One Health
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Green-Synthesised Nanoparticles for the Management of *Meloidogyne incognita* and Enhancement of Plant Growth under Greenhouse Conditions

Nicholus MNYAMBO, Zakheleni DUBE, Nokuthula KHANYILE

nicholus.mnyambo@ump.ac.za

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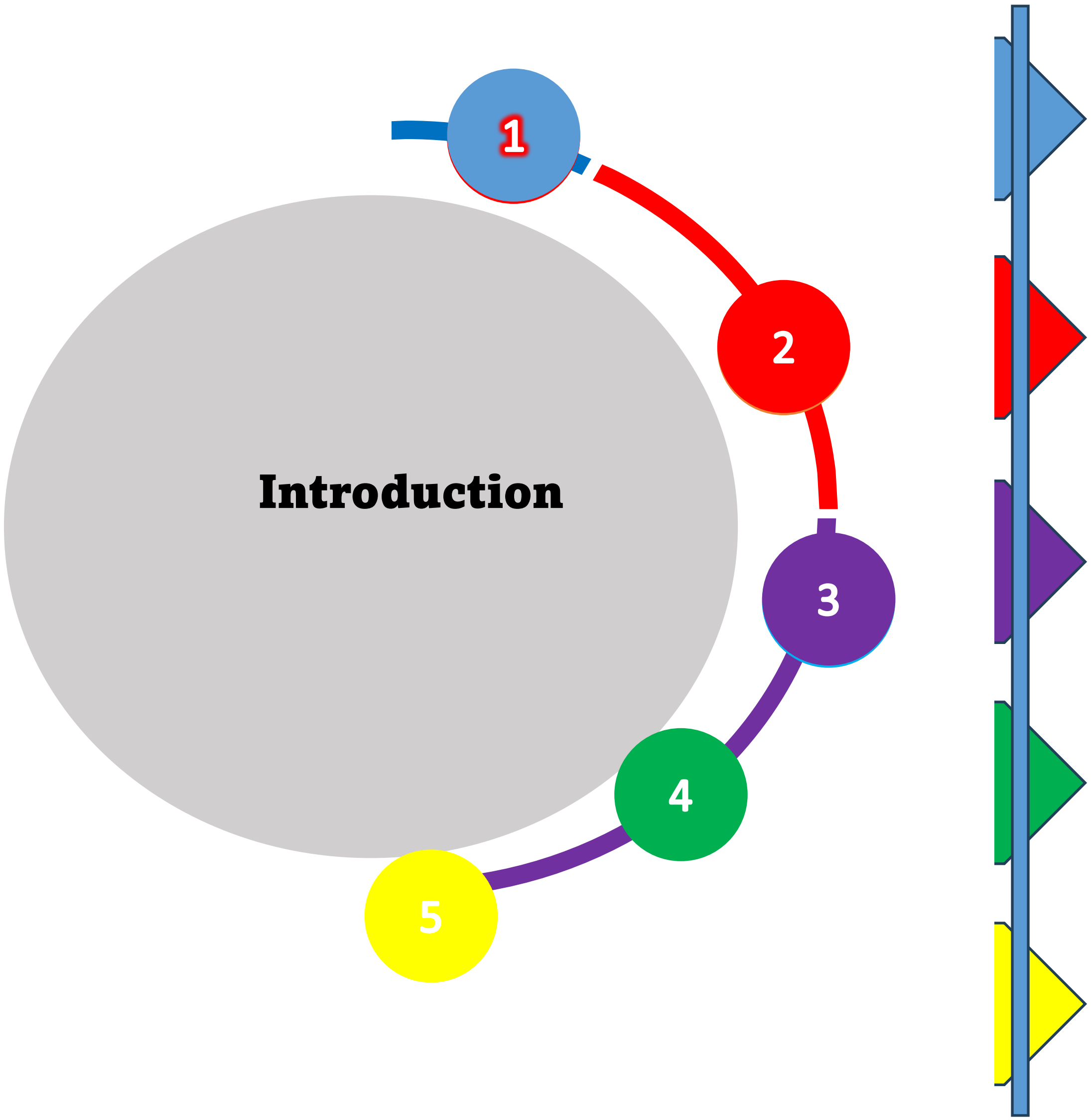
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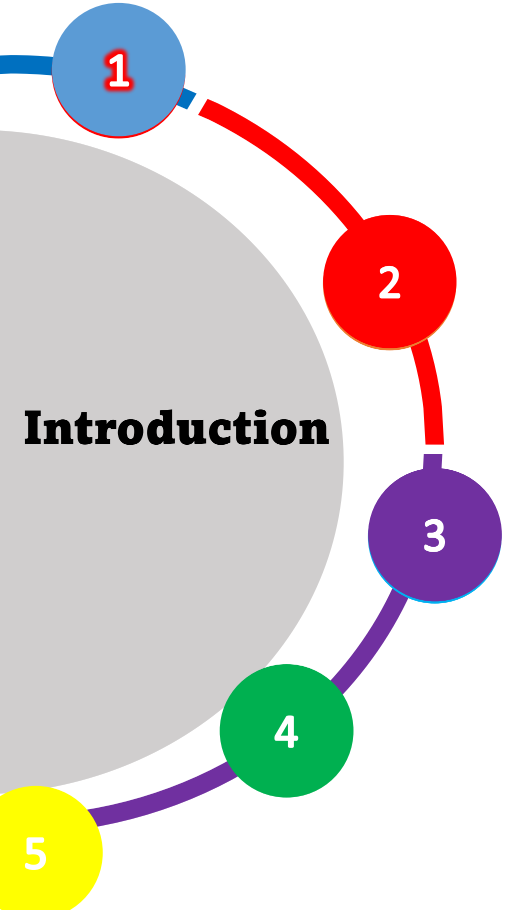
Background on Tomato Cultivation:



