



## Cyst Nematode and its Impacts on Soybean and Potato: A Review

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### Abstract

Globally, nematodes are the most abundant multicellular creatures. The nematodes that are of animal parasitic in nature may reach up to 2 mm in length while nematodes that are free-living in nature can be as extended up to 5 cm. Furthermore, many nematodes are dangerous for agriculture and subsequently lead to decrease in yield of many crops like soybean and potato etc. Soya is a productive crop but, there are some challenges which affect the production of Soybean and cyst nematode is one of them. On the other hand, Potato Cyst Nematode also causes significant yield losses and have been listed as quarantine pests in many countries round the world. The Cyst Nematode is the most damaging pest disturbing the yield level of soybean and potato globally. Documenting the impact of Cyst Nematodes economically is difficult because several producers suffer deteriorating in yield for a number of years without knowing that they have Cyst Nematodes. Moreover, this minuscule, soilborne worm is existing in nearly 75% of the fields, and can shrink the yield up to 50% or more. In this review article, efforts have been made to describe Cyst Nematodes and their impacts on soybean and potato.

**Keywords:** Cyst Nematodes; Soybean; Potatoes; Morphology; Yield Losses; Integrated Management

## Abbreviations

CNs: Cyst Nematodes; SCN: Soybean Cyst Nematode; PCN: Potato Cyst Nematode; S-PCNs: Soybean and Potato Cyst Nematodes; J1: First-Stage Juvenile; J2: Second-Stage Juvenile; J3: Third-Stage Juveniles

## Introduction

Major worldwide challenge in the upcoming years will be the increasing human population and to ensure availability of food for all. According to the survey carried out by World Bank in 2008, there will be the need of sustainable rise in agricultural output in line with growing demand be more relevant than in poor areas of the domain. The maximum abundant set of multicellular animals on world in terms of amounts of individuals are nematodes. Even though over 400 types of nematodes have been identified which are basically plant parasitic in nature [1]. The fresh species are repeatedly being termed while others, formerly viewed as non-damaging, are suitable pests as change in cropping patterns [2].

Moreover, for the development of emerging nation is the farming sector through which maintainable growth of economic system and reduction in poverty can be achieved. It is generally known that broad-based development in farming profits is vital to stimulate growth of economic system in predominantly agricultural civilizations [3]. The production of soybean opens the doors of chances for poor farmers. Particularly, the environment in various parts of the world is satisfactory for the production of soybean and the arable land is massive enough to put up upcoming growth. Significantly, soybean is a very gainful crop. On the other hand, there are some challenges which affect the production of soybean [4]. Soybeans are categorized as legumes or another type of beans because it can be stated as one of the sensation crops which deliver vegetable protein and oil more than many other crops. Soybeans are categorized in the oilseed type of edible oil which is produced in bulky amounts. Soybean embraces varied climatic conditions and diverse types of land that's why it is known as a versatile crop. In the entire world soybeans are one of the extensively produced oilseed products [5].

Potato is also one of the most significant industrial food crops. In diverse environmental conditions due to its high adaptableness, it may be grown in many regions of the world and is a main component in the diet of human as an ironic source of vitamins which

include C, B1, B3, B6, K, carbohydrates, proteins, and minerals [8]. That's why, potato is cultivated in about 19 million hectares worldwide at the rate of 368 million tons/year at global production level. All over the world, potato is one of the most vital crops and its rate of production comes only after wheat, maize, and rice [7]. For attaining growth objectives, the growth of the farming sector is essential, in the initial phases of progress [3]. Potato cyst nematodes (PCN) are 1-millimeter in length be appropriate to the *Globodera* genus, which includes round 12 species. Mostly PCN present on the plant roots of family Solanaceae, such as tomatoes and potatoes and cause delay of growth as well as damage the roots of plants [8,9]. Basically, nematode originates from the Andes and not native to Europe. From PCN fields are free of S-PCNs until an introduction occurs, when the typical spots arise on the farmland. At high population densities of S-PCNs reductions in yield can usually up to 60% [10].

## Nematode extraction and population

Study was conducted during the season of wheat cultivation in 2015–2016 from diverse areas covering the main areas of Algeria which is used for the production of wheat [11]. Total of 83 samples comprising of parts of root and soil was collected from the wheat fields. The sampling elaborate accumulating resources from the nematode pretentious areas that presented symptoms of chlorosis and poor growth. A 1kg sample of soil was composed of ten randomized sub samples drawn from each intersection grid, while samples of root were procured by lifting plants carefully at the similar points. Individually sample of soil was mixed carefully and an illustrative sample of 2.5 kg soil was used for cyst extraction by using the Fenwick technique [11]. In addition to the morphometric assets of the (J2) 2<sup>nd</sup> stage juvenile, structures were observed and measurements were taken which belongs to vulval cyst cone. According to McSorley (2004) [12], the vulval cone of the cysts is usually detached and equipped to study under an optical microscope. The documentation of the cysts are complete on the basis of structure which is under bridge, shape like a semi fenestra, and the growth of the bullae [13].

