Efficacy of some agro-wastes of date palm as soil amendment for management of *Meloidogyne javanica* and *Rotylenchulus reniformis* on common bean

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Abstract

The efficacy of date palm (*Phoenix dactylifera* L.) agro-wastes viz. palm fibers, green drop fruits, palm fronds and rules of leaves applied as powder or soakage to soil at various rates of application were evaluated for their nematisidal activates against root-knot nematode, *Meloidogynejavanica*and reniform nematode, *Rotylenchulusreniformis* infected common bean (*Phaseolus vulgaris* L.) cv. Polista under greenhouse conditions. All the tested soil amendments of date palm wastes significantly reduced the number of nematode in soil, developmental stages and egg-masses per root for both nematode species as well as the number of root galls formed by root-knot nematode on common bean roots when compared with untreated check. Also, the percentage values of reductions of nematode final population and egg production as well as the rate of nematode reproduction gradually decreased with increasing the amount of agro-wastes of date palm to the soil. The agro-wastes of green drop fruits and rules of leaves applied as powder or soakage at the rates of 15 and 20 g/kg soil proved to be the best effect in controlling for both nematode species than those of the other tested treatments. It is worthy to not that the effect of the powder of agro-wastes of date palm on *M. javanica* reproduction was more than the soaking agro-wastes while the soaking agro-wastes on nematode reproduction of *R. reniformis* was more effective than powder agro-wastes.

Key words:wastes, date palm, *Meloidogynejavanica,Rotylenchulusreniformis*, common bean.

Introduction

Root-knot nematodes, *Meloidogyne* spp., and reniform nematode, *Rotylenchulusreniformis* are economically important plant pathogens that can be managed by cultural practices, chemical nematicides, and resistant cultivars. Use of nematicides for the management of root-knot nematodes is being restricted due to environmental and human health concerns. In addition, nematicides often do not provide long-term suppression of the pathogen. Therefore, there is a need to develop alternative, environmentally friendly management strategies for root-knot

nematode and the reniform nematode including use of biocontrol agents and organic amendments (**Noling and Becker, 1994**). Several workers have reported that waste materials of plant wastes and industrial origin have nematicidal properties (**Sharma *et al*., 1971; Singh and Sitaramaiah, 1969 and 1971; Miller *et al*., 1973; Travedi*et al*., 1973; Akhtar, 1993 & 1998; Kimpinski*etal*., 2003; Nico*et al*., 2004 and Osei*et al*., 2011).** Spent coffee grinds, crotalaria hay, kudzu hay and ramie hay applied at 1% were the most effective to reduce root galling caused by the nematode on squash plant (**Mian and Rodriguez-Kabana, 1982**).

The addition of cocoa pod husks as soil amendments, significantly suppressed the root-knot nematodes *Meloidogyne* spp. **(Egunjobi, 1975** and **1985)**. Thehighest reduction in nematode populations of root-knot nematode and number of galls was found on plant growing in soil amended with sawdust at the rate of 2.0 t/ha. **(Jagdale*et al*., 1985)**. Soil application with plant wastes of *Tageteslucida*, *T. minuta* and *T. tenuifolia* resulted in significant reduction in the populations of *Rotylenchulusreniformis,* on tomato and eggplant **(Siddiqui and Alam, 1988)**. The tested materials of sow dust with various rates of application as soil amendments greatly suppressed population of the reniform nematode on both soil and roots and the nematode reproduction decreased gradually with increasing amounts of sow dust added to soil **(Duhaylongsod, 1988 and Montasser, 1991a)**. The degree of nematode control was dependent on the type and the amount of employed organic plant wastes **(Montasser, 1991 b**). Soil amendments with a wide range of composted organic wastes frequently documented a suppressive effect on root-knot nematode species **(Akhtar& Malik, 2000).** Root galling and final populations of *M. incognita* and *M. javanica* in tomatoplants were reduced and increasing the rate of the tested materials exponentiallyreduced the root galling and the final nematode population density **(Andres *et al*., 2004)**.The individual applications of fruit wastes of sweet orangereduced the nematode multiplication of *R. reniformis*(**Ashraf and Khan 2008).**Three organic materials decreased the level of harmful nematodes and increased the yield and increasing the rate of organic amendments enhanced the reduction of nematode population **(Hassan *et al*., 2010)**. Olive pomace-based composts resulted in the highest nematode suppression and significantly reduced gall formation on tomato roots **(Addabbo*et al*., 2011)**.

