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***Nysius cymoides* (Hemiptera: Lygaeidae) as an Emerging Global Crop Pest: A Systematic Synthesis of Biology, Outbreak Drivers, Host Range and Integrated Management**

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ABSTRACT

Nysius cymoides (Spinola) (Hemiptera: Lygaeidae), commonly known as the false chinch bug or seed bug, is a polyphagous Palaearctic species increasingly reported as an agricultural pest across the Mediterranean basin, the Middle East, and, more recently, central Europe and South Asia. Although historically regarded as a minor and sporadic pest, *N. cymoides* now causes recurrent and at times severe outbreaks on a wide range of economically important crops, including oilseed rape, sunflower, soybean, quinoa, pistachio, jojoba, solanaceous vegetables, cactus, and carob, among others. Outbreaks are typically associated with hot, dry conditions and by the presence of crop residues or weedy field margins, which provide overwintering refugia and breeding sites. This review summarizes current knowledge on the biology and ecology, geographic distribution, host range, damage symptoms, natural enemies, and management strategies of *N. cymoides*. By consolidating this fragmented information, the review aims to provide concise, up-to-date reference for researchers, extension workers, and growers dealing with this emerging and increasingly damaging pest, and to identify knowledge gaps that warrant further investigation. The apparent geographic expansion of the species reported here should nevertheless be interpreted with some caution, since increased surveillance and reporting effort may have contributed to this pattern alongside any genuine change in range.

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1. Introduction

The family Lygaeidae (seed bugs) (Hemiptera: Heteroptera) includes numerous phytophagous species that primarily feed on developing seeds, fruits, flowers, and other seed-bearing structures of plants. Within this family, the subfamily Orsillinae and, in particular, the genus *Nysius* Dallas, 1852 (tribe Nysiini) contains some of the most economically important seed-feeding bugs worldwide. Worldwide, the genus comprises roughly 106 described species, about ten of which occur in the Euro-Mediterranean subregion [1]. Several *Nysius* species are recognized pests on other continents: *Nysius huttoni* White in New Zealand wheat and brassica crops, *Nysius raphanus* Howard (the 'false chinch bug' sensu stricto) in North America, *Nysius vinitor* Bergroth in Australian grain and horticultural systems, and *Nysius natalensis* Evans in southern Africa — all sharing the genus's hallmark combination of strong polyphagy, high mobility and a propensity to erupt into very large, damaging populations under favorable weather [1-3].

Among the Old World species, *Nysius cymoides* (Spinola, 1837) [4], first described from specimens collected near Genova, in north-western Italy, is the species most frequently associated with agricultural damage across the Mediterranean basin and the Middle East [5]. For much of the twentieth century, it was regarded as a relatively minor curiosity, occasionally reported to damage jojoba plantations in Apulia, southern Italy [6], or grapevines and field crops in the Near East [7]. The picture has changed markedly since the mid-2000s. A first documented outbreak on canola in Mazandaran, Iran, was reported in 2006 [8]; by 2009 the species had been formally recorded damaging canola crops in Hatay province, Turkey [9]; unexpected outbreaks appeared in oilseed rape fields across five departments of western France in 2009 and again, more extensively, in 2016 [10]; a severe soybean outbreak with densities of up to 250 specimens per plant hit the Veneto region of northern Italy in 2017 [11]; the species reached Tunisia for the first time in June 2018, damaging chilli pepper and tomato seedlings [12]; it caused both crop damage and a documented nuisance to farm workers in southern Jordan in 2019 [13]; and, in the same year, it was reported as a new pest of sugarcane in Khuzestan, Iran [14]. Surveys across 25 Turkish provinces in 2018–2019 subsequently confirmed a very broad and climatically diverse establishment within Turkey alone [15]. Most recently, the species has been recorded for the first time on chamomile crops in New Delhi, India, well outside its previously known range, with molecular confirmation of the identification.

This trajectory from a sporadic, locally reported insect to a recurrent, geographically expanding pest across at least nine countries within roughly fifteen years is the central reason this overview was assembled. This apparent expansion should be interpreted with some caution, however, since increased surveillance and reporting effort across the region may have contributed to the pattern independently of any genuine change in the species' range (see Limitations, below). The following sections cover, in turn, the wider genus *Nysius* as a taxonomic and pest-management context; the detailed biology of *N. cymoides*, including developmental rates, thermal thresholds and fecundity figures reported under controlled conditions; its ecology, host-shifting behaviour and the environmental drivers of outbreaks; its distribution and host range; and, finally, the integrated pest management (IPM) options that have been proposed or tested against it, with the specific quantitative results reported in the primary literature.

2. Taxonomy and Identification

Nysius cymoides belongs to the family Lygaeidae, subfamily Orsillinae, tribe Nysiini. The Italian entomologist Massimiliano Spinola originally described it as *Artheneis cymoides* in 1837; the original type series, collected near Genova, was probably lost. Subsequent revisions of the Lygaeidae [1, 16-18] clarified the genus placement, and the species has since been recorded under the combination *Nysius* (Macroparius) *cymoides* in several regional catalogs [16]. Adults measure roughly 3–4.5 mm in length, are greyish-brown and oval in outline, and are fully winged (macropterous), unlike two closely related, flightless species endemic to the summit of Mauna Loa, Hawaii, which are otherwise atypical within the genus. Nymphs pass through five instars, growing from about 1.0 mm (third instar) to about 2.5 mm at the final (fifth) instar/early adult stage, based on measurements reported from French outbreak material [10]. Nymphs of different *Nysius* species are very difficult, in most cases impossible, to separate morphologically, and reliable identification generally requires reared or field-collected adults; several outbreak reports explicitly note that the responsible species could only be confirmed once adults emerged [10, 19].

Molecular identification (COI barcoding) has increasingly been used to confirm field identifications, for example in the 2018 *Acacia tortilis* outbreak in Iran [20]. The 2022–2023 chamomile infestation in India, where morphological identification of *N. cymoides* on *Matricaria chamomilla* L. (Asteraceae) in New Delhi was subsequently confirmed by molecular techniques [21].