## Scientific classification

- Kingdom: Animalia
- Phylum: Nematoda
- Class: Secernentea

- Order: Tylenchida
- Family: *Heteroderidae*
- Subfamily: Heteroderinae
- Genus: *Globodera*.

### Morphology

Structurally S-PCNs are cylindrical and bilaterally symmetrical. Moreover, S-PCNs have digestive, excretory, reproductive and nervous systems. Although S-PCNs lacks circulatory system. Body of nematode is enclosed and unsegmented in a dense cuticle which keeps them save from the outside atmosphere and forms an exoskeleton which is stretchy. There is a muscle cells layer beneath the epidermis that spread all over the body, allowing the movement of S-PCNs. A cuticle-lined capsule is basically an oral cavity having variations such as tooth like structures, bristles, or plates. They have feeding stylet that injures root cells (Figure 1). Many nematodes have a severe stylet through they attack into their victim for example, plant parasitic. Glands that play an essential role in digestive system are found in the pharynx which produce food digesting enzymes. Using the hollow stylet mouth with the emission aid of various proteins, entry is achieved into the tissues of plant host. The cell wall-degrading enzymes may contain in the case of hosts plants. On the other hand, nematodes can move and penetrate while feeding from host cells with the help of vertebrate parasitic nematodes hyaluronidases and proteases.

