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Impact of chitosan based bioactive seed coating on field performance, yield and yield attributing characters of Chickpea (*Cicer arietinum* L.)

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ABSTRACT

The present investigation was carried out for "Impact of chitosan based bio-active seed coating on field performance, yield and yield attributing characters of Chickpea (*Cicer arietinum* L.)". For this purpose, 11+1 treatments including control on Chickpea seeds variety-Pragati were used to study under field conditions during Rabi, 2022. Field experiment was laid out in Randomized Block Design with three replications. Analysis for the data based on ANOVA and mean performance in field experiment revealed significance mean sum of squares due to seed treatments for all the characters under study. In order to response different method of seed treatment were evaluated by screening a range of duration and concentration viz T0- Control, T1- Chitosan @1%+Salicylic acid @1% for 8Hrs, T2- Chitosan @2%+Salicylic acid @1% for 8 hrs, T3- Chitosan @3%+Salicylic acid @1% for 8Hrs, T4- Chitosan @4%+Salicylic acid @1% for 8hrs, T5- Chitosan @5%+Salicylic acid @1% for 8hrs, T6- Chitosan @1%+Bee Wax @0.1% for 8hrs, T7- Chitosan @2%+Bee Wax @0.1% for 8hrs, T8- Chitosan @1%+Bee Wax @0.1%+Lime essential Oil @0.1% for 8hrs, T9- Chitosan @1%+Oleic acid @1% for 8hrs, T10- Chitosan @2%+Oleic acid @1% for 8 hrs, T11- Chitosan @2%+Oleic acid @1%+Lime essential Oil @0.1% for 8hrs. To find out Impact of different concentration seed treatment on Chitosan, Salicylic acid, Bees Wax, Oleic acid, Lime essential oil on growth, yield and yield attributing traits of Chickpea showed that significant treatment Field emergence, Plant height, Number of Branches, Days to 50% flowering, Days to maturity, Number of leaves per plant, Number of pods per plant, Number of Seeds per pod, Seed yield per plant, Seed yield per plot, Biological yield, Harvest index. The study helps to improve the quality of seed with help of Chitosan, Salicylic acid, Bee Wax, Lime essential Oil, Oleic acid seed bioactive coating treatment which are cost effective and economic, non-toxic, eco-friendly sources. seed bioactive coating treatment with it is concluded from the present study that Impact of chitosan based bioactive seed coating on germination growth and yield of Chickpea. T4- Chitosan @4%+Salicylic acid @1% for 8 hrs showed significantly enhance the yield and yield attributing traits followed by T6- Chitosan @1%+Bee Wax @0.1% as compared to control(untreated) seeds. These recommendations are based on six months experimentation and the treatment recommended is T4- Chitosan @4%+ Salicylic acid @1% for 8 hrs.

Key words: Chickpea, Chitosan, Salicylic acid, Bee Wax, Lime essential oil, Oleic acid, RBD

Introduction

Chickpea (*Cicer arietinum* L.), Chromosome Number $2n=16$, it belongs to legumenaceae. It is the third most important pulse crop worldwide, with a cultivated area of 14.84 million hectares, a production of 15.08 million tons, and an average yield of 1.01 t/ha in 2020 FAOSTAT (2021).

Chickpea is mostly grown in under developed nations, where more than 90% of the crop is consumed domestically Misra *et al.* (2020). The Indian subcontinent (India, Pakistan, Myanmar, Bangladesh, and Nepal) is the primary producer and consumer of chickpeas, accounting for almost 70% of global production. Jain *et al.* (2013). The desi kind, on the other hand, is more prevalent, accounting for close to 80-85% of global production, while the Kabuli form contributes for 15-20% Dhima *et al.* (2015).

Chitosan is a carbohydrate biopolymer formed from the deacetylation of chitin, which can be found in crustacean shells, insect cuticles, and fungal cell walls. Chitosan is derived from chitin, which is the most prevalent carbohydrate after cellulose Duan *et al.* (2019). Chitosan is essential in plant defense responses (Malerba and Cerana, 2015). Chitosan seed priming improved seed germination and seedling growth in wheat under osmotic stress, leading to increased tolerance. Hameed *et al.* (2014). Chitosan, a natural polysaccharide, has a wide range of applications due to its biodegradability, nontoxicity, biocompatibility, antibacterial and antioxidant characteristics. When sunflower and broccoli seeds were immersed in chitosan solutions, greater sprout development and nutritional enhancement were observed. Greater drought was reported by Li *et al.* (2017). When we coat Chickpea seeds with chitosan it has shown improved growth in root development and growth. Objectives: 1) To investigate the impact of chitosan based bioactive seed coating on field performance, yield and yield attributing characters of Chickpea (*Cicer arietinum* L.). 2) To find out the suitable Bioactive coating seed treatment for Chickpea.