Materials and Methods

Date palm wastes as powder:

Fresh date palm (*Phoenix dactylifera*L.) agro-wastes were collected from New Valley Governorate, Egypt during May 2014. Collected material (palm fronds, green drop fruits, rules of leaves and fiber) was washed thoroughly in running tap water and shade dried for one week in open-air, crushed using mortar and pestle, reduced to powder using laboratory blender for 5 min at high speed and then stored in airtight as a powder. The organic materials were applied to the soil at the rate of

5, 10, 15 and 20 grams per Kilogram soil. Four seeds were sown in 15 cm diam. clay pots containing autoclaved sandy clay soil 1: 1 (v: v). after two weeks of germination, seedlings were trend to one plant per pot and each plant was inoculated with 1000 new hatching root knot nematode or immature females of reniform nematode per pot. Uninoculated pots served as control. Treatments were replicated 4 times. All pots arranged in a randomized block design at greenhouse. All plants were grown during the normal growing seasons at greenhouse temperature of 35 ± 5C°. Forty five days after inoculation, all plants were harvested and removed gently, washed in water and the root of each plant was stained in lacto phenol acid fuchsine**.** The number of juveniles in soil per pot, galls, developmental stages on root and egg-masses per root were counted. The rate of nematode reproduction was calculated.Average number of eggs per egg-mass was counted by a random selection of 10 egg-masses from each root system. The potential of each treatment to support egg production of nematodes was estimated.

Date palm wastes as soakage:

All date palm wastes were ground into powdered prior to assay for allopathic effect against root-knot nematodes. Ground powder was made into leachate by soakage 5, 10, 15, and 20 gm. in 100 ml water, filtered after 24 hours then watering the plant. The plant was irrigated 3 times one day before infecting, 2 day after infecting and week after that, respectively. After two weeks from sowing plants were inoculated with 1000 newly hatched root knot nematodes or immature females on reniform nematodes per pot. Un-inoculated pots served as control. Treatments were replicated 4 times. All pots were arranged in a randomized block design. All plants were grown during the normal growing seasons at greenhouse temperature of 35 ± 5 C, 45 days after inoculation, all plants were harvested and removed gently, washed in water and the root of each plant was stained in lacto phenol acid fuchsine (**Goodey, 1963**). The number of juveniles in soil per pot, galls developmental stages on root, egg-masses per root was counted. The rate of nematode reproduction was calculated. Data were then analyzed according to **Duncan's** multiple range tests **(Duncan,1955)**.

Results and Discussion

The efficacy of some date palm wastes namely date palm fiber, date palm fronds, green drop fruit and rules of leaves applied as soil powder amendment at four different rates of application in controlling the root-knot nematode, *Meloidogynejavanica* infecting common bean cv. Polista was studied under greenhouse conditions. Data inTable (1) and Fig. (1) reveled that all the tested treatments significantly reduced the numbers of galls per root, nematode juveniles in soil per pot, nematode developmental stages per root, egg-masses per root, eggs per egg-mass. Also, all such nematode criteria were decreased gradually with increasing the amounts of the tested organic wastes of date palm added to the soil,

Table (1) and Fig. (1). However, the highest reduction in such nematode criteria and the number of galls was found on common bean plants growing in soil amended with dry powder of date palm fronds, green drop fruits, date palm fiber, and rules of leaves at rates of 15 and 20 g / 1 kg soil. The calculated percentage of reduction in final population and eggs production with {(93.43 % & 5.81 %) & (99.29 & 5.11%)}, {(93.26 & 5.99 %) & (98.40 & 1.41 %)}, {(, 94.97 & 3.46 %) & (98.96 & 1.01%)} and {(89.24 & 10.07 %) & (97.45 & 1.88%)}, respectively.

Data of the effect of some organic date palm applied as soil powder amendment at four different rates of application against the reniform nematode, *Rotylenchulusreniformis* infecting common bean cv. Polista are presented inTable (2) and Fig.(2). The rate of nematode reproduction and percentage of eggs production decreased gradually with increasing the amounts of the tested organic wastes of date palm. Therefore, the addition of date palm fiber, green drop fruits, rules of leaves and date palm fronds at the rate of 15g / 1kg soil or higher to soil increased percentages of reduction in final population and decreased percentages of eggs production with {(93.26 & 6.41%) & (95.18 & 5.31%)}, {(86.62 & 13.24%) & (96.77 & 2.70%)}, {(93.60 &16.14%) & (96.86 & 4.51%)} and {(75.77 & 91.98%) & (98.10 & 4.47%)}, respectively.

The effect soaking wastes of date palm applied as soil drench in controllingthe root-knot nematode *Meloidogynejavanica* infecting common bean cv. Polista at four different concentrations was studied under greenhouse conditions. Data in Table (3) and Fig. (3) demonstrated that the nematode counts as measured with the number of galls, the nematode juveniles in the soil, the embedded immature, mature stages, egg-masses and eggs per egg-mass on the root system, were significantly reduced by increasing the amount of the tested soaking wastes of organic materials. Thereupon the highest reduction percentage of final population and eggs production were recorded of the concentrations of 15 and 20 g / kg of the green drop fruits, palm fronds, roles of leaves and date palm fibers. The calculated values of such nematode criteria were {(94.92 & 4.68 %) & (97.41 & 2.64%)}, {(91.00 & 8.25%) & (97.69 & 2.32 %)}, {(93.04 & 5.89 %) & (97.06 & 2.71%)} and {(83.08 &16.65%) & (89. 65 & 10. 65%)}, respectively.

