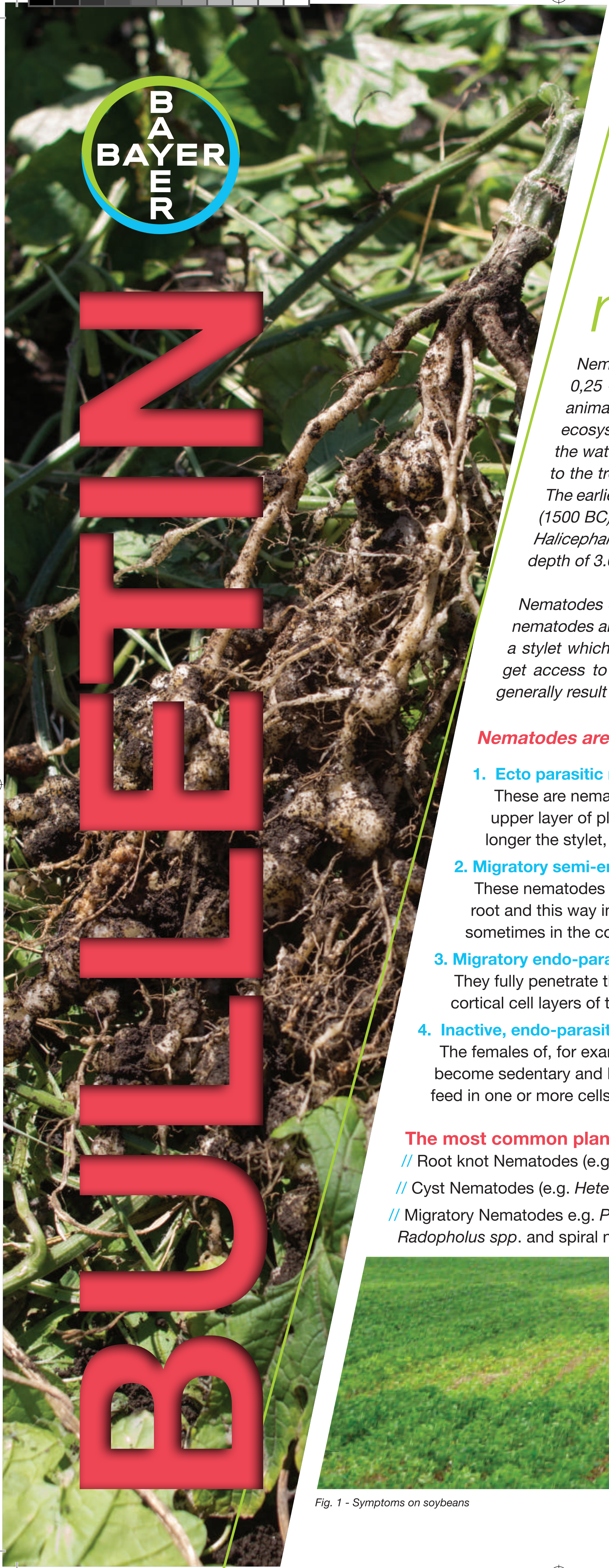


WHAT ARE *nematodes?*

Nematodes are multicellular worm-like organisms - typically 0,25 - 1 mm long and 0,1 - 0,2 in diameter. They are aquatic animals and have successfully adapted to nearly every ecosystem from marine (salt water) to fresh water, to soils (in the water layer around soil particles), and from the polar regions to the tropics, as well as the highest to the lowest of elevations. The earliest nematode recordings were found in Egyptian papyrus (1500 BC). In 2012, the first multicellular organism (the nematode, Halicephalobus mephisto) was found in a Free State mine at a depth of 3.6km.

Nematodes occur in large numbers in soils and feed on fungi, other nematodes and plant roots. Typically, plant paracitic nematodes have a stylet which penetrates and infects the cell walls of a plant part to get access to nutrients. In agricultural crops, soil-borne nematodes generally result in yield losses of 15 - 20 %.

