

Original Research Article

Effect of seed priming on seed quality attributes in chickpea (*Cicer arietinum* L.)

Comment [RK1]: Need to revise complete manuscript with citation in [1] number style used in citation and references in Vancouver style

ABSTRACT

Effect of seed priming on seed quality attributes in chickpea (*Cicer arietinum* L.), one varieties Field and Laboratory experiment (G₂-315) with 10 treatments. Viz T₁- Tulsi leaf extract @ 1 % (12hours). T₂ - Tulsi leaf extract @ 3% (12hours). T₃ Tulsi leaf extract @5% (12hours). T₄ Neem seed extract 1% (12hours), T₅- Neem seed extract @ 3% (12hours), T₆- Neem seed extract @ 5% (12hours), T₇- KNO₃ @ 1% (12 hours). T₈ - KNO₃ @ 3% (12 hours). T₉ - KNO₃ @ 5% (12hours). T₁₀- Control. In all treatment the seeds of chickpea were soaked for 12 hours and dried for 2 hours except control (untreated seeds). It was found that all the priming treatments showed significance difference with the control while highest plant height, number of primary branches per plant germination percentage. Days to 50% flowering. Number of siliqua per plant. Number of seeds per siliqua, seed weight (gm), and seed quality parameters viz, Germination percentage(%), Root length (cm), Shoot length (cm), Seedling length (cm). Seedling fresh weight (gm). Seedling dry weight (gm), Vigour index-I, Vigour index -II. electrical conductivity were observed for seeds treated with T₉-KNO₃@ 5% followed by T₃-Tulsi Leaf Extract @ 5%, while the lowest was observed in T₁₀-Control. The study helps to study field and seed quality parameters with the help of seed priming treatments which are effective, economic, non-toxic and eco-friendly sources.

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Keywords: G₂-315, Chickpea. Seed priming

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Introduction

Pulses improve soil structure and fix atmospheric nitrogen, preserving soil fertility. Pulses are regarded as an excellent crop for the management of natural resources, environmental crop diversification, and consequently for sustainable agriculture because they play a significant role in improving the physical, chemical, and biological properties of soils in rain fed agriculture (Khan *et al.*, 2006). India's trade, production, and consumption of pulses. Leguminaceae, or chickpea (*Cicer arietinum* L.), has a 2n=16 genetic makeup. The name Cicer is a translation of the Greek word kiros, which refers to the famous Roman family Cicero. The Latin word arietinum, which means "ram," refers to the chickpea's ram-like head shape. It also goes by the name Bengal gramme. It is a cool-season legume crop that is grown as a food crop in many nations around the world.

Chickpea contains protein (22-28 %), fat (4.8-5.5 %), carbohydrates (40-65 %), ash (48 %), moisture (4.9-15.59), vital vitamins like vitamin A, vitamin B₁, B₂ and B₃, vitamin C, vitamin E, vitamin K, folic acid and pantoic acid (Zohary and Hopf, 2000). Additionally, chickpeas contain a variety of vital minerals, including calcium, iron, molybdenum, potassium, manganese, copper, and zinc. Additionally, chickpeas contain dietary fibre, water, and other nutrients. Generally improving germination rate and plant performance, seed priming is a pre-sowing technique for influencing seedling development by modifying pre-germination metabolic activity before the radicle emerges (Bradford, 1986). The primary goals of the investigation are to evaluate the impact of various priming techniques on the development, yield, and defining characteristics of chickpeas, as well as to identify the most effective priming technique for this crop. Perhaps the osmotic potential and chemical makeup of the salt species used have an impact on how effective priming with simple salt solution is. It has been suggested that compounds containing nitrate may act as priming agents more effectively than other salts. Numerous salts have been found to work very well as primers.

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Materials and Methods:

The field experiment was carried out at the crop research centre of department of Genetics and Plant Breeding, ITM University, Gwalior, Madhya Pradesh, India, geographically located at 26.22°N, 78.18°E

and at an average elevation of about 197m above the mean sea level. The experimental research material was collected from local farmer from Maharashtra, the pure seeds of chickpea variety G₂-315. The seeds of the varieties G₂-315 were primed for 12 hours with various doses of Tulsi leaf extract, Neem seed extract, and KNO₃ leaf extract, then dried to their original moisture content according to the treatment. Foliar applications of various chemicals were given at the bud initiation stage and 8 days after bud initiation. Details of the treatments are mentioned below.

