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DD Thanekar
P.G. Student Plant physiology, Department of Agricultural Botany, college of Agriculture, VNMKV, Parbhani, Maharashtra, India

AV Shinde
Assistant Proffesor, COA, Jirewadi, Maharashtra, India

PS Bhosale
Assistant Proffesor SIT, Jainapur, Maharashtra, India

Dhanashri Shid
Senior Research Fellow - ICAR, NIASM, Baramati, Maharashtra India

Corresponding Author:
DD Thanekar
P.G. Student Plant physiology, Department of Agricultural Botany, college of Agriculture, VNMKV, Parbhani, Maharashtra, India

Effect of nano zinc, iron and phosphorus on yield and seed quality parameters of the rabi chickpea (*Cicer arietinum* L.)

DD Thanekar, AV Shinde, PS Bhosale and Dhanashri Shid

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Abstract
A field investigation on "Growth and yield analysis of chickpea (*Cicer arietinum* L.) as influenced by nutrient management through nano fertilizer." was carried out during *Rabi* season, 2020-2021 at post graduate institute research farm Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. Research was undertaken to study of morphological, growth and yield attributing traits of chickpea (*Cicer arietinum* L.) through nano fertilizer. Experiment design with the randomized block design with three replication and ten treatments. The nano Fe, Zn and P fertilizer were used with NPK. The yield attributing characters are pod number, test weight, yield per plant, yield per plot, yield per hector and seed recovery and seed quality parameters includes germination percent, seedling length, seedling weight, seed vigour index involve under the study. Among all ten treatments T_8 and T_{10} treatments shows significant effect on the pod number, seed yield per plant and per plot other in seed quality parameters also shows significantly increase in germination, seedling length, seedling dry weight and seed vigour index of *Rabi* chickpea. The most increase in yield attributes and seed quality parameters was obtained by the seed coating and foliar application of nano Zn and Fe @ 62.5 ml/ha and 250 ml/ha. In conclusion, this study proved that 100% RDF , seed coating of nano Zn + Fe @ 62.5 ml/ha and foliar spray of nano Zn + Fe @ 250 ml/ha can increase in the plant yield in chickpea.

Keywords: Nano fertilizer, seed coating, foliar application, seed quality parameters, yield, chickpea

Introduction
India is the largest producer of pulses in the world and more than a dozen pulse crops are grown in the country. These play a significant role in biological nitrogen fixation from the atmosphere and enrich the soil fertility. Pulses also form a major source of dietary protein in India, especially for vegetarians as they form a major population. India has lion share in area is 42.6% with a production of 28.34% Indian share is maximum for pigeon pea in area (73%) and production (67%) followed by chickpea (68% area and 66% production) (Chaturvedi *et al.*, 2018) [1]. Chickpea belong to tribe Viciae, family leguminacea and subfamily Papilionaceae. Initially, chickpea was a part of the tribe Viciae, but due to its distinct characters, it was included in a new monogeneric tribe *Cicereae* later. The detailed taxonomic information on chickpea is given below:

- **Kingdom:** Plantae
- **Subkingdom:** Tracheobionta
- **Super division:** Spermatophyta
- **Division:** Magnoliophyta
- **Class:** Magnoliopsida
- **Subclass:** Rosidae
- **Order:** Fabales
- **Family:** *Fabaceae* (Leguminosae)
- **Subfamily:** *Faboideae* (Papilionaceae)
- **Tribe:** *Cicereae*
- **Genus:** *Cicer*

Chickpea occupies a unique position in Indian agriculture by virtue of its high protein content and its capacity to fix atmospheric nitrogen in the soil. The plant grows to 20-50 cm

high and small, feathery leaves on either side of the stem. Chickpea are a type of pulse, with one seedpod containing two or three peas. It has white flowers with blue violet or pink veins. Under optimum moisture and temperature condition, chickpea seed imbibe water quickly and germinate within a few days. Emergence occurs in 7 to 30 days, depending on the soil moisture and temperature condition and depth of sowing. Chickpea is the world's third pulse crop and fifth food legume. It is mainly cultivated in Asia, Africa and Europe and to a lesser extends in central and Latin America. It plays an important role in meeting the qualitative and quantitative protein requirement of a large part of humanity. India is the largest producer of gram in the world sharing 65% area and 70% of the total global production. Chickpea varieties developed by pure line selection in India. Among grain legume grown in India, chickpea ranks first with annual acreage and production of million metric tons respectively. The leading states of chickpea production in India are Madhya Pradesh.

