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# Effect of organic nano and macro materials on seed quality of pulses

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**Abstract**
This study was performed to determine the effect of organic macro and nano insecticides on seed quality of pulses. Treatments were 11 levels of organic based macro and nano insecticides. Sweet flag and neem seed kernel powder materials were synthesized to nano form using high energy planetary ball mill. The chickpea, pigeonpea and green gram seeds were treated with organic macro and nano based materials *i e.,* 10-90% reduction in actual dosage. Among the different treatments studied, seed treated with sweetflag 70 per cent lesser than normal dosage (6.0 g/kg seed), neem seed kernel powder 40% lesser than actual recommended (3.0 g/kg seed) in chickpea. In pigeonpea sweetflag 60 per cent lesser (8.0 g/kg seed), neem seed kernel powder 70 per cent lesser than actual recommended dosage (1.5 g/kg seed) and that of green gram sweetflag 70 per cent lesser (10 g/kg seed), neem seed kernel powder 60 per cent lesser than actual recommended dosage (2.0 g/kg seed) recorded significantly higher seed germination and seedling vigour index over the other treatments and control.

**Keywords:** Nano insecticides, seed treatment, pulses and seed quality

## Introduction

Pulses constitute an important ingredient in vegeterian diet and are source of protein, containing nearly twice as much protein as that of cereals and nutritionally balances the protein requirement of vegeterian population. Hence called as ‘poor man’s meat. These are also suitable for sustainable agriculture as they enrich the soil through biological fixation.

Quality seed play an important role in the agricultural production. It acts as a catalyst for realizing the potential of all other inputs in agriculture. Modern agriculture demands that each and every seed must germinate readily and produce a vigorous seedling, thus ensuring high yield. Among the different characteristics of a quality seed, seed viability and vigour are the vital factors that determine the stand of the crop in field and ultimately the yield. Seed vigour is a vital character of seed lot and is of greater importance for successful establishment of plant in the field especially under stressed situations.

The seed treatment with nano insecticides has gaining much importance with respect to seed research. Nanomaterials have gained increasing attention because of their novel properties, including a large specific surface area and high reaction activity (Suresh Babu and Narayan. 2013: Khorsand *et al*, 2011) [19, 8]. Nanomaterials have also been used for various fundamental and practical applications. Nanoparticles represent a new generation of environmental remediation technologies that could provide cost effective solution to some of the most challenging environmental clean up problems (Chinnamuthu and Murugesa, 2009) [5].

Nanoparticles help to produce new pesticides, insecticides and insect repellants (Owolade *et al.,* 2008) [12]. The use of nanoparticles in the growth of plants and for the control of plant diseases is a recent practice studied the effect of mixtures of nano-SiO2 and nano-TiO2 on soybean seed and they found that the mixture of nanoparticles increases nitrate reductase in soybean increasing its germination and growth (Prasad *et al*, 2009) [15]. Nanotechnology has the potential to protect plants, monitor plant growth, detect plant and animal diseases, increase global food production, enhance food quality, and reduce waste for “sustainable intensification”( Locke J.M. *et al*, 2000) [9].

In order to exploit the potential of nano based seed treatment the present study is planned standardization of nano based selected organic materials on seed quality of pulses.

## Materials and Methods

The laboratory studies were carried out to find out the effect of seed treatment with organic macro and nano based insecticide on seed quality of pulses (chickpea, pigeonpea and green gram). The experiment were laid in Completely Randomized Design (CRD) consisted of 11 treatments *viz.*, $T_0$: Absolute control, $T_1$: Recommended dosage of sweet flag rhizome powder (20 g/kg of seed), neem seed kernel powder (5 g/kg of seed), $T_2$: Nano SWF (100% - 20 g/kg of seed), NSK (100% - 5 g/kg of seed), $T_3$: Nano SWF (18 g/kg of seed), NSK (10% less than the normal dosage - 4.5 g/kg of seed), $T_4$: Nano SWF (16 g/kg of seed), NSK (20% less than the normal dosage - 4.0 g/kg of seed), $T_5$: Nano SWF (14 g/kg of seed), NSK (30% less than the normal dosage - 3.5 g/kg of seed), $T_6$: Nano SWF (12 g/kg of seed), NSK (40% less than the normal dosage - 3.0 g/kg of seed), $T_7$: Nano SWF (10 g/kg of seed), NSK (50% less than the normal dosage - 2.5 g/kg of seed), $T_8$: Nano SWF (8 g/kg of seed), NSK (60% less than the normal dosage - 2.0 g/kg of seed), $T_9$: Nano SWF (6 g/kg of seed), NSK (70% less than the normal dosage - 1.5 g/kg of seed), $T_{10}$: Nano SWF (4 g/kg of seed), NSK (80% less than the normal dosage - 1.0 g/kg of seed), $T_{11}$: Nano SWF (2 g/kg of seed), NSK (90% less than the normal dosage - 0.5 g/kg of seed). In order to study the effect of both macro and nano materials on seed quality, known quantity of chickpea, pigeonpea and green gram seeds soaked in solution prepared by dissolving insecticide in the 1:2 ratio for 1 hr and dried back the seeds to original weight and then different seed quality parameters were assessed.