The treatments used at different concentrations viz.,

- T1 - Tulsi leaf extract @ 1%
- T2 - Tulsi leaf extract @ 3%
- T3 - Tulsi leaf extract @ 5%
- T4 - Neem seed extract @ 1%
- T5 - Neem seed extract @ 3%
- T6 - Neem seed extract @ 5%
- T7 - KNO₃ leaf extract @ 1%
- T8 - KNO₃ leaf extract @ 3%
- T9 - KNO₃ leaf extract @ 5%

T₁₀. Unprimed Control

After cleaning and grading, these seeds were soaked in respective priming solutions at different volume of seeds for twelve hours. Then the seeds were air dried under the shade to bring back to their original moisture content and used for sowing.

Field observations:

1. Days to 50 percent Flowering:
2. Plant height at maturity (cm):
3. Number of primary branches per plant:
4. Pod per plot :
5. Seed yield per pod (g)
6. 100 seed weight (g)

Laboratory observation:

7. Germination percentage (%)
8. Shoot length (cm):
9. Root length (cm):
10. Seedling length (cm):
11. Seedling fresh weight (SFW):
12. Seedling dry weight (SDW):
13. Seedling vigour Index I:
14. Seedling Vigour Index II:
15. Electrical conductivity (ds/m):

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Results and Discussion:

A field experiment was conducted to study the effect of priming on the growth, yield, field attributing traits and seedling parameters on Desi Chickpea (*Cicer arietinum* L.) areas follows. The experiment was carried out during Rabi season 2021-2022, Department of Genetics and Plant Breeding, School of Agriculture, ITM University, Gwalior. The results are given and discussed under following headings.

Analysis of variance
Mean performance

Analysis of variance:

The analysis of variance for growth and seed yield characters was presented in Table 1. Analysis of variance revealed that the differences among thirteen treatments were significant for growth and yield, viz., field emergence percentage, Plant Height at Maturity, Primary Branches, Days to 50% Flowering,

Pods per Plant, Seeds per Pod, Plot Yield (g), 100 Seed Weight (g), Seed Germination Percentage (%), Fresh Weight of Seedling, Dry Weight of Seedling (g), Shoot Length, Root Length, Seedling Length, Vigour index 1, Vigour index 2, Electrical conductivity.

Table :1 Analysis of Variance for 16 Characters in Chickpea

S.No	Characters V1(G2 -315)	Mean sum of squares		
		Replications (DF=2)	Treatments (DF=9)	Error (DF=18)
1	Plant Height at Maturity	27.140	199.541**	4.282
2	Primary Branches	0.261	1.308	0.146
3	Days to 50% Flowering	1.43	327.73	7.69
4	Pods per Plant	43.90	456.922	22.678
5	Seeds per Pod	0.0025	0.292	0.014
6	Plot Yield (g)	3.0	24815.66	52.227
7	100 Seed Weight (g)	3.1930	18.80	0.108
8	Seed Germination Percentage (%)	0.354	88.486	1.443
9	Fresh Weight of Seedling	0.4459	2.0839	0.008
10	Dry Weight of Seedling (g)	0.0228	0.2639	0.008
11	Shoot Length	0.436	10.069	0.208
12	Root Length	0.012	0.17866	0.0074
13	Seedling Length	0.508	12.77	0.1936
14	Vigour index 1	4857	199412	2350
15	Vigour index 2	168.2	3616.2	77.4
16	Electrical conductivity	0.03033	1.04922	0.03700

** 5% significant level

2. Mean performance:

Effect of different priming methods on field emergence percent:

1 Days to 50% flowering:

The data regarding Days to 50% Flowering as influenced by different seed priming treatments was shown in the Table –2

