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Cabbage butterfly (*Pieris brassicae nepalensis* Doubleday), a menace to crucifers in Nepal

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Abstract
Crucifers are significant commercially grown vegetable crops that are produced throughout the world, especially in Nepal's high highlands and terai areas. Numerous significant insect pests usually attack them. The cabbage butterfly is one of them and is a worldwide nuisance of cruciferous vegetables like cabbage, cauliflower, and Knol Khol. It can also attack radish, turnip, Sarson, toria and other cruciferous plants. In the Terai and mid hills, the subspecies *Pieris brassicae* nepalensis outnumbers other subspecies. Early instar larvae munch haphazardly on the leaf, scrapping the leaf lamina before eating holes in it. This results in severe crop loss, and in the worst cases, crop collapse. In Nepal, the late-season crops of cabbage and cauliflower are severely harmed by the cabbage butterfly (*Pieris brassicae* nepalensis), which can result in yearly output losses of up to 80–100%. The cabbage butterfly of cruciferous vegetables is a significant insect pest. This page concentrates on its identification, distribution, host range, life cycle, nature of the damage, and long-term treatment, including IPM measures.

Keywords: Crucifers, cabbage, cabbage butterfly, *Pieris brassicae* nepalensis

1. Introduction
Insect pests are the most important crop-limiting factor for crucifers (Bhavani *et al*., 2009) [9]. Each year, they can account for up to 40% of crop loss (Ali & Rizvi, 2007; Hasan & Ansari, 2010; Sood & Bhalla, 1996) [2, 15, 27]. In Nepal, four cabbage butterfly species have been identified. The species are *P. brassicae*, *P. brassicae* nepalensis, *P. canidida*, and *P. canidid*a indica (Thapa, 1987) [30]. In Nepal's Terai and inner Terai regions, P.brassicae nepalensis predominates, followed by P. candida (Thapa, 1987) [30]. *P. brassicae* readily consumes members of five major plant families, including the Cruciferae), Tropaeolaceae, Capparaceae, Resedaceae, and Papilionaceae (Feltwell, 1982) [12]. *P. brassicae* nepalensis, on the other hand, prefers the Cruciferae, of which cabbage is a major host (Feltwell, 1982) [12]. *Pieris brassicae nepalensis* Doubleday (Lepidoptera: Pieridae) is a cruciferous plant pest that feeds on cabbage, cauliflower, mustard, turnip, and other plants. It is a serious pest of nearly all crucifers, attacking crops at various stages and causing significant damage and yield losses. They are usually known by their names cabbage worm, big white butterflies, cabbage white, or cabbage moth, and are the most common crucifer lepidopteran pest (Ansari *et al*., 2012) [3]. They were given the nickname "cabbage butterfly" because of their snow-white wing and the reality that cabbage is their primary food source (Wilbur, 2011) [31]. In Nepal, it is a damaging pest that lowers the annual output of late-planted cabbage and cauliflower reaching up to 80–100%. (Joshi, 1994) [18]. In order to maintain this pest population underneath the level that generates economic impact, integrated pest management (IPM) control is critical.

2. Materials and Methods
This review's content is solely based on secondary sources. Numerous academic journals, agriculture institutions, and some other resources including MoALD, CABI, and pertinent reports were used to construct a sample of the information that is presently accessible. This analysis was then concluded, and the main findings were summarized. The investigation also took advice from officials and experts in related disciplines.

3. Results and Discussion
3.1. Taxonomic position
Cabbage butterflies are the most common members of the genus Pieris, which belongs to the order Lepidoptera, family Pieridae, and sub-species nepalensis.

Kingdom: Animalia
Phylum: Arthropoda
Class: Insecta
Order: Lepidoptera
Family: Pieridae
Genus: Pieris
Species: brassicae
Subspecies: nepalensis

3.2. Distribution
P. brassicae was discovered in South Africa's Western Cape in 1994 (Claassens, 1995) [10]. In February 1996, the first record of *P. brassicae* from Delhi was made. Given that it is primarily a nuisance in mountainous areas, its high prevalence was surprising (Bhalla *et al*., 1997) [7]. This species is found as subspecies *P. brassicae nepalensis* in Nepal, India, Tibet (Xizhang), and Yunnan, China.