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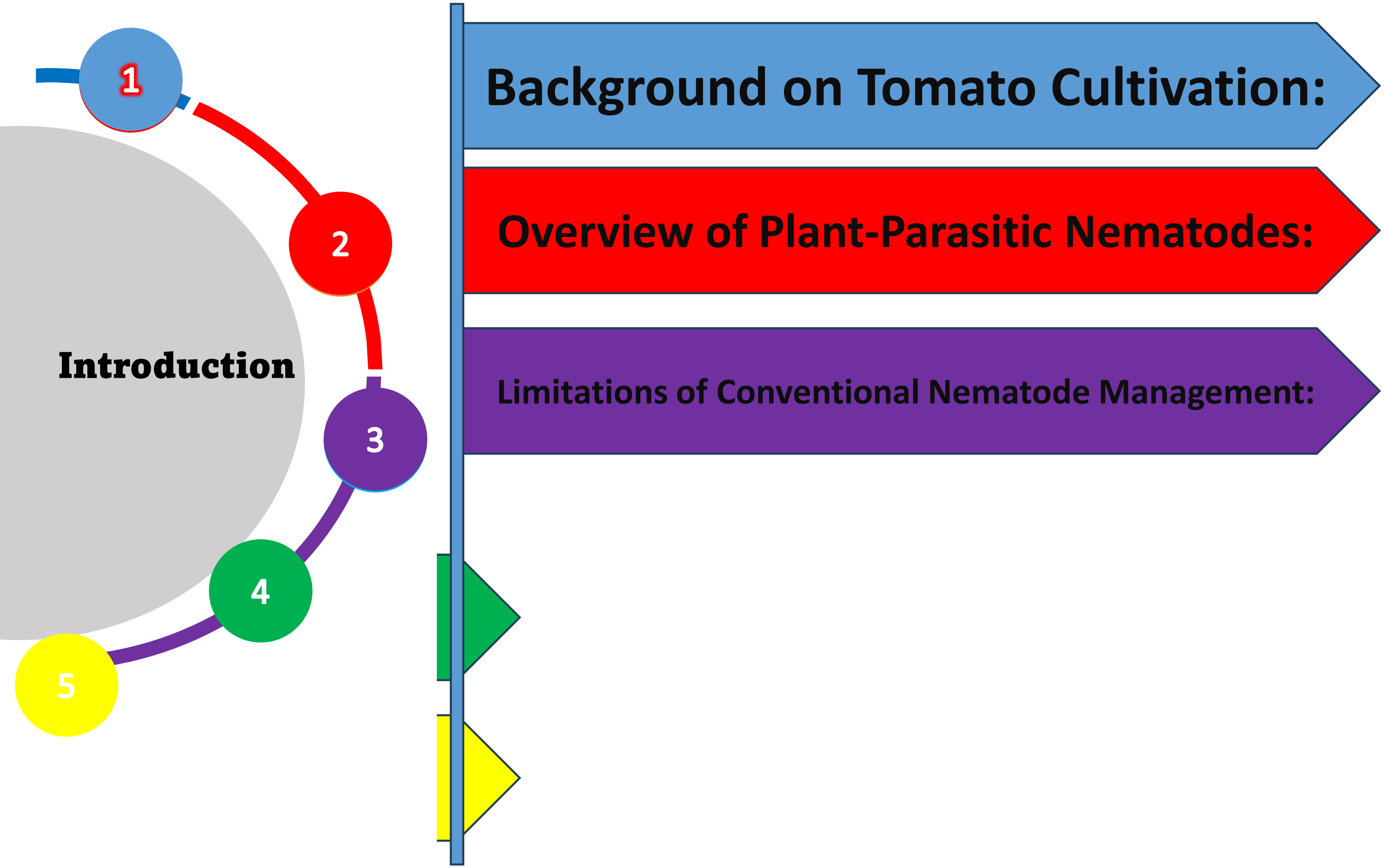
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