



Effectively mitigating the impact of *Meloidogyne incognita* on common beans through the strategic use of soil amendments

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Abstract. Using completely randomized pot trials, soil amendments such as poultry droppings, cabbage, and carrot composts were effective in mitigating the impact of *Meloidogyne incognita*. All treated plots, except mocap, produced taller plants compared to the uninfected control at 70 DAS. Poultry 100% and poultry 50% plots had significantly more leaves. Trial 1 produced higher pod weights in poultry 100%, cabbage 100%, and carrot 100% compared to the control, with cabbage 100% and carrot 100% yielding the most. Trial 2 provided higher pod weights in cabbage 100%, carrot 100%, and poultry 100% in decreasing order of magnitude. The treatment given to the organic matter showed that the botanicals may not be directly nematicidal.

Keywords: fertilizers, kidney beans, manures, bio-pesticides, plant-parasitic nematodes

1. Introduction

Common beans (*Phaseolus vulgaris* in the plant family Fabaceae) are socio-economically important in Asia, the Americas, and Africa. It is invaluable as an affordable, healthy source of food, feed, and industrial raw material [1]. However, these exquisite beans are highly susceptible to infection by enumerable plant parasitic nematodes, especially root-knot nematodes such as *Meloidogyne incognita*, *Meloidogyne javanica*, and *Meloidogyne arenaria*.

Nematode-induced damage on beans may result in a yield loss of up to 90%, but typically a yield loss of 60% has been reported globally [2]. Plant resistance

to these plant-parasitic nematodes is infrequent, especially in Kenya, Nigeria, Pakistan, Brazil, and Ghana [3].

Hence, control of these nematodes is highly desirable. But agrochemicals are dangerous to man, animals, and the environment alike [4]. This calls for the use of supplementary materials like organic soil amendments that are affordable, environmentally friendly, and sustainable. Decomposing organic materials decreases nematode populations rapidly due to the release of toxigenic chemicals depending on factors like the type of organic matter applied, length of time used for composting, the amount of organic matter applied, type of land amended, farming practices, type of soil, climate/weather, and so on.

Yet there is reluctance to depend solely on soil amendments because they may not always reduce or control the nematode populations as expected. Moreover, it has been demonstrated that nematode populations may increase instead after applying soil amendments [5]. However, [6] opposed this view by stating that all the organic materials they applied were superior to carbofuran, except cow dung. Also, [7] testified that carbofuran, poultry manure, and cow dung manure applied as soil amendments effectively reduced root-knot nematode populations and controlled *M. incognita*. The final nematode populations recorded were many times lower compared to the infested treatments that received no soil amendment.

Organic amendments controlled *Meloidogyne* species in descending order of efficacy as follows: poultry droppings, *Aradirachta* species, *Tagetes* species, and finally cow dung [6]. Applying *Bacillus* species combined with cow dung can keep these parasitic nematodes under beans below economic injury level [8]. Soil amendments may be best applied in conjunction with other strategies for nematode amendments.

Generally, the reports on the use of cow dung and poultry manure show that they are good soil amendments, although their application may not necessarily be tied to nematode control. Nonetheless, contradictory results tied to the use of soil amendments need to be further investigated. The use of composted materials may result in different levels of management of nematode populations compared to the application of undecomposed organic materials or the application of bio-fumigation techniques. This may be tied to the mechanism involved in the control of the nematodes.

Over 3,000 species of higher plants are susceptible to infection by *M. incognita*, which culminates in a highly significant yield loss [2]. Eggplant fruit and shoot yield were significant but partially directly proportional to the population of root-knot nematodes [5]. Based on this literature, our objective will be to decisively reduce the impact of *Meloidogyne incognita* on common beans by implementing effective soil amendments, which is essential for achieving optimal crop health and yield.

2. Materials and methods

2.1. *The site of the experiments*

This investigation was carried out at the University of Buea's Teaching and Research Farms (4.1489° N, 9.2879° E) in Cameroon. Buea experiences a humid subtropical montane climate that is moderated by its location in a tropical rainforest climatic zone. The warmest month is February, but the coldest month is August. The rainfall in the area is circa 370 mm monthly. The rainy season is characterized by extended periods of drizzling rain and damp fog rolling in from the mountain tops.