3. Comparative Biology of *Nysius* Species

Because the literature specifically on *N. cymoides* remains comparatively thin on certain quantitative points, particularly precise thermal thresholds and degree-day requirements, it is useful, as in reviews of other pest genera, to place the species within the broader biology of *Nysius*. The best-quantified congener is *N. huttoni*, the New Zealand wheat bug, for which [3] measured development, survival and reproduction at five constant temperatures (10, 15, 20, 25 and 30 °C). At 10 °C, neither eggs nor early-instar nymphs of *N. huttoni* could complete development, although nymphs continued to grow; fifth-instar nymphs nevertheless survived for up to 145 days at this temperature, and adults survived for at least 100 days [3]. The species could not complete its life cycle at or below 15 °C, and between 15 and 30 °C, developmental rate increased approximately linearly with temperature [3]. From these data, He *et al.* (2003) [3] estimated lower temperature thresholds of 11.9 °C for completion of the life cycle, 12.3 °C for mating and 16.8 °C for oviposition, and calculated a thermal constant of 625 degree-days for a complete generation. For *N. cymoides* itself, the only directly comparable figures come from laboratory rearing under near-optimal conditions reported by Mohaghegh-Neyshabouri (2009a) [22]: at approximately 24 °C, development of both sexes to adulthood took about 40 days, a complete generation (egg to egg) required about 60 days, and the lower developmental threshold was estimated at roughly 14 °C, broadly consistent with the thermal range established for *N. huttoni* by He *et al.* (2003) [3]. A related 2009 study by the same author (Mohaghegh-Neyshabouri, 2009b) [23] additionally reported that the number of specimens recorded increased steadily as temperature rose from 17.5 °C to 37.5 °C, a pattern consistent with the species' known preference for hot, dry conditions and its frequent association with outbreaks during summer droughts, as documented by Chapelin-Viscardi *et al.* (2017) [10] and Mollashahi *et al.* (2016a, 2017) [24, 25]. Other congeners illustrate the same recurring pattern of polyphagy, seed feeding and outbreak potential under warm, dry conditions, each with a distinct regional profile. *Nysius raphanus*, the false chinch bug of North America, is considered the most economically damaging species in the genus, although severe outbreaks remain infrequent and unpredictable [26, 27]. It breeds in enormous numbers on weedy hosts, particularly London rocket (*Sisymbrium irio* L.), shepherd's purse (*Capsella bursa-pastoris* (L.) Medik.) and shining pepperweed (*Lepidium nitidum* Nutt.). It migrates to adjacent crops once these hosts dry out in late spring [28]. Because winged adults typically walk rather than fly during these migrations, damage is often concentrated along field margins closest to the source weed stands, and vineyards, cotton, canola and other seedling crops in California and the southwestern United States have all suffered documented feeding injury [27, 29, 30]. *Nysius vinitor* Bergroth, the Rutherglen bug, is a major, highly mobile pest of Australian grain and horticultural systems, particularly sunflower, sorghum, canola, and safflower [28]. Long-distance dispersal is well documented: aerial trapping studies have shown the species regularly present in the upper air over eastern Australia, with adults capable of wind-assisted migration over hundreds of kilometers between weedy pasture and cropping regions [27–31]. Outbreaks remain difficult to forecast because *N. vinitor* persists year-round on a wide range of non-crop weed and pasture hosts before moving into cultivated fields. Because it frequently co-occurs with the morphologically similar grey cluster bug, *Nysius caledoniae* Distant, complicating field identification and risk assessment [2]. *Nysius natalensis* Evans is a sporadic but locally damaging pest of sunflower (*Helianthus annuus* L.) in South Africa, where outbreaks typically occur in localized areas toward the end of the summer season [32]. Laboratory studies across a range of constant temperatures (15–38 °C) showed that the species cannot complete its life cycle or lay eggs at or below 15 °C, that development is most favourable between 26 and 36 °C, and that oviposition peaks at 26–28 °C, with a lower developmental threshold of approximately 14–15 °C depending on life stage, figures broadly comparable to those reported for *N. cymoides* and *N. huttoni* [32].

4. Biology of *Nysius cymoides*

Nysius cymoides spends the winter as an adult bug, hiding in soil, dead leaves, leftover crop material, and field edges [7]. In the Near East (Turkey, Lebanon, Syria, Jordan, and nearby areas), fields usually have only young bugs

(nymphs) in spring [12]. Adult bugs that survive winter remain inactive during the hot, dry summer and resume reproducing the next spring [7]. They lay eggs one at a time, usually in soil, dead plant matter, or plant tissue near the base of host plants [22].

Under standard laboratory rearing conditions employed in several life-table studies (24 ± 1 °C, $65 \pm 5\%$ relative humidity, 16:8 h L:D photoperiod), key developmental and reproductive parameters of *N. cymoides* have been directly quantified. At approximately 24 °C, development from egg to adult required approximately 40 days, while a complete generation (egg to egg) was completed in approximately 60 days [22]. A temperature-dependent developmental rate model derived from laboratory data estimated lower developmental thresholds of 13.6 °C for eggs and above 15.0 °C for nymphal instars, with developmental rate increasing progressively as temperature rose across the tested range of 17.5–37.5 °C [23]. Mohaghegh-Neyshabouri [22] and Mohaghegh-Neyshabouri [23] reported slightly different lower developmental thresholds. The first study [22] reported a threshold of approximately 14 °C, whereas the second study [23] estimated thresholds of 13.6 °C for eggs and >15.0 °C for nymphs. These differences likely reflect variation in methodology and developmental stage examined rather than a contradiction between the studies. To date, however, an upper developmental threshold—the temperature at which development ceases or declines—has not been established for this species, representing a gap in current understanding of its thermal biology.

Mean fecundity per female is strongly host-dependent. On sunflower (*Helianthus annuus* L.), mean fecundity reached 58.72 eggs per female, with female longevity averaging 68.09 days [24]. On wild mustard (*Sinapis arvensis* L.), a common weedy host, fecundity fell to a mean of only 5.67 eggs per female, and adult longevity was significantly shorter than on sunflower [24]. Developmental time, calculated as the sum of the incubation and nymphal periods, was also significantly longer on wild mustard than on sunflower [24]. However, the incubation period alone did not differ significantly between the two hosts, as results showed no significant differences in the incubation period of *N. cymoides* on the two hosts. Mean generation time (T), however, was reported as slightly longer on sunflower than on wild mustard (58.01 ± 1.59 days versus 56.76 ± 2.43 days, respectively [24])—a counter-intuitive result given the shorter development and much higher fecundity recorded on sunflower. The source study does not explain this discrepancy, and it is reported here descriptively rather than as an interpreted pattern; it may reflect a longer adult pre-oviposition period on the more fecund host, sampling variance, or another factor not captured by the life-table analysis.

Host-plant identity at the cultivar level further shapes population growth potential. Among five Iranian canola cultivars tested (Hayula420, Hayula401, Hayula50, Hayula60 and RGS), the net reproductive rate (R_0) reached 11.40 offspring per individual on Hayula420, the most suitable cultivar. It fell to 5.47 offspring per individual on Hayula401, the least suitable [33]. The intrinsic rate of increase (r) ranged from 0.0395 per day on Hayula60, the highest value recorded, to 0.0261 per day on Hayula401, the lowest [33]. Hayula401 and RGS were identified as the least susceptible cultivars overall; Hayula420 supported the longest nymphal period among the cultivars tested, while Hayula50 supported the shortest [33]. Photoperiod also affects development and reproduction: a two-sex life-table analysis conducted under different photoperiod regimes found measurable shifts in developmental duration and reproductive output between treatments, consistent with a seasonally cued reproductive strategy [25].