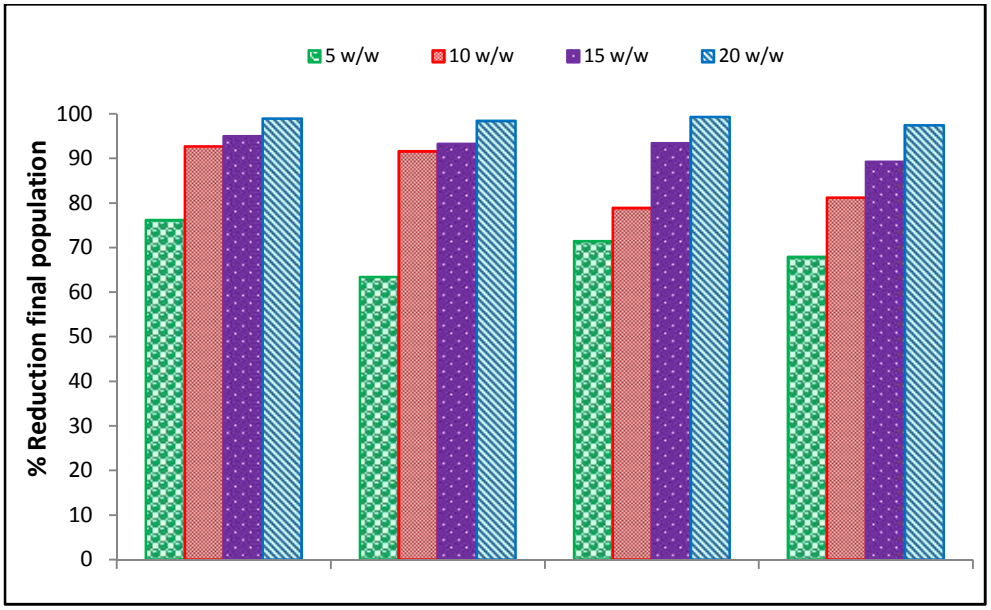
Similarly, the influence of soaking wastes of some date palm applied as soil drench against the reniform nematode *Rotylenchulusreniformis* infecting common bean cv. Polista at different concentration was studied under greenhouse conditions. Data presented in Table (4) & Fig. (4) indicated that the nematode final population of reniform nematode on common bean roots was less than initial population amongst all tested treatments. Also, all the applied soaking wastes of date palm significantly reduced the number of juveniles in soil per pot, nematode developmental stages, egg-masses per root and eggs per egg-mass in all the tested treatments at the different rates of application when compared with the

Table (1): Effect of powder date palm as agro-wastes for soil amenddments against root knot nematode, *Meloidogynejavanica* infecting common bean cv. Polista under greenhouse condition.

Materials	g/kg soil	No. gall /root	No. nematodes in soil	Develop. stages /root	No. egg-masses /root	No. eggs/ egg-mass	Nematode final population	% Reduction final population	Rate of nematode reprod.	Egg produc. %
Date palm fiber	5	16 c	199 b	21 c	15 c	118 b	1990	76.14	1.99	22.28
	10	8 ef	170 bc	12 de	6 def	71 de	608	92.71	0.60	5.36
	15	4 fg	136 d	8 ef	5 ef	55 ef	419	94.97	0.41	3.46
	20	5 fg	0 g	6 fg	5 ef	16 g	86	98.96	0.08	1.01
Green drop fruits	5	16 c	135 d	22 c	15 c	193 a	3052	63.41	3.05	36.45
	10	8 ef	85 e	14 d	9 de	67 de	702	91.58	0.70	7.59
	15	7 ef	75 ef	11 de	7 de	68 de	562	93.26	0.56	5.99
	20	1 g	18 g	3 g	2 f	56 ef	133	98.40	0.13	1.41
Palm fronds	5	18 c	180 bc	22 c	18 c	121 b	2380	71.46	2.38	27.42
	10	15 cd	152 cd	19 c	15 c	106 bc	1761	78.88	1.76	20.02
	15	7 ef	82 e	11 de	7 de	66 de	548	93.43	0.55	5.81
	20	1 g	0 g	3 g	2 f	28 fg	59	99.29	0.07	5.11
Rules of leaves	5	27 b	195 b	33 b	25 b	98 bcd	2678	67.89	2.67	30.84
	10	19 c	136 d	23 c	19 c	74 cde	1565	81.23	1.56	17.70
	15	16 c	78 ef	19 c	16 c	50 ef	897	89.24	0.89	10.07
	20	11 de	48 f	14 d	10 d	15 g	212	97.45	0.21	1.88
Check	--	43 a	349 a	50 a	38 a	209 a	8341		8.34	100.00

Means in each column followed by the same letter(s) are not significantly (P≥0.05) different according to Duncan's multiple range test.

$$\text{Egg production \%} = \frac{\text{Egg masses} \times \text{Eggs/egg mass materials}}{\text{Egg masses} \times \text{Eggs/egg check}} \times 100$$