Germination per cent was determined as per ISTA rules for seed testing. The seeds were placed in rolled paper towels. Hundred seeds of four replications were tested at a constant temperature of 25$^{o}$C. The number of normal seedlings were recorded in per cent germination was expressed on normal seedling basis (Anon, 2013) [3].

Seedling vigour index was computed by adopting the formula as suggested by Abdul-Baki and Anderson (1973) and expressed in whole number.

Seedling vigour index-I = Germination (%) x Mean seedling length (cm)

## Results and discussion

### Chickpea

Among the different concentrations of the organic macro and nano sweetflag rhizome powder (6.0 g/kg seed) recorded significantly the highest seed germination (97.00 %) and seedling vigour index (2408), (Fig. 1) this treatment performed better over other concentrations and control. The probable reason could be due to the excess absorption at higher concentration resulted from penetration of NPs in to cell wall and plasma membrane of epidermal layers in shoot and root and accumulation in vascular tissues thereby increase cell division and cell elongation. Hence, increased the overall seedling growth of chickpea. Similar results were also obtained by Prasad *et al.* (2012) [16] in ground nut, Adhikari *et al*. (2013) [2] in rice, Mahmoodzadeh *et al*. (2013) [11] in wheat, Vinodh Kumar and Udaysoorian (2014) [20] in maize.

Sweetflag rhizome powder presence of an active principle, asarone. A compound ß- asarone which helps for maintained seed quality (Paneru *et al*., 1997; Chiranjeevi and Sudhakar, 1996) [13, 6].

The seeds treated with macro and nano neem seed kernel powder it was noticed that, among the different concentrations, 40 % reduction in its actual dosage 3.0 g per kg of seed, recorded significantly the highest seed germination (97.33 %), and seedling vigour index (2475), (Fig. 2) over other concentrations and untreated.

Parsley seeds exposed to nano anatase, enhanced germination, root and shoot length and chlorophyll content of the seedling, root elongation were promoted at a particular concentration of ZnO NPs in soybean, seed germination, radicle and plumule growth of canola seedlings was stimulated by $TiO_2$ NPs. Similar results were also obtained by Dehkourdi and Mosavi (2013) [7] in parsley, Lopez *et al*. (2010) [10] in soybean, Mahmoodzadeh *et al.* (2013b) [11] in canola seeds.

### Pigeonpea

Among the different concentration standardized, nano sweetflag rhizome powder 60 % reduction in its actual dosage 8.0 g/kg of seed recorded significantly the higher seed germination (99.00 %) and seedling vigour index (2785) (Fig. 3) over the other concentrations. Seeds treated with nano sweetflag rhizome powder maintained higher germination over their bulk form and control. The probable reason might be due to nanoparticles would induce oxidation-reduction reactions via the superoxide ion radicals during germination, resulting the quenching of free radicals in the germinating seeds. In turn, oxygen produced in such process could also be used for respiration, which would further promote germination (Zhang *et al.*, 2004) [21].

In case of seeds treated with macro and nano neem seed kernel powder it was noticed that among the different concentrations 70 % reduction in its actual dosage 1.5 g/kg of seed recorded significantly the highest seed germination (98.67 and seedling vigour index (2354), (Fig.4) this treatment performed better over different concentrations. The superiority of neem seed kernel powder might be due to the fact that, it keeps the seed intact as a binding material and covers the minor cracks and aberrations on the seed coat at initial stage thus blocking the fungal invasion. (Prakash and Jagadishwari rao, 1992) [14]. Further, the botanicals might also have the phytotonic effect resulting higher seed quality parameters.