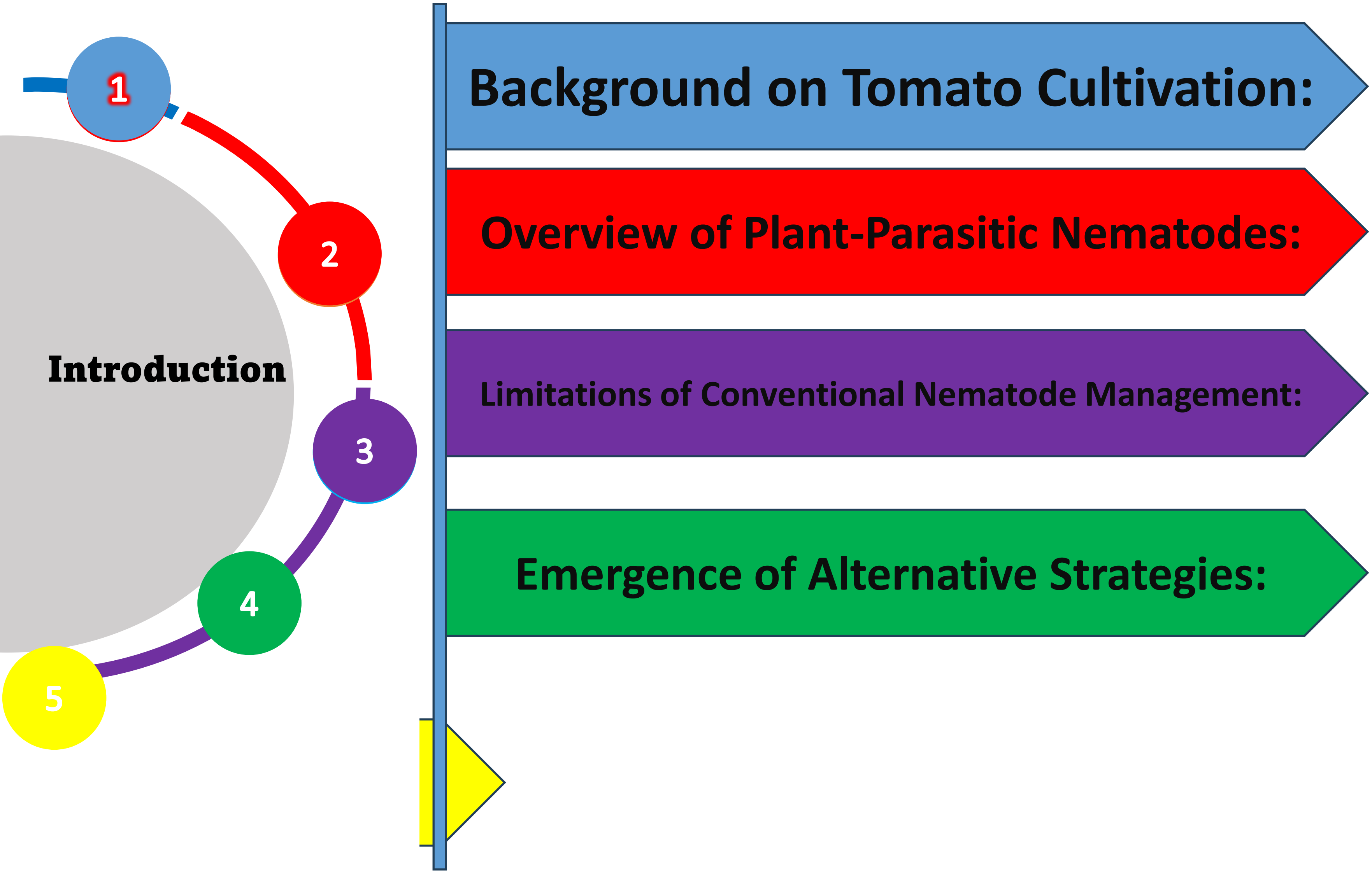
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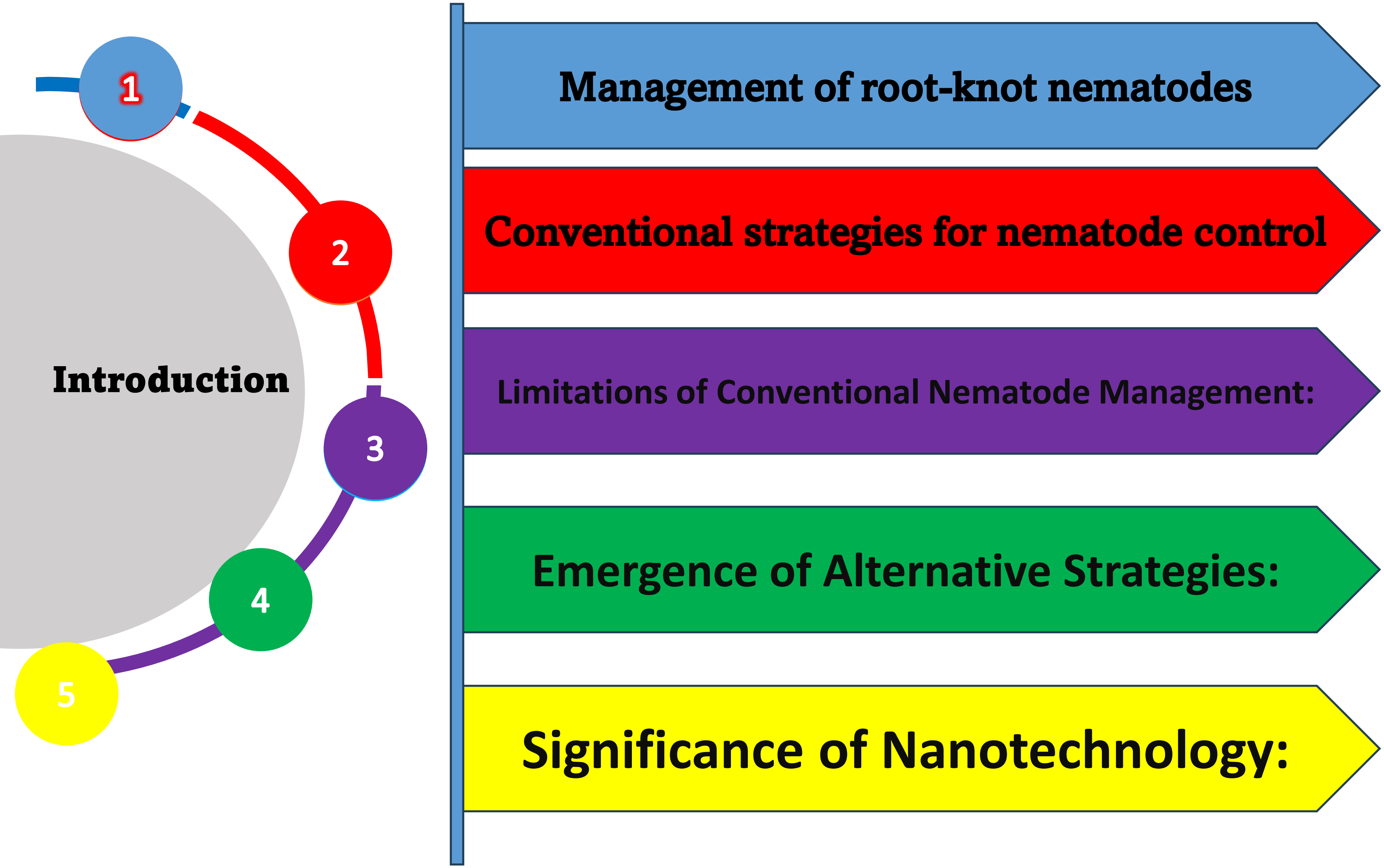