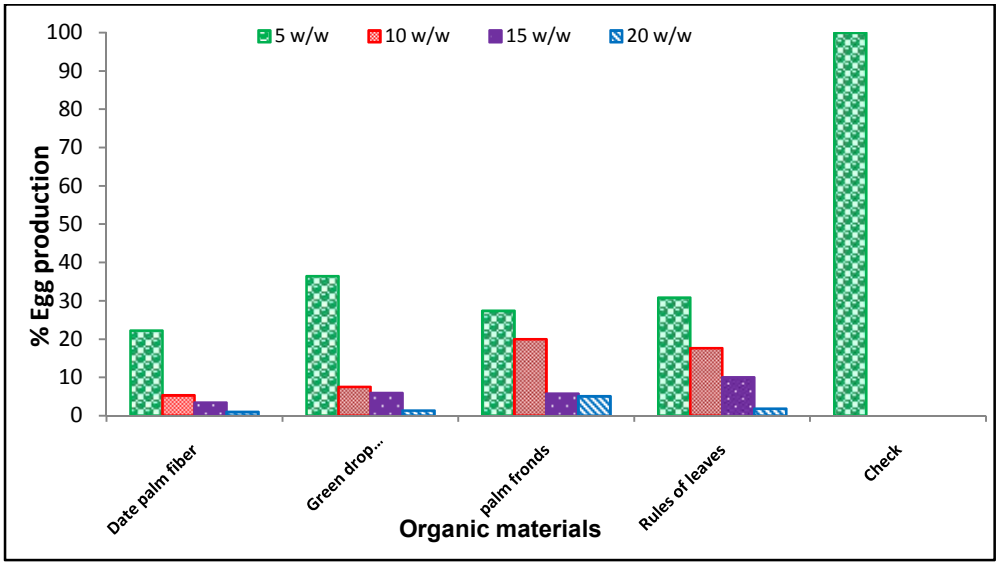


Fig. (1): Effect of powder date palm wastes on percentage of reduction final population and egg production on roots of common bean cv. Polesta infected by *Meloidogynejavanica* infection.

Table (2): Evaluation of powder date palm as agro-wastes for soil amendments against reniform nematode, *Rotylenchulusreniform is* infecting common bean cv. Polista under greenhouse condition.

Materials	g./ kg. soil	No. nematodes in soil / pot	Develop. stages /root	No. egg-masses /root	No. eggs /egg-mass	Final population	% Reduction final population	Rate ofnematode reproduce.	Egg produc. %
Date palm fiber	5	333 cdef	21 c	15 de	55 a	1179	64.07	1.18	39.17
	10	170 defg	14 de	11 fgh	44 abc	668	79.64	0.66	22.98
	15	78 efg	8 fg	5 ijk	27 de	221	93.26	0.22	6.41
	20	40 fg	6 g	4 jk	28 de	158	95.18	0.15	5.31
Green drop fruit	5	230 defg	22 c	16 de	34 bcd	796	75.74	0.79	25.83
	10	173 defg	18 cd	14 ef	47 ab	849	74.13	0.84	31.24
	15	148 defg	12 ef	9 hi	31 cde	439	86.62	0.43	13.24
	20	45 fg	4 g	3 k	19 e	106	96.77	0.11	2.70
Palm fronds	5	770 b	29 b	21 bc	51 a	1870	43.02	1.87	50.85
	10	595 bc	22 c	18 cd	55 a	1607	51.03	1.61	47.00
	15	542 bc	13 e	8 hij	30 de	795	75.77	0.79	11.39
	20	157 defg	6 g	5 ijk	20 e	263	91.98	0.26	4.74
Rules of leaves	5	403 cd	28 b	22 b	42 abc	1355	58.71	1.35	43.87
	10	358 cde	18 cd	13 efg	44 abc	948	71.11	0.94	27.16
	15	155 defg	15 de	10 gh	34 bcd	210	93.60	0.51	16.14
	20	0 g	8 fg	5 ijk	19 e	103	96.86	0.10	4.51
Check		1125 a	51 a	39 a	54 a	3282		3.28	100.00

Means in each column followed by the same letter(s) are not significantly (P≥0.05) different according to Duncan's multiple range test.

Eggproduction % = $\frac{\text{Egg masses} \times \text{Eggs / egg mass of the treatment}}{\text{Egg masses} \times \text{Eggs / egg mass of highest treatment}} \times 100$.

