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To study the level of self-incompatibility in Indian cauliflower (*Brassica oleracea* var. *botrytis* L.)

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Abstract
The present investigation was conducted during the year 2019-20 and 2020-21 at horticultural research cum instructional farm, IGKV, Raipur. The experimental material comprised of 24 genotypes and the experiment was layout in Randomized Block Design with 3 replications. The study was primarily focused on assessing percentage of self- incompatibility in each genotype. All the genotype during 1st year exhibited high level of self-incompatibility (self-pollination Vs cross pollination) per cent ranged from (91.93) Kartika×Rajasthan Early Kunwari to (96.43) Rajasthan Early Kunwari. All the genotype exhibited high level of self-incompatibility (bud pollination Vs cross pollination) per cent ranged from Kartika (91.63) to Rajasthan Early Kunwari (72.37). All the genotype during 2nd year exhibited high level of self-incompatibility (self-pollination Vs cross pollination) per cent ranged from (87.66) Rajasthan Early Kunwari to (98.25) Kartika. All the genotype exhibited high level of self-incompatibility (bud pollination Vs cross pollination) per cent ranged from IGC-9×Sabour Agrim (88.87) to Pusa Meghna (62.32).

Keywords: Self-incompatibility, self-pollination, cross pollination, bud pollination etc.

Introduction
Cauliflower, *Brassica oleracea var. botrytis* h. (2n=2x-18) belongs to the cole group of vegetables. It originated primarily from the ancestor *Brassica oleracea var. oleracea L.* (syn. *sylvestris* L.), commonly known as wild cabbage through mutation, human selection and adaptation about 2000 years ago in the Eastern Mediterranean region (Boriss *et al* 2006) [2]. Among the cole crops, cauliflower is comparatively of a later origin, about 500 years ago, probably through introgression within broccoli gene pool. It probably originated in the island of Cyprus from where it moved to other areas like Syria, Turkey, Egypt, Italy, Spain and north-western Europe. It was first introduced in Italy around 1490 and Italy became the centre of genetic diversity of cauliflower where several land races of this crop are still available even today. Cauliflower is a low-calorie food with good dietary fiber, abundant in vitamins (C, B, A, K) and minerals like phosphorus, potassium, calcium, sodium, iron, manganese, magnesium and molybdenum. It also contains fair amount of glucosinolates and isothiocyanates, those having antioxidant and anti-inflammatory properties. Compound allicin also found in cauliflower which reduces the risk of heart strokes and maintain healthy cholesterol levels in addition to phytochemical, sulphorafane (organo sulflir compound) and phyto-nutrienls. Cauliflower also helps, in preventing cancer because of the presence of compound sinigrin, glucobrassicin, gluco-raphanin, gluconasturatian Smethylcysteine sulfoxide and other compounds. These compounds act as anticarcinogenic which may help in eliminating carcinogens before they can cause the DNA damage that cause cancer. It also contains selenium which along with vitamin C, Strengthen our immune system.

Cauliflower is a cross pollinated vegetable in which self-pollination is prevented by the sporophytic type of self-incompatibility. Sporophytic self-incompatibility is a type of self-incompatibility in which germination of the pollen grain hindered on stigma due to the similar S genotype of pollen and stigma. A single S locus with multiple alleles was reported to be involved in its inheritance (Bateman, 1955) [1]. Two major genes S-locus receptor kinase (*SRK*) and S-locus cysteine rich protein (*SCR*) were found to be present at this locus and involved in the recognition of self-pollen. Both the genes are tightly linked to each other and always inherited as a single unit, but perform independent action in male and female reproductive organs.

SRK was reported as a female determinant and its protein product was found in the papilla cells of stigma while *SCR* identified as a male determinant and found in the pollen coat and tapetum of the anther (Jung *et al.*, 2013; Kitashiba and Nasrallah, 2014) [3, 4].

Previously sporophytic self-incompatibility based this system was used for hybrid development in cauliflower worldwide. But due to its highly non-stable nature, it was replaced with cytoplasmic male sterility (CMS) system when Seminis vegetable seed inc. published patent (US6046383A, April 4, 2000) titled Cytoplasmic male sterile *Brassica oleracea* plants which contain the polima CMS cytoplasm and are male sterile at high and low temperatures. The presence of self-incompatibility creates hindrance while developing CMS and their maintainer lines. The assessment of self-incompatibility is still necessary to perform successful self-pollination and back-crossing for male-sterile and maintainer development and also for making successful crosses among inbred lines for hybrid cultivar development. So, still, breeders have to know the extent of self-incompatibility among the breeding material to develop hybrid cultivars.