The species is generally multivoltine, completing several generations per year in warm climates, whereas in temperate Mediterranean regions it may complete only a single generation annually [12]. Outbreaks are strongly favored by hot, dry conditions and depressed by rainfall. In western France, an outbreak affecting canola fields across the departments of Vendée, Charente-Maritime, Charente, Vienne and Deux-Sèvres was attributed to nymphal feeding on seedling canola, with sap withdrawal by larvae causing visible desiccation and death of affected plants [10]. In the Veneto region of northern Italy, populations reaching up to 250 specimens per plant caused underdeveloped growth, leaf necrosis and plant death in second-crop soybean during the summer of 2017, with pest presence recurring in the same fields the following year [11]. A comparable drought-associated outbreak pattern has been documented for the North American congener *N. raphanus* in California vineyards, where weedy host stands are exhausted during dry periods, triggering mass migration of the bugs onto adjacent vines [28].

A behavioral feature repeatedly documented in outbreak reports is dense aggregation: large numbers of nymphs and adults congregate on plant stubble, field margins, machinery and vehicles, apparently in search of moisture during hot, dry spells [10]. In southern Jordan in June 2019, aggregating bugs were reported biting agricultural workers and causing skin irritation, with a particular tendency to congregate in large numbers on workers wearing yellow clothing and hats; mating pairs were additionally observed flying and coupling in the air at heights of up to approximately ten meters above the ground [13].

5. Ecology and Outbreak Drivers of *Nysius cymoides*

Nysius cymoides is ecologically a habitat generalist that exploits the boundary between weedy or fallow land and cultivated fields. It typically builds initial populations on weeds and volunteer or residual host material—wild mustard (*Sinapis arvensis* L.), flaxweed and other Brassicaceae, and crop stubble—before large numbers move onto adjacent susceptible crops as weedy hosts senesce or are cut [11, 22]. This host-shifting pattern has been documented in several cropping sequences: from alfalfa after cutting into adjoining canola; from canola stubble into a following soybean crop; and from wild mustard into sunflower fields as the wild hosts dry out [11, 24].

Crop sequence and tillage strongly influence outbreak risk. In a two-year study (2017–2018) of second-crop soybean in the Veneto region of Italy, canola as the preceding crop increased *N. cymoides* populations that subsequently damaged the following soybean crop. In 2017, infestation densities reached up to 250 specimens per plant, causing underdeveloped plants, leaf necrosis, and plant death. In contrast, no false chinch bug was recorded in soybeans sown after winter wheat in the same fields, indicating that host-plant residues, not simply field history, drive the risk [11]. The same authors note that infestations were consistently associated with reduced or no-till management, since undisturbed stubble and litter provide shelter and oviposition sites; based on their field observations, they propose a provisional action threshold of 10 *N. cymoides* specimens per 250 mL of crop litter sampled from the previous crop, as an early warning indicator before sowing a susceptible second crop [5, 11].

Species distribution modelling (MaxEnt) using 219 occurrence records of *N. cymoides* across Iran found that suitable habitat covered 68.78% of the studied area, driven primarily by precipitation of the driest month (20% relative contribution), altitude (19.2%), annual precipitation (18.4%), and precipitation of the wettest month (13.1%), with occurrence probability increasing with precipitation but decreasing with altitude [11, 34]. Model performance was strong, with an AUC of 0.88 on training data and 0.84 on test data (SD = 0.02), and the binomial omission test was statistically significant ($P < 0.01$) with a test omission rate not exceeding 2% [34]. A dedicated population-fluctuation and spatial-distribution study of the canola false chinch bug was also carried out in Kermanshah province, western Iran, tracking seasonal population build-up and within-field spatial pattern across a growing season [35].

Climatic drivers identified across multiple independent studies converge on the same picture: hot, dry weather, particularly during spring flowering and pod- or seed-set stages, favors rapid population growth and mass dispersal flights, while episodes of heavy rain reduce survival, especially of early nymphal instars [5, 10, 11, 24]. This matches the broader genus-level pattern documented for *N. vinitor* in Australia [2] and is consistent with the projected effects of warmer, drier Mediterranean summers on outbreaks.

6. Distribution

Nysius cymoides is distributed across the Mediterranean basin, extending through central Europe and the Middle East to Iran, with records also from parts of Africa [1, 18, 22, 23]. Table 1 summarises the reported geographic occurrences of the species. The species' apparent range has broadened markedly since the early 2000s, with new pest reports from France (2009, 2016), Tunisia (2018), Turkey (2018–2020), Jordan (2019) and, outside its traditional range altogether, New Delhi, India, on chamomile.

Table 1: Chronological summary of geographic records and selected sources documenting the distribution of *Nysius cymoides*.

Country/Area	Selected Sources	Range Category
Italy (type locality: Genova)	[4-6, 11, 36]	Established/native range
Algeria	[37, 38]	Established/native range
Madeira (Portugal)	[39]	Established/native range
Mauritania	[40]	Established/native range
Wider Palaearctic range (Mediterranean basin, central Europe, Middle East to Iran)	[1, 17, 18, 41, 42]	Established/native range
Iran	[22-25, 33-35, 43]	New outbreak report (since 2000)
Israel and neighboring Middle East	[22, 23]	Established/native range
Turkey	[9, 15, 38]	New outbreak report (since 2000)
France	[10]	New outbreak report (since 2000)
Egypt (Sinai)	[13]	Established/native range
Jordan	[13]	New outbreak report (since 2000)
Tunisia	[12]	New outbreak report (since 2000)
India (New Delhi, chamomile)	[21]	New outbreak report (since 2000)

7. Host Plants

Nysius cymoides is a highly polyphagous species that feeds on stems, leaves, flowers, and developing seeds and seed pods using its piercing-sucking mouthparts [22, 23]. Its feeding can cause leaf necrosis, wilting, poor plant development, and, at high densities, plant death in crops such as canola/oilseed rape and soybean [10, 11]. On jojoba, feeding and associated secretions can result in debris accumulation on leaves, potentially affecting plant development [6], while on pistachio, the species has been reported in association with twigs, branches, and leaves [44, 45].

The species has been associated with economically important outbreaks in several countries. In France, canola outbreaks occurred in 2009 and 2016 across five departments [10]. In Italy, outbreaks affected quinoa and second-crop soybean, with densities reaching up to 250 individuals per plant in soybean in 2017 and recurring in 2018 [11, 36]. In Tunisia, an outbreak on chili pepper and tomato in 2018 caused major crop losses [12], whereas aggregations in southern Jordan in 2019 caused crop damage and considerable nuisance to farm workers [13]. In Iran, outbreaks have been reported on canola, sunflower, pistachio, and sugarcane [11]. Table 2 summarises the documented host plants and crops of *N. cymoides*.

Table 2: Chronological summary of host plants recorded for *Nysius cymoides*, by family and selected source.