3.3. Host range and crop losses
This oligophagous pest feeds on a variety of family members and prefers cruciferous crops. Cabbage and cauliflower are the most commonly attacked host plants, but it also attacks knoll khol, turnip, radish, sarsoo, mustard, and other cruciferous crops. *P. brassicae* (L.) is one of the most destructive and cosmopolitan pests of cruciferous crops in India, accounting for 40% of crop damage each year, according to Hasan and Ansari (2011) [14]. Damage to cabbage heads is estimated to be 70 to 98 percent (Prasad, 1963). *P. brassicae* larvae attacked 68.5 percent of the marketable yield of cabbage cv. Pride of India conducted field research in Upper Shillong, Meghalaya, India, in 1991-92. (Thakur, 1996) [29]. In 1985 and 1986, *P. brassicae* caused 40.45% damage to cabbages in Izmir, Turkey, and 27.06 percent damage to cauliflowers (Atalay and Hincal, 1992) [5]. Crop attacks are more localized and can result in complete crop loss in one area. The pest causes severe damage to crucifer crops at every stage of development, from seedling to flowering (Bhandari *et al*., 2009) [8]. This pest causes losses ranging from 27 to 41% in various conditions (Ali & Rizvi, 2007; Atalay & Hincal, 1992; Eichler, 1948; Shapiro, 1975) [2, 5, 11, 25]. Furthermore, because adults tend to migrate, they may infest previously uninfested areas. As a result, because of its ability to spread to new areas, this pest is becoming a threat to our country.

3.4. Seasonal abundance
Research on the population dynamics of the cabbage butterfly indicates that this pest first appears on cruciferous crops in early October and is active through the end of April. From May to September, this pest is scarce from the plain; however, breeding normally occurs in the mountainous area. High temperatures, extended daylight hours, low relative humidity, and little rain all contribute to population increase (Sood & Bhalla, 1996) [27]. Abiotic variables can be employed to manage the cabbage butterfly outbreak and stop future damage. *P. brassicae* reproduces three times each year in Nepal, for each generation lasting 32–64 days. During February and May, the first generation wreak havoc on cauliflower and cabbage.

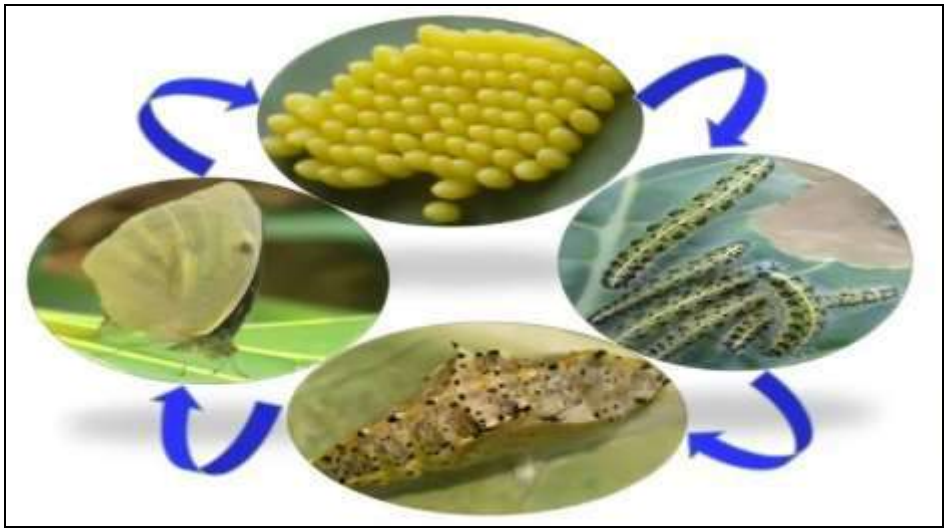
3.5. Life cycle
The life span of *Pieris brassicae* changes based on the surrounding environment. Its life cycle lasts 15 to 22 days from March to April, and 30 to 40 days from November to February. Such weather factors are typical in Nepal's hills and plains, except for the colder months.

3.5.1. Eggs
Under the leaf sheath, the adult moth lays 160–170 eggs on average. Eggs are normally adhered to the backside of the surface of the leaf and are always placed in bunches. Before hatching, the newly produced eggs are yellow in color with grayish-black tips. Eggs have a form resembling a bullet or a maize cob with longitudinal ridges (Kumar *et al*., 2020) [20]. For two to three days, the females continue to deposit eggs in groups beneath the surface of cabbage leaves. The incubation period is influenced by seasonal variations. Eggs are incubated for 3-6 days on average. The incubation period is influenced by seasonal variations.