The mean performance of days to 50% flowering variety G2-315 ranged from T₉ KNO₃ 5% (69.66) to T₄ Neem seed extract 1% (94.00) with mean value of 84.03. Significantly taken highest days to 50% flowering (99.00) was reported in T₁₀ with control and it was followed by T₄ Neem seed extract 1% (94.00), T₅ Neem seed extract 3% (92.00), T₆ Neem seed extract 5% (89.00), T₁ tulsī leaf extract 1% (88.66). Minimum days to 50% flowering was recorded by T₉ KNO₃ 5% (72.00). The present findings are in confirmation with the results of Nelakurthi Venkata Praveen *et al.*, (2020) G. Abdul Wajid *et al.*, (2021) Deepak Chand Bhatshwaret *et al.*, (2020)

2 plant height at maturity (cm):

The mean performance of plant height at maturity in variety G2-315 ranged from T₄ Neem seed extract 1% (54.00) to T₉ KNO₃ 5% (72.06) with mean value of 59.80. Significantly taken highest plant height at maturity flowering (72.06) was reported in T₉ KNO₃ 5% and it was followed by T₃ tulsī leaf extract 3% (68.50) T₈ KNO₃ 3% (64.56), T₂ tulsī leaf extract 3% (59.63), T₁ tulsī leaf extract 1% (58.13). Minimum plant height at maturity was recorded by T₁₀ with control (43.30). Similar result was observed by Kalyanrao Patil *et al.*, (2018) Nelakurthi Venkata Praveen *et al.*, (2020) Deepak Chand Bhatshwaret *et al.*, (2020) G. Abdul Wajid *et al.*, (2021)

3 Number of primary branches per plant:

The mean performance of Number of primary branches per plant in variety G2-315 ranged from T₄ Neem seed extract 1% (2.03) to T₉ KNO₃ 5% (3.66) with mean value of 2.78. Significantly taken highest primary branches per plant flowering (3.66) was reported in T₉ KNO₃ 5% and it was followed by T₈ KNO₃ 3%

(3.50) T₇ KNO₃ 1% (3.33) , T₃tulsi leaf extract 5% (3.13), T₁tulsi leaf extract 3% (3.00) .Minimum Number of primary branches per plant was recorded by T₁₀ with control (1.66). Similar result was observed by NelakurthiVenkata Praveen *et al.*, (2020) G. Abdul Wajid *et al.*, (2021) Deepak Chand Bhatেশwari *et al.*, (2020) Bethalakumeera *et al.*, (2018)

4. Number of pods per plant:

The mean performance of Number of Pods per plant in variety G2-315 ranged from T₄ Neem seed extract 1% (103.00) to T₉ KNO₃ 5% (134.33) with mean value of 117.70. Significantly taken highest pods per plant flowering (134.33) was reported in T₉ KNO₃ 5% and it was followed by T₃tulsi leaf extract 5% (133.00), T₇ KNO₃ 1% (126.33) T₈ KNO₃ 3% (125.66) , T₂tulsi leaf extract 3% (119.33) .Minimum Number of pods per plant was recorded by T₁₀ with control (97.66). Similar result was observed by NelakurthiVenkata Praveen *et al.*, (2020) Deepak Chand Bhatেশwari *et al.*, (2020) SampathiSowjanya *et al.*, (2020) G. Abdul Wajid *et al.*, (2021)

5. Number of seeds per pod:

The mean performance of Number of Seeds per pod in variety G2-315 ranged from T₄ Neem seed extract 1% (1.100) to T₉ KNO₃ 5% (1.933) with mean value of 1.4637. Significantly taken highest Seeds per pod flowering (1.933) was reported in T₉ KNO₃ 5% and it was followed by T₈ KNO₃ 3% (1.833) T₇ KNO₃ 1% (1.733) , T₃tulsi leaf extract 5% (1.567), T₃tulsi leaf extract 3% (1.400) T₁tulsi leaf extract 1% (1.303) .Minimum Number of Seeds per pod was recorded by T₁₀ with control (1.000). Similar result was observed by NelakurthiVenkata Praveen *et al.*, (2020) Deepak Chand Bhatেশwari *et al.*, (2020) G. Abdul Wajid *et al.*, (2021)