Crop/Plant	Family	Selected Sources
Jojoba (<i>Simmondsia chinensis</i> (Link) C.K.Schneid.)	Simmondsiaceae	[6]
Canola/oilseed rape (<i>Brassica napus</i> L.)	Brassicaceae	[9, 10, 24, 33, 43]
Grapevine (<i>Vitis vinifera</i> L.)	Vitaceae	[7]
Sunflower (<i>Helianthus annuus</i> L.)	Asteraceae	[24, 33]
Wild mustard (<i>Sinapis arvensis</i> L.) and other Brassicaceae weeds	Brassicaceae	[12, 24, 33]
Quinoa (<i>Chenopodium quinoa</i> Willd.)	Amaranthaceae	[36]
Acacia (<i>Acacia tortilis</i> (Forssk.) Hayne)	Fabaceae	[20]

Table 2 (contd....)

Crop/Plant	Family	Selected Sources
Soybean (<i>Glycine max</i> (L.) Merr.)	Fabaceae	[11]
Tomato (<i>Solanum lycopersicum</i> L.)	Solanaceae	[12]
Chili/bell pepper (<i>Capsicum annuum</i> L.)	Solanaceae	[12]
Olive (<i>Olea europaea</i> L.)	Oleaceae	[12, 46]
Barley (<i>Hordeum vulgare</i> L.)	Poaceae	[12]
Sugarcane (<i>Saccharum officinarum</i> L.)	Poaceae	[14]
Cotton (<i>Gossypium</i> spp.)	Malvaceae	[12]
Pistachio (<i>Pistacia vera</i> L. and wild <i>Pistacia</i> spp.)	Anacardiaceae	[38, 44, 45]
Maize (<i>Zea mays</i> L.)	Poaceae	[15]
Chamomile (<i>Matricaria chamomilla</i> L.)	Asteraceae	[21]
Cactus (<i>Opuntia</i> spp.)	Cactaceae	[46]
Carob (<i>Ceratonia siliqua</i> L.)	Fabaceae	[46]

8. Natural Enemies: Comparative Records from Other *Nysius* Species

Information on the natural enemies of *N. cymoides* remains limited compared with that available for other well-studied Mediterranean pests. Several generalist predators and parasitoids have been reported in association with *N. cymoides*, but none has been demonstrated to be host-specific or to provide reliable control when used alone [23]. A similar situation has been reported for the related North American species *N. raphanus*, for which biological control remains a minor component of pest management [47]. Parasitism appears to be uncommon within the genus. Only two confirmed parasitoids have been documented: the tachinid *Alophora lepidofera* (Malloch), recorded from *N. vinitor* and *N. clevelandensis* in Australia, and *Phasia occidentis*, recorded from *N. raphanus* in Colorado (USA). No parasitoid has been identified from *N. huttoni* in New Zealand, despite this species being relatively well studied [48]. In contrast, the predator community associated with *N. huttoni* in New Zealand is comparatively well documented and includes beetles (Coleoptera), true bugs (Hemiptera), and spiders (Araneae). These records identify predator groups that could be investigated as potential natural enemies of *N. cymoides*, particularly ground-active beetles, nabid bugs, and spiders occurring in crop margins and soil litter. However, their ability to suppress *N. cymoides* populations established. Table 3 summarises the predators and parasitoids documented in association with *Nysius* species worldwide, providing the broader taxonomic context for potential natural enemies of *N. cymoides*. The 2026 Moroccan field observations reported in this review (see Case Illustration) did not include systematic natural-enemy sampling, and no predators or parasitoids of *N. cymoides* were recorded during that survey; this remains an open gap and a specific target for future field work on the species.

Table 3: Natural enemies (predators and parasitoids) documented for *Nysius* species worldwide. No dedicated, species-level natural enemy survey has been published for *N. cymoides*, so most confirmed records come from other *Nysius* species and should be read as suggestive rather than directly applicable.

Natural Enemy	Order: Family	Type	<i>Nysius</i> Species/Region	Source
<i>Alophora lepidofera</i> (Malloch, 1929)	Diptera: Tachinidae	Parasitoid	<i>N. vinitor</i> & <i>N. clevelandensis</i> / Australia	[49]
<i>Phasia occidentis</i> (Walker, 1849)	Diptera: Tachinidae	Parasitoid	<i>N. raphanus</i> — Colorado, USA	[50]
<i>Neocicindela parryi</i> (White, 1846)	Coleoptera: Cicindelidae	Predator	<i>N. huttoni</i> / New Zealand	[48]
<i>Metaglymma moniliferum</i> Bates, 1874	Coleoptera: Carabidae	Predator	<i>N. huttoni</i> / New Zealand	[48]

Table 3 (contd....)

Natural Enemy	Order: Family	Type	<i>Nysius</i> Species/Region	Source
<i>Coccinella trifasciata</i> (Linnaeus, 1758)	Coleoptera: Coccinellidae	Predator	<i>N. huttoni</i> / New Zealand	[48]
<i>Nabis maoricus</i> Walker, 1873.	Hemiptera: Nabidae	Predator	<i>N. huttoni</i> / New Zealand	[48]
<i>Lycosa hilaris</i> L. Koch, 1877; <i>Pardosa bellicosa</i> (Goyen, 1888)	Araneae: Lycosidae	Predator (spiders)	<i>N. huttoni</i> / New Zealand	[48]
<i>Badumna longinqua</i> (L. Koch, 1867)	Araneae: Desidae	Predator (spider)	<i>N. huttoni</i> / New Zealand	[48]
<i>Supunna picta</i> Simon, 1897	Araneae: Corinnidae	Predator (spider)	<i>N. huttoni</i> / New Zealand	[48]
<i>Steatoda grossa</i> (C.L. Koch, 1838)	Araneae: Theridiidae	Predator (spider)	<i>N. huttoni</i> / New Zealand	[48]

9. Insecticide Efficacy: Comparative Evidence from other *Nysius* Species

Insecticide-efficacy data for *N. cymoides* remain limited, and no dedicated large-scale efficacy trial has been conducted specifically on this species. The official communication issued by the National Office for Food Safety (ONSSA) in consultation with the competent ONSSA services [51]. No insecticide efficacy data are available for *N. cymoides* itself; all comparative data below come from other *Nysius* species and should not be read as demonstrated or recommended treatments for *N. cymoides*. Available evidence from other *Nysius* species provides useful comparative information. Against *N. raphanus*, d-limonene and mineral oil showed high efficacy, with the highest tested rates resulting in 97–100% mortality within 48 h and 98–100% population reduction under field conditions [52]. Historical trials on *N. raphanus* reported effective control with endrin and heptachlor, whereas carbaryl was less effective [53]. Malathion, dieldrin, and trichlorfon were also tested against *N. raphanus* and showed insecticidal activity in laboratory assays [52, 53]. In additional studies on *N. raphanus*, chlorpyrifos and diazinon showed high efficacy, whereas permethrin, endosulfan, esfenvalerate, lambda-cyhalothrin, imidacloprid, and thiamethoxam produced variable results among trials [54]. Permethrin-treated pollination bags were also evaluated against *N. raphanus*, reducing populations by 91% and 85.5% at 12 and 15 days after treatment, respectively, and increasing yield by 25–79% compared with untreated bags [30].