Materials and Method

The present investigation was conducted during the year 2019-20 and 2020-21 at horticultural research cum instructional farm, IGKV, Raipur. The experimental material comprised of 24 genotypes. The experiment was layout in Randomized Block Design with 3 replications. Observation were recorded for 15 characters *viz*., plant height at harvest (cm), Stalk length (cm), Number of leaves per plant, Days to 1st flowering, Days to 50% flowering, Days to 50% curd initiation, Days to 50% curd maturity, Curd diameter (cm), Curd depth (cm), Curd size index (cm^2), Gross curd weight (g), Net curd weight (g), Harvest index (%), Yield (q/ha). The levels of self-incompatibility in all the genotypes were assessed by using the following formula

Self-incompatibility (SI) % = 100-Self-compatibility percentage, where

$$\text{SI} = \frac{\text{Average number of seed per siliqua from self pollination/bud pollination}}{\text{Average number of seed per siliqua from natural cross pollination}} \times 100$$

Result and Discussion

Analysis of variance revealed significant differences among genotypes for all traits studied indicating presence of significant variability in the materials. Hence, the data was further subjected to self -incompatibility % to estimate the association existing between yield and yield attributing components and direct and indirect effects of yield related traits, respectively. The average number of seed per pod produced under three pollination method (self – pollination, Bud pollination and Cross pollination) and estimated percentage of self- incompatibility in each genotype is given in Table – 1 and Table – 2.

Level of Self Incompatibility in 1st year

Variable number of seeds per pod was observed in the experimental material. In all the cases the seed set per siliqua under natural self-pollination was very low and it varied from 0.40 in Rajasthan Early Kunwari and 0.44 in IGC-8×Pusa Ashwin. Under bud pollination condition the genotype Rajasthan Early Kunwari produced maximum (3.10) average number of seed whereas Kartika produced the minimum (0.85). Under cross pollination condition the genotype IGC-9×Rajasthan Early Kunwari was maximum (12.23) average seed set per pod where the minimum (9.02) average seed set per recorded in genotype IGC-1×Sabour Agrim. All the genotype exhibited high level of self-incompatibility (self-pollination Vs cross pollination) per cent ranged from (91.93) Kartika×Rajasthan Early Kunwari to (96.43) Rajasthan Early Kunwari. All the genotype exhibited high level of self-incompatibility (bud pollination Vs cross pollination) per cent ranged from Kartika (91.63) to Rajasthan Early Kunwari (72.37).

Level of Self Incompatibility in 2nd year

Variable number of seeds per pod was observed in the experimental material. In all the cases the seed set per siliqua under natural self-pollination was very low and it varied from 0.22 in Kartika and 0.33 in Pusa Meghna. Under bud pollination condition the genotype IGC-8×Pusa Ashwin produced maximum (4.56) average number of seed whereas IGC-9×Sabour Agrim produced the minimum (1.10). Under cross pollination condition the genotype IGC-9×Pusa Ashwin so maximum (13.19), average seed set per pod where the minimum (8.92) average seed set per recorded in genotype Pusa Meghna. All the genotype exhibited high level of self-incompatibility (self-pollination Vs cross pollination) per cent ranged from (87.66) Rajasthan Early Kunwari to (98.25) Kartika. All the genotype exhibited high level of self-incompatibility (bud pollination Vs cross pollination) per cent ranged from IGC-9×Sabour Agrim (88.87) to Pusa Meghna (62.32).

Bud pollination was found to be effective for breaking down the self-incompatibility in cauliflower. Thus, it is possible to postulate that immature style has not yet received the necessary information for rejecting its own pollen (from immature flower in cauliflower). However, in some other cases, it has been hypothesized that self-sterility in cauliflower was caused by a substance which was in maximum concentration in the flower just opened and went on decreasing in intensity as the flower got older and it was absent in young buds (Rauala, 1972) [5].

Table 1: Level of Self Incompatibility in 1st year.

1st Year (Level of self-incompatibility)					
Treatments	Open pollination (OP)	Bud pollination		Natural Self- pollination	
		Number of seed (BP)	SI %	Number of seed (NSP)	SI %
IGC-9 × Pusa Meghna (15×23)	9.04	2.11	76.70	0.46	94.91
IGC-9 × Pusa Ashwin (15×6)	11.14	2.20	80.30	0.50	95.51
Kartika (3)	10.19	0.85	91.63	0.67	93.42
I.G.C.1	9.03	2.12	76.57	0.60	93.36
Kartika × Sabour Agrim (3×7)	9.04	1.35	85.07	0.49	94.58

