

# Effect of Phosphorus Management and Drought Mitigating Strategies on Yield and Economics of Rainfed Chickpea (*Cicer arietinum* L.)

## ABSTRACT

A field experiment was conducted to find out the Phosphorous and drought mitigating strategies on yield and economics of Chickpea (var. RVG-202) with the different levels of Phosphorus (40, 50, 60 P<sub>2</sub>O<sub>5</sub> kg/ha) and with the application of Drought mitigating strategies applied at pre-flowering and pod formation stage) respectively, at Crop Research Farm, Department of Agronomy, Faculty of Agriculture, SHUATS, Prayagraj, Uttar Pradesh, India. The soil of the experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), low in organic carbon (0.28%), available N (225 kg/ha), available P (19.50 kg/ha), and available K (92.00 kg/ha). The experiment was laid out in Randomized Block Design, with ten treatments and replicated thrice. Results obtained that there was a significant increase in yield attributes, viz., Seed yield (2332.00 kg/ha), Straw yield (4571.33 kg/ha) and Harvest index (33.51%) were recorded with the application of P<sub>2</sub>O<sub>5</sub> 60kg/ha + 25kg ZnSO<sub>4</sub>/ha + 1%KCl + 0.5% sodium selenite spray. However, Maximum Gross return (124481.70 INR/ha), Net net return (89064.67 INR/ha) and B: C ratio (2.51) was recorded with the application of P<sub>2</sub>O<sub>5</sub> 60 kg /ha+ 25 kg ZnSO<sub>4</sub>/ ha + 1 % KCl + 0.5 % sodium selenite spray. Therefore, it is concluded that the application of P<sub>2</sub>O<sub>5</sub> 60 kg /ha+ 25 kg ZnSO<sub>4</sub>/ ha + 1 % KCl + 0.5 % sodium selenite spray was more productive and economically feasible.

**Keywords:** Phosphorus, Drought mitigation, Chickpea, Yield, and Economic.

## INTRODUCTION

Chickpea (*Cicer arietinum* L.) is the world's-world's third most important winter (*rabi*) food legume, with 96% cultivation in the developing countries, and in India, it occupies a 9.18 million ha area, with a production of 8.22 million tons registering the a productivity of 900kg/ha900kg/ha productivity. Chickpea is the fourth largest grain legume crop in the world, globally in India, with a total production-output of 11.09 million tons from an area of 14.56 million ha and a productivity of 1.31t/ha. Major producing countries include India, Pakistan, and Iran (FAO, 2019) [1]. In India, Chickpea is the premier pulse crop occupying 8.32 million hectares area and contributing 7.5 million tons to the national pulse basket with a productivity of 912 kg ha<sup>-1</sup> in 2011-12. Uttar Pradesh produced 0.72 million tons of Chickpea with a productivity of 1248 kg ha<sup>-1</sup> in 2011-12 [2].

Phosphorus (P) is one of the macronutrients for the growth and developments of the plants, and it's it's the second in importance next to nitrogen (N). The P plays a vital role in the metabolism of plants. It is also known as a structural component of nucleic acid, co-enzymes, phosphor-proteins, and phosphor-lipids present in plants. Foliar application of N at particular stage may solve the slow growth, nodule senescence and low seed yield of pulse without involving a particular stage may solve the slow growth, nodule senescence, and low seed yield of pulse without root absorption at the critical stage [3]; [4]. Under the situation of terminal drought, the photosynthetic activity of leaves is rampant, t. The foliar nutrition with nitrogenous fertilizer, i.e., 2% urea spray, is essential as roots fails to absorb nitrogen from the dry soil profile. Zinc is the only metal that is required in all six enzyme classes (oxidoreductases, transferase, hydrolases, lyases, isomerases, and ligases). The requirement of zinc for the function of a wide range of enzymes indicates that the metabolism of proteins, carbohydrates and auxin as well as reproductive processes are zinc requirement for the function of a wide range of enzymes indicates that the metabolism of proteins, carbohydrates, auxin, and reproductive processes is hampered under zinc deficiency [5].