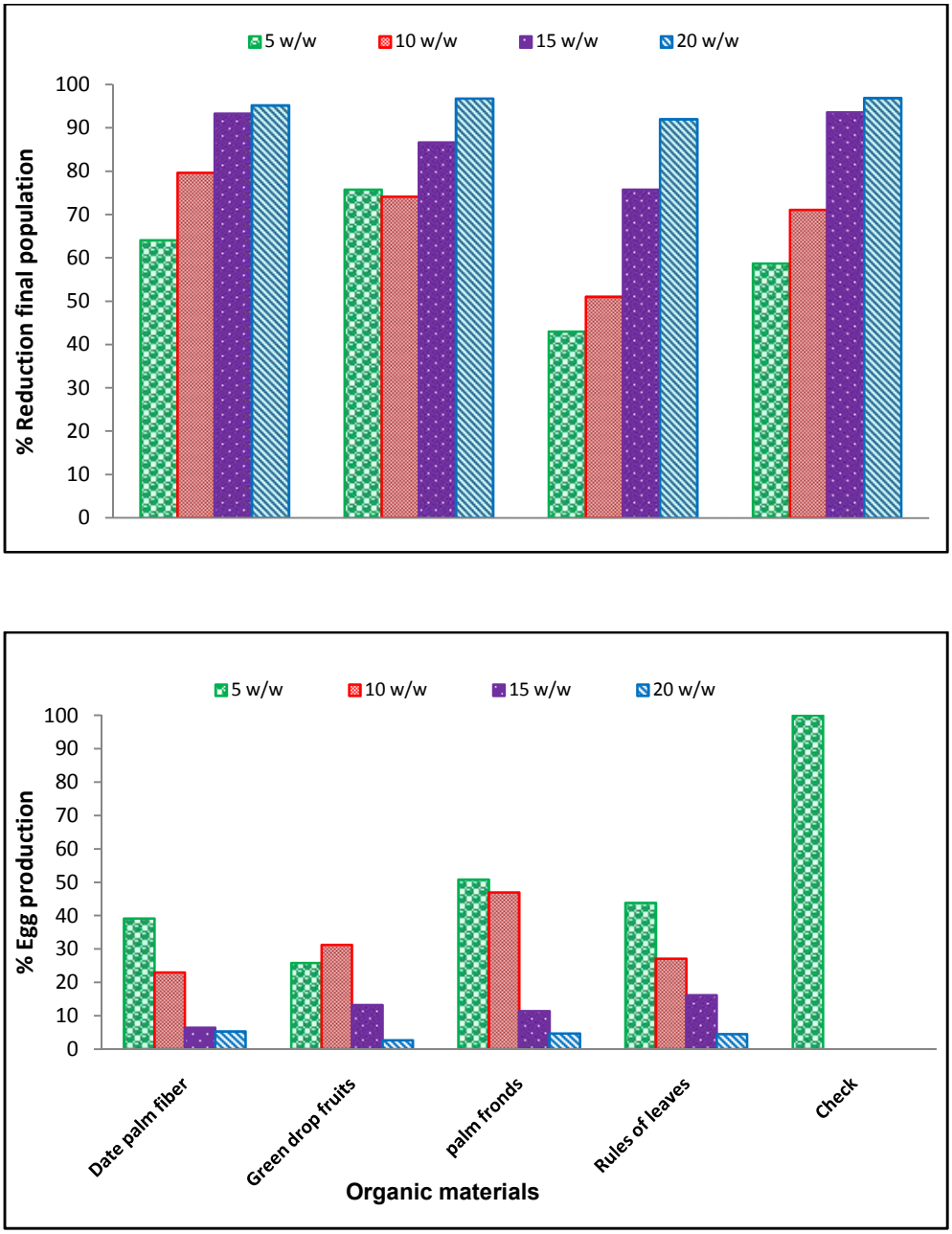


Fig. (2): Effect of powder date palm wastes on percentage of reduction final population and egg production on roots of common bean cv. Polesta inflected by *Rotylenchulusreniformis* infection.