Nematodes are able to attack plants in various ways:

1. **Ecto parasitic nematodes**
   These are nematodes living in the soil and feed from the outside of the upper layer of plant roots. Only their stylet is placed in the root cell. The longer the stylet, the deeper it can penetrate the plant.
2. **Migratory semi-endo/ecto-parasitic nematodes**
   These nematodes partially penetrate the root by inserting the stylet into the root and this way infecting the cells directly underneath the epidermis or sometimes in the cortical cell layer.
3. **Migratory endo-parasitic**
   They fully penetrate the roots and move around inside the epidermal and cortical cell layers of the roots whilst feeding and reproducing.
4. **Inactive, endo-parasitic or semi-endoparasitic nematodes**
   The females of, for example, root knot, cyst, citrus and reniform nematodes become sedentary and lose their ability to move. These nematodes permanently feed in one or more cells of the host plant.

The most common plant parasitic nematodes can be grouped into:

// Root knot Nematodes (e.g. *Meloidogyne spp.*)

// Cyst Nematodes (e.g. *Heterodera spp.*, *Globodera spp.*)

// Migratory Nematodes e.g. *Pratylenchus spp.*, *Ditylenchus spp.*, *Radopholus spp*. and spiral nematodes

Fig. 1 - Symptoms on soybeans

SUITABLE **conditions**

1. Temperatures

// Nematodes are flexible regarding temperatures with an optimum temperature aound 25°C.
// The temperature ranges vary between species.
// Suitable temperatures for nematode development are usually similar to that of the host plants.

2. Soil pH

// Optimum pH is generally at pH 4 - 7 (neutral to slightly acidic).
// The pH range varies between species and is usually the same as for host plants.

3. Soil texture and moisture

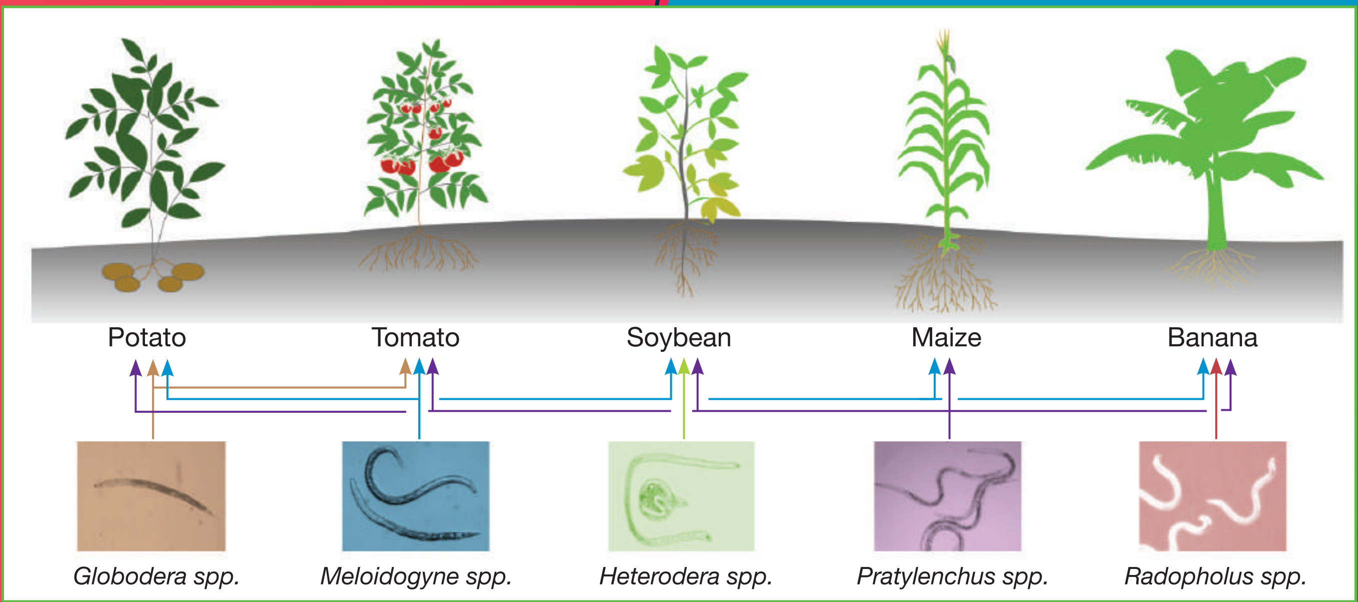
// Sandy soils with some silt or clay content are generally optimal for nematode development, penetration of host plants and reproduction.
// They need space to move in and occur in the water layer adherent to soil particles.
// The space between particles must contain oxygen to be viable.
// There must be enough fine soil particles to bind root exudates, to allow them to trace and find the roots. However, some nematode pests only need optimal temperatures and moisture to hatch and penetrate roots of their hosts.
// Flexibility regarding soil texture conditions varies between species.

