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CULTIVAR VARIATION OF CAULIFLOWER AGAINST CABBAGE BUTTERFLY *Pieris brassicae* (L.) PIERIDAE: LEPIDOPTERA

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In the present study, eighteen genotypes of cauliflower were used to identify their resistance and susceptibility against cabbage butterfly. All genotypes were sown following RCBD with three replicates and plant-to-plant as well as row-to-row distance was maintained as 0.46m and 0.61m, respectively. Data regarding larval population were recorded by selecting 10 plants randomly from each plot at 4±1 day intervals throughout the crop season and analyzed following DMR test at p=0.05. Genotypes viz. Cool Sun-70, Cauliflower Desi, Cash Mare, White Island were susceptible; whereas Shumila F1 H was recorded as intermediate; however, Pari F1 H showed resistant responses during 2008-09. They were again sown during 2009-10 to confirm the findings of the previous year. The population of *Pieris brassicae* differed significantly among genotypes, dates of observation and among their interactions. The genotype Cool Sun-70 was recorded susceptible; whereas Pari F1 H was recorded as resistant with 30.02 and 3.44 per plant population of *P. brassicae*, respectively. Based on the preliminary screening trials data, selected genotypes viz. Cool Sun-70, Cauliflower Desi, Cashmere, White Island, shumila F1H and Pari F1 H differed significantly regarding per plant population of *P. brassicae*. The highest population (28.71 per plant) was observed on Cool Sun-70, whereas minimum population (15.45 per plant)was recorded on Pari F1 H, and these two cultivars were proved to be susceptible and resistant cultivars, respectively against *P. brassicae*.
Keywords: Resistance appraisal, Cauliflower, genotypes, *Pieris brassica*, larvae

INTRODUCTION

Cauliflower (*Brassica oleracea)* is an excellent human food with high nutritive value. It has low fats and carbohydrate contents; is rich in dietary fiber, folate, water and vitamin C and possesses a high nutritional density. It also contains several phytochemicals beneficial to human health which may include sulforaphane (a safeguard against cancer), many glucosinolates, carotenoids,Indole-3-carbinol (a chemical that enhances DNA repairing and acts as an estrogen antagonist) to slow down the growth of cancer cells (FAO, 2012). A high intake of cauliflower has been associated with reduced risk of aggressive prostate cancer (Kirsh *et al*., 2007).

The cabbage butterfly, *Pieris brassicae* (Lepidoptera: Pieridae) is a common insect pest of cauliflower. Young larvae graze away the lower epidermis of the leaves whereas the older larvae cause extensive defoliation. They often reduce the plant to a skeleton of stems, veins and finally may kill the plant. Previously, the resistance to cabbage butterfly larvae's attack of a transgenic insect resistant rapeseed line carrying the *Bacillus thuringiensis* insecticidal protein gene was investigated (Lin *et al.,* 2001). They reported the death rate of the pest as 11.11% to 12.50%, 35.71%, 66.67%, 33.33% and 50.00% at the first, second, third, fourth and fifth instar stage of the larvae and at the pupal stage, respectively. Moreover, the total death rate was 94.44% when the larvae were reared in the laboratory and fed on the transgenic rap-seed leaves as compared to a mortality of 15.55% in control.Similarly the brassicae genotypes (Cylone, SPS-5, CON-III, CCS-01, Oscar, CON-II and KS-75) were used to study the impact of *P. brassicae* under field conditions. It was observed that the cabbage butterfly showed the highest preference towards the genotype Cyclone whereas, CON-II was the least preferred Aslam *et al.* (2000). Younas *et al*. (2004) studied the population dynamics of cabbage butterfly and cabbage aphids on different cultivars of cauliflower namely Snowball, Snowdrift, Tropical, Pioneer and Meigettsal and concluded these two pests as the major pests of cabbage. The development of *P. brassicae* larvae on different food plants i.e., white cabbage (*Brassica oleracea ar.* capitata f. alba.) red cabbage (*B. oleracea* var. Capitata f. rubra), kale (*B. oleracea* var. acephala (*B. oleracea* var. virdis), swede (*Brassica napus* var. napobrassica) and nasturtium (*Tripaeolum najus*) studied by Jogar *et al.* (2005). The results of that study showed the highest mortality rate (78%) when the larvae were fed nasturtium, while the mortality rate was the lowest (8%) in the larvae that were reared on white cabbage. Another experiment conducted by Ali and Rizvi (2007) showed that the developmental response of cabbage butterfly (*P. brassicae*) was significantly higher on yellow sarson and lower on cabbage under laboratory and field conditions, respectively. Rather and Azim (2009)