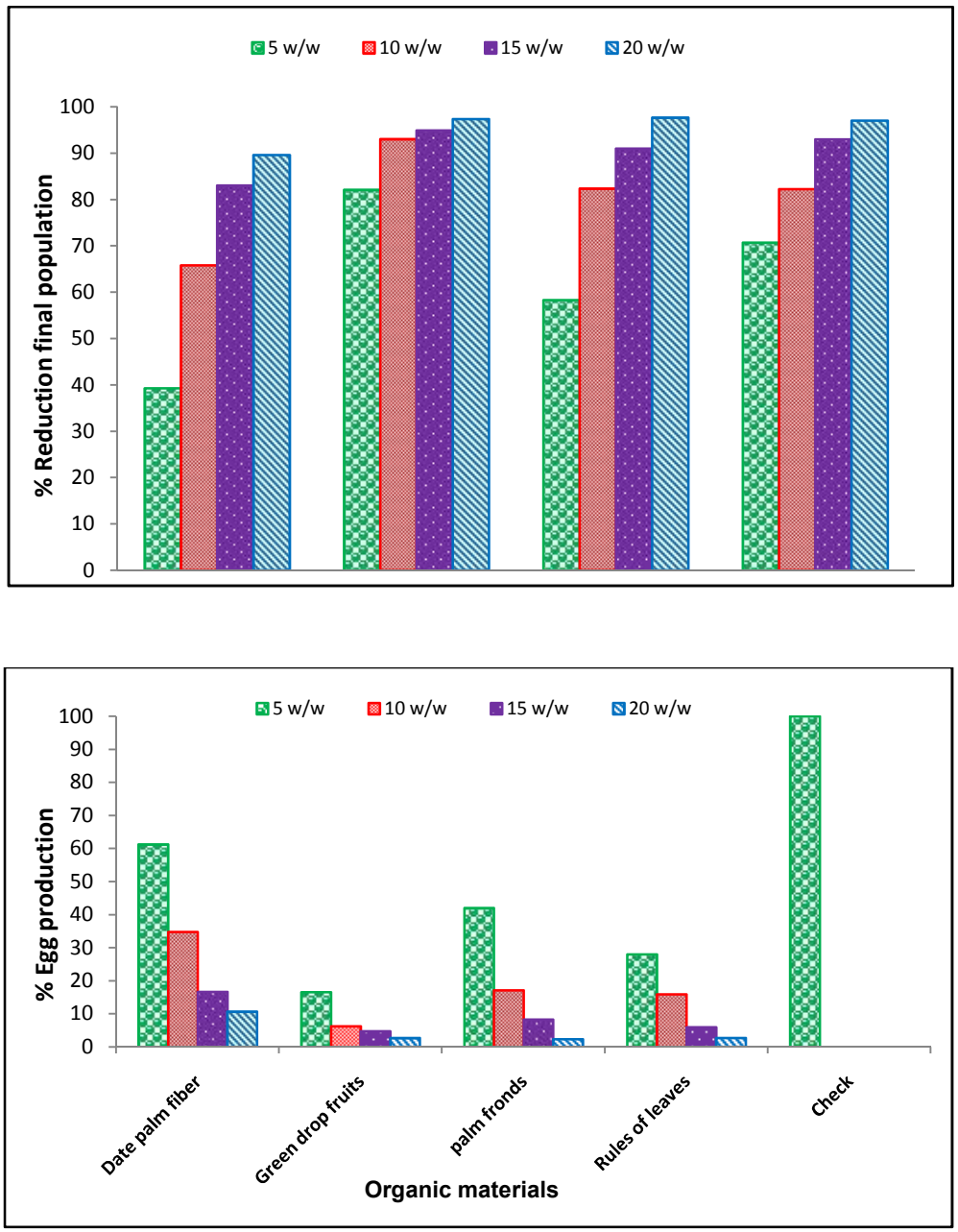


Fig. (3): Effect of soakage date palm wastes on percentage of reduction final population and egg production on roots of common bean cv. Polesta infected by *Meloidogynejavanica* infection.

Table (3): Evaluation of soakage date palm as agro-wastes for soil amendments against root knot nematode, *Meloidogynejavanica* infecting common bean cv. Polista under greenhouse condition.

Materials	Concen.	No.galls /root	No. nematodes in soil	Develop. stages/root	No.egg-masses /root	No. eggs/egg-mass	Final population	% Reduction final population	Rateof nematode reproduc.	Egg produc. %
Date palm fiber	5	22 c	170 c	30 bc	22 c	221 a	5062	39.31	5.06	61.21
	10	15 d	73 e	17 ef	15 e	184 b	2850	65.83	2.85	34.75
	15	9 ef	77 e	11 gh	9 f	147 c	1411	83.08	1.41	16.65
	20	5 fg	33 f	8 gh	6 fgh	137 c	863	89.65	0.86	10.65
Green drop fruits	5	10 e	165 c	13 fg	9 f	146 c	1492	82.11	1.49	16.54
	10	6 efg	77 e	6 h	4 gh	124 cd	579	93.05	0.57	6.24
	15	5 fg	45 f	6 h	4 gh	93 defg	423	94.92	0.42	4.68
	20	2 g	0 g	6 h	3 h	70 ghi	216	97.41	0.21	2.64
Palm fronds	5	29 b	112 d	32 b	28 b	119 cde	3476	58.32	3.47	41.95
	10	17 d	87 de	23 d	17 de	80 gh	1470	82.37	1.47	17.12
	15	8 ef	81 e	13 fg	8 fg	82 fgh	750	91.00	0.75	8.25
	20	5 fg	0 g	7 h	5 fgh	37 i	192	97.69	0.19	2.32
Rules ofleaves	5	19 cd	190 bc	26 cd	19 cd	117 cdef	2439	70.75	2.43	27.99
	10	16 d	200 b	18 e	15 e	84 efgh	1478	82.28	1.47	15.86
	15	6 efg	100 de	12 g	9 f	52 hi	580	93.04	0.58	5.89
	20	6 efg	20 fg	9 gh	6 fgh	36 i	245	97.06	0.24	2.71
Check	–	43 a	349 a	50 a	38 a	209 ab	8341		8.34	100.00

Means in each column followed by the same letter(s) are not significantly (P≥0.05) different according to Duncan's multiple range test.

Eggproduction % = $\frac{\text{Egg masses} \times \text{Eggs per cultivar}}{\text{Egg masses} \times \text{Eggs of highest treatment}} \times 100$

Table (4): Evaluation of soakage date palm as agro-wastes for soil amendments against reniform nematode, *Rotylenchulusreniform is* infecting common bean cv. Polista under greenhouse condition.