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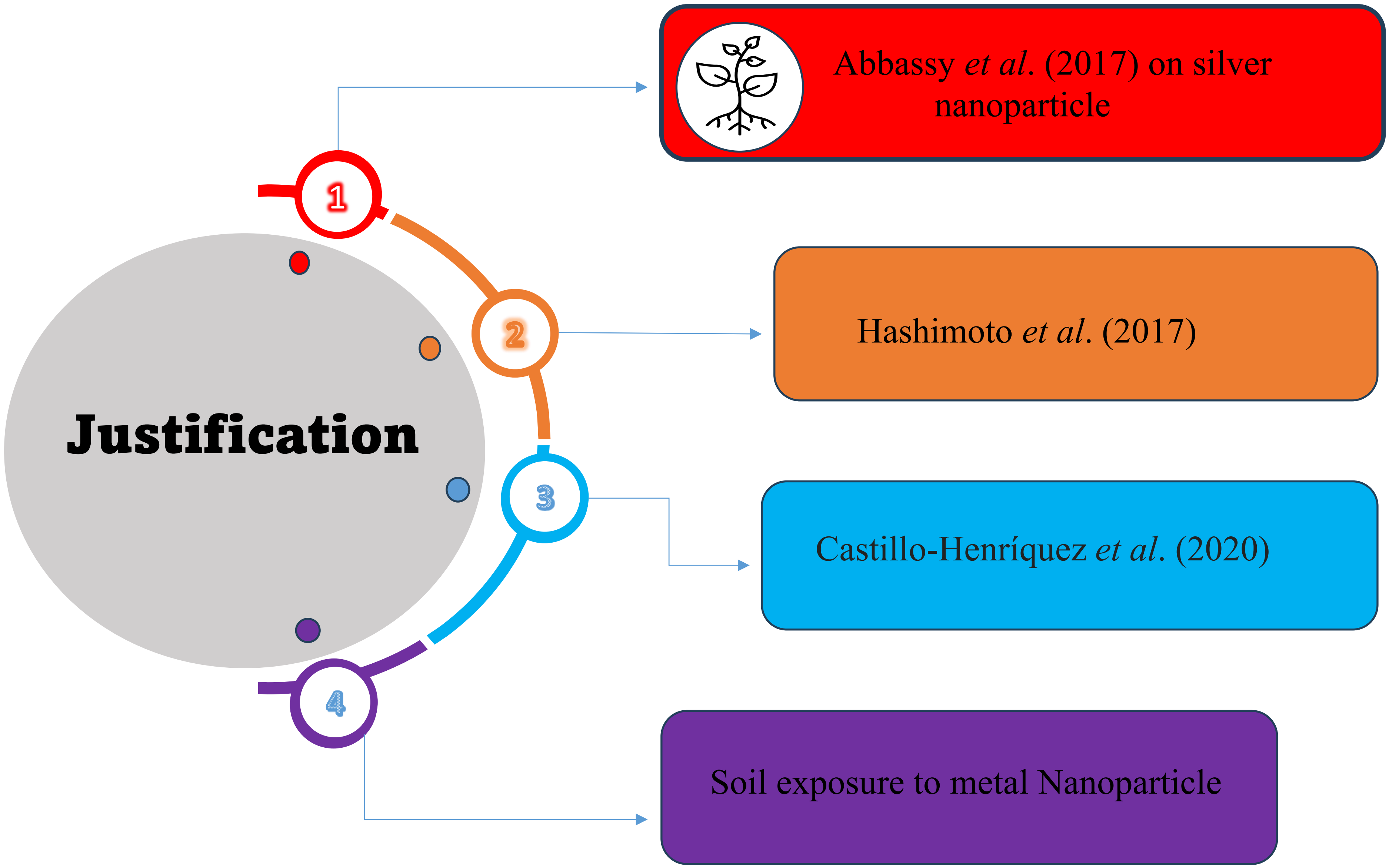
Introduction
Management of root-knot nematodes
Conventional strategies for nematode control
Limitations of Conventional Nematode Management:
Emergence of Alternative Strategies:
Significance of Nanotechnology:


Justification
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Abbassy et al. (2017) on silver nanoparticle
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Hashimoto et al. (2017)
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Castillo-Henríquez et al. (2020)
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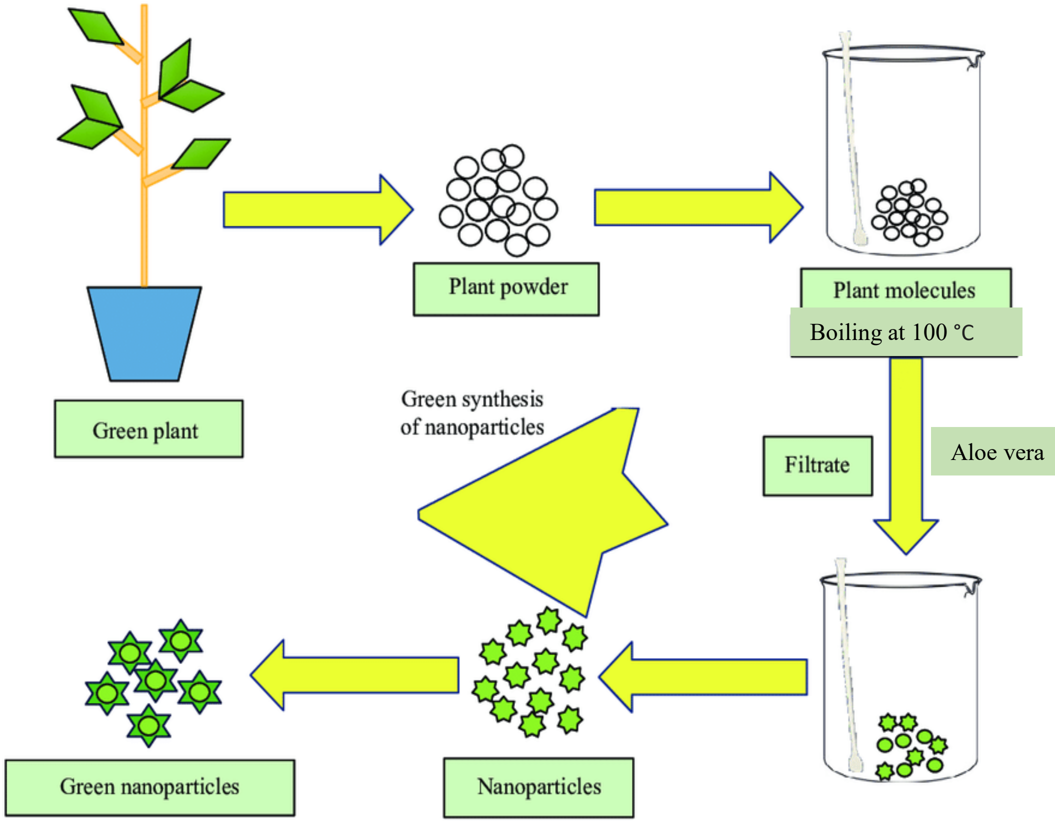
Soil exposure to metal Nanoparticle