The mild climate of Buea is dependent on its location on Mount Fako and its nearness to the Atlantic Ocean with its warm currents. Thus, the environs with higher altitudes in Buea experience cooler temperatures, unlike the low-altitude, hot coastal environs. The main occupation of the natives is farming, and with the year-round farming ongoing on the highly fertile volcanic soil, nematode populations are becoming unbearable.

2.2. *Extraction and raising of *M. incognita**

Nematode-infested common bean plants were collected from the university and its environs. The female root-knot nematode was teased out and identified as outlined [5]. Then the egg masses from these identified females were inoculated into the sterilized soil in pots under Roma VF tomato seedlings in the greenhouse.

The soil used for raising the nematodes was collected after 10 weeks and bulked into a composite soil sample. A sample of the soil (600 ml) was poured into a small bucket. The nematodes were extracted using the method outlined [1].

2.3. *Preparation of the potted soil and inoculation of the soil*

The 3 loamy soil: 1 sand substrate used for this trial was steam sterilized using a cut metal drum and fuel wood for 120 minutes. The soil in each pot was inoculated using the same amount of the extracted nematodes. The control was not inoculated at all with the nematodes. An aliquot (4,000 nematode juveniles (J2)) of the supernatant was applied under the base of each one-week-old seedling using a pipette pump at transplanting time [1, 5].

2.4. *Preparation of the organic manures*

Poultry droppings, carrot tops, and cabbage tops were prepared by composting the manures in separate plastic containers for one month and were applied as soil amendments during the experiment. The organic materials were moistened

frequently to promote decomposition. Each pot had a diameter of 30 cm and contained six litres of soil besides the manure that was mixed into it.

2.5. Experimental design and layout

The experiment was set up using a replicated completely randomized design. Each treatment was replicated 6 times. The treatments were standard (control), check (Mocap 15G at 100% rate), poultry dropping 100%, poultry dropping 50%, cabbage tops 100%, cabbage tops 50%, carrot tops 100%, and carrot tops 50%. The composts were mixed into the soil before sowing the seeds. Thus, each 100% concentration was approximately 159.9 g/pot or 2.261 tons manure ha⁻¹ and the 50% rates constituted 1.1305 tons manure ha⁻¹ of the specific compost.

Mocap 15G is Ethoprophos®, whose active ingredient is O-ethyl S, S-dipropyl phosphorothioate. It contains 69.6% active ingredient prepared as granular contact chemical nematicide and insecticide that can be used to control soil-borne pests like nematodes and certain insects. It was applied after preparing the soil in the pots as a nematode suppression agent at the rate of 1.0-1.5 kg a.i. acre⁻¹. The nematodes were thus inoculated into the soil one week after application of the nematicide. Finally, this experiment was repeated using the same methods and materials outlined herein.

2.6. Data collection and analysis

Data collection commenced 30 days after the sowing (DAS) of the seedlings and continued every 20 days till the termination of the experiment 70 days after sowing. Data were collected on the number of nematodes per plot, plant height (thrice; 1st data at 30 DAS, 2nd data at 50 DAS, and 3rd data at 70 DAS), number of leaves (thrice), number of pods, fresh shoot weight, and fresh pod/fruit yield. Plant height (cm) was determined using a tape at 30, 50, and 70 DAS. The number of leaves was counted at 30, 50, and 70 DAS.

The number of pods was counted while fresh shoot weight and fresh pod/fruit yield were attained by weighing with a Mettler balance. Gall index was scored using a scale [5]. The data were subjected to analysis of variance test and means of separation using the Second Discovery version of Genstat, and then IBM statistical package for social sciences version 25 was used to improve the charts.

3. Results

The effect of nematode infestation on common bean shoot height when managed using soil amendments and mocap 15G at 30, 50, and 70 DAS are presented in *Figure 1*. At 50 DAS during trials 1 and 2, the control had the tallest plants in both

trials, but this height was statistically comparable to those of poultry 100%, poultry 50%, and cabbage 100% for both trials 1 and 2. All the other treated plots, except for carrot 50% and cabbage 50%, were similar to the control for both trials 1 and 2.

During trials 1 and 2 in *Figure 1* at 70 DAS, the heights of plants in mocap 100% and control were similar/identical. The plants in all treated plots were taller than those in mocap and control. The tallest plants were from poultry 100%, carrot 100%, and carrot 50%. The other treated plots had plants whose heights were between those of plots with mocap/control and heights of poultry 100% / carrot 100% / carrot 50%.