investigated the feeding behaviour of *P. brassicae* larvae under laboratory conditions in response to different plants viz., *Brassicae oleracea*, *Raphanus sativas*, *Lycopersicon esculentum*; capitata and botrylis varities of *B. oleracea*and different forms of plants (intact/macerated) using Y-tube olfactometer. They reported that *B. oleracea* was highly preferred by the larvae as compared to *Raphanus sativus* and *Lycopersicon esculentum*. Rizvi *et al.* (2009) studied the response of cabbage butterfly on cabbage, cauliflower, yellow sarson, gobhi sarson and Indian mustard. The results showed that cabbage was the most preferred food of *P. brassicae* than other cole crops. Sharma *et al*. (2005) studied the population dynamics of cabbage butterfly on cauliflower (*Brassica oleracea* var. Botrytis) seed crop variety Sel.4 in relation to biotic factors and recorded peak population (12.03 larvae per plant) in the fourth week of January, 2005. Similarly, a study conducted by Akhtar *et al.* (2012) has provided insights into the population dynamics of diamondback moth on various cabbage varieties in relation to host plant resistance. Based on these studies, the present study was conducted to screen the available cauliflower cultivars for their resistance/susceptibility against cabbage butterfly.

MATERIALS AND METHODS

Eighteen cultivars of cauliflower viz., Candid Charm, Cashmere, Cauliflower Desi, Cool Sun-70, Cool Sun-71, Early Kanwari, Shamila F1 H, Pari, Pari F1 H, Snow Ball, Snow Crown, Snow Drift, Snow Grace, White Corona H, White Excel, White Island, White Magic H and White Shot H were grown using the Randomized Complete Block Design (RCBD) replicated thrice. Based on the preliminary screening trials data, two susceptible genotypes viz. Cool Sun-70 and Cauliflower Desi, two intermediate viz. Cashmere and White Island and two showing comparatively resistant response viz. Shumila F1 H and Pari F1 H were selected for the final screening experiments.

The plant-to-plant and row-to-row distance was kept at 0.46m and 0.61m, respectively. The data on larval population were recorded from ten randomly selected plants from each plot at 4±1 day intervals throughout the crop season during the session 2008-09 and 2009-10. The data were analyzed statistically with the help of MSTAT software package and means were separated following DMR test at p = 0.05.

***Calculation of host plant susceptibility indices (HPSI)*:** The objective of the present study was to determine the role of genotypes towards susceptibility in percentage within the test materials. For this purpose, a graphic Microsoft package was used with IBM compatible computer. However, HPSI was calculated by the following formula (Aziz, 2010).

$$\text{Percent HPSI} = 100 - \frac{\text{B x A}}{\text{B}} \times 100$$

Where, A is larval population per plant in individual genotype of cauliflower and B is larval population on all genotypes of cauliflower on average basis.

The host plant susceptibility indices were calculated based on the larval population of *P. brassicae* per plant for the years 2008-09 and 2009-10 to find the actual role of individual genotype compared with the genotypes under study.

RESULTS AND DISCUSSION

***Preliminary screening trial during 2008-09*:** The analysis of variance (Table 1a) reveals significant difference (P≤0.01) among dates of observation, genotypes and in their interactions (Table 1a and Fig. 1a).

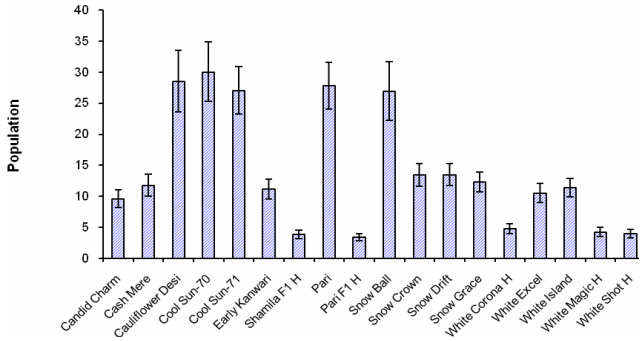

Figure 1. Population of *Pieris brassicae* per plant on different genotypes of cauliflower during 2008