I.G.C.8	10.21	1.76	82.81	0.69	93.24
IGC-8 × Rajasthan Early Kunwari (14×19)	10.38	2.60	74.98	0.74	92.90
Sabour Agrim (7)	11.95	2.68	77.57	0.82	93.14
IGC-9 × Rajasthan Early Kunwari (15×19)	12.23	1.52	87.57	0.66	94.60
IGC-8 × Sabour Agrim (14×7)	9.18	2.40	73.86	0.54	94.12
IGC-8 × Pusa Meghna (14×23)	10.83	1.20	88.92	0.64	94.09
Kartika × Pusa Ashwin (3×6)	9.15	2.34	74.43	0.48	94.75
IGC-1 × Pusa Ashwin (1×6)	9.17	2.40	73.83	0.54	94.11
IGC-1 × Rajasthan Early Kunwari (1×19)	10.03	2.12	78.86	0.62	93.82
IGC-1 × Pusa Meghna (1×23)	11.81	1.80	84.76	0.64	94.58
Kartika × Rajasthan Early Kunwari (3×19)	9.17	1.60	82.55	0.74	91.93
IGC-8 × Pusa Ashwin (14×6)	11.59	3.06	73.60	0.44	96.20
I.G.C.9	11.99	2.92	75.65	0.76	93.66
Rajasthan Early Kunwari (19)	11.22	3.10	72.37	0.40	96.43
IGC-1 × Sabour Agrim (1×7)	9.02	1.40	84.48	0.54	94.01
Pusa Meghna 23	9.57	1.86	80.56	0.50	94.78
IGC-9 × Sabour Agrim (15×7)	9.31	1.60	82.81	0.74	92.05
Pusa Ashwin 6	9.16	1.36	85.15	0.50	94.54
Kartika × Pusa Meghna (3×23)	10.26	1.62	84.25	0.756	92.63

Table 2: Level of Self Incompatibility in 2nd year.

2nd Year (Level of self-incompatibility)					
Treatments	**Open pollination (OP)**	**Bud pollination**		**Natural Self- pollination**	
		Number of seed (BP)	**SI %**	**Number of seed (NSP)**	**SI %**
IGC-9 × Pusa Meghna (15×23)	10.84	2.61	75.95	0.38	96.53
IGC-9 × Pusa Ashwin (15×6)	13.19	3.70	71.98	0.47	96.47
Kartika (3)	12.77	2.35	81.57	0.22	98.25
I.G.C.1	9.07	3.22	64.54	0.39	95.74
Kartika × Sabour Agrim (3×7)	11.38	2.85	74.96	0.62	94.55
I.G.C.8	9.04	3.26	63.98	0.42	95.35
IGC-8 × Rajasthan Early Kunwari (14×19)	10.99	2.10	80.93	0.87	92.11
Sabour Agrim (7)	12.51	4.18	66.59	0.95	92.41
IGC-9 × Rajasthan Early Kunwari (15×19)	11.76	3.02	74.32	0.39	96.68
IGC-8 × Sabour Agrim (14×7)	11.83	3.90	67.04	0.67	94.34
IGC-8 × Pusa Meghna (14×23)	10.50	2.70	74.28	0.47	95.52
Kartika × Pusa Ashwin (3×6)	11.86	3.84	67.63	0.61	94.86
IGC-1 × Pusa Ashwin (1×6)	9.13	1.90	79.20	0.67	92.66
IGC-1 × Rajasthan Early Kunwari (1×19)	11.35	3.62	68.09	0.39	96.56
IGC-1 × Pusa Meghna (1×23)	10.16	1.30	87.20	0.47	95.37
Kartika × Rajasthan Early Kunwari (3×19)	10.87	3.10	71.49	0.37	96.60
IGC-8 × Pusa Ashwin (14×6)	12.87	4.56	64.56	0.83	93.55
I.G.C.9	12.23	3.42	72.05	1.19	90.27
Rajasthan Early Kunwari (19)	11.10	4.10	63.06	1.37	87.66
IGC-1 × Sabour Agrim (1×7)	10.97	2.90	73.56	0.67	93.89
Pusa Meghna 23	8.92	3.36	62.32	0.33	96.30
IGC-9 × Sabour Agrim (15×7)	9.88	1.10	88.87	0.37	96.26
Pusa Ashwin 6	10.82	2.86	73.58	0.63	94.18
Kartika × Pusa Meghna (3×23)	11	3.12	71.67	0.37	96.64

Conclusion

It can be concluded that self-incompatibility would be used for the production of parental lines for hybridization program. For improvement of curd yield per hectare plant selection should be practiced primarily for marketable curd weight, net curd weight, gross plant weight, harvest index and curd size index while other characters like plant height, number of leaves per plant and stalk length should be considered as next important characters. All the genotypes under study were highly self-incompatible.

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