The effect of nematode infestation on the common bean number of leaves when managed using composts and mocap at 30, 50, and 70 DAS are presented in *Figure 2*. During trial 1 at 50 DAS, cabbage 100% had the highest number of leaves, which were significantly different compared to the control. Generally, all the leaves of treated plots were significantly lower than those of the control and carrot 50%.

At the same time interval during trial 2, the number of leaves was not significantly different. The number of leaves of poultry 100%, cabbage 50%, carrot 100%, and carrot 50% was similar to those of plants in control plots. Other treatments not mentioned had plants whose number of leaves was similar to those of plants in the mocap 100% plot but lower than the control plot.

At 70 DAS during both trials 1 and 2, only the number of leaves of plants in poultry 100% and then poultry 50% plots were higher than those of the control. Carrot 100% and carrot 50% plots were at par with the control, but cabbage 100% and cabbage 50% plants had a higher number of leaves than plants that had received mocap 100% and the control.

The effect of nematode infestation on the number of common bean pods when managed using composts and mocap at 70 DAS is shown in *Figure 3*. During trial 1 at 70 DAS, the number of pods was the highest in poultry 100%, then in cabbage 100% and carrot 100%. The number of pods in mocap was similar to that of control and poultry 50%; however, the number of pods was lower in cabbage 50% and carrot 50% compared to the control.

Meanwhile, in trial 2, the number of pods was significantly higher in all treated plots except mocap 100% compared to the control. The highest number of pods was from poultry 100% followed by poultry 50%, cabbage 50%, carrot 100%, and then carrot 50% plots.

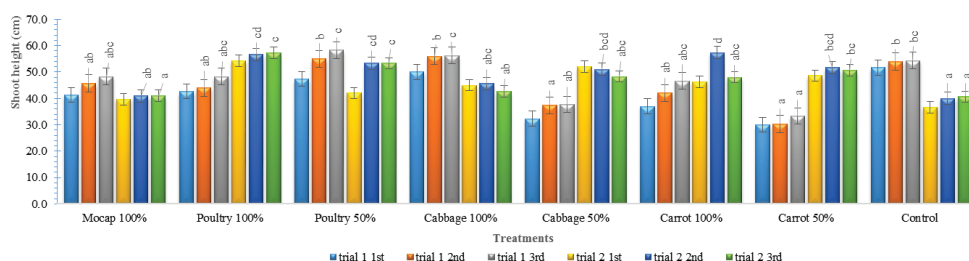
The effect of nematode infestation on common bean yield when managed using composts and mocap at 70 DAS is presented in *Figure 4*. It shows that at 70 DAS during trial 1, only the shoot weight in cabbage 100% plots was above that of control plots. Shoot weights in poultry 50% and poultry 100% plots were fairly similar to those of the control. Generally, all the shoots were lighter than those of control plots in trial 1.

For trial 2 at this same time interval, all the shoot weights except that of mocap 100% were higher than those of the control. The highest shoot weight was from poultry 100%, then poultry 50%, cabbage 100%, carrot 100%, cabbage 50%, and carrot 50% manure.

During trial 1 at 70 DAS, the pod weights of poultry 100%, cabbage 100%, and carrot 100% were higher than those of the control (*Figure 4*). All the weight of lower rates of poultry, cabbage, and carrot manure were lower than the control and mocap. The highest pod weights came from cabbage 100% and then carrot 100%. For trial 2 at 70 DAS, all the treated plots had higher pod weights than the control. The highest pod weights came from cabbage 100% and poultry 100% and then poultry 50% followed by carrot 50%, mocap 100%, and lastly carrot 50%.