The KCl (1%) sprays had a positive effect on root and shoot growth recording maximum seedling root length and shoot length, fresh weight, dry weight positively affected root and shoot growth, recording maximum seedling root length and shoot length, fresh weight, dry weight, and vigour

index. [6] Selenium (Se) is a trace element; it can exert beneficial effects at low concentrations. It can increase the tolerance of plants to UV-UV-induced oxidative stress, delay senescence, and promote the growth of ageing seedlings. Recently it has been shown that Se is able to can regulate the water status of plants under conditions of droughtdrought conditions. It has also been reported that Selenium (Se) has an antioxidant effect and can increase the anti-oxidative capacity and stress tolerance of plants [7]; [8]. There is increasing-growing evidence that Selenium has a positive effect ~~enpositively affects~~ crop growth and stress tolerance at low concentrations [9]; [10]. Selenium can regulate the water status of plants under conditions of water deficiency and there-by performs its protective effect [11]. By keeping these points in mind, ~~the~~ present research carried out in ~~the~~ title, **"Effect of Phosphorous management and drought mitigating strategies on yield and economics of rainfed Chickpea (*Cicer arietinum* L.)".**

## MATERIALS AND METHODS

A field trial was conducted during Rabi, 2021, at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P), which is located at 25°39'42" N latitude, 81°67'56" E longitude, and 98m altitude above the mean sea level (MSL). The soil was sandy loam in texture, low in organic carbon and medium in available nitrogen, ~~phosphorus~~Phosphorus, and low in potassium. Nutrient sources were Urea, Single Super Phosphate, and Murate of potash to fulfill the requirement of Nitrogen, Phosphorus, and Potassium. The experiment was laid out in Randomized Block Design with ten treatments, each replicated thrice. The treatments which are with 1: Control(RDF) 2: P<sub>2</sub>O<sub>5</sub> 40 kg / ha + 1 % KCl spray 3: P<sub>2</sub>O<sub>5</sub> 40kg/ha + 0.5% sodium selenite spray 4: P<sub>2</sub>O<sub>5</sub> 40 kg/ha+1% KCl + 0.5% sodium selenite spray 5: P<sub>2</sub>O<sub>5</sub> 50 kg / ha+1 % KCl spray 6: P<sub>2</sub>O<sub>5</sub> 50kg/ha+2% Urea + 0.5% sodium selenite spray 7: P<sub>2</sub>O<sub>5</sub> 50 kg/ha + 2% Urea + 1% KCl +0.5% sodium selenite spray 8: P<sub>2</sub>O<sub>5</sub> 60kg/ha + 25kg ZnSO<sub>4</sub>/ha + 1% KCl spray 9: P<sub>2</sub>O<sub>5</sub> 60kg/ha + 25kg ZnSO<sub>4</sub>/ha + 0.5% sodium selenite spray10: P<sub>2</sub>O<sub>5</sub> 60kg/ha+25kg ZnSO<sub>4</sub>/ha + 1%KCl +0.5% sodium selenite spray. Blanket application of a recommended dose of Nitrogen and Potassium (20:0:20 NPK kg/ha). The ~~date of sowingsowing date~~ was 28<sup>th</sup> November ~~2021–2021~~, with ~~the a~~ seed rate of 20kg/ha. The foliar application of 1% Potassium chloride, 0.5% Sodium selenite, and 1% Potassium chloride along with 0.5% Sodium selenite ~~are is~~ applied during ~~the~~ pre-flowering and pod formation stage., The yield parameters were recorded after harvest and ~~also, economic analysis ofeconomic analysis of the~~ overall trial. The yield parameters such as number of pods per plant, number of seeds per pod, test weight, seed yield, stover yield, and harvest index ~~were recorded~~. These parameters were recorded and statistically analyzed using analysis of variance (ANOVA) as applicable to Randomized Block Design [12]. Economic analysis is also calculated according to valid data.