Overall, the available insecticide evidence concerns mainly *N. raphanus* rather than *N. cymoides*. Therefore, these results should be considered comparative evidence only and should not be interpreted as demonstrated efficacy against *N. cymoides*. Table 4 summarises the documented active ingredients, application rates, target *Nysius* species, and reported efficacy results.

Table 4: Active ingredients tested against *Nysius* species worldwide, with concentration/dose and reported efficacy, and the species and source for each record. Percentages and doses are quoted exactly as reported in the source; where a source did not report a numeric efficacy value, this is stated explicitly.

Active Ingredient	Concentration/Dose Tested	Efficacy Result	<i>Nysius</i> Species	Source
d-limonene	0.2, 0.3, 0.5, 1, 1.5 g a.i./L	97–100% mortality at 48 h (lab contact bioassay) at 1 and 1.5 g a.i./L; also field-tested	<i>N. raphanus</i>	[52]
Mineral oil	5, 8, 10, 20, 24 g a.i./L	97–100% mortality at 48 h at 20 and 24 g a.i./L	<i>N. raphanus</i>	[52]
Potassium salts of fatty acid	0.05, 0.1, 0.2, 0.4, 0.6 g a.i./L	Lower mortality than d-limonene/mineral oil at the doses tested (exact % not given in available abstract)	<i>N. raphanus</i>	[52]
Permethrin (0.01% mesh-bag residue)	0.01% w/w on polypropylene pollination-bag mesh	91% and 85.5% population reduction at 12 and 15 days after exposure; 25–79% yield increase vs untreated bags	<i>N. raphanus</i>	[30]
Diazinon	Laboratory bioassay spray	Significantly more effective than most other actives tested (year 1)	<i>N. raphanus</i>	[53]

Table 4 (contd....)

Active Ingredient	Concentration/Dose Tested	Efficacy Result	<i>Nysius</i> Species	Source
Chlorpyrifos	Laboratory bioassay spray	Among the most effective actives in both years of testing	<i>N. raphanus</i>	[53]
Thiamethoxam	Laboratory bioassay spray	Least effective in year 1; among most effective in year 2 (inconsistent across years)	<i>N. raphanus</i>	[53]
Spinosad	Laboratory bioassay spray	Least effective active tested (year 1)	<i>N. raphanus</i>	[53]
Endosulfan	Laboratory spray; aerial field spray (mixed with cypermethrin for <i>N. natalensis</i>)	Among most effective in year 2 lab trial (<i>N. raphanus</i>); effective field control of <i>N. natalensis</i> , but re-infestation within 5 days	<i>N. raphanus</i> ; <i>N. natalensis</i>	[53, 54]
Esfenvalerate	Laboratory bioassay spray	Less effective (year 2)	<i>N. raphanus</i>	[53]
Lambda-cyhalothrin	Laboratory bioassay spray	Less effective (year 2)	<i>N. raphanus</i>	[53]
Imidacloprid	Laboratory bioassay spray; field systemic application	Less effective in Colorado lab trial (year 2); used successfully in the field against the pest outbreak	<i>N. raphanus</i> ; <i>N. cymoides</i>	[12, 53]
Malathion	Laboratory bioassay, $\mu\text{g a.i./insect}$	$\sim 0.0017 \mu\text{g}$ for 50% mortality — most potent per μg of the historic set; described as the most effective compound in laboratory trials	<i>N. raphanus</i>	[47]
Dieldrin (historical, discontinued)	Laboratory bioassay, $\mu\text{g a.i./insect}$	$\sim 0.3 \mu\text{g}$ for 50% mortality; about equally effective as endrin/trichlorfon	<i>N. raphanus</i>	[47]
Endrin (historical, discontinued)	Laboratory bioassay; field spray	$\sim 1.0 \mu\text{g}$ for 50% mortality; gave satisfactory field control	<i>N. raphanus</i>	[47]
Trichlorfon (Dipterex) (historical, discontinued)	Laboratory bioassay, $\mu\text{g a.i./insect}$	$\sim 1.6 \mu\text{g}$ for 50% mortality; about equally effective as dieldrin/endrin	<i>N. raphanus</i>	[47]
Toxaphene (historical, discontinued)	Laboratory bioassay, $\mu\text{g a.i./insect}$	$\sim 30 \mu\text{g}$ for 50% mortality; relatively ineffective	<i>N. raphanus</i>	[47]
Carbaryl (Sevin)	Laboratory bioassay; field spray	$\sim 50 \mu\text{g}$ for 50% mortality; relatively ineffective in field trials	<i>N. raphanus</i>	[47]
DDT (historical, discontinued)	Laboratory bioassay, $\mu\text{g a.i./insect}$	$\sim 80 \mu\text{g}$ for 50% mortality; relatively ineffective	<i>N. raphanus</i>	[47]
Heptachlor (historical, discontinued)	Field spray	Gave satisfactory field control	<i>N. raphanus</i>	[47]
Acephate (Orthene)	Field spray	Used for control on jojoba plantations	<i>N. cymoides</i>	[6]
Deltamethrin (Decis)	Field spray	Used for control on jojoba plantations	<i>N. cymoides</i>	[6]
Cypermethrin, methomyl, mevinphos, dichlorvos+monocrotophos, endosulfan+cypermethrin	Aerial field spray during budding, pre-anthesis	All treatments gave effective control vs untreated control, but re-infestation occurred in all treatments within 5 days	<i>N. natalensis</i>	[54]
Neonicotinoids (unspecified), permethrin, chlorpyrifos	Seed treatment / standing-crop spray	Standard chemical management options reported in New Zealand brassica/wheat systems	<i>N. huttoni</i>	[55]

10. Integrated Pest Management (IPM)

Because no natural enemy has yet been shown to give reliable field control, and because registered insecticides for many affected crops remain limited, the sources reviewed here converge on an integrated strategy built around four pillars: monitoring and thresholds, cultural/agronomic practices, host plant resistance, and targeted chemical control as a last resort.

10.1. Monitoring and Provisional Thresholds

The most concrete, field-tested monitoring tool identified in this review is the litter-sampling threshold proposed by Scaccini & Furlan (2019, 2021) [5, 11]: 10 *N. cymoides* specimens per 250 mL of crop residue/litter sampled from the field before sowing a susceptible second crop (e.g., soybean after canola). Counts above this level flag an elevated risk of outbreak in the following crop and can justify pre-emptive residue management or closer in-season scouting. At the trap-development stage, Heidary Alizadeh *et al.* (2009) [56] identified ethyl 4-isothiocyanatobutyrate as a candidate attractant semiochemical for *N. cymoides*, offering a possible basis for pheromone- or kairomone-based monitoring traps, though this has not yet been developed into a validated commercial lure. Pitfall trapping along fixed transects, with traps spaced ~60 m apart, has also proven useful for characterizing within-field spatial distribution and could be adapted for routine monitoring on a smaller grid [31].