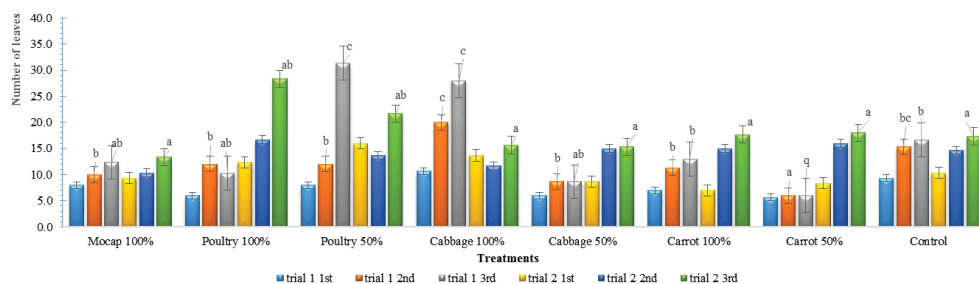
The effect of nematode infestation on nematode population densities when managed using composts and mocap at 70 DAS is presented in *Figure 5*. There were significant differences between the treatments based on the nematode populations at 70 DAS, as revealed from the pooled data. The highest nematode populations were extracted from carrots 50% followed by cabbage 50%, cabbage 100%, and then poultry droppings 50%. The other treatments revealed less population build-up, which was below the mean population density.

Similarly, in *Figure 6* at 70 DAS, the pooled galling index was statistically similar for all the treated plots, but it was significantly different compared to the control. The highest galling index was in the plots treated with both rates of cabbage manure which were above the mean galling index. The galling index in all other plots was similar to that of Mocap 15G plants.



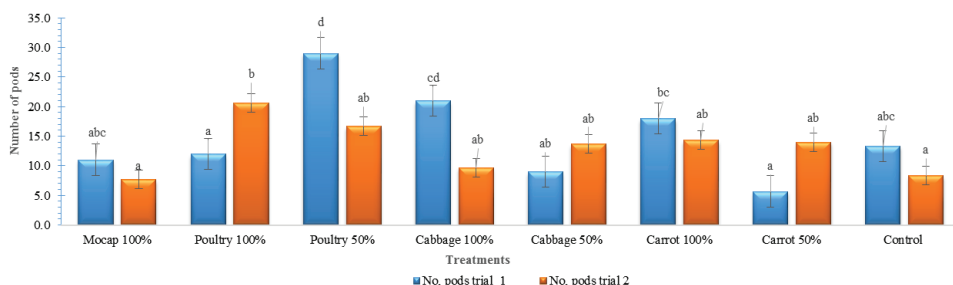
Notes: 1st, 2nd, 3rd data collected with time. Columns in a series overlaid by the same letter(s) are statistically similar using Duncan's multiple range test ($p \leq 0.05$).

Figure 1. The effect of nematode infestation on common bean shoot height when managed using composts and mocap at 30, 50, and 70 DAS



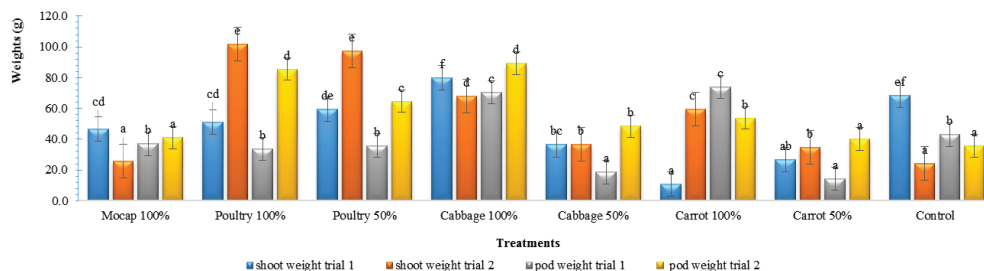
Note: Columns in a series overlaid by the same letter(s) are statistically similar using Duncan's multiple range test ($p \leq 0.05$).

Figure 2. The effect of nematode infestation on common bean number of leaves when managed using composts and mocap at 30, 50, and 70 DAS



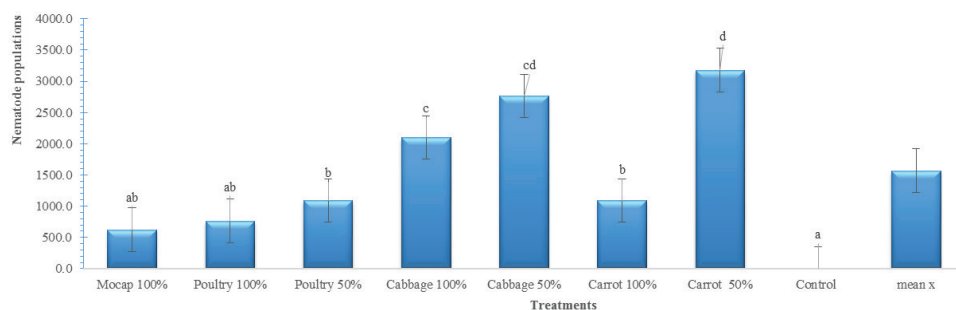
Note: Columns in a series overlaid by the same letter(s) are statistically similar using Duncan's multiple range test ($p \leq 0.05$).