However, maximum population of *P. brassicae* was recorded on Cool Sun-70 (30.02 larvae/ plant) and differed significantly from those of observed on all other genotypes. The minimum larval population of *P. brassicae* was recorded as 3.44 per plant on Pari F_1 H and did not show significant difference with those of recorded on Shumila F_1 H and White Shot with 3.88 and 4.04 number of larvae of *P. brassicae* per plant, respectively. The larval population of *P. brassicae* was recorded 11.83 and 11.39 per plant on Cashmere and White Island, respectively and they were categorized as intermediate. Both these genotypes also showed non-significant variation with those of recorded on Snow Grace and Early Kanwari with 11.86 and 11.17 per plant population of *P. brassicae*, respectively. In brief, the genotypes ranked in descending order are as followed; Cool Sun-70 > Cauliflower Desi > Pari > Cool Sun-71 > Snow Ball > Snow Drift > Snow Crown > Snow Grace > Cashmere > White Island > Early Kanwari > White Excel > Candid Charm > White Corona H > White Magic H > White Shot H > Shumila F1 H > and Pari F1 H. From these results, it was concluded that the genotype Cool Sun-70 was

Table 1. Population of *P. brassicae* per plant on different selected genotypes of cauliflower at various dates of observation during 2009-10

Dates of Observation	Interaction between Dates of Observation and Genotypes (LSD at 5% = 4.48)						Average (LSD at 5%=1.83)
	Cool Son-70	Cauliflower Desi	Cashmere	White Island	Shumila F1 H	Pari F1 H	
05.10.2009	61.03 d	44.90 fgh	34.00 j	39.43 i	44.00 ghi	29.90 jk	42.21 C
09.10.2009	88.83 a	77.00 b	58.10 d	49.46 ef	40.56 hi	40.73 hi	59.12 A
13.10.2009	62.70 d	68.50 c	51.23 e	41.37 hi	33.00 jk	43.33 ghi	50.02 B
17.10.2009	52.56 e	59.43 d	47.86 efg	34.67 j	28.46 k	31.53 jk	42.42 C
21.10.2009	31.46 jk	30.07 jk	28.16 k	28.76 k	17.53 l	19.86 l	25.98 D
25.10.2009	17.30 l	15.70 lm	18.73 l	19.10 l	12.56 mn	10.80 no	15.70 E
29.10.2009	10.43 no	8.20 nop	5.50 o-t	7.46 opq	3.43 p-t	4.43 p-t	6.58 F
03.11.2009	8.43 nop	6.36 o-r	4.46 p-t	6.06 o-s	2.63 q-t	3.60 p-t	5.26 F
07.11.2009	6.27 o-r	6.39 o-r	2.60 q-t	2.70 q-t	0.63 st	1.00 rst	2.26 G
11.11.2009	4.16 p-t	5.06 p-t	2.06 q-t	2.30 q-t	0.16 t	0.16 t	2.32 G
15.11.2009	0.93 rst	0.33 t	0.13 t	0.26 t	0.00 t	0.00 t	0.28 H
19.11.2009	0.36 t	0.13 t	0.03 t	0.06 t	0.00 t	0.00 t	0.10 H
Average (LSD at 5% =1.29)	28.71 A	26.84 B	21.07 C	19.31 D	15.25 E	15.45 E	

Means sharing similar letters in rows and columns regarding interaction, in columns regarding average dates of observation and in row regarding average of genotypes are not significantly (P>0.05) different by DMR Test.

comparatively susceptible whereas Pari F1 H showed comparatively resistant response against *P. brassicae*. Furthermore, the genotypes Cashmere and White Island were intermediate. However, overall, the genotypes did not differ significantly from each other (R^2 = 0.2206) (Fig. 1). Keeping in view the above results (plants were selected randomly), two genotypes viz. Cool Sun-70 and Cauliflower Desi showing susceptible response, two genotypes viz. Cashmere and White Island showing intermediate response and two genotypes viz. Shumila F1 H and Pari F1 H showing a comparatively resistant trend against *P. brassicae* were selected for final screening experiment during 2009-10.

***Period of population abundance*:** The results showed that the peak population of *P. brassice* was recorded on 08.10.2008, thereafter, it gradually decreased on subsequent dates, reaching to a lowest level i.e., 0.08 per plant on 17-11-2008 (Fig. 2). Only one peak was recorded in this cropping season. Means sharing alphabet letters showed significant difference among the dates of observation (LSD value at 5%;P=0.576).

***Final screening trials during 2009*:** The results revealed a significant difference (P<0.01) among dates of observation, genotypes and their interaction. The genotype Cool Sun-70 had the highest population of *P. brassicae* i.e., 28.71 per plant and differed significantly from those recorded on all other genotypes. The lowest population of 15.45 per plant was recorded on genotype Pari F1 H and did not show significant difference with those of recorded on Shumila F1 H with 15.25 larvae per plant. The genotypes White Island and Cashmere with 21.07 and 19.31 larvae per plant respectively, differed significantly with one another as well as with all other genotypes. These genotypes were categorized as intermediate (Table 1).