Nano fertilizers possess unique features which enhance plants performance in terms of ultrahigh absorption, increase in production, rise in photosynthesis, and significant expansion in the leaves surface area. Besides, the controlled release of nutrients contributes in preventing eutrophication and pollution of water resources. Replacement of traditional fertilizer by nano fertilizer is beneficial as upon application, it releases nutrients into the soil steadily and in a controlled way.

Materials and Methods

The present investigation entitled "Growth and Yield Analysis of Chickpea (*Cicer arietinum* L.) As Influenced by Nutrient Management through Nano Fertilizers" is conducted at the farm of Seed Technology Research unit, VNMKV, Parbhani during the *Rabi* season 2020-2021. Ten different treatments of nano fertilizers *viz*., T_1 (no fertilizer), T_2 (25N: 50P kg/ha RDF), T_3 (100% RDF +seed coating of nano P @ 125 ml / ha), T_4 (100% RDF + seed coating of nano Zn + Fe @ 125 ml / ha), T_5 (75% RDF + seed coating of nano P @ 125 ml / ha), T_6 (75% RDF + seed coating of nano Zn +Fe @ 125 ml / ha), T_7 (100% RDF + seed coating of nano P @ 62.5 ml/ha + Foliar spray of nano P @ 250 ml/ha), T_8 (100% RDF + seed coating of nano Zn +Fe @ 62.5 ml/ha + Foliar spray of nano Zn +Fe @ 250 ml/ha), T_9 (75% RDF + seed coating of nano P @ 62.5 ml/ha + Foliar spray of nano P @ 250 ml/ha), T_{10} (75% RDF + seed coating of Zn +Fe @ 62.5 ml/ha + Foliar spray of nano Zn +Fe @ 250 ml/ha). The experiment was conducted in Randomized Block Design with three replications, at spacing of 10 cm between plant to plant and 30 cm between row to row. There were thirty treatment combinations involving the effect of nano fertilizer of different combination with different concentration on the chickpea, also involves different nano nutrient application methods. The observation were recorded on following characters *viz*., pod number, yield per plant and per plot other in seed quality parameter includes parameters like seed germination percentage, seedling length, seedling dry weight, seed vigour index. The significance of treatment difference was tested by "F" test at 5 per cent levels of probability. The distribution of degree of freedom for analysis of variance is given as per Panse and sukhatme (1985) [6]. The following equations were used to calculate yield parameters.

$$1)\quad \text{Seed yield (qt/hector)} = \frac{\text{Seed yield (g)/plot} \times 10000 \text{ (sq.m)}}{\text{Size of plot (sq.m)} \times 1000 \times 100}$$

$$2)\quad \text{Seed recovery} = \frac{\text{Seeds of controlled plot}}{\text{Seeds of treated plot}} \times 100$$

3) Seed vigour index I = Germination % × Seedling length

4) Seed vigour index II = Germination % × Seedling dry weight

Results and Discussion

The result of analysis of variance of *Rabi* chickpea are evaluated in Table 1 and Table 2. Highly significant difference among the treatments was observed indicating different efficiency of nano fertilizers. Variation among the nano fertilizer treatments for some growth contributing characters for chickpea was also reported by the Drostkar *et al* (2016) [2].

The yield parameters like seed yield per hector and seed recovery and in seed quality parameters the germination percentage, seed vigour index 1 and 2 are calculated by using appropriate statistical formulas and carried out with proper procedure. Yield characters pod number, seed recovery, yield per plant, yield per plot, yield per hector.

Number of Pods

The results have revealed that nano fertilizer application on chickpea had significant effect on the pod numbers. Higher pod number was obtained by the application of Zn, P and Fe application on comparison of control. The highest pod number was obtained by the seed coating and foliar application of Zn and Fe with NPK.

Seed Yield

Data represented in table revealed that there were significant differences in respect of chickpea yield per plant (gm), plot (kg) and per hectare (kg) amongst different nano fertilizer application. From table we can observed that the seed yield per plant, seed yield per plot and per he was higher in the treatment T_8 (100% RDF + Seed coating of nano Zn +Fe @ 62.5 ml/ha + Foliar Spray of nano Zn +Fe @ 250 ml/ha), which was superior over all other treatments under study.