6. Seed yield per plot (kg):

The mean performance of Seed yield per plot in variety G2-315 ranged from T₄ Neem seed extract 1% (500.00) to T₉ KNO₃ 5% (707.46) with mean value of 580.48. Significantly taken highest Seed yield per plot flowering (707.46) was reported in T₉ KNO₃ 5% and it was followed by T₈ KNO₃ 3% (699.70) T₇ KNO₃ 1% (685.93) , T₃tulsi leaf extract 5% (641.46), T₃tulsi leaf extract 3% (531.16) T₁tulsi leaf extract 1% (515.60) .Minimum Seed yield per plot (kg) was recorded by T₁₀ with control (493.70). NelakurthiVenkata Praveen *et al.*, (2020) Deepak Chand Bhatেশwari *et al.*, (2020) G. Abdul Wajid *et al.*, (2021)

Effect of different priming methods Seed quality parameters:

7.100 seed weight (gms):

The mean performance of hundred seed weight in variety G2-315 ranged from T₄ Neem seed extract 1% (10.66) to T₉ KNO₃ 5% (17.13) with mean value of 13.51. Significantly taken highest hundred seed weight flowering (17.13) was reported in T₉ KNO₃ 5% and it was followed by T₃tulsi leaf extract 5% (16.36), T₈ KNO₃ 3% (15.90) T₇ KNO₃ 1% (14.36) , T₂tulsi leaf extract 3% (13.93), T₁tulsi leaf extract 1% (13.16). Minimum hundred seed weight was recorded by T₁₀ with control (9.63). Similar result was observed by NelakurthiVenkata Praveen *et al.*, (2020)

8. Seed germination percentage (%):

The mean performance of Seed germination percentage in variety G2-315 ranged from T₄ Neem seed extract 1% (81.10) to T₉ KNO₃ 5% (94.80) with mean value of 88.44. Significantly taken highest Seed germination percentage flowering (94.80) was reported in T₉ KNO₃ 5% and it was followed by T₈ KNO₃ 3% (93.20) T₇ KNO₃ 1% (92.93) , T₃tulsi leaf extract 5% (92.73), T₃tulsi leaf extract 3% (90.43) T₁tulsi leaf extract 1% (88.30) .Minimum Seed germination percentage (%) was recorded by T₁₀ with control (79.10). The present findings are in confirmation with the results of Kalyanrao Patil *et al.*, (2018) NelakurthiVenkata Praveen *et al.*, (2020)

9. Shoot length (cm):

The mean performance of Shoot length (cm) in variety 1 – G2-315 ranged from T₄ Neem seed extract 1% (11.73) to T₉ KNO₃ 5% (15.93) with mean value of 13.21. Significantly taken highest Shoot length (cm) flowering (15.93) was reported in T₉ KNO₃ 5% and it was followed by T₈ KNO₃ 3% (15.10) T₇ KNO₃ 1% (14.60) , T₃tulsi leaf extract 5% (14.43), T₃tulsi leaf extract 3% (13.06) T₁tulsi leaf extract 1% (12.90) .Minimum Shoot length (cm) was recorded by T₁₀ with control (9.83). the finding are in SampathiSowjanya *et al.*, (2020) G. Abdul Wajid *et al.*, (2021)

10. Root length (cm):

The mean performance of Root length (cm) in variety G2-315 ranged from T₄ Neem seed extract 1% (1.50) to T₉ KNO₃ 5% (2.13) with mean value of 1.68. Significantly taken highest Root length (cm) flowering (2.13) was reported in T₉ KNO₃ 5% and it was followed by T₈ KNO₃ 3% (1.96) T₇ KNO₃ 1% (1.90), T₃tulsi leaf extract 5% (1.70), T₃tulsi leaf extract 3% (1.63) T₁tulsi leaf extract 1% (1.56). Minimum Root length (cm) was recorded by T₁₀ with control (1.36). Similar result was observed by Kalyanrao Patil *et al.*, (2018) NelakurthiVenkata Praveen *et al.*, (2020)