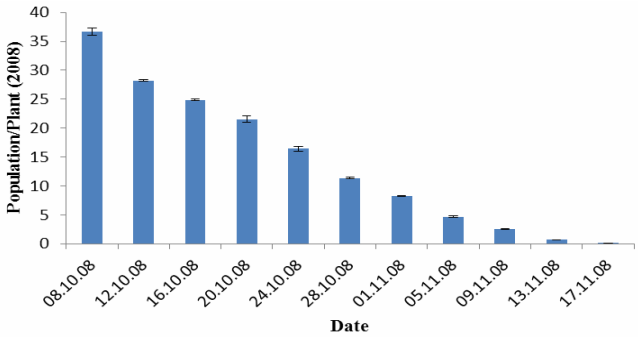

Figure 2. Population of *Pieris brassicae* per plant on cauliflower at various dates of observation during 2008.

The genotype Cauliflower Desi with 26.84 larvae per plant also showed a significant difference from all other genotypes and proved comparatively resistant followed by Cool Sun-70. Conclusively the genotypes ranked in descending order like: Cool Sun-70 > Cauliflower Desi > Cashmere > White Island > Pari F1 H > Shumila F1 H. Furthermore, the response of genotypes towards susceptibility and resistance was almost similar to those observed in the preliminary screening experiment during 2008-09, except a non-significant variation found between Shumila F1 H and Pari F1 H, where Shumila F1 H showed the lowest population of

P. brassicae but in the preliminary screening experiment Pari F1 H resulted in the lowest population of the pest (Table 1).

***Period of abundance*:** The results showed that the observation recorded on 09-10-2009 had the highest population of the pest with a subsequent decline in the population trend reaching to a minimum of 0.10 per plant on 19-11-2009 (Table 2b). From these results, it was concluded that there was also only one peak of the pest throughout the crop season, which was recorded on 9-10-2009.

Table 2. HPSI in various selected genotypes of cauliflower based on the population of *Pieris brassicae* per plant during 2008-09 and 2009-10.

Genotypes	Host Plant Susceptibility Indices (%)		
	2008-09	2009-10	Average
Cool Sun-70	34	23	27
Cauliflower Desi	32	21	26
Pari F1 H	4	12	9
Shumila F1 H	4	12	9
Cash Meri	13	17	14
White Island	13	15	15

***Interactional response between dates of observation and genotypes*:** The results presented in Table 2b are regarding interaction between the dates of observation and genotypes. All the genotypes showed the highest population of *P. brassicae* on 9-10-2009 except Pari F1 H which showed the maximum population of the pest on 13-10-2009. Furthermore, all the genotypes showed a decreasing trend throughout the cropping season starting from the observation recorded on 13-10-2009 to 19-11-2009.

In case of Pari F1 H, it was observed that the population of the pest was recorded 29.90 per plant on 5-10-2009 and this population increased up to the highest peak i.e., 43.33 per plant on 13-10-2009. A continuous decreasing trend was observed thereafter on the subsequent dates of observation.

***HPSI for the year 2008*:** The results presented in Fig. 3 are regarding HPSI in different genotypes of cauliflower based on the larval population of *P. brassicae* per plant during 2008-09. It was observed that the genotype Cool Sun-70 showed maximum HPSI i.e., 12% followed by Cauliflower Desi, Pari, Cool Sun-71 and Snow Ball each showing 11% HPSI. The minimum HPSI recorded was 1% for Pari F1 H that was the most resistant genotype. 2% HPSI was recorded on Shumila F1 H, White Shot, White Magic H and White Corona H, 4% HPSI was observed on Candid Charm, White Excel, Early Kanwari and White Island and 5% HPSI was found each on Cashmere, Snow Grace, Snow Crown and Snow Drift. From these results, it was concluded that the genotype Pari F1 H showed minimum HPSI i.e., 1%, whereas Cool Sun-70 proved a susceptible genotype showing maximum HPSI i.e., 12%.

***HPSI during 2008-09 on selected genotypes of cauliflower*:** The results presented in Table 2 are regarding HPSI in various selected genotypes of cauliflower based on the larval population of *P. brassicae* per plant during 2008-09. The genotype Cool Sun-70 showed maximum HPSI i.e., 34% followed by Cauliflower Desi that possessed 32% HPSI. The minimum HPSI i.e., 4% was recorded on Pari F1 H and Shumila F1 H. The genotypes Cash Meri and White Island showed 13% HPSI and they were categorized as intermediate.

