 885.34 | 546.00 | 11.15 | 11.18 | 1.00 | 39.28 | 215.92 |
| III-105-CMS | 111.83 | 39.27 | 2.95 | 11.20 | 830.00 | 532.67 | 11.90 | 11.58 | 1.04 | 32.93 | 210.37 |
| III-M-CMS | 99.55 | 33.54 | 3.00 | 10.79 | 839.00 | 526.67 | 12.96 | 12.98 | 1.00 | 24.15 | 195.18 |
| GI-S-CMS | 98.08 | 38.62 | 3.19 | 10.11 | 850.34 | 479.67 | 11.28 | 11.31 | 1.00 | 33.33 | 165.92 |
| GI-M-CMS | 113.16 | 35.44 | 3.14 | 10.94 | 829.34 | 551.34 | 11.59 | 11.75 | 1.01 | 34.73 | 170.37 |
| G7-S-CMS | 118.23 | 34.09 | 2.61 | 11.38 | 758.00 | 378.34 | 10.37 | 9.94 | 1.05 | 36.18 | 121.48 |
| G7-M-CMS | 117.28 | 39.84 | 2.99 | 11.68 | 764.34 | 399.00 | 11.73 | 10.84 | 1.08 | 27.82 | 138.15 |
| GAP-105-CMS | 109.33 | 35.33 | 2.54 | 10.83 | 807.67 | 481.34 | 12.29 | 11.60 | 1.06 | 28.28 | 172.59 |
| GAP-S-CMS | 111.44 | 32.29 | 2.38 | 9.79 | 883.67 | 497.67 | 12.57 | 12.16 | 1.04 | 26.35 | 172.22 |
| GAP-M-CMS | 111.99 | 34.76 | 2.71 | 11.39 | 853.67 | 428.34 | 10.81 | 10.81 | 1.00 | 34.04 | 153.33 |
| SC 2008-2009 | 114.22 | 34.52 | 2.08 | 11.05 | 544.34 | 266.00 | 10.16 | 9.88 | 1.03 | 26.50 | 95.18 |
| E-1-3-1&2 | 116.14 | 30.63 | 2.06 | 10.88 | 570.67 | 356.67 | 10.59 | 9.99 | 1.06 | 33.29 | 123.33 |
| Range | 92.99-118.23 | 30.63-39.84 | 2.06-3.46 | 9.79-11.91 | 544.34-993.00 | 266.00-646.00 | 10.16-12.96 | 9.88-12.98 | 0.92-1.08 | 24.15-39.28 | 95.18-231.48 |
| General mean | 108.13 | 35.76 | 2.76 | 10.94 | 831.26 | 469.45 | 11.59 | 11.38 | 1.02 | 31.01 | 167.14 |
| SE (m) ± | 1.21 | 1.25 | 0.27 | 0.73 | 6.09 | 4.89 | 0.18 | 0.17 | 0.03 | 0.60 | 5.38 |
| CD (5%) | 3.64 | 3.75 | 0.83 | 2.21 | 18.97 | 15.41 | 0.55 | 0.53 | 0.09 | 1.99 | 21.11 |
| CV (%) | 1.40 | 4.31 | 10.99 | 8.09 | 0.83 | 1.09 | 1.91 | 1.83 | 3.84 | 2.27 | 26.98 |

CMS (12.57 cm) were statistically at par with III-M-CMS. The perusal of data showed a range of equatorial diameter of head varying from 9.88 cm (SC 2008-09) to 12.98 cm (III-M-CMS). III-M-CMS was found to have maximum equatorial diameter of head and was statistically at par with I-105-CMS (12.56 cm) and II-105-CMS (12.96 cm). Similarly head shape index was maximum in G7-M-CMS (1.08) and minimum in II-105-CMS (0.92).The range of CMS lines for compactness of head varied from 24.15 g/cm$^3$ (III-M-CMS) to 39.28 g/cm$^3$ (II-M-CMS). Highest marketable head yield was recorded in II-105-CMS (231.48 q/ha) and lowest in SC 2008-09 (95.18 q/ha). CMS lines viz. II-M-CMS(215.92 q/ha) and III-105-CMS(210.37 q/ha) and)were statistically at par with II-105-CMS. Considerable amount of variability was observed with respect to range and mean values of all the traits studied. The results are in agreement with those of Thakur and Thakur (2002), Raygade (2015) and Kibar *et al*. (2016). Therefore, those CMS lines with the best means for targeted characters should be selected as parents for production of superior recombinant genotypes by using appropriate breeding designs.

**Conflict of interest:** The authors declare that there is no conflict of interest among them in this research paper.

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