11. Seedling length (cm):

The mean performance of seedling length (cm) in variety G2-315 ranged from T₄ Neem seed extract 1% (13.23) to T₉ KNO₃ 5% (18.06) with mean value of 14.89. Significantly taken highest seedling length (cm) flowering (18.06) was reported in T₉ KNO₃ 5% and it was followed by T₈ KNO₃ 3% (17.06) T₇ KNO₃ 1% (16.50), T₃tulsi leaf extract 5% (16.13), T₃tulsi leaf extract 3% (14.70) T₁tulsi leaf extract 1% (14.46). Minimum seedling length (cm) was recorded by T₁₀ with control (11.20). The findings are in SampathiSowjanya *et al.*, (2020) G. Abdul Wajid *et al.*, (2021)

12. Seedling Fresh weight (gms):

The mean performance of Seedling Fresh weight in variety G2-315 ranged from T₄ Neem seed extract 1% (6.20) to T₉ KNO₃ 5% (8.43) with mean value of 7.03. Significantly taken highest Seedling Fresh weight flowering (8.43) was reported in T₉ KNO₃ 5% and it was followed by T₃tulsi leaf extract 5% (7.90), T₈ KNO₃ 3% (7.80) T₇ KNO₃ 1% (7.42), T₂tulsi leaf extract 3% (7.06), T₁tulsi leaf extract 1% (6.64). Minimum Seedling Fresh weight was recorded by T₁₀ with control (5.90). Similar result was observed by Singh Kalyanrao Patil *et al.* (2018)

13. Seedling Dry weight (gms):

The mean performance of Seedling Dry weight (gms) in variety G2-315 ranged from T₄ Neem seed extract 1% (1.44) to T₉ KNO₃ 5% (2.16) with mean value of 1.69. Significantly taken highest Seedling Dry weight (gms) flowering (2.16) was reported in T₉ KNO₃ 5% and it was followed by T₈ KNO₃ 3% (1.98) T₇ KNO₃ 1% (1.93), T₃tulsi leaf extract 5% (1.87), T₃tulsi leaf extract 3% (1.69) T₁tulsi leaf extract 1% (1.60). Minimum Seedling Dry weight (gms) was recorded by T₁₀ with control (1.17). The findings are in G. Abdul Wajid *et al.*, (2021)

14. Seedling vigour index I:

The mean performance of Seedling vigour index 1 in variety G2-315 ranged from T₄ Neem seed extract 1% (1.073.48) to T₉ KNO₃ 5% (1.712.74) with mean value of 1326.70. Significantly taken highest Seedling vigour index flowering (1.712.74) was reported in T₉ KNO₃ 5% and it was followed by T₈ KNO₃ 3% (1.590.70) T₇ KNO₃ 1% (1.533.60), T₃tulsi leaf extract 5% (1.496.70), T₃tulsi leaf extract 3% (1.329.21) T₁tulsi leaf extract 1% (1.277.19). Minimum Seedling vigour index was recorded by T₁₀ with control (885.95). Similar results were found by Kalyanrao Patil *et al.*, (2018) NelakurthiVenkata Praveen *et al.*, (2020)

15. Seedling vigour index II:

The mean performance of Seedling vigour index 2 in variety G2-315 ranged from T₄ Neem seed extract 1% (117.27) to T₉ KNO₃ 5% (204.71) with mean value of 150.95. Significantly taken highest Seedling vigour index flowering (204.71) was reported in T₉ KNO₃ 5% and it was followed by T₈ KNO₃ 3% (185.17) T₇ KNO₃ 1% (179.66), T₃tulsi leaf extract 5% (173.80), T₃tulsi leaf extract 3% (153.12) T₁tulsi leaf extract 1% (141.27). Minimum Seedling vigour index was recorded by T₁₀ with control (93.16). Similar results were observed by Kalyanrao Patil *et al.*, (2018) NelakurthiVenkata Praveen *et al.*, (2020)