Materials	Conc.	No. nematodes in soil/pot	Develop. stages/root	No.egg-masses /root	No. eggs /egg-mass	Final population	% Reduction final population	Rate of nematode reproduc.	Egg produc. %
Date palm fiber	5	176 bc	22 cd	17 bcd	27 defg	657	79.98	0.65	21.79
	10	148 bc	16 def	11 ef	22 fg	442	86.53	0.44	11.49
	15	60 bc	13 fg	12 de	15 g	253	92.29	0.25	8.54
	20	35 c	6 h	4 g	25 efg	141	95.70	0.14	4.74
Green drop fruit	5	325 bc	21 cd	18 bc	29 cdefg	868	73.55	0.86	24.78
	10	330 bc	19 cde	15 cde	41 abcde	946	71.17	0.94	29.20
	15	268 bc	16 def	14 cde	29 cdefg	690	78.97	0.69	19.27
	20	580c	5 h	4 g	23 fg	155	95.27	0.15	4.36
Palm fronds	5	205 bc	22 cd	14 cde	34 bcdef	703	78.58	0.70	22.17
	10	265 bc	14 ef	10 ef	49 ab	769	76.56	0.76	23.26
	15	141 bc	8 gh	6 fg	28 cdefg	317	90.34	0.31	7.97
	20	480c	5 h	4 g	25 efg	153	95.33	0.15	4.74
Rules of leaves	5	168 bc	28 b	22 b	45 abc	1186	63.86	1.18	47.00
	10	127 bc	24 bc	19 bc	44 abcd	987	69.92	0.98	39.69
	15	65 bc	7 h	4 g	31 cdefg	196	94.02	0.19	5.88
	20	40 bc	6 h	4 g	16 g	110	96.64	0.11	3.03
Check		1125 a	51 a	39 a	54 a	3282		3.28	100.00

Means in each column followed by the same letter(s) are not significantly (P≥0.05) different according to Duncan's multiple range test.

Eggproduction % = $\frac{\text{Egg masses} \times \text{Eggs per cultivar}}{\text{Egg masses} \times \text{Eggs of highest treatment}} \times 100.$