Germination Percentage

Germination percentage was influenced with treatment. Among these treatments the T_8 (100% RDF + Seed coating of nano Zn +Fe @ 62.5 ml/ha + Foliar Spray of nano Zn +Fe @ 250 ml/ha) treatment was shows maximum germination percentage (98%) followed by T_{10} (75% RDF +Seed coating of Zn +Fe @ 62.5 ml/ha + Foliar spray of nano Zn +Fe @ 250 ml/ha) treatment (96.66%) in comparison to the T_1 control treatment show lowest germination percentage (79.33%). The germination percentage was higher in seed treated with the zinc and iron combination over the other treatment, the probable reason for the enhanced germination due to nano size of particles

allow them to penetrate through seed coat easily and hence, provided better absorption and utilization of these particles by seeds while decreased germination at higher concentration could be attributed to increased absorption and accumulation of these NPs both in extracellular space and within the cells which resulted in reduction in cell division, cell elongation and inhibition of the hydrolytic enzymes involved in food mobilization during the process of seed germination.(Pradeep Korishettar *et al.*, 2016 and Prasad *et al.*, 2012) [3, 8] and (prashant and raju, 2017) [9].

Seedlings Dry Weight (gm.)

From the table it was observed that the seedling dry weight was influenced with the nano fertilizer application. The maximum dry weight value occur in the T_8 (100% RDF + Seed coating of nano Zn +Fe @ 62.5 ml/ha + Foliar Spray of nano Zn +Fe @ 250 ml/ha) treatment (2.61 g). And the lowest seedling dry weight observed in the control treatment T_1 treatment (0.97 g).

Seedling Length (cm)

The maximum Seedling Length was occur in the T_8 (100% RDF + Seed coating of nano Zn +Fe @ 62.5 ml/ha + Foliar Spray of nano Zn +Fe @ 250 ml/ha) treatment (15.30 cm). And the lowest seedling dry weight value observed in the control treatment T_1 treatment (13.96 cm). increase seedling length this could be ascribed to the increased synthesis and activity of hydrolytic enzymes during the early phases of germination and effective mobilization of the available food reserves in the seeds resulted in the early emergence and growth of the seedlings.

Seed Vigour Index I

From the table it is observed that the Seed Vigour Index I was influenced with the nano fertilizer application. The maximum dry weight value occur in the T_8 (100% RDF + Seed coating of nano Zn +Fe @ 62.5 ml/ha + Foliar Spray of nano Zn +Fe @ 250 ml/ha) treatment 1685.23. And the lowermost seedling dry weight value observed in the control treatment T_1 treatment i.e.1029.83. The increased vigour index I mainly due to overall improvement in germination and seedling growth characteristics (Raju and Rai, 2017) [9].

Seed Vigour Index II

From the table it is observed that the Seed Vigour Index II was influenced with the nano fertilizer application. The maximum dry weight value occur in the T_8 (100% RDF + Seed coating of nano Zn +Fe @ 62.5 ml/ha + Foliar Spray of nano Zn +Fe @ 250 ml/ha) treatment i.e. 240.90. And the lowest seedling dry weight value observed in the control treatment T_1 treatment i.e. 189.40. The increased vigour index II was mainly due effective mobilization of the available food reserves in the seeds resulted in the early emergence and growth of the seedlings. In proportional to increase in seedling growth and dry matter production increased.

Table 1: Effect of different nano fertilizer on yield and yield attributing characters of the chickpea

Treatment	Pod number	Seed yield/ plant	Seed yield/ plot	Seed yield/ he
T_1	29	8.02	7.91	13.83
T_2	31	8.15	10.96	14.50
T_3	30	8.27	9.59	14.66
T_4	33	8.46	10.67	16.33
T_5	32	8.35	12.36	15.50
T_6	33	8.55	11.59	16.33
T_7	35	8.59	13.89	17.00
T_8	40	9.3	16.34	20.50
T_9	34	8.7	11.39	15.50
T_{10}	39	9.1	16.25	19.83
MEAN	33.60	8.55	12.09	16.4
S.E.±	2.23	0.25	1.72	1.29
C.D. at 5%	6.68	0.75	5.12	3.86

Table 2: Effect of different nano fertilizer on seed quality parameters of the chickpea.

Treatment	Germination	Seedling length	Seedling dry weight	Seed vigour index I	Seed vigour index II
T_1	79.33	13.96	0.97	1029.83	189.4
T_2	89.66	14.10	1.88	1368.36	192.03
T_3	89.33	14.13	1.67	1270.43	189.73
T_4	92.33	14.46	1.90	1332.93	195.96
T_5	91.66	14.3	1.85	1207.77	200.96
T_6	91.33	14.46	1.79	1362.4	212.30
T_7	93.66	14.6	2.07	1507.13	229.52
T_8	98.00	15.3	2.61	1685.23	240.90
T_9	95.66	14.7	2.27	1531.33	218.84
T_{10}	96.66	15.1	2.29	1444.93	233.15
MEAN	91.76	14.51	1.93	1374.04	210.28
S.E.±	3.04	0.27	0.24	106	12
C.D. at 5%	9.05	0.81	0.71	316	35.80

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