16. Electrical conductivity (ds/m):

The mean performance of Electrical conductivity in variety G2-315 ranged from T₉ KNO₃ 5% (1.933) to T₄ Neem seed extract 1% (3.400) with mean value of 2.9367. Significantly taken highest Electrical conductivity flowering (3.933) was reported in T₁₀ control and it was followed by T₄ Neem seed extract 1% (3.400) T₅ Neem seed extract 5% (3.233) T₁tulsi leaf extract 1% (3.200) T₂tulsi leaf extract 3% (2.933), T₃tulsi leaf extract 5% (2.700). Minimum Electrical conductivity was recorded by T₉ KNO₃ 5% (1.933). Similar result was observed by Kalyanrao Patil *et al.*, (2018) NelakurthiVenkata Praveen *et al.*, (2020)

Table:2 Mean performance of chickpea for 7 quantitative chickpea Variety G2-315field

	Treatment Name	Plant height at maturity (cm)	Primary Branches Per Plant	Days to 50% Flowering	Pods Per Plant	Seeds Per Pod	Plot Yield (gms)	100 Seed Weight (gms)
T1	Tulsi 1%	58.133	2.767	88.667	115.667	1.303	515.600	13.167
T2	Tulsi 3%	59.633	3.000	87.333	119.333	1.400	531.167	13.933
T3	Tulsi 5%	68.500	3.133	74.333	133.000	1.567	641.467	16.367
T4	Neem seed extract 1%	54.000	2.033	94.000	103.000	1.100	500.000	10.667
T5	Neem seed extract 3%	56.000	2.367	92.000	109.000	1.233	511.933	11.467
T6	Neem seed extract 5%	57.467	2.367	89.000	113.000	1.533	517.867	12.467
T7	KNO3-1%	64.400	3.333	74.333	126.333	1.733	685.933	14.367
T8	KNO3-3%	64.567	3.500	72.000	125.667	1.833	699.700	15.900
T9	KNO3-5%	72.067	3.667	69.667	134.333	1.933	707.467	17.133
T10	Control	43.300	1.667	99.000	97.667	1.000	493.700	9.633
C.D.		3.577	0.661	4.795	8.232	0.207	12.493	0.569
SE(m)		1.195	0.221	1.601	2.749	0.069	4.172	0.190
SE(d)		1.689	0.312	2.265	3.888	0.098	5.901	0.269
C.V.		3.460	13.735	3.301	4.046	8.165	1.245	2.438

Table:3 Mean performance of chickpea for 9 quantitative chickpea lab condition variety G2-315

	Treatment Name	Seed Germination Percentage (%)	Shoot Length	Root Length	Seedling Length	Fresh Weight of Seedling (gms)	Dry Weight Of Seedling (gms)	Vigour Index 1	Vigour Index 2	Electrical Conductivity
T1	Tulsi 1%	88.300	12.900	1.567	14.467	6.643	1.600	1,277.193	141.274	3.200
T2	Tulsi 3%	90.433	13.067	1.633	14.700	7.067	1.693	1,329.210	153.121	2.933
T3	Tulsi 5%	92.733	14.433	1.700	16.133	7.900	1.873	1,496.707	173.803	2.700
T4	Neem seed extract 1%	81.100	11.733	1.500	13.233	6.207	1.447	1,073.480	117.277	3.400

T5	Neem seed extract 3%	84.200	11.900	1.500	13.400	6.313	1.493	1,128.617	125.773	3.233
T6	Neem seed extract 5%	87.633	12.600	1.533	14.133	6.657	1.547	1,238.843	135.603	3.233
T7	KNO ₃ -1%	92.933	14.600	1.900	16.500	7.423	1.933	1,533.600	179.660	2.567
T8	KNO ₃ -3%	93.200	15.100	1.967	17.067	7.807	1.987	1,590.707	185.172	2.233
T9	KNO ₃ -5%	94.800	15.933	2.133	18.067	8.437	2.160	1,712.747	204.714	1.933
T10	Control	79.100	9.833	1.367	11.200	5.900	1.177	885.950	93.167	3.933
C.D.		2.078	0.790	0.150	0.761	0.323	0.157	83.803	15.204	0.333
SE(m)		0.694	0.264	0.050	0.254	0.108	0.053	27.989	5.078	0.111
SE(d)		0.981	0.373	0.071	0.359	0.153	0.074	39.582	7.181	0.157
C.V.		1.359	3.460	5.174	2.955	2.658	5.379	3.654	5.826	6.550