Figure 3. The effect of nematode infestation on number of common bean pods when managed using composts and mocap at 70 DAS



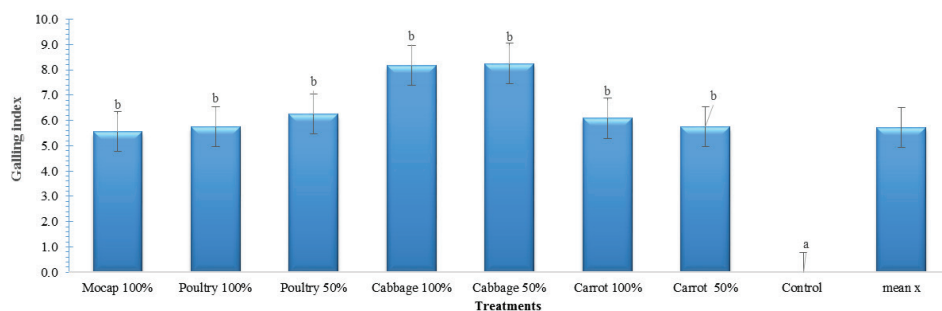
Note: Columns in a series overlaid by the same letter(s) are statistically similar using Duncan's multiple range test ($p \leq 0.05$).

Figure 4. The effect of nematode infestation on common bean yield when managed using composts and mocap at 70 DAS



Note: Columns in a series overlaid by the same letter(s) are statistically similar using Duncan's multiple range test ($p \leq 0.05$).

Figure 5. The effect of nematode infestation on nematode population densities when managed using composts and mocap at 70 DAS



Note: Columns in a series overlaid by the same letter(s) are statistically similar using Duncan's multiple range test ($p \leq 0.05$).

Figure 6. The effect of nematode infestation on the galling index when managed using composts and mocap at 70 DAS

4. Discussion

Biochar was recommended for integrated pathogenic nematode management since it improved crop yield and lowered populations of harmful nematodes [9]. Biochar was the least effective against nematodes, so its use should be further researched [1]. Maybe it releases less chemical reagents that are nematicidal. The soil amendments were all comparable to mocap 15G and the healthy control. In most cases, the organic amendments surpassed the synthetic agent, which could be tied to their effect on crop nutrition.

Cow dung was the most effective organic soil amendment [5]. Integrated *Bacillus subtilis* and cow dung decreased the population of nematodes by 54% in comparison to the uninfected control [8]. These findings corroborate the findings of the current

research. Applying decomposed manure, especially nematicidal-glucosinolates or nematicidal-thiophenes-rich cruciferous and sage waste materials reduces the population of *Meloidogyne* species [4, 10, 11].

Organic manures and plant organs in the greenhouse controlled *Meloidogyne* species [6]. The galling indices in this study were higher, which supported the findings of [9] and [1], who reported higher galling indices in some treatments. The rate of galling in vermin-compost-treated plots was significant [9].

4. Conclusions

Significantly reducing the impact of *Meloidogyne incognita* on common beans through targeted soil amendments is essential for achieving optimal crop health, a goal that was successfully attained in this study. The soil amended with poultry, cabbage, and carrot manure contained fewer nematodes equivalent to the number of nematodes in the mocap check. In Trial 1, in terms of pod weight, only cabbage 100% exceeded the control. Trial 2 showed a significant increase in pod number in all treated plots except mocap, with poultry 100%, poultry 50%, cabbage 50%, and carrot 100% having the highest yields. Trial 1 saw higher pod weights in poultry 100%, cabbage 100%, and carrot 100% compared to the control, with cabbage 100% and carrot 100% yielding the most. In Trial 2, all treatments (except mocap) showed higher shoot weight, with poultry 100%, poultry 50%, cabbage 100%, and carrot 100% being the most effective. In Trial 2, all treated plots had higher pod weights, with cabbage 100% and poultry 100% and then poultry 50% being the most productive. Cabbage 50%, cabbage 100%, poultry 50%, and carrot 50% had the highest nematode populations. All soil amendments tested can be recommended for improving common bean production, particularly in areas affected by *M. incognita*.