SYMPTOMS

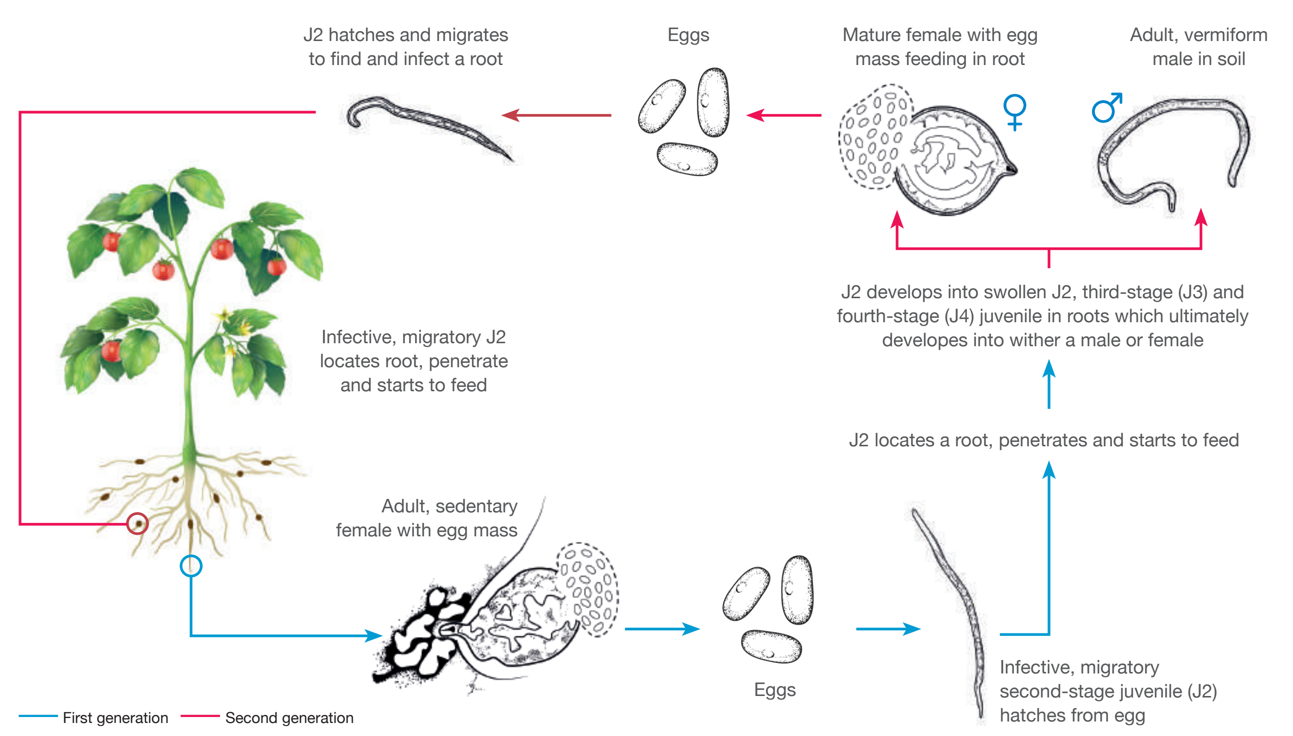
// In-field damage spots (Fig. 1 - Symptoms on soybeans).
// Root symptoms include root knots or galls, root lesions, excessive root branching, injured root tips and stunted root systems (Fig 2. Symptoms on potato).
// Above ground symptoms are usually not visible or confused with those caused by drought, phytotoxicity, water logging but may include wilting (even in wet soils) with ample soil moisture.
// Yellowing with fewer or smaller leaves in a patchy appearance (Fig. 3 - Symptoms on maize).
// Bulb and stem nematodes produce stem swellings and shortened internodes.
// Reduced crop growth in patches (Fig. 3 - Symptoms on maize).
// Plant growth distortion.
// Crop losses.
// Yield and quality reduction.
// Infection with secondary fungal and bacterial diseases.