10.2. Cultural and Agronomic Control

The single most consistently repeated recommendation across the literature is management of crop residues and stubble: plowing down plant litter before sowing a susceptible crop reduces the population of *N. cymoides* sheltering and ovipositing in residues. It has been specifically recommended following canola in areas at risk of a following soybean, sunflower or vegetable crop [5, 10, 11, 43]. Field data directly support crop sequencing: in the Veneto (Italy) study, soybean sown after canola suffered a damaging outbreak (up to 250 specimens/plant), while soybean sown after winter wheat in the same fields and years showed no *N. cymoides* presence at all — indicating that avoiding a canola-to-soybean (or similarly high-risk) sequence, or managing the intervening residue thoroughly, is an effective, no-cost preventive measure [11]. Weed management is the second pillar: because wild mustard (*S. arvensis*) and other Brassicaceae weeds both host and, to a lesser extent, disperse the pest, controlling these weeds on field margins and within rotations reduces the reservoir population available to invade cultivated crops, even though *N. cymoides* reproduces comparatively poorly on wild mustard itself (mean fecundity 5.67 eggs, versus 58.72 eggs on sunflower) [24, 33], meaning weeds function mainly as a bridging or shelter host rather than a preferred breeding site.

10.3. Host Plant Resistance

Cultivar screening in canola provides the clearest quantitative basis for a resistance-based component of IPM identified in this review. Among five Iranian cultivars, Hayula401 and RGS supported the lowest net reproductive rates ($R_0 = 5.47$ and comparably low values, respectively) and the lowest intrinsic rates of increase (r as low as 0.0261 per day for Hayula401). They were classified as non-susceptible to *N. cymoides*, whereas Hayula420 supported the highest R_0 (11.40 offspring per individual) and the longest nymphal development period, and Hayula60 supported the fastest population growth ($r = 0.0395$ per day) [24, 33]. Selecting less-susceptible cultivars where regionally available is therefore a low-cost, complementary tactic, particularly in areas with a history of outbreaks [35].

10.4. Chemical Control

Where outbreaks threaten economic loss and other measures are insufficient, growers have used contact and systemic insecticides: an imidacloprid-based systemic insecticide was used against the 2018 Tunisian outbreak on chili pepper and tomato [12], and various insecticide classes have been used in Iranian canola systems [5, 11]. However, Mohaghegh-Neyshabouri (2009a) [22] notes that chemical options are not currently formally recommended for the species in that region and that efficacy data remain limited, and [5] similarly flag the absence of validated economic thresholds tied to specific crops and life stages as a major outstanding gap. Because *N. cymoides* aggregates densely in a comparatively short window (often triggered by harvest, mowing, or field desiccation), well-timed, localized treatment of aggregation sites—rather than blanket crop spraying—has been suggested as a way to reduce insecticide use while still addressing the nuisance and yield-limiting aspects of an outbreak.

Taken together, the evidence assembled here supports a practical, ranked IPM sequence for at-risk crops worldwide. (1) Where crop rotation is an option, avoid known high-risk sequences (e.g., canola immediately followed by soybean); more broadly, monitor weedy borders and cover crops before they dry out or are

mowed/disc'd, since mass migration into adjacent crops is triggered by desiccation of the weed host, and avoid mowing or discing such vegetation once nearby susceptible crops or trees have already leafed out or are actively growing, as this redirects the migrating population onto the cash crop. (2) Sample residue, litter, or weedy ground cover before sowing or during vulnerable growth stages against the 10 specimens/250 mL threshold established for crop residue, adapting this benchmark to the relevant reservoir type. (3) Plough down or otherwise manage crop residues and control bridging weed hosts such as *S. arvensis*; because bugs typically move in a directional mass migration, treating the weedy border strip itself is usually sufficient and more efficient than whole-field intervention, and for young perennial trees (walnut, pomegranate, avocado) only border rows adjacent to uncultivated land are normally at economic risk, allowing protection to be targeted rather than applied orchard-wide. (4) Where regionally available, prefer crop cultivars with demonstrated lower susceptibility (e.g., Hayula401 and RGS over Hayula420 in the Iranian canola dataset), extending similar screening to other affected crops lacking such data. (5) Reserve targeted insecticide application for confirmed outbreaks exceeding locally observed damage thresholds, prioritizing dense aggregation sites and field margins over blanket spraying — soil-applied insecticide bands (e.g., a 30-inch/76-cm band in vineyards) can additionally serve as a physical/chemical barrier against migrating, ground-dwelling nymphs. Because false chinch bug nymphs are understood to inject a phytotoxin while feeding, leaf damage can occur within hours of a mass migration event, reinforcing the value of pre-emptive, localized treatment over reactive whole-field spraying once damage is visible.

11. Crop Yield Losses Caused by *Nysius* Species

The economic impact of *N. cymoides* (Hemiptera: Lygaeidae) remains unquantified, with no species-specific economic injury level or monetary loss estimate available; establishing standardized monitoring methods and economic thresholds has therefore been identified as a research priority [5]. Field evidence nevertheless indicates substantial damage potential. In Italy, populations of up to 250 individuals per plant were recorded on soybean in 2017, causing underdeveloped plants, necrotic leaf spots, and plant mortality; comparable population increases and associated damage were also reported in quinoa (*Chenopodium quinoa* Willd.) [11]. In Tunisia, a severe infestation of chili pepper and tomato in June 2018 caused major crop losses, while *N. cymoides* was also recorded on barley, oilseed rape, newly planted olive trees, and acacia [12].

The strongest quantitative evidence from a related species comes from *N. raphanus*. In a two-year canola study, artificial infestations of 10, 20, and 40 bugs per head at early flowering resulted in mean yield losses of 43%, 68%, and 69%, respectively, in the first trial and 26%, 58%, and 55% in the second. At the early pod stage, the corresponding losses were 11%, 26%, and 23% and 35%, 20%, and 35%, respectively [27, 30]. These results demonstrate that yield loss is strongly influenced by both infestation density and crop developmental stage, with flowering generally more sensitive than pod development. However, these values cannot be directly applied to *N. cymoides* because they were obtained from a different species and crop. For *N. vinitor*, quantitative evidence demonstrates that outbreaks can cause substantial yield losses. In Australia, sorghum yield losses exceeding 20% have been reported during outbreak years in northern New South Wales and southeastern Queensland [57, 58]. Cropping patterns also influence the risk of damaging infestations in summer crops: when canola and summer crops are grown in close proximity, *N. vinitor* populations can build up in canola and then move into nearby summer crops [2]. A comparable crop-sequence effect has been reported for *N. cymoides* in Italy, where population increases were associated with soybean following canola [11]. Thus, although *N. vinitor* provides evidence that related *Nysius* species can cause substantial yield losses, no equivalent quantitative estimate is currently available for *N. cymoides*. Its economic impact therefore remains to be established through studies relating population density and infestation timing to crop yield loss and economic damage [5].