References

- [1] Ndifon, E. M., Lum, A. F., Amabo, J. (2025), Explore the nematodes associated with scarlet garden eggplant (*Solanum aethiopicum*) and implement soil amendment for effective management. *Res. Agric. Sci.* 56(3), 227–233. DOI: 10.17097/agricultureatauni.
- [2] Tauheed, A., Mustansar, M., Yasha, J., Usama, A., Hamza, A. K., Aiman, S. I., Yusra, B., Farazia, H., Hafiz, M. U., Muhammad, A. S., Aqleem, A. (2021), An overview of root-knot nematodes and their management. *J. Entomo. Zool. Stud.* 9(1), 35–40. www.entomoljournal.com.

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- [3] Dias, W. P., Wendland, A., de Souza Carneiro, G. E., de O Filho, F. G., Lopes, I. de O. N. (2023), Reaction of common bean genotypes to plant parasitic nematodes. *Pesqui. Agropecu. Trop.* 53. <https://doi.org/10.1590/1983-40632023v5374717>.
- [4] Aji, M. B. (2024), *Use of plant material in the management of plant parasitic nematodes*. DOI: 10.5772/intechopen.1002742. Open access peer-reviewed chapter from the edited volume: Mukherjee, Soumalya, Ray, Sajal: Nematodes – Ecology, adaptation and parasitism.
- [5] Ndifon, E. M. (2023), Host-parasite interactions between *Solanum aethiopicum*, *Meloidogyne incognita*, and *Fusarium oxysporum* f.sp. melongenae as portrayed by disease traits and crop yield. *Yuzuncu Yil Univ. J. Agric. Sci.* 33(3), 461–477. <https://doi.org/10.29133/yyutbd.1256166>.
- [6] Kimenju J. W., Muiro, D. M., Karanja, N. K., Nyongesa, W. M., Miano, D. W., Mutua, G. K. (2004), Assessing the role of organic soil amendments in management of root knot nematodes on common bean, *Phaseolus vulgaris* L. *J. Trop. Microbiol. Biotech.* DOI: 10.4314/jtmb.v3i1.35424.
- [7] Ndifon, E. M. (2013), Evaluation of some soil amendments for the management of root knot nematode (*Meloidogyne incognita*) on grapevine (*Vitis vinifera* L.) in Zaria, Nigeria. *Adv. Agric. Sci. Engin. Res.* 3(9), 1145–1150. <http://www.ejournal.sedinst.com>.
- [8] Wepukhulu, M., Kimenju, J., Anyango, B., Wachira, P., Kyallo, G. (2014), Effect of soil fertility management practices and *Bacillus subtilis* on plant parasitic nematodes associated with common bean. *Trop. Subtrop. Agroecosys.* 13(1), 27–34. <https://alliancebioiversityciat.org/publications-data/effect-soil-fertility-management-practices-and-bacillus-subtilis-plant-parasitic>.
- [9] Aduke, V. D. O. (2016), *Nematode response to soil organic amendments in a semi-arid region under soybean (Glycine max), Naivasha, Kenya*. Master of Science Applied Parasitology University of Nairobi. <https://erepository.uonbi.ac.ke/bitstream/handle/11295/97150/ADUKE%20VIOLET%20DOLLY%20ORLANDO.pdf?sequence=1&isAllowed=y>.
- [10] Tian, Y., Wang, X., Qiao, K., Han, Y., Li, X. (2020), Effect of different *Brassica* spp. residues on the activity of root-knot nematode (*Meloidogyne incognita*) and nematode community in soil. *Plant Dis.* 104(6), 1643–1652.
- [11] Saha, D., Ansari, M. S., Al-Hejely, W., Sharma, M., Kumar, J. (2021), Glucosinolate from *Tagetes patula* L. roots and their nematicidal activity against root-knot nematodes (*Meloidogyne incognita*). *Indian J. Agric. Sci.* 91(4), 602–605.