Fig. 2 - Symptoms of galls on potato

What nematode can be FOUND IN WHICH CROP?



Life cycle of root knot NEMATODES



Source: Mashela et al. 2017. Chapter 7. Alternative Nematode Management Strategies. In: Fourie, H, Spaulls, V.W., Jones, R.K., Daneel, M.S. and De Waele, D. (Eds.) Nematology in South Africa: A view from the 21st Century.Springer Publishing, Germany. DOI:10.1007/978-3-319-44210-5)

CONTROL strategies

The use of crop protection products is the most popular short term strategy to reduce nematodes in agricultural crops.

PRODUCT	ACTIVE	WHO CLASSIFICATION	APPLICATION	HOW IT WORKS
Velum® Prime	*Fluopyram*	*Blue label*	*In furrow application*	*A combined contact and systemic action for the control of nematodes on potatoes, tobacco, tomatoes and citrus.*
Velum® GR	*Fluopyram*	*Blue label*	*In furrow application*	*A combined contact and systemic action for the control of nematodes in maize.*

crop ROTATION

The use of tolerant cultivars and non-hosts to target nematodes contribute significantly to reducing such pest populations. However, the traditional crop rotation systems applied in South African agricultural areas are conducive to the build-up of high numbers of target nematode pests such as root-knot and lesion nematodes. For example, crops such as potato, dry bean, soybean, sunflower, other vegetable crops (except some Brassicaceae cultivars) are highly susceptible to root-knot and lesion nematodes.

(Fig. 3 - Symptoms on maize).

Host plant **resistance**

Susceptible cultivar

Resistant soybean cultivar

SUSCEPTIBLE CULTIVAR	HIGHLY RESISTANT CULTIVAR
- severe galling visible	- minimal galling visible
- optimal nematode reproduction and development	- restricted nematode reproduction and development
- high final populations	- significantly lower populations compared to susceptible cultivar
Example: Each female = produces 1 800 + eggs each 20 - 30 days (soil temp. 26 °C) Each female lives approximately 3 months x 1 800 eggs/month = 5 400 eggs in her life BUT if there is 100 females in a root the final population could be: 100 females x 540 000 eggs per female = 540 000 eggs **Result:** High population pressure	**Example:** Each female = produces ±30 eggs each 20 - 30 days (soil temp. 26 °C) Each female lives approximately 3 months x 30 eggs/month = 90 eggs in her life BUT if there is 100 females in a root the final population could be: 100 females x 90 eggs per female = 9 000 eggs Final population in roots of a resistant cultivar is ± 60 times lower than that in a susceptible cultivar **Result:** Lower population pressure

OTHER *management strategies*

Other management strategies can be used to reduce nematode populations (if possible and practical):

- *// Growing cover crops with biofumigation properties*
- *// Fumigation*
- *// Burning of stubble*
- *// Trap cropping*
- *// Mulching*

Bayer (Pty) Ltd. Reg. No. 1968/011192/07
27 Wrench Road, Isando, 1601
PO Box 143, Isando, 1600,
Tel: +27 11 921 5002
@Bayer4Crops
www.cropscience.bayer.co.za
www.bayer.co.za

Facebook: Bayer Crop Science Division Southern Africa ///// **Twitter:** @bayer4cropssa

05/2020