Materials and Methods

The research was conducted at Crop Research Farm unit, Department of Genetics and Plant Breeding during *Rabi* (2022-2023). Sam Higginbottom University of Agriculture, Technology and Sciences,

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The typical version of a humid subtropical climate that is common to cities in north-central India. Prayagraj experiences three seasons: hot dry summer, cool dry winter and warm humid monsoon. The summer season lasts from April to June with the maximum temperatures ranging from 40°C (104°F) to 45°C (113°F). Monsoon begins in early July and lasts till September. The winter season lasts from December to February when the temperature falls upto 1! to 2 °C.

The twelve treatment combinations along with control were employed in the present study. The details of the treatments combinations, their dosage and the duration of the treatment were present.

Experimental Material

Variety : Pragati

Total number of treatments : 12

Table 1. Treatment combination details

Treat- ment	Chemicals	Duration
T0	Control	-
T1	Chitosan @ 1%+ Salicylic acid @1%	8 hours
T2	Chitosan @ 2%+ Salicylic acid @1%	8 hours
T3	Chitosan @ 3%+ Salicylic acid @1%	8 hours
T4	Chitosan @ 4%+ Salicylic acid @1%	8 hours
T5	Chitosan @ 5%+ Salicylic acid @1%	8 hours
T6	Chitosan @ 1%+Bee Wax @0.1%	8 hours
T7	Chitosan @ 2%+Bee Wax @0.1%	8 hours
T8	Chitosan @1%+Bee Wax @0.1%+ Lime essential oil@0.1%	8 hours
T9	Chitosan @ 1%+Oleic acid @1%	8 hours
T10	Chitosan @ 2%+Oleic acid @1%	8 hours
T11	Chitosan @ 2%+Oleic acid @1%+ Lime essential Oil@0.1%	8 hours

Preparation of Solution

Materials required

Chitosan powder, Salicylic acid, Beewax pellets, Lime essential oil, Oleic acid, Distilled water, Measuring tools.

Seed Coating with Chitosan and Salicylic acid

Weigh the desired amount of chitosan powder required for 1%-5% level of concentration. Dissolve the different amount of chitosan powder in distilled water to prepare chitosan solution of concentration around 1%-5% solution. Weigh the appropriate amount of salicylic acid powder required for 1%

concentration. Dissolve the salicylic acid powder in a small amount of distilled water. Add the concentrated salicylic acid to the different concentrations of chitosan solution in required level. Take Chickpea seeds in a container and slowly pour the chitosan-salicylic acid mixture over the seeds until they soak in the solution. Allow the seeds to incubate in the solution for about 8 hours, after this period spread the seeds and let them dry under shade.

Seed Coating with Chitosan and Beewax

Prepare chitosan solution of 1% and 2% in way which was given in previous step. weigh necessary amount of bee wax pellets and melt those pellets at low heat using a boiler setup while stirring occasionally until its completely melted. Once the beeswax is melted slowly add chitosan solution into it continue stirring until the mixture is well combined. Place the Chickpea seeds in a container and pour the chitosan-beeswax mixture over the seeds by stirring gently to ensure even coating. Leave the seeds for 8hr under shade for drying.

Seed Coating with Chitosan, Beeswax and Lime essential Oil

Prepare the mixture of chitosan solution@1% and beeswax using the process which was given in previous step. Now add a few drops of lime essential oil in the chitosan solution and beeswax while stirring it gently until all components are well combined. Place the Chickpea seeds in a container and pour the chitosan-beeswax-Lime essential oil mixture over the seeds by stirring gently to ensure even coating. Leave the seeds for 8hr under shade for drying.

Seed Coating with Chitosan and Oleic acid

Prepare chitosan solution of 1% and 2% in way which was given in first step. Take appropriate amount of oleic acid in a measuring cylinder and add small amount of distilled water to create a oleic acid solution slowly pour the oleic acid solution into the chitosan solution while stirring gently until the solutions are well mixed. Place the Chickpea seeds in a container and pour the chitosan-Oleic acid mixture over the seeds by stirring gently to ensure even coating. Leave the seeds for 8hr under shade for drying.

Seed coating with chitosan, Oleic acid and Lime essential oil

Prepare the mixture of chitosan solution@1% and

Oleic acid using the process which was given in previous step. Now add a few drops of lime essential oil in the chitosan solution and Oleic acid while stirring it gently until all components are well combined. Place the Chickpea seeds in a container and pour the chitosan-Oleic acid-Lime essential oil mixture over the seeds by stirring gently to ensure even coating. Leave the seeds for 8hr under shade for drying.