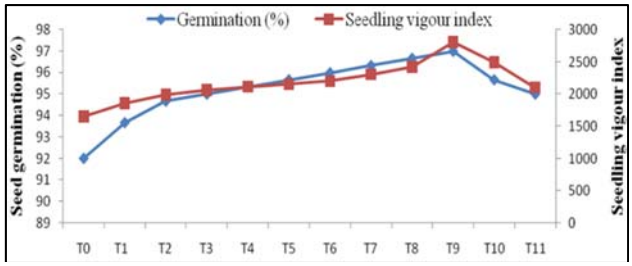


**Fig 1:** Influence of seed treatment with macro and nano sweetflag seed germination (%) and seeding vigour index in chickpea.

$T_0$: Absolute control
$T_1$: Recommended dosage of sweetflag rhizome powder (20 g/kg of seed)
$T_2$: Nano sweetflag rhizome powder (100% - 20 g/kg of seed)
$T_3$: Nano sweetflag rhizome powder (10% less than the normal dosage - 18 g/kg of seed)
$T_4$: Nano sweetflag rhizome powder (20% less than the normal dosage - 16 g/kg of seed)
$T_5$: Nano sweetflag rhizome powder (30% less than the normal dosage - 14 g/kg of seed)
$T_6$: Nano sweetflag rhizome powder (40% less than the normal dosage - 12 g/kg of seed)
$T_7$: Nano sweetflag rhizome powder (50% less than the normal dosage - 10 g/kg of seed)
$T_8$: Nano sweetflag rhizome powder (60% less than the normal dosage - 8 g/kg of seed)

$T_9$: Nano sweetflag rhizome powder (70% less than the normal dosage - 6 g/kg of seed)
$T_{10}$: Nano sweetflag rhizome powder (80% less than the normal dosage - 4 g/kg of seed)
$T_{11}$: Nano sweetflag rhizome powder (90% less than the normal dosage - 2 g/kg of seed)

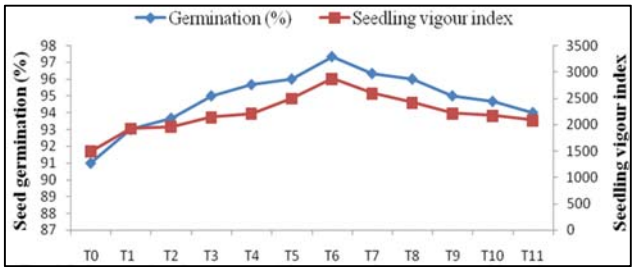


**Fig 2:** Influence of seed treatment with macro and nano neem seed kernel powder on seem germination (%) and seedling vigour index in chickpea

$T_0$: Absolute control
$T_1$: Recommended dosage of neem seed kernel powder (5 g/kg of seed)
$T_2$: Nano Neem seed kernel powder (100% - 5 g/kg of seed)
$T_3$: Nano Neem seed kernel powder (10% less than the normal dosage - 4.5 g/kg of seed)
$T_4$: Nano Neem seed kernel powder (20% less than the normal dosage - 4.0 g/kg of seed)
$T_5$: Nano Neem seed kernel powder (30% less than the normal dosage - 3.5 g/kg of seed)
$T_6$: Nano Neem seed kernel powder (40% less than the normal dosage - 3.0 g/kg of seed)
$T_7$: Nano Neem seed kernel powder (50% less than the normal dosage - 2.5 g/kg of seed)
$T_8$: Nano Neem seed kernel powder (60% less than the normal dosage - 2.0 g/kg of seed)
$T_9$: Nano Neem seed kernel powder (70% less than the normal dosage - 1.5 g/kg of seed)
$T_{10}$: Nano Neem seed kernel powder (80% less than the normal dosage - 1.0 g/kg of seed)
$T_{11}$: Nano Neem seed kernel powder (90% less than the normal dosage - 0.5 g/kg of seed)

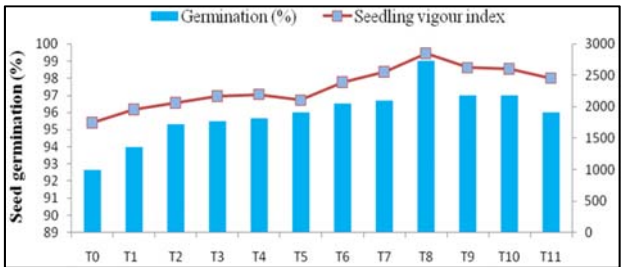


**Fig 3:** Influence of seed treatment with macro and nano sweetflag on seed germination (%) and seedling vigour in pigeonpea