12. Climate Change and Anticipated Future Outbreak Risk

Two structural factors are converging across the wider Mediterranean and semi-arid regions. They are expected to influence the frequency and severity of future *N. cymoides* outbreaks: accelerating regional climate change and adoption of no-till cultivation practices. Both act directly on the two proximate conditions associated with outbreak onset throughout this review — a hot, dry period following a wet spring, and undisturbed crop residue providing shelter for overwintering and breeding populations.

Climate change is reshaping the thermal and hydrological regime of the wider Mediterranean basin, with potential consequences for the distribution and outbreak dynamics of *N. cymoides*. In Morocco, for example, mean annual temperature has increased by approximately 0.42 °C per decade since 1990, while annual precipitation declined by more than 20% between 1961 and 2005 [59]. By 2050, ensemble projections for this region indicate a further increase of about 1.5 °C under RCP4.5 and 2.0 °C under RCP8.5 relative to the 1986–2005 baseline, along with an average precipitation decline of about 15%, with individual models projecting reductions of up to 40% [59]. Heat waves and droughts are expected to become more frequent [59]. By the end of the century, summer warming of 2–6 °C is projected, most pronounced inland, where the moderating influence of the Atlantic Ocean is weaker [60].

Species distribution modeling also supports a broader climatic constraint on the species' range. Solhjoui-Fard *et al.* (2013) [34], working from 663 occurrence records in Iran, developed a MaxEnt model with an AUC >0.80 and a test omission rate <3%, predicting 68.78% of Iranian territory as environmentally suitable; precipitation and altitude were leading determinants, with suitability highest in northern regions and lowest in the hottest desert interior. This indicates that climatic and topographic factors constrain the species' distribution, and suggests that comparable warming and drying trends across other Mediterranean and semi-arid regions could reshape both the spatial extent and seasonal timing of suitable habitat — though the model reflects present-day rather than future conditions, and range extrapolation from it should be treated with caution.

Outbreak development for *N. cymoides* appears to depend on the interaction between host-plant availability and seasonal weather. A documented mechanism from Morocco's 2026 outbreak involved a cool, humid spring supporting dense growth of wild cruciferous vegetation, particularly *S. arvensis*, followed by hot, dry conditions that caused host-plant desiccation and promoted movement of *N. cymoides* toward remaining green and irrigated vegetation [51]. This mechanism remains hypothetical rather than demonstrated, but comparable sequences may plausibly become more frequent as warming and drought intensify across other Mediterranean and semi-arid regions.

Documented outbreaks in Iran (2006), Turkey (2009 and again by 2018–2019, across 25 provinces), France (2009 and 2016), Italy (2017), Tunisia (2018), Jordan (2019), Morocco (2026), and India (2022–2023) place the species in nine countries across three continents since the mid-2000s [5, 10, 11, 24, 33]. This pattern is compatible with a climatic contribution to outbreak occurrence, but increased surveillance, cropping-system change, host-plant availability, and reporting effort are equally plausible contributors [5]. Climate change should therefore currently be regarded as a plausible ecological driver rather than a demonstrated cause of the species' changing distribution and outbreak dynamics.

13. No-till Adoption as a Compounding Factor

No-till cultivation is associated with well-documented soil-health and water-conservation benefits. In Morocco, for example, area under no-till increased from approximately 30,000 ha in 2019–2020 to approximately 400,600 ha in 2025–2026, associated with a mean net benefit of 4,912 MAD ha⁻¹ versus 950 MAD ha⁻¹ under conventional tillage, and yield gains of up to 155% in dry years [61]. The residue retention underlying these benefits is also the habitat feature most consistently linked to *N. cymoides* outbreaks elsewhere. In western France, Chapelin-Viscardi *et al.* (2017) [10] attributed the scale of oilseed-rape outbreaks in part to undisturbed stubble offering shelter and oviposition sites, reporting an association between unploughed fields and elevated infestation. In northern Italy, Scaccini and Furlan (2019, 2021) [5, 11] identified no-till management as a specific risk factor for the 2017 soybean outbreak, contrasting it with tilled fields, and proposed a residue-based monitoring threshold of 10 individuals per 250 mL of crop litter.

A meta-analysis of 30 studies across five continents found that foliar-feeding pests were generally more abundant under conventional, high-disturbance tillage. In contrast, soil- and residue-associated predators, particularly ground beetles (Carabidae) and spiders, were more abundant and diverse under reduced-tillage and no-till systems [62]. Because *N. cymoides* overwinters and lays eggs primarily in soil litter and crop stubble rather than on standing foliage, residue-retaining systems may provide favorable habitat for its persistence. However, the same conditions can also support ground-active predators that are potential natural enemies of *Nysius* species.

Predator communities may require several years to establish after a change in tillage regime; consequently, rapid conversion to no-till could temporarily increase pest risk before predator populations respond. This consideration may be particularly relevant in Morocco, where the no-till area reportedly increased approximately thirteen-fold between 2019–2020 and 2025–2026. Monitoring *N. cymoides* populations in crop residues during the first years after conversion to no-till could help detect potential population increases early.

14. Implications for Related *Nysius* Species and Future Outbreak Dynamics

The combination of warming, drying, increasingly variable climatic conditions with the presence of conservation agriculture is not specific to any single country or to *N. cymoides* alone. Comparable vulnerability to warm, dry, residue-rich conditions has been documented for other economically important *Nysius* species worldwide. In New Zealand, *N. huttoni* has been associated with yield losses of 70–90% in brassica seedlings, and a 1970 outbreak destroyed an estimated 10,000 t of wheat [48]; researchers have since developed a degree-day phenological model requiring 625 degree-days for this species [3]. In North America, a barrier approach using permethrin-treated pollination bags conferred 25–79% yield protection against *N. raphanus*, alongside population reductions of 91% and 85.5% at 12 and 15 days after treatment, respectively [30]. In Australia, *N. vinitor* and *N. clevelandensis* are recurrent pests of sunflower and cotton under climatic triggers comparable to those described for *N. cymoides* [49, 63]. In South Africa, *N. natalensis* is a pest of sunflower for which endosulfan achieved effective field control, but with re-infestation occurring within five days [54].

Given the concurrent presence of conservation agriculture across semi-arid regions with existing or emerging *N. cymoides* records, three developments appear plausible over the coming decade. First, continued outbreak activity, rather than stabilization, is expected in affected regions, consistent with the multi-country pattern documented since the mid-2000s [5, 10, 11, 24, 33, 51]. Second, parallel increases in the economic significance of other seed bugs sharing similar residue-associated, heat- and drought-triggered biology are anticipated, within and beyond the genus *Nysius* [30, 49, 48, 54, 63]. Third, a validated economic threshold specific to *N. cymoides*, a degree-day phenological model comparable to that available for *N. huttoni* [3], and empirically tested guidance for integrating residue-based monitoring into no-till extension programs.