3.5.2. Larva
There are 5 larvae instars and four molts in the *P. brassicae nepalensis* caterpillar featuring a slightly dark head and a hairy body the newly born caterpillars are cylindrical in shape mild yellow in color and have a smooth exterior. The 3rd instar larvae are often more active and have a greenish body color with black spots during this instar it is typical to observe the larvae devouring their host plant ferociously as the larvae move through the 4th instar they resemble those in the 3rd instar but are bigger and feed differently there is a lot of hair on the 5th instar larvae after reaching this stage they are elongated robust and golden in hue with vivid coloration on their abdomen and thorax (Molet, 2011) [22]. Their heads are depicted as being black and grey. To complete development during this instar, the larva needs the best quality and amount of food; otherwise, it will perish before maturing into a mature butterfly (Metspalu *et al*., 2003) [21]. The pupal phase lasts 8–15 days (about two weeks) in March–April and 20–28 days in November–February (about 4 weeks).

3.5.3. Pupa
Under the leaves, pupation takes place. The pupae contain multiple dots and are pale to greyish in hue. The pupae had lateral ridges that ran down both sides, and a dorsal ridge that extended from the centre of the anterior across the entire body. The pupal stage of a butterfly's life cycle typically lasts 7 to 10 days (Hasan *et al*., 2008) [16].

3.5.4. Adult
The cabbage caterpillar's adults are pale white in color. In both males and females, the wings are white with dark brown tips on the forewings. Females have one pair of brownish-black spots on the dorsal side of each forewing, whereas males have none. A female had two black circular spots on the dorsal side of each forewing (Atwal and Dhaliwal, 2015) [6]. Adult butterflies have a lifespan of 2.5-12.5 days.



Source: CABI

Fig 1: Biology of cabbage butterfly

3.6. Nature of damage

All of the plant's above-ground components are infested by *Pieris brassicae* at every stage of growth. Caterpillars harm plants by eating in large groups and poking round holes, typically on the outside leaves, in the foliage (Younas *et al*., 2004; Khalid, 2006) [33, 19]. In contrast to later instar caterpillars, which consume leaves from the periphery inward while leaving the primary veins intact, the very first instar caterpillar just scrapes the leaf surface. If the vegetable's leaves are punctured, it can become unfit for consumption. The caterpillar causes the most damage when it burrows into the crown of cauliflower and cabbage. In extreme infestations, plants succumb and the leaves are completely destroyed. The pest is extremely terrible in the months of April and March.

All development stages of crucifer crops, from juvenile to blossoming, are severely harmed by the insect (Bhandari *et al*., 2009) [8]. Damage from this pests vary from 27 to 41% depending on the situation. (Eichler, 1948; Shapiro, 1975; Atalay & Hincal, 1992; Ali & Rizvi, 2007; Atalay & Rizvi) [11, 25, 5, 2].

Source: Adhikari

Fig 2: Damage symptoms by cabbage butterfly

3.7. Integrated pest management

3.7.1. Cultural control

In Nepal, uprooting and removing all weeds and previous crop remnants, burning or composting, and intercropping with repellent crops, such as onion and garlic. Plant one repellent plant for every ten cauliflowers, using the recommended crop spacing, e.g., Kathmandu local = 60X60cm (it's important to avoid dense planting), and the recommended fertilizer dose, with a split dose of nitrogen. 4.5 kg Urea+13 kg DAP +3.5 kg MOP/ropani as a starting dose, then one month later after seedling transplant Some of the cultural controls used to prevent cabbage butterfly infestation include 5.5 kg urea/ropani and routine irrigation to keep the field from becoming too dry (Adhikari *et al*., 2014) [1]. Planting resistant cultivars, such as the Copenhagen market, also aids in avoiding an infestation. In a Nepalese experiment, the lowest cabbage butterfly population was recorded in the Copenhagen market (10.06 larva/plant).

3.7.2. Mechanical control

In several experiments conducted in 1987 and 1988, cauliflower fields planted from May to July in Germany were covered with netting. Covering the crop for 4-5 weeks after planting was sufficient to exclude and control *P. brassicae* in the first few weeks after planting (Wonneberger and Gawehn, 1989) [32]. Hand-picking leaves with egg masses and larvae, crushing or keeping them in a bucket of soapy water, and collecting and destroying adult butterflies using a sweep net during the day when adults are active have all been used as mechanical control by Nepalese farmers (Adhikari *et al*., 2014) [1].