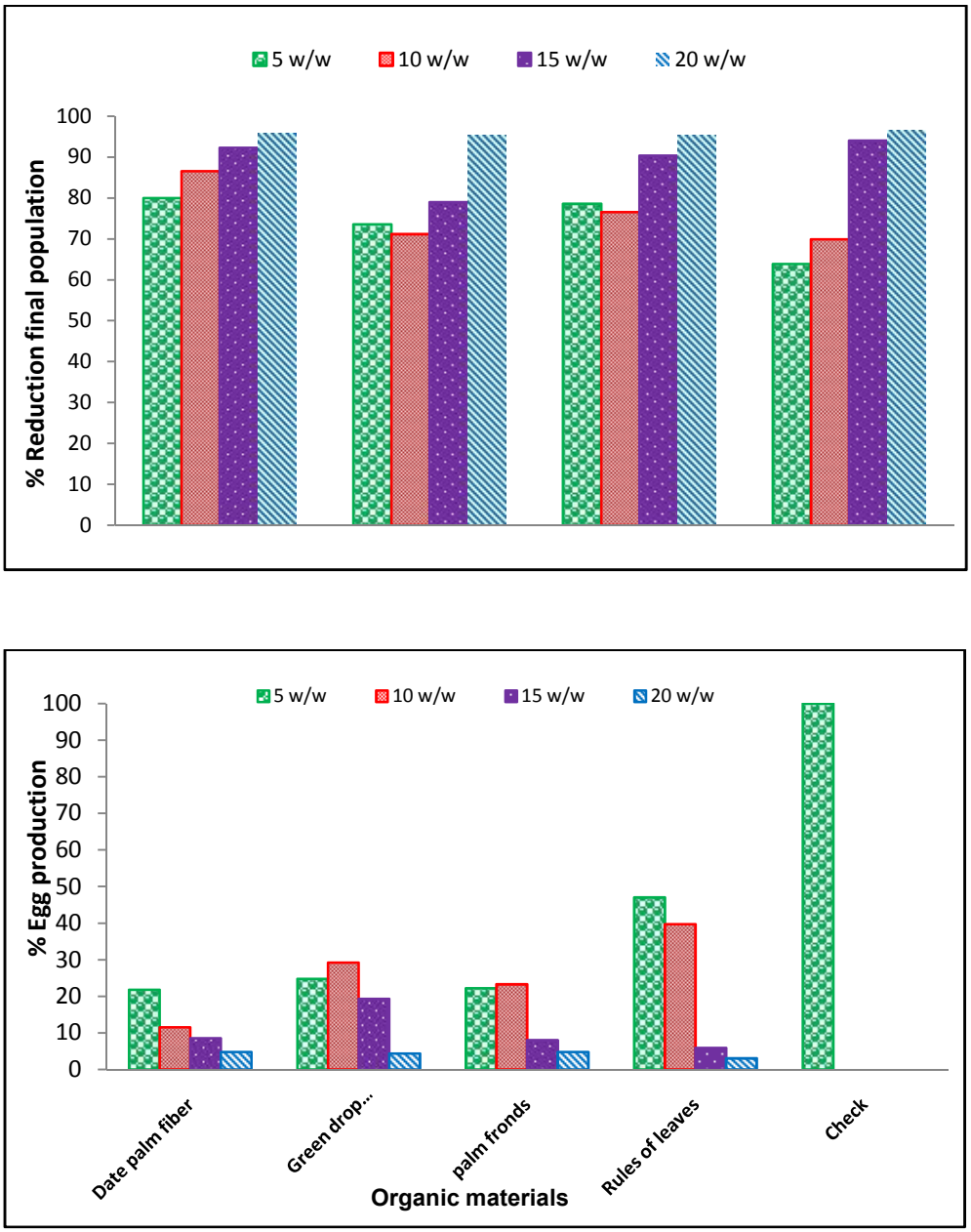


Fig. (4): Effect of soakage date palm wastes on percentage of reduction final population and egg production on roots of common bean cv. Polestainfected by *Rotylenchulusreniformis* infection.

untreated check. Therefore, the highest reduction percentage of final population and eggs production were found at higher concentrations of roles of leaves, date palm

fibers, palm fronds and green drop fruits.

The calculated values were {(94.02 & 5.88 %) & (96.64 & 3.03%)}, {(92.29 & 8.54 %) & (95.70 & 4.74%)}, {(90.34 & 7.97 %) & (95.33 & 4.74%)} and {(78.97 & 19.27 %) & (95.27 & 4.36 %)}, respectively. It is worthy to note that the effect of soaking wastes of the organic date palm on the nematode reproduction of *Rotylenchulusreniformis* was more than the powder wastes. The efficacy of powder of the organic date palm on nematode reproduction of *Meloidogynejavanica* was more than the soaking wastes.

These obtained results are in general agreement with findings of **Tijani*et al*., (2000); Nwanguma&Awoderu, (2002); Abubakar&Adamu, (2004); Ganaie*et al*., (2011) and Prakash& Singh, (2014)** which reported beneficial effect of organic wastes on nematode control. Also, **Nico*et al*., (2004)** reported that composted agro-industrial wastes reduced the population of *Meloidogyne* spp. by 24.4 % to 87.9 %. The management potential of an organic soil amendment to control nematode is directly related to its nitrogen content or inversely related to the C: N ratio **(Oka *et al*., 2006 and Oka, 2010).Akhtar&Alam, (1990) and Bello *et al*., (2006)** suggested that after decomposition of organic wastes, the toxic products are released and kill or inactivate the nematodes. The nemato-toxic compounds produced during decomposition of plant residues reduce root infection by plant parasitic nematodes while several secondary metabolites such as terpenoids, alkaloids and phenolic compounds also showed nematicidal activity **(Thoden*et al*., 2009 & 2011).**

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الملخص العربي

استخدام بعض المخلفات الزراعية للنخيل كمخصبات للتربة في مكافحة نيماتودا تعقد الجذور ميلودوجينجافانيكاوالنيماتودا الكلوية روتيلينكيولسرينيفورمس على نباتات الفاصوليا

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استهدف البحث دراسة فاعلية وتأثير بعض المخلفات الزراعية للنخيل وهي الألياف والثمار الخضراء المتساقطة وسعف النخيل وقواعد الأوراق علىنيماتودا تعقد الجذور ميلودوجينجافانيكاوالنيماتودا الكلوية روتيلينكيولسرينيفورمسبإضافتها للتربة المنزرعة بنباتات الفاصوليا صنف بوليستا في صورة بودرة أو منقوع بأربعة معدلات مختلفة. ولقد أشارت النتائج إلى أن جميع معاملات المخلفات الزراعية للنخيل سواء استخدمت في صورة بودر أو منقوع قد أدت إلى تناقص أعداد النيماتودا خارج وداخل الجذور وكذلك أكياس البيض علي الجذور المصابة بكلا نوعي النيماتودا تناقصًا معنويًا. كما أظهرت النتائج أن استخدام المخلفات الزراعية من الثمار المتساقطة الخضراء وقواعد الأوراق عند معاملات ١٥ و٢٠ جم/كجم تربة قد أظهرت أعلى كفاءة في مكافحة كلا نوعي النيماتودا عند مقارنتها ببقية المعاملات الأخرى. كما أوضحت النتائج أن قيم النسب المئوية لمعدلات تكاثر النيماتودا ومعدلات إنتاج البيض لكلا نوعي النيماتودا قد تناقص تدريجيًا بزيادة معدل الكمية المضافة من مخلفات النخيل الزراعية للتربة. ومما هو جدير بالملاحظة أن إضافة مخلفات النخيل الزراعية في صورة بودر للتربة قد أظهرت كفاءة عالية في مكافحة نيماتودا تعقد الجذور بعكس إضافتها في صورة منقوع حيث أظهرت كفاءة عالية في مكافحةالنيماتودا الكلوية.