$T_0$: Absolute control
$T_1$: Recommended dosage of sweetflag rhizome powder (20 g/kg of seed)
$T_2$: Nano sweetflag rhizome powder (100% - 20 g/kg of seed)
$T_3$: Nano sweetflag rhizome powder (10% less than the normal dosage - 18 g/kg of seed)
$T_4$: Nano sweetflag rhizome powder (20% less than the normal dosage - 16 g/kg of seed)
$T_5$: Nano sweetflag rhizome powder (30% less than the normal dosage - 14 g/kg of seed)
$T_6$: Nano sweetflag rhizome powder (40% less than the normal dosage - 12 g/kg of seed)
$T_7$: Nano sweetflag rhizome powder (50% less than the normal dosage - 10 g/kg of seed)
$T_8$: Nano sweetflag rhizome powder (60% less than the normal dosage - 8 g/kg of seed)
$T_9$: Nano sweetflag rhizome powder (70% less than the normal dosage - 6 g/kg of seed)
$T_{10}$: Nano sweetflag rhizome powder (80% less than the normal dosage - 4 g/kg of seed)
$T_{11}$: Nano sweetflag rhizome powder (90% less than the normal dosage - 2 g/kg of seed)

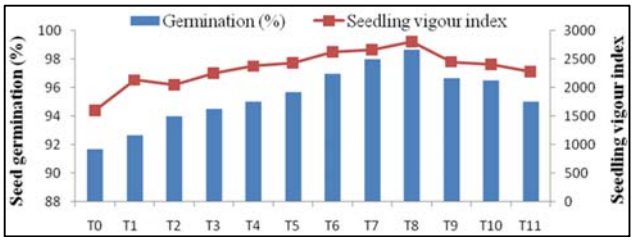


**Fig 4:** Influence of seed treatment with macro and nano neem seed kernel power on seed germination (%) and seedling vigour in pigeonpea

$T_0$: Absolute control
$T_1$: Recommended dosage of neem seed kernel powder (5 g/kg of seed)
$T_2$: Nano Neem seed kernel powder (100% - 5 g/kg of seed)
$T_3$: Nano Neem seed kernel powder (10% less than the normal dosage - 4.5 g/kg of seed)
$T_4$: Nano Neem seed kernel powder (20% less than the normal dosage - 4.0 g/kg of seed)
$T_5$: Nano Neem seed kernel powder (30% less than the normal dosage - 3.5 g/kg of seed)
$T_6$: Nano Neem seed kernel powder (40% less than the normal dosage - 3.0 g/kg of seed)
$T_7$: Nano Neem seed kernel powder (50% less than the normal dosage - 2.5 g/kg of seed)
$T_8$: Nano Neem seed kernel powder (60% less than the normal dosage - 2.0 g/kg of seed)
$T_9$: Nano Neem seed kernel powder (70% less than the normal dosage - 1.5 g/kg of seed)
$T_{10}$: Nano Neem seed kernel powder (80% less than the normal dosage - 1.0 g/kg of seed)
$T_{11}$: Nano Neem seed kernel powder (90% less than the normal dosage - 0.5 g/kg of seed)

**Green gram**

The seed treatment with organic macro and nano sweetflag on seed quality of green. Among the different concentrations of the macro and nano sweetflag rhizome powder, 50 % reduction in its actual dosage 10 g/kg of seed recorded significantly the highest seed germination (98.00 %) and seedling vigour index (2521), (Fig.5) this treatment performed better over different concentrations. The probable reason could be due to the excess absorption at higher concentration resulted from penetration of NPs in to cell wall and plasma membrane of epidermal layers in shoot and root and accumulation in vascular tissues thereby affected cell division and cell elongation. Hence, reduced the overall seedling growth of pigeonpea. Similar results were also obtained by Prasad *et al.* (2012) [16] in ground nut, Azimi and Mohammad (2013) [4] in *Vicia faba.*, Adhikari *et al*. (2013) [2] in rice, Mahmoodzadeh *et al.* (2013a) [11] in wheat, Vinodh Kumar and Udaysoorian, (2014) [20] in maize.