After seeds are coated with all the treatments and dried under shade then the seeds are manually sowed along with control in the experimental field of department of Genetics and Plant Breeding.

Results and Discussion

Analysis of Variance: The analysis of variance for germination growth and seed yield characters was given in below table. Analysis of variance revealed that the differences among twelve treatments were significant for growth and yield, *viz.*, Field emergence percentage, Plant height at 30DAS, 60DAS, 90DAS. Number of Primary branches per Plant at 60DAS & 80DAS, Secondary branches per plant at 60DAS & 80DAS, Number of Branches per plant at 30DAS & 60DAS, Days to 50% flowering, Days to maturity, Number of pods per plant, Number of seeds per pod, Seed yield per plant, Seed yield per plot, Biological yield, Harvest index.

Germination percentage

The mean performance of Germination percentage ranged from 77.38 % to 90.48 % with mean value of 82.74%. Significantly highest germination percentage was recorded T4- Chitosan@4%+Salicylic acid @1% for 8hrs(90.48%) and it was followed by T6- Chitosan@1%+Bee Wax @0.1% for 8hrs(86.9%), T8- Chitosan@1%+Bee Wax @0.1%+Lime essential oil @0.1% for 8hrs (85.71%). Minimum germination percentage at 8DAS was recorded by T0-Control (77.38%).

Plant height (cm) at 90 DAS

The mean performance of Plant height at 60DAS ranged from 55.16 cm to 66.54 cm with mean value of 59.98cm. Significantly highest plant height was recorded T4-Chitosan@4%+Salicylic acid @1% for 8hrs (66.54cm) for 8hrs and it was followed by T6- Chitosan@1%+Bee Wax @0.1% for 8hrs(63.26cm), T8- Chitosan@1%+Bee Wax @0.1%+Lime essential Oil@0.1% for 8hrs (62.28cm). Minimum Plant height was recorded by T0-Control (55.16cm)

Number of Primary branches at 80 DAS

The mean performance of Number of primary branches per plant at 80DAS ranged from 3.45 to 3.66 with mean value of 3.50. Significantly maximum Number of primary branches per plant at 80DAS was recorded by T4-Chitosan@4%+ Salicylic acid @1% for 8hrs(4.75) and it was followed by T6-Chitosan@1%+Bee Wax @0.1% for 8hrs(4.52), T8-Chitosan@1%+Bee Wax @0.1%+Lime essential Oil@0.1% for 8hrs(4.18). Minimum Number of primary branches per plant at 80DAS was recorded by T0 - Control (3.45).

Number of secondary branches at 80 DAS

The mean performance of Number of secondary branches per plant at 80DAS ranged from 2.41 to 3.05 with mean value of 2.91. Significantly maximum Number of Secondary branches per plant was recorded by T4-Chitosan@4%+ Salicylic acid @1% for 8hrs (3.71), it was followed by T6-Chitosan@1%+ Bee Wax @0.1% for 8hrs (3.47), T8-Chitosan @1%+ Bee Wax @0.1%+Lime essential Oil@0.1% for 8hrs(3.14). Minimum Number of secondary branches per plant at 80 DAS was recorded by T0 - Control (2.41).

Number of branches at 60 DAS

The mean performance of Number of branches per plant at 60DAS ranged from 7.53 to 10.87 with mean value of 9.03. Significantly maximum Number of branches per plant at 60DAS was recorded by T4-Chitosan@4%+Salicylic acid @1% for 8hrs(10.87) was followed by T6-Chitosan@1%+Bee Wax @0.1% for 8hrs (10.00), T8- Chitosan@1%+Bee Wax @0.1%+Lime essential@0.1% for 8hrs(9.60). Minimum Number of branches per plant at 60DAS was recorded by T0 - Control (7.53).

Days to 50% flowering

The mean performance of Days to 50% flowering ranged from 76.00 to 64.33 with mean value of 69.64%. Significantly minimum Days to 50% flowering was recorded T4-Chitosan@4%+Salicylic acid @1% for 8hrs(64.33) was followed by T6-Chitosan@1%+Bee Wax @0.1% for 8hrs(66.33), T8-Chitosan@1%+Bee Wax @0.1%+Lime essential Oil@0.1% for 8hrs(68.67%). Maximum days to 50% flowering was recorded by T0 - Control (76.00).

Days to Maturity

The mean performance of Days to Maturity ranged

from 130.67 to 121.00 with mean value of 125.78. Significantly minimum Days to maturity was recorded by T4-Chitosan@4%+Salicylic acid @1% for 8hrs(121.00) was followed by T6-Chitosan@1%+Bee Wax @0.1% for 8hrs(123.00), T8-Chitosan@1%+Bee Wax @0.1%+Lime essential Oil@0.1% for 8hrs(124.33). Maximum days to maturity was recorded by T0 - Control (130.67).