Conclusion:

In conclusion the priming increases the germinability and vigour of chickpea seeds, significantly all the field parameters. KNO₃ 5% with significantly increased the germination per cent and other seedling characters of chickpea. KNO₃ showed maximum increase in germinability and vigour and showed maximum increase in germination. Priming of the chickpea seeds for 12 hrs, in which best result to enhanced germinability, vigour and seedling characters. These conclusions are based on the results of six months investigation and therefore further investigation is needed to arrive at valid recommendations.

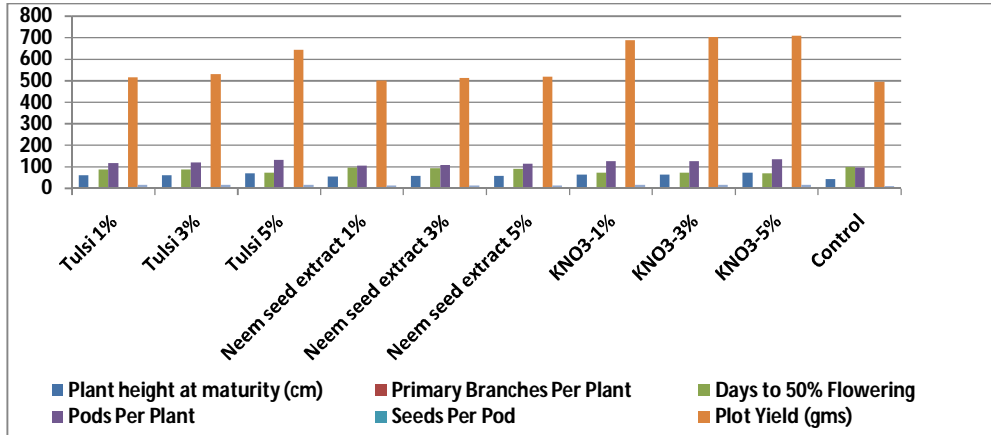


Fig No: 1 Mean performance of variety G₂315 field condition

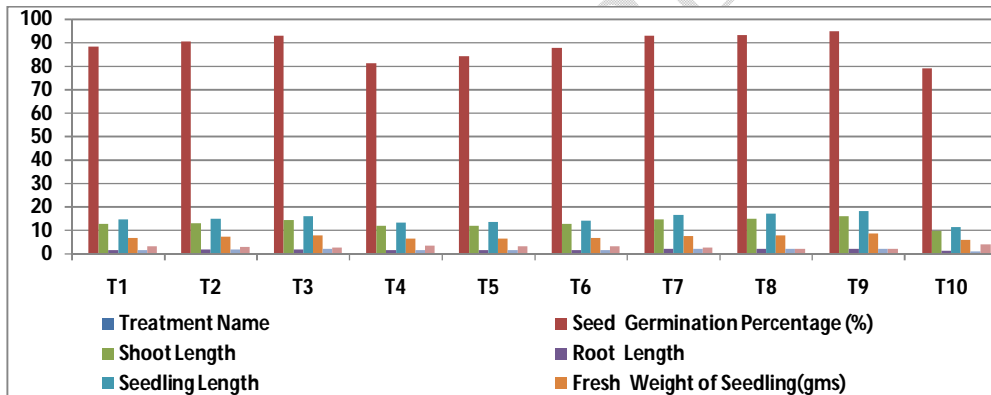


Fig No:2 Mean performance of variety G₂315 lab condition

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Comment [RK6]: Mention all references used in citations in Vancouver format

Comment [RK7]: Add reference
Tutlani A, Kumar R, Kumari S, Chouhan S. Correlation and path analysis for yield and its phenological, physiological, morphological and biochemical traits under salinity stress in chickpea (*Cicer arietinum* L.). *International Journal of Bio-resource and Stress Management*. 2023;14(Jun, 6):878-90.