Nano neem seed kernel powder at 60 % reduction in its actual dosage 2.0 g per kg of seed, recorded significantly the highest seed germination (97.00 %) and seedling vigour index (2466), (Fig. 6) this treatment performed better over different concentrations. The current investigation reveals that nanoparticles did not reduce germination and thereby paving way for its use in agricultural practice. Germination percentage was higher in treated seeds when compared to untreated control. Similar results were also reported by

Senthilkumar (2011) [17] and Sridhar (2012) [18]. The reason could be that the nanoparticles may form new pores on seed coat during penetration facilitating the influx of the nutrients inside the seed or nanoparticles may enter into the seed through the cracks present over the surface of the seed and quench the free radical.

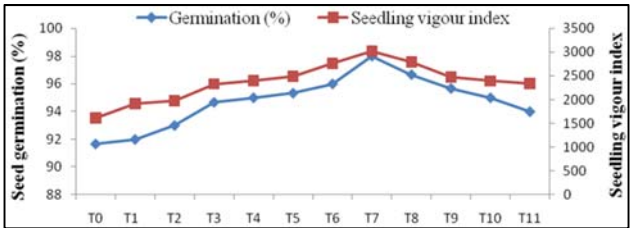


**Fig 5:** Influence of seed treatment with macro and nano sweetfleg seed germination (%) and seedling vigour in green gram

$T_0$: Absolute control
$T_1$: Recommended dosage of sweetflag rhizome powder (20 g/kg of seed)
$T_2$: Nano sweetflag rhizome powder (100% - 20 g/kg of seed)
$T_3$: Nano sweetflag rhizome powder (10% less than the normal dosage - 18 g/kg of seed)
$T_4$: Nano sweetflag rhizome powder (20% less than the normal dosage - 16 g/kg of seed)
$T_5$: Nano sweetflag rhizome powder (30% less than the normal dosage - 14 g/kg of seed)
$T_6$: Nano sweetflag rhizome powder (40% less than the normal dosage - 12 g/kg of seed)
$T_7$: Nano sweetflag rhizome powder (50% less than the normal dosage - 10 g/kg of seed)
$T_8$: Nano sweetflag rhizome powder (60% less than the normal dosage - 8 g/kg of seed)
$T_9$: Nano sweetflag rhizome powder (70% less than the normal dosage - 6 g/kg of seed)
$T_{10}$: Nano sweetflag rhizome powder (80% less than the normal dosage - 4 g/kg of seed)
$T_{11}$: Nano sweetflag rhizome powder (90% less than the normal dosage - 2 g/kg of seed)

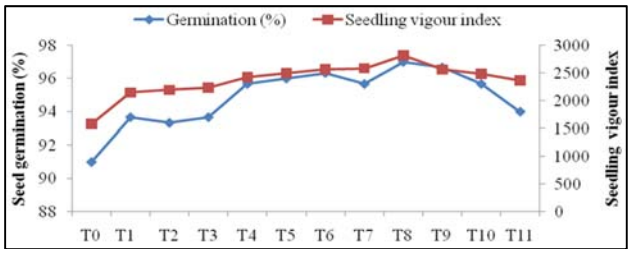


**Fig 6:** Influence of seed treatment with macro and nano neem seed kernel powder seed germination and seedling vigour in green gram

$T_0$: Absolute control
$T_1$: Recommended dosage of neem seed kernel powder (5 g/kg of seed)
$T_2$: Nano Neem seed kernel powder (100% - 5 g/kg of seed)
$T_3$: Nano Neem seed kernel powder (10% less than the normal dosage - 4.5 g/kg of seed)
$T_4$: Nano Neem seed kernel powder (20% less than the normal dosage - 4.0 g/kg of seed)
$T_5$: Nano Neem seed kernel powder (30% less than the normal dosage - 3.5 g/kg of seed)
$T_6$: Nano Neem seed kernel powder (40% less than the normal dosage - 3.0 g/kg of seed)
$T_7$: Nano Neem seed kernel powder (50% less than the normal dosage - 2.5 g/kg of seed)
$T_8$: Nano Neem seed kernel powder (60% less than the normal dosage - 2.0 g/kg of seed)
$T_9$: Nano Neem seed kernel powder (70% less than the normal dosage - 1.5 g/kg of seed)
$T_{10}$: Nano Neem seed kernel powder (80% less than the normal dosage - 1.0 g/kg of seed)
$T_{11}$: Nano Neem seed kernel powder (90% less than the normal dosage - 0.5 g/kg of seed)

## Conclusion

The nano insecticides can be used for seed treatment over macro insecticides, which inturn reduces the use of unnecessary higher dosage of insecticides. Efficiency of nano insecticides is more than the macro insecticides in maintaining the seed quality of pulses.

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