Objective

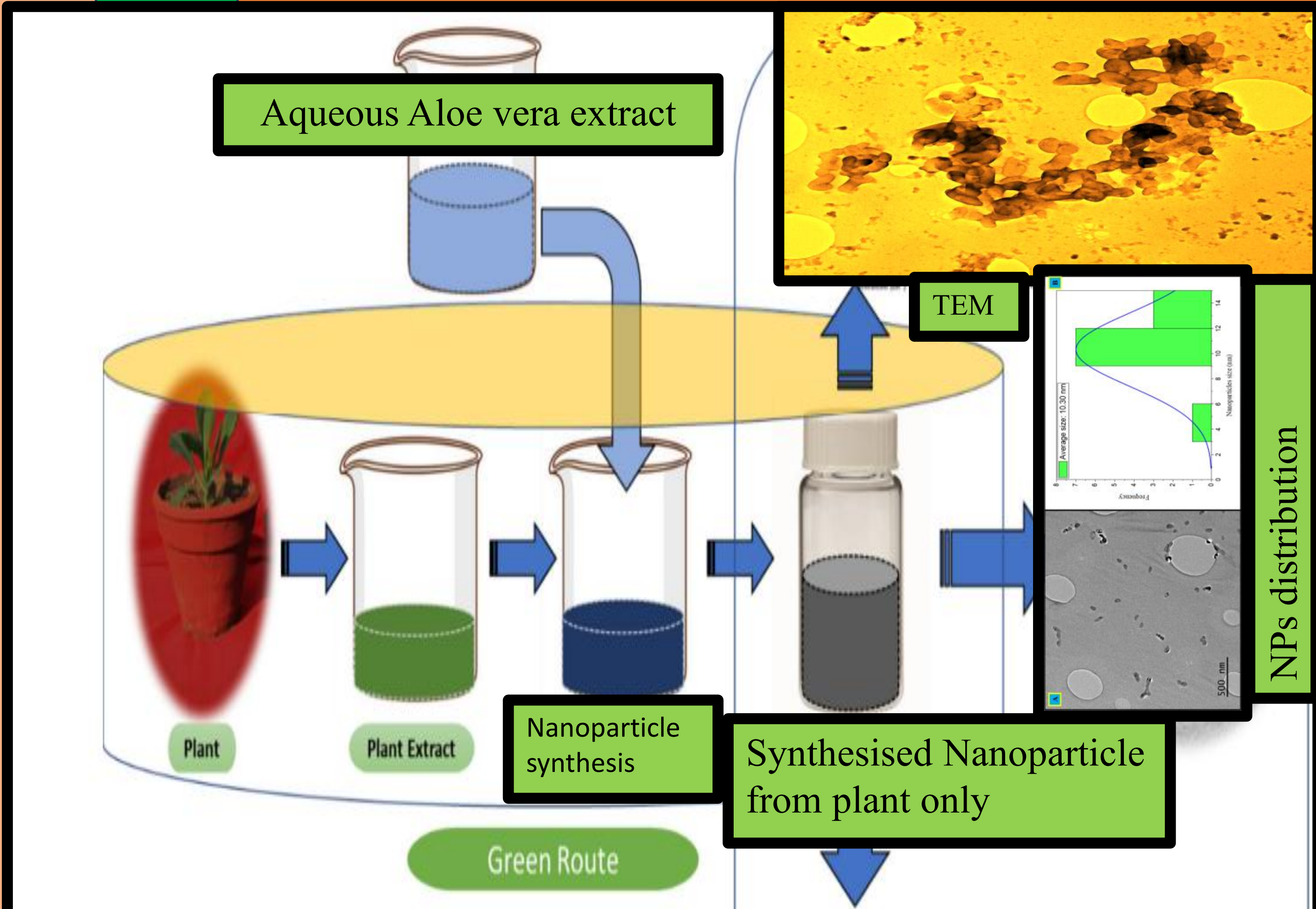
To investigate the effects of nanoparticles synthesized from *Tabernaemontana elegans* and *Lantana camara* using *Aloe vera* as a reducing and stabilizing agent on root-knot nematodes (*Meloidogyne incognita*) and plant growth variables under greenhouse conditions.



Method and Materials

- University of Mpumalanga
- Plant material and preparation of powdered leaf meals
- Phase 1: Phytochemical analysis
- Phase 2: Nanoparticle synthesis
- Phase 2: Greenhouse experiment