15. Case Illustration: The 2026 Outbreak in Morocco

The 2026 Moroccan outbreak illustrates the broad host range and field behavior of *Nysius cymoides*. On 14 July 2026, the National Office for Food Safety (ONSSA) reported an outbreak in Zagora Province, mainly affecting market-garden crops. Subsequent observations documented the pest in El Kelâa des Sraghna, Rehamna, Chichaoua, Béni Mellal, and Fquih Ben Salah, including olive-growing areas [51]. During field surveys, *N. cymoides* was also found on cactus (*Opuntia* spp.), carob (*Ceratonia siliqua* L.), and date palm (*Phoenix dactylifera* L.) (Figs. 1–3). These three plants may therefore represent new host records for *N. cymoides* in Morocco.



Figure 1: *Nysius cymoides* aggregations on olive (*Olea europaea* L.) shoots and stems (left) and a close-up of a mixed-instar aggregation on a heavily infested shoot (right), Morocco, 2026.

Damage varied among host plants. On young olive trees, feeding was associated with leaf and shoot yellowing, wilting, and necrosis and, in severe cases, branch damage and tree mortality. Similar damage to young olive trees was reported during the 2018 outbreak in Tunisia [12]. On cactus, bugs aggregated on cladodes and caused localized discoloration and necrotic feeding sites. On carob, feeding produced chlorotic areas and necrotic leaf spots. At the same time, on date palm, individuals concentrated around frond bases and young offshoots, where feeding was associated with chlorotic streaks and marginal necrosis. No mortality was observed in date palms.

During hot daytime conditions, adults and nymphs were frequently found inside soil cracks, irrigation channels, and beneath soil clods. This behavior is consistent with observations from no-till soybean fields in northern Italy, where *N. cymoides* was associated with soil litter and crop residues [11].



Figure 2: *Nysius cymoides* aggregation on *Opuntia* spp. cladodes, Morocco, 2026.



Figure 3: *Nysius cymoides* aggregation on date palm (*Phoenix dactylifera* L.) fruit clusters, Morocco, 2026.

16. Methods: Literature Search Strategy

This review synthesizes information on *N. cymoides* and related congeneric species from the peer-reviewed and grey literature. Relevant literature was identified by searching Google Scholar, Web of Science, Scopus, and the CABI Compendium, together with the AGRIS database for regional and grey literature, using combinations of the terms “*Nysius cymoides*”, “*Nysius*”, “false chinch bug”, “seed bug”, “Lygaeidae”, and “Orsillinae”, combined with terms including “outbreak”, “biology”, “thermal threshold”, “natural enemies”, “insecticide”, and “management”, and with the names of the congeneric species discussed (*N. raphanus*, *N. huttoni*, *N. vinitor*, *N. natalensis*, *N. clevelandensis*). Reference lists of retrieved papers were also screened for additional relevant sources. Searches were last conducted in August 2026 and were not restricted by publication date; sources in English and French were included. Regional bulletins and extension publications (e.g., ONSSA phytosanitary bulletins, agricultural-extension fact sheets) were included where they provided otherwise-unavailable information on recent outbreaks, such as the 2026 Morocco outbreak, and are identified as grey literature in the reference list. No formal systematic-review protocol was followed, and no formal quality-appraisal or risk-of-bias assessment was applied to included sources, consistent with the narrative, rather than systematic, nature of this review.

17. Limitations

Several limitations should be considered when interpreting this review. First, because dedicated experimental and field data on *N. cymoides* itself remain scarce for several topics, this review relies substantially on data from related congeneric species—principally *N. raphanus* and *N. huttoni*—for thermal-development parameters and for insecticide-efficacy information; these comparative data provide useful context but cannot be assumed to apply directly to *N. cymoides*, and are flagged as such throughout the text. Second, no validated, species-specific economic threshold exists for *N. cymoides*, and the provisional residue-based threshold discussed in this review (10 specimens per 250 mL of crop litter) has been proposed and field-tested in only one cropping system (soybean following canola in northern Italy) and has not been validated more broadly. Third, the apparent geographic range expansion of *N. cymoides* documented across nine countries since the mid-2000s should be interpreted with caution: increased surveillance, extension outreach, and reporting effort, alongside genuine ecological or climatic drivers, may all have contributed to this pattern, and the relative contribution of each cannot be disentangled from the available literature. Fourth, the 2026 Moroccan observations reported in this review (Case Illustration) are unreplicated field observations made during a single outbreak response rather than a designed survey; the host records, damage descriptions, and behavioral observations drawn from this material should accordingly be treated as preliminary and hypothesis-generating rather than definitive, pending replicated, systematic field studies.

18. Conclusions and Future Directions

This review has synthesized current knowledge on *N. cymoides* across taxonomy, biology, ecology, distribution, host range, natural enemies, and pest management, before turning to the climate change expected to shape its future trajectory. *Nysius cymoides* has moved from a locally reported curiosity to a recurrent pest across at least nine countries spanning the Mediterranean basin, the Middle East, and South Asia—although, as noted above, increased surveillance and reporting effort may account for part of this apparent expansion, with a host range now extending well beyond cereals and oilseeds to legumes, solanaceous vegetables, cotton, olive, carob, and cactus. Outbreaks follow a consistent mechanism: a wet spring builds up populations on wild weed hosts, and a subsequent hot, dry period desiccates them and triggers mass migration into cultivated crops. This pattern recurs across the wider genus *Nysius* — in *N. huttoni*, *N. raphanus*, *N. vinitor*, *N. clevelandensis*, and *N. natalensis* — pointing to a genus-wide vulnerability rather than a species-specific anomaly. Despite this expanding record, key gaps remain: no validated economic threshold, a poorly characterized natural enemy complex, and no field-tested monitoring tools calibrated specifically to *N. cymoides* rather than assembled from related-species evidence.

Two structural factors are likely to increase the risk of *N. cymoides* outbreaks over the coming decade: continued warming and drying across the Mediterranean and Maghreb, and the increasing adoption of no-till farming, in which crop residues are retained at the soil surface and may provide suitable overwintering habitat for

the pest. These trends do not justify reversing the well-established agronomic and soil-health benefits of conservation agriculture. Instead, they highlight the need to address the main knowledge gaps before these factors translate into greater pest pressure. Three research priorities are therefore particularly important: (i) developing and field-validating a species-specific economic threshold for *N. cymoides*; (ii) developing a degree-day phenology model, similar to that available for *N. huttoni*, to predict seasonal development and outbreak timing under current and future climate conditions; and (iii) evaluating residue-based monitoring methods that can be integrated into no-till production systems. Addressing these priorities would support a shift from reactive outbreak responses to proactive, threshold-based management of *N. cymoides* as its geographic and host ranges continue to expand.

Conflict of Interest

There is no competitive interest regarding this manuscript.

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Original data for the manuscript can be obtained from the corresponding author upon reasonable request.

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