3.7.3. Biological control

Apanteles wasps attacked the larvae, laying eggs inside their bodies and spinning cocoons on or near them. Kumar *et al*., 2020 discovered that Apanteles sp. parasitized larvae exhibited no visible symptoms until the apanteles cocoon formed or the parasitoid emerged. Apanteles parasitizes *P. brassicae* larvae in their natural habitat (Atwal and Dhaliwal, 2015) [6]. The larval survival rate of *P. brassicae* has been reported to be 83%. 1999 (Aslam and Suleman). In Nepal, foliar application of Azadirachtin (neem-based insecticide) at 5 ml /lit water and 25 lit water /ropani; maximum three sprays, at one-week intervals, and foliar application of Beauveria bassiana (e.g.'Daman') 1% WP @ 5 gm /lit water and 25 lit water /ropani during the late afternoon (to avoid the sun); maximum three sprays (Adhikari *et al*., 2014) [1]. According to Jaquet *et al*., *P.*

brassicae larvae were highly susceptible to purified crystals of Bacillus thuringiensis (Bt) subsp. thuringiensis (1986) [17]. Metarhizium anisopilae and Beauveria bassiana were also effective against the pest. CAMB Bt-based biopesticides were found to be effective against *P. brassicae* on cauliflower (Zafar *et al*., 2002) [34]. Spinosad and Cypermethrin, for example, were more effective in causing death and reducing leaf damage (Giri *et al*., 2020) [13].

3.7.4. Chemical control

In field trials in Manipur, India, Ram and Pathak (1992) [24] found that carbaryl and dimethoate were effective at reducing *P. brassicae* infestation on cabbage. Eleven insecticides were tested for *P. brassicae* control in cabbage cv. Pride of India grown in Barapani, Meghalaya, India, in 1991-92. The plants were sprayed twice, once before and once after heading. Overall, fenvalerate was almost completely effective against *P. brassicae*, followed by deltamethrin (97.3%), cypermethrin (96.8%), malathion (96.08%), and fenitrothion (93.3%). Chlorpyrifos, quinalphos, and diflubenzuron were the least effective insecticides tested, while fenvalerate-treated plots yielded the highest yield.

Ram and Pathak (1992) [24] reported that carbaryl and dimethoate were effective in reducing *P. brassicae* infestation on cabbage in field trials in Manipur, India. During 1991-92, eleven insecticides were tested for control of *P. brassicae* in cabbage cv. Pride of India grown in Barapani, Meghalaya, India. Plants were sprayed twice, once before heading and again after heading. Overall, fenvalerate controlled *P. brassicae* almost completely, followed by deltamethrin (97.3%), cypermethrin (96.8%), malathion (96.08%), and fenitrothion (93.3%). The least effective insecticides tested were chlorpyrifos, quinalphos, and diflubenzuron whereas the highest yield was obtained in fenvalerate-treated plots. Fenvalerate also had the highest cost-benefit ratio (Thakur and Deka, 1997) [28]. Foliar application of Malathion (50 EC) at a rate of 2 ml /lit water and 25 lit water /ropani, Emamectin Benzoate (5% SG) at a rate of 2 gm /16 lit water and 25 lit water /ropani, and Cypermethrin (10 EC) at a rate of 2 ml /lit water and 25 lit water /ropani, and Cypermethrin (Adhikari *et al*., 2014) [1].

4. Conclusion

The oligophagous cabbage butterfly is a pest that consumes cruciferous plants. While attacking Brussels sprouts, mustard, and other vegetables, it favors cabbage and cauliflower. To control this destructive crucifer pest, IPM techniques like cultural control, mechanical control, biological control, and chemical control may be used. The right date of planting may aid in preventing pest incidence by severing the link between crop stage and pest appearance. In order to decrease the number of adults, hand picking and netting are useful mechanical IPM tools. For keeping an eye on pests in new places, it is a very useful technique. In cultural techniques, companion planting with nasturtium, marigold, onion, and garlic is also possible. Resistant/tolerant kinds exceed chemical control as a damaging larval stage. Entomopathogenic fungi like M. anisopliae and B. bassiana can be utilized to lessen this pest. Beauveria bassiana, cow urine solution with water, and foliar spray of the neem-based pesticide Azadirachtin are some biological controls for this pest. This pest was effectively controlled by insecticides like Cypermethrin (10 EC) at 2 ml/lit water and 25 lit water/ropani and Emamectin Benzoate (5% SG) at 2 gm/lit water and 25 lit water/ropani.

5. Acknowledgement

A review paper incorporates data from a wide range of verified sources, therefore we would like to convey our appreciation to all authors for contributing sources cited in this paper.

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