Nanoparticle Synthesis using *Aloe vera* as a reducing and stabilizing agent

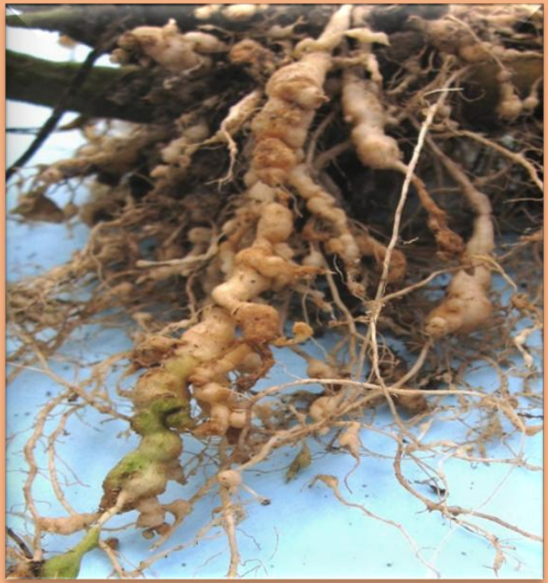


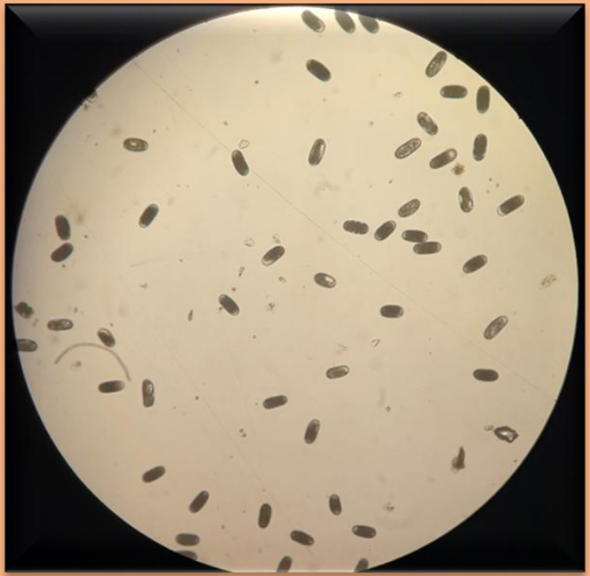
Greenhouse experiment

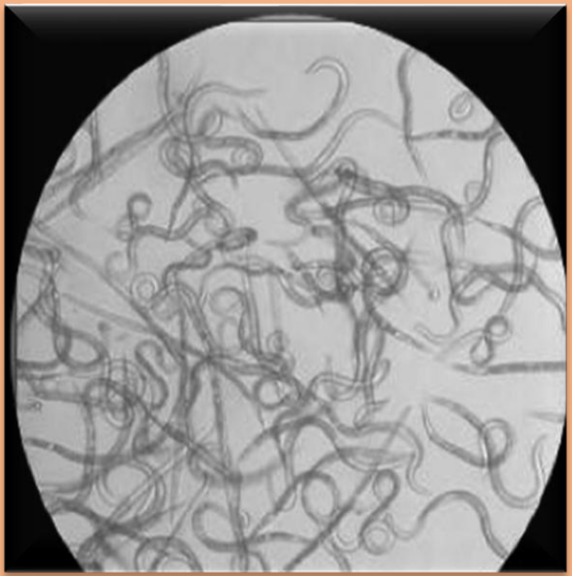
- 2 x 6 x 3 factorial RCBD with 5 replications.
- The first factor consisted of two plant extracts (*Lantana camara* and *Tabernaemontana elegans*).
- The second factor: nanoparticle concentrations (75:25; 50:50; 25:75; 0:100), positive control (Nemacur® 10GR (i.e. fenamiphos) at a recommended rate of 5g per plant, negative control (plants inoculated with nematode only)].
- The third factor: three application rate (5g; 10g and 15g) of the nanoparticles.

Data collection

At 56 days, the experiment was terminated, and plant growth and nematodes variables were collected.







Tiny but brutal!


RESULTS

Effects of nanoparticle concentration on root weight, juvenile in roots and juvenile in soil

NANOPARTICLE CONCENTRATION (PLANT EXTRACT: ALOE VERA)	ROOT WEIGHT	JUVENILE IN ROOTS	JUVENILE IN SOIL
75:25	1,1228[a] (12,609)	2,6023[b] (423,3)	2,7701[d] (683,3)
25:75	1,0745[a] (11,393)	1,7353[c] (156,7)	2,7807[d] (660,0)
50:50	1,0025[b] (9,627)	1,7588[c] (143,3)	2,7972[d] (690,0)
100:0	0,9160[c] (7,744)	2,7313[b] (570,0)	2,9819[b] (923,3)
0:100	0,9988[b] (9,490)	2,5907[b] (430,0)	2,9240[bc] (1020,0)
Negative	0,8780[c] (6,647)	3,0001[a] (1186,7)	3,1969[a] (1610,0)
Positive	0,9846[b] (9,024)	2,7019[b] (526,7)	2,8612[cd] (763,3)
F-value	17.92	29.53	19.78
$LSD_{0.05}$	0.0557	0.2549	0.0625
P-value	0.0000	0.0000	0.0000

Interactive effects of nanoparticles and concentration on nematode eggs in roots, total nematode in roots and total nematode in pot

Treatment	Concentration	Eggs in root	Total nematodes in roots	Total nematode in pot
NPlc	**75:25**	[x]2,7980^{c} (640,0) [y]	3,0124^{d} (1046,7)	3,2306^{f} (1726,7)
NPte	**75:25**	2,7970^{c} (650,0)	3,0254^{d} (1090,0)	3,2423^{ef} (1776,7)
NPlc	**25:75**	2,4052^{de} (286,7)	2,6063^{e} (426,7)	2,9846^{h} (1000,0)
NPte	**25:75**	2,3548^{de} (280,0)	2,6154^{e} (453,3)	3,0578^{gh} (1200,0)
NPlc	**50:50**	2,5094^{d} (380,0)	2,6396^{e} (480,0)	3,0243^{gh} (1106,7)
NPte	**50:50**	2,2895^{e} (300,0)	2,6475^{e} (486,7)	3,0741^{g} (1240,0)
L. camara	**100**	2,8112^{c} (700,0)	3,0598^{cd} (1173,3)	3,3211^{cde} (2146,7)
T. elegans	**100**	2,7951^{c} (640,0)	3,0084^{d} (1026,7)	3,2711^{def} (1900,0)
Aloe vera	**100**	3.3557^{b} (2880,0)	3,5017^{b} (3800,0)	3,7073^{b} (5426.7)
Negative control	**-**	3,6452^{a} (4606,7)	3,7679^{a} (6060,0)	3,8729^{a} (7653,3)
Positive control	**Crop guard**	2,9342^{c} (900,0)	3,1395^{c} (1420,0)	3,3487^{cd} (2253,3)
F-value		2.43	3.45	2.90
$LSD_{0.05}$		0,1998	0,1108	0,0811
P-value		0.0282	0.0031	0.0104

Interactive effects of nanoparticles and concentration on nematode reproductive potential and reproductive factor