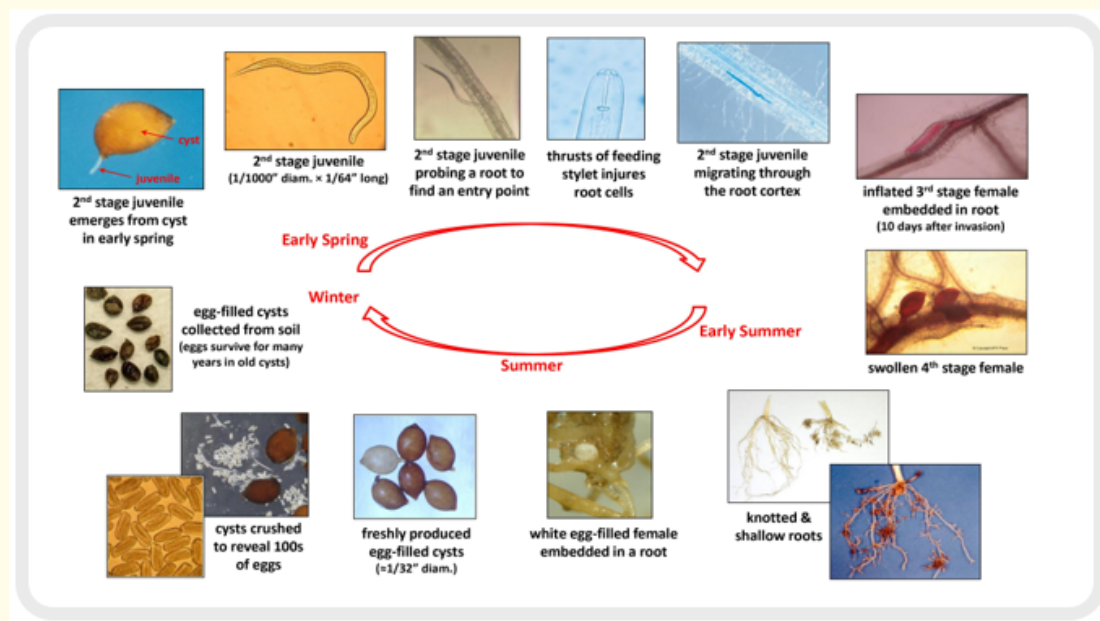


**Figure 1:** Feeding stylet injures root cells (Courtesy: Richard W. Smiley<sup>1</sup>).

### Biology and life cycle

In the existence of Solanoeclepine, the eggs hatch, a material secreted by the host plants roots otherwise identified as exudates of root. At second-stage juvenile (J2) the nematodes start hatching. The J2 nematodes at this stage find host cells for feeding. The PCN are endoparasites by nature because they go fully into the root of plant for feeding. The contact of PCN to the cells of root is through penetrating from cell wall expending the nematode's stylet. Once a suckling is done, a tube is created, a syncytium starts to form via the collapse of various cell walls contiguous to each other. They carry on feeding until J2 nematodes develop into (J3) which is known as third-stage juveniles, then (J4) which is known as fourth-stage of juveniles, and lastly reaches the adult stage. As the female develops into a fourth-stage of juveniles' the character of the J3 females starts to more look like a sac. The physique of the female nematode at the J4 stage lies externally in the root although the cell head remains inside. On the other hand, male nematodes develop motile again during this phase, and then capable to pollinate the female prominent to embryos emergent within the female nematodes body (Figure 2). The male nematodes develop motile again during this phase, and are then capable to fertilize the female prominent to embryos emerging inside the body of female nematodes [15]. When the female nematodes are fertilized, they dies and leaves a defensive cyst holding eggs up to 200-500 [16]. From the new hosts once the cysts nematodes (CNs) separate, they stay within the soil till they find alternative appropriate host start the cycle again. Other hand, per season CNs have one life cycle because they are monocyclic [17]. By their irregular distribution Potato cyst nematodes (P-SCNs) can be spotted in the field. By the limited extent the definite spreading of P-SCNs is caused. Most P-SCNs don't transfer very far through an agriculture field because of their patterns of feeding. At medium and low populations densities, both resistant and susceptible varieties of potato will suffer from the retardation of growth. On the other hand, at high population densities mechanical loss will occur in the root system. On the roots surface the female nematodes swell up and seem as cysts, each holding 400 eggs. Annually only one generation occur in temperate zones but occasionally a 2<sup>nd</sup> generation is also reported in the Mediterranean nations. On the skin of the tubers, CNs can also be found. Each year without host, a spontaneous hatch is done and these eggs can stay alive up to 20 years inside the cysts.

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**Figure 2:** Feeding stylet injures root cells (Courtesy: Richard W. Smiley).

### Favourable environment

According to various researches, it has been demonstrated that CNs are prevalent in various fields worldwide. In warm environments particularly. An eggshell which is dried can also cause reduction in the loss rate of water by exchanging its penetrability, during dry conditions [19]. Dissimilar activities for example, development and growth, infection, mobility, hatching and capability are affected by its nearby heat [20]. Some nematodes are need 12.2°C at least with small photoperiod for the production of egg mass. Extra investigation on shell permeability was complete by Goggin FL, et al 2004 [21], and he identified the lipid coating of the eggshell that played a main part in dropping the water loss during desiccation.

### Economical importance

Due to the huge quantities of embryos of nematode in each cyst P-SCNs have the capability to cause a huge scale damage in crops. Soybean basically fall in the category of cereals which are the key source of diet in the world. About 70% of the agricultural land is used for the production of crops that belongs to cereal crop family [22]. According to an estimate after 10 years in 2030, production of cereal is reach up to 8 billion tons, worldwide [23].

Through in the many continents of the world such as North of America, Australia, Africa, Asia and Europe have had various epidemics of PCNs that stay to keep on time after time [13]. Economically PCNs are vital due to the statistic that they decrease the crop yield exceptionally. The PCNs species named as pale cyst nematodes (*Globodera pallida*) are capable to reduce the yield up to 80% in a field of potato plant if left unprocessed. Potato Cyst Nematodes also called as (PCN) is important species that producing huge harm to potato crop. Reproduction of potato is made by mostly as propagation through vegetative technique, thus it enables the soil borne pathogens and pests of plant which include insects, nematodes, bacteria, viruses, fungi, weeds that can extent out into fresh zones [24].

### Integrated control of pest

From field to field, nematodes speed of spread can be controlled by equipment washing of feasibly infected soil formerly location fluctuating and by using PCN-free tubers seed which is certified. Furthermore, seed of potatoes grown on lands which were confirmed free from PCNs using a soil sampling scheme which is AMI-intensive but unluckily that scheme presently only accessible in Netherlands. Insecticides can be used on lands (pesticides), but

unfortunately not get a nematodes free field. They will only gainful at extraordinary population densities, and upturn the yields, the price of the application of pesticide will exceed with the economic turnover of the additional yield. Rotation of crop with minimum six years among the susceptible crop planting is an operational resource to decrease the densities of nematode population to below threshold injury. On the other hand, finest way to manage S-PCNs is the use of potato resistant varieties. Throughout the previous 10 years, an amount of many varieties has been established which can manage both species of S-PCNs revealing threshold and below harm, without the pesticides use [25]. Another nematicides pest control method is Fosthiazate. It is applied openly to the land in definite intervals of time. Although, toxicity level is vital to study when spread and depends on the producer and the definite application instructions. The use of disease resistance seed with certified quality will also declare that S-PCNs are not existing due to the infected tubers planting. Testing of soil for S-PCNs is also critical in observance track of occurrence. The quantity controlling of nematodes lets the epidemic prevention. Finally, S-PCNs resistance has been found in *Solanum acaule*. The problem is that *Solanum acaule* is a wild species of potato that comprise of high content of glycoalkaloid making it contaminated for users.

## Conclusion

Mostly in the moderate areas of the world, S-PCNs cause a range of plant diseases. Species of S-PCNs attack simply on a limited species of plants and are present over inadequate geographical parts, whereas others species attack a great amount of plant types. S-PCNs produce a huge scale damage in plants yield due to the considerable sums of each cyst embryos of nematodes. S-PCNs are the most abundant multicellular animals and some of them are damaging most of the crops by reducing there yield annually. For example, soybeans and potato both are good and friendly cash crops that are able to enhance the livelihoods of the rural farmers as it is able to improve their life standard.

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