Number of pods per plant

The mean performance of Number of pods per plant ranged from 47.47 to 61.87 with mean value of 87.5%. Significantly maximum number of pods per plant was recorded by T4- Chitosan@4%+Salicylic acid @1% for 8hrs (61.87) and it was followed by T6-Chitosan@1%+Bee Wax @0.1% for 8hrs (60), T8-Chitosan@1%+Bee Wax @0.1%+Lime essential Oil@0.1% for 8hrs(57.67). Minimum Number of pods per plant was recorded by T0 - Control (47.47).

Number of seeds per pod

The mean performance of Number of seeds per pod ranged from 1.47 to 3.27 with mean value of 2.18. Maximum Number of seeds per pod were recorded by T4-Chitosan@4%+Salicylic acid @1% for 8hrs(3.27) followed by T6-Chitosan@1%+Bee Wax @0.1% for 8hrs(2.93) and T8- Chitosan@1%+Bee Wax @0.1%+Lime essential Oil@0.1% 8hrs(2.73) and the lowest was recorded in T0 - control (1.47).

Seed yield per plant (g)

The mean performance of seed yield per plant(g) ranged from 5.87g to 10.39g with mean value of 7.40g. Significantly maximum seed yield per plant was recorded by T4- Chitosan@4%+Salicylic acid @1% for 8hrs(10.39) followed by T6- Chitosan @1%+Bee Wax @0.1% for 8hrs(10.27), T8-Chitosan @1%+BeeWax @0.1%+Lime essential Oil @0.1% for 8hrs(9.52). Minimum seed yield per plant was recorded by T0 - Control (5.87).

Seed yield per plot(g)

The mean performance of seed yield per plant(g) ranged from 93.99g to 166.18g with mean value of 166.18g. Significantly maximum seed yield per plot was recorded by T4-Chitosan@4%+ Salicylic acid @1% for 8hrs(166.18g) followed by T6-Chitosan@1%+Bee Wax @0.1% for 8hrs(164.36g), T8-Chitosan@1%+Bee Wax @0.1%+Lime essential Oil@0.1% for 8hrs(152.25g). Minimum seed yield per plant was recorded by T0 - Control (93.99g).

Biological yield (g)

The mean performance of Biological yield(g) ranged from 218.33 to 275.73 with mean value of 196.96g. Significantly maximum Biological yield was recorded by T4- Chitosan@4%+Salicylic acid @1% for 8hrs (275.73) was followed by T6-Chitosan@1%+Bee Wax @0.1% for 8hrs (264.47), T8-Chitosan@1%+Bee Wax @0.1%+Lime essential Oil@0.1% for 8hrs (246.67). Minimum Biological yield was recorded by T0 – Control (218.33).

Harvest index (%)

The mean performance of Harvest index(%) ranged from 43.26% to 62.39% with mean value of 48.21(%). Significantly maximum Harvest index(%) was recorded by T4- Chitosan@4%+Salicylic acid @1% for 8hrs(62.39%) was followed by T6-Chitosan@1%+Bee Wax @0.1% for 8hrs (3.9%), T8-Chitosan@1%+Bee Wax @0.1%+Lime essential oil@0.1% (3.86%). Minimum Harvest index(%) was recorded by T0 – Control (2.70%).

Test weight (g)

The mean performance of test weight(g) ranged from 229.03g to 265.03g with mean value of 197.37(g). Significantly maximum test weight(g) was recorded by T4-Chitosan@4%+Salicylic acid @1% was followed by T6-Chitosan@1%+Bee Wax @0.1% for 8hrs(250.93g), T8-Chitosan@1%+Bee Wax @0.1%+Lime essential Oil@0.1% for 8hrs (244.23g). Minimum test weight was recorded by T0 – Control (229.03g).

Conclusion

It is reported that “Impact of chitosan based bioactive seed coating on field performance, yield and yield attributing characters of Chickpea (*Cicer arietinum* L.)”. According to the studies the seed treatment T4 in which seeds are treated with Chitosan@4%+Salicylic acid@1% has recorded significantly the highest result in all parameters like seed germination, plant height, number of branches, number of pods, number of seeds, days to 50% flowering, days to maturity, pod yield per plant/plot, biological yield, seed yield per plant/plot, harvest index and test weight followed by T6 in which seeds are treated with Chitosan@1%+Beeswax@0.1% when compared with control (T0) which has shown lowest values in all parameters.

It is concluded that the seed coating with chitosan and salicylic acid is suitable and helpful for Chickpea for its germination, yield and yield attributes.

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