Treatment	Concentration	Reproduction potential	Reproduction factor
NPlc	75:25	1,9645[e] (93,76)	0,1965[e] (0.5756)
NPte	75:25	1,9072[e] (81,39)	0,2010[de] (0.5922)
NPlc	25:75	1,6301[fg] (46,79)	0,1241[f] (0.3333)
NPte	25:75	1,5461[g] (36,98)	0,1446[f] (0.4000)
NPlc	50:50	1,6949[f] (52,60)	0,1350[f] (0.3689)
NPte	50:50	1,7015[f] (56,20)	0,1487[f] (0.4133)
L. camara	100	2,1539[cd] (155.99)	0,2326[bcd] (0.7156)
T. elegans	100	2,0213[de] (107.55)	0,2119[cde] (0.6333)
Aloe vera	100	2,3054[b] (213.80)	0,2562[b] (0.8422)
Negative control	-	2,9350[a] (637.16)	0,4385[a] (1.8089)
Positive control	Crop guard	2,2034[bc] (155.99)	0,2562[cd] (0.7511)
F-value		2.85	5.60
$LSD_{0.05}$		0.1381	0.0343
P-value		0.0115	0.0000

Effect of plant extract on chlorophyll content, root weight and juvenal in roots

PLANT	Chlorophyll	Root weight	Juvenile in roots
Tabernaemontana elegans	[x]1.6017[a] (40.921)	1.0156[a] (9.9515)	2.5240[a] (534.29)
Lantana camara	1.5490[b] (35.733)	0.9779[b] (9.0582)	2.3675[b] (447.62)
F-value	12.48	6.25	5.15
$LSD_{0.05}$	0.0295	0.0298	0.2549
P-value	0.0005	0.0134	0.0246

[x]Column means followed by the same letters are not significantly different at $P \leq 0.05$ according to Fisher's Least Significant Difference. Values in brackets are untransformed means [log10 (x+1)].

Effects of nanoparticle concentration on stem diameter, chlorophyll, plant height, dry weight and flowers

Concentration (Plant extract: Aloe vera)	Stem diameter	Chlorophyll	Plant height	Dry weight	Flowers
75:25	0,8126^{a} (5,5227)	1,6663^{a} (46,607)	1,9667^{a} (84,86)	0,8592^{a} (5,6148)	0,2134^{ab} (0,8333)
25:75	0,8035^{a} (5,3750)	1,6136^{ab} (42,875)	1,9571^{ab} (82,43)	0,8128^{ab} (5,7402)	0,3130^{a} (1,2667)
50:50	0,7966^{ab} (5,2730)	1,5414^{c} (35,570)	1,9190^{bc} (82,53)	0,7754^{bc} (5,5547)	0,2476^{ab} (1,0333)
100:0	0,7702^{c} (4,9267)	1,5385^{c} (34,483)	1.9738^{a} (141,87)	0,7511^{c} (5,4287)	0,2628^{a} (1,0667)
0:100	0,8037^{a} (5,3933)	1,5553^{c} (35,567)	1,9037^{c} (77,02)	0,8055^{b} (6,4844)	0,2535^{ab} (1,0333)
Negative	0,6280^{d} (3,2603)	1,5395^{c} (36,097)	1,8772^{c} (74,70)	0,6680^{d} (5,6675)	0,1062^{c} (0,3667)
Positive	0,7789^{bc} (5,0533)	1,5728^{bc} (37,090)	1,9169^{bc} (76,27)	0,8090^{b} (5,9704)	0,1539^{bc} (0,5667)
F-value	78,05	5.97	4.78	11.89	3.38
$LSD_{0.05}$	0,0204	0,0551	0,0460	0.0492	0,4514
P-value	0,0000	0,0000	0,0002	0.0000	0.0036

General Discussion

- Nanoparticles synthesized through green methods using *T. elegans* and *L. camara* extracts provided consistent results in both plant growth enhancement and nematode suppression.
- The use of *Aloe vera* as a stabilizing agent ensured uniformity in size and bioavailability, addressing the limitations of raw plant extracts.
- The superior performance of nanoparticle formulations over conventional nematicides highlights their potential to replace harmful chemicals in pest management.
- By reducing reliance on synthetic agrochemicals, plant-based nanoparticles contribute to environmental conservation and public health while improving crop productivity
- Additionally, their cost-effectiveness and ease of synthesis make them accessible to resource-limited farming communities.

Conclusion and Recommendation

- The optimal formulations, particularly 50:50 and 25:75 nanoparticle concentration, outperformed raw plant extracts and conventional nematicides, highlighting the potential of nanotechnology in sustainable agriculture.
- This study underscores the importance of green synthesis as an environmentally friendly alternative to chemical treatments, paving the way for safer and more effective agricultural practices.
- Future work should focus on validating these findings in real-world settings and exploring their broader applications in crop protection.
- Future research should also focus on scaling up nanoparticle production, conducting field trials, and exploring their long-term effects on soil health and crop performance.
- Integrating plant-based nanoparticles into integrated pest management (IPM) strategies could revolutionize sustainable agriculture by providing eco-friendly, efficient solutions to pest and disease challenges

Thank you, Ngiyabonga, Multumesc

Nicholus Mnyambo

Mobil: (+27) 76 992 9120

E-mail: **nicholus.mnyambo@ump.ac.za**

Address: Cnr R40 and D725 Roads,
Mbombela, 1200

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