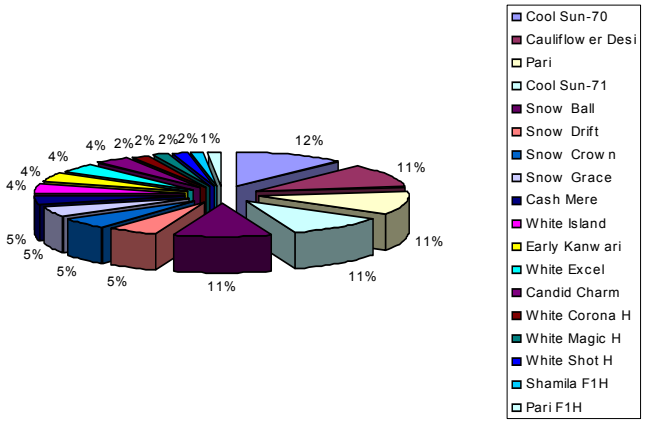

Figure 3. HPSI in different genotypes of cauliflower based on the population of *Pieris brassicae* per plant during 2008.

***HPSI during 2009 on selected genotypes of cauliflower*:** The results presented in Table 2 show the HPSI in various selected genotypes of cauliflower based on the larval population of *P. brassicae* per plant during 2009. The genotype Cool Sun-70 with maximum HPSI i.e., 23% was comparatively susceptible, followed by Cauliflower Desi with 21% HPSI. The minimum HPSI was recorded 12% for Pari F1 H and Shumila F1 H. The genotypes Cashmere and White Island recorded with 17% and 15% HPSI, respectively and were categorized as intermediate.

***HPSI during 2008-09 and 2009-10 (average)*:** The results presented in Table 2 are regarding HPSI in various selected genotypes of cauliflower based on the larval population of *P. brassicae* per plant on an average of 2008-09 and 2009-10. The genotype Cool Sun-70 showed 27% HPSI followed by Cauliflower Desi 26%. The minimum HPSI was calculated 9% for Pari F1 H and Shumila F1 H. The genotypes Cashmere and White Island were categorized as intermediate with 14% and 15% HPSI, respectively.

The genotype Cool Sun-70 showed a maximum population of *P. brassicae* and was found to be comparatively susceptible with 30.02 populations per plant whereas the genotype Pari F1 H appeared comparatively resistant with the lowest population of *P. brassicae* i.e., 3.44 per plant. In brief, genotypes were ranked under descending order as

follows: Cool Sun-70 > Cauliflower Desi > Pari > Cool Sun-71 > Snow Ball > Snow Drift > Snow Crown > Snow Grace > Cashmere > White Island > Early Kanwari > White Excell > Candid Charm > White Corona H > White Magic H > white Shot H > Shumila F1 H > and Pari F1 H.

Variation was found significant among genotypes, dates of observation and in their interaction during 2009-10. The genotype Cool Sun-70 again showed susceptible response with a maximum population of *P. brassicae* i.e. 28.71 per plant and the genotype Pari F1 H appeared resistant with a minimum population of the pest i.e., 15.45 per plant. The response of other genotypes was almost similar to those observed in the preliminary screening trial. Resultantly, the genotypes Cool Sun-70 and Pari F1 H were declared as the most susceptible and the most resistant respectively to *P. brassicae*.

The present findings cannot be compared with those of Lin *et al.* (2001), Aslam *et al*. (2000), Younas *et al.* (2004), Ali and Rizvi (2007), Metspalu *et al*. (2009), Rather and Azim (2009) and Rizvi *et al*. (2009) because they studied different host plants in various ecological conditions. Similarly, the findings of Yadav *et al.* (2008) are concerned with a different ecological condition and different cultivars of cauliflower. Furthermore, in the present study, the peak population of the pest was recorded 36.63 per plant on 08-10-2008 while 59.12 per plant on 09-10-2008. A decreasing trend in population abundance of *P. brassicae* was observed, thereafter on the subsequent dates of observation during both study years and the population reached to a minimum level of 0.08 on 17-11-2008 and 0.10 on 19-11-2009. The variations in the population can be justified by the results of Siddiqui *et al*. (2009) study that elucidated the effect of cultivation on aphid population in cauliflower cultivars. It should be further investigated the impact of sowing timing on the population dynamics of the cabbage butterfly.

The present study explores new horizons of providing detailed characteristics of various cauliflower cultivars regarding susceptibility and resistance to *P. brassicae*. The cultivation of Pari F1 H in such condition can be suggested on the bases of present findings but further investigations are required to elucidate the response of these cultivars against other pests.

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