## RESULTS AND DISCUSSION

**Effect on the yield of Chickpea.** As can be seen in Table 1, yield parameters are summarized statistically. ~~Significantly A significantly~~ higher number of pods/plant was observed with the P<sub>2</sub>O<sub>5</sub> 60 kg /ha along with 25 kg ZnSO<sub>4</sub>/ ha and 1 % KCl and 0.5 % sodium selenite spray (59.10). However, P<sub>2</sub>O<sub>5</sub> 60 kg/ha along with 25 kg ZnSO<sub>4</sub>/ ha and 1 % KCl spray (58.66), P<sub>2</sub>O<sub>5</sub> 60 kg /ha along with 25 kg ZnSO<sub>4</sub> and 0.5 % sodium selenite spray (58.00) statistically at par P<sub>2</sub>O<sub>5</sub> 60 kg /ha along with 25 kg ZnSO<sub>4</sub>/ ha and 1 % KCl + 0.5 % sodium selenite spray. ~~Maximum-The maximum Number-number~~ of seeds/pod was observed with the P<sub>2</sub>O<sub>5</sub> ~~of~~ 60 kg /ha along with 25 kg ZnSO<sub>4</sub>/ ha and 1 % KCl and 0.5 % sodium selenite spray (1.66). However, P<sub>2</sub>O<sub>5</sub> 60 kg /ha + 25 kg ZnSO<sub>4</sub>/ ha + 1 % KCl spray (1.58), P<sub>2</sub>O<sub>5</sub> 60 kg /ha + 25 kg ZnSO<sub>4</sub>/ ha +0.5 % sodium selenite spray (1.54) statistically at par P<sub>2</sub>O<sub>5</sub> 60 kg /ha along with 25 kg ZnSO<sub>4</sub>/ ha and 1 % KCl + 0.5 % sodium selenite spray. The highest Test weight was observed with P<sub>2</sub>O<sub>5</sub> ~~at~~ 60 kg /ha along with 25 kg ZnSO<sub>4</sub>/ ha and 1 % KCl and 0.5 % sodium selenite spray (23.48). However, P<sub>2</sub>O<sub>5</sub> 60 kg /ha + 25 kg ZnSO<sub>4</sub>/ ha +1 % KCl spray (23.37), P<sub>2</sub>O<sub>5</sub> 60 kg /ha + 25 kg ZnSO<sub>4</sub>/ ha + 0.5 % sodium selenite spray (23.18) statistically at par P<sub>2</sub>O<sub>5</sub> 60 kg /ha along with 25 kg ZnSO<sub>4</sub>/ ha and 1 % KCl + 0.5 % sodium selenite spray. Maximum seed yield was observed with P<sub>2</sub>O<sub>5</sub> 60 kg /ha along with 25 kg ZnSO<sub>4</sub>/ ha and 1 % KCl and 0.5 % sodium selenite spray (2332.00 kg/ha). However, P<sub>2</sub>O<sub>5</sub> 60 kg /ha + 25 kg ZnSO<sub>4</sub>/ ha +1 % KCl spray (2246.33 kg/ha), P<sub>2</sub>O<sub>5</sub> 60 kg /ha + 25 kg ZnSO<sub>4</sub>/ ha + 0.5 % sodium selenite spray (2169.33 kg/ha) statistically at par P<sub>2</sub>O<sub>5</sub> 60 kg /ha along with 25 kg ZnSO<sub>4</sub>/ ha and 1 % KCl + 0.5 % sodium selenite spray. Maximum stover yield was observed with P<sub>2</sub>O<sub>5</sub> 60 kg /ha along with 25 kg ZnSO<sub>4</sub>/ ha and 1 % KCl and 0.5 % sodium selenite spray (4571.33 kg/ha). However, P<sub>2</sub>O<sub>5</sub> 60 kg /ha + 25 kg ZnSO<sub>4</sub>/ ha +1 % KCl spray (4510.00 kg/ha), P<sub>2</sub>O<sub>5</sub> 60 kg /ha + 25 kg ZnSO<sub>4</sub>/ ha + 0.5 % sodium selenite spray (4448.67 kg/ha) statistically at par P<sub>2</sub>O<sub>5</sub> 60 kg /ha along with 25 kg ZnSO<sub>4</sub>/ ha and 1 % KCl + 0.5 % sodium selenite spray. ~~Higher-A higher~~ harvest index was observed with P<sub>2</sub>O<sub>5</sub> 60 kg /ha along with 25 kg ZnSO<sub>4</sub>/ ha

and 1 % KCl and 0.5 % sodium selenite spray (33.51). However, P<sub>2</sub>O<sub>5</sub> 60 kg /ha + 25 kg ZnSO<sub>4</sub>/ ha +1 % KCl spray (33.01), P<sub>2</sub>O<sub>5</sub> 60 kg /ha + 25 kg ZnSO<sub>4</sub>/ ha + 0.5 % sodium selenite spray (32.50) statistically at par P<sub>2</sub>O<sub>5</sub> 60 kg /ha along with 25 kg ZnSO<sub>4</sub>/ ha and 1 % KCl + 0.5 % sodium selenite spray. The results demonstrate that [13]. Foliar spray of 2% KCl + 0.4% Sodium selenite was significantly superior to the rest of the treatments. The second treatment in order of magnitude was 2% KCl which proved significantly superior to rest of the three treatments in respect of the rest of the three treatments regarding yield attributes number of pods/plants. [14] stated that the seed yield of Chickpea improved with each increase with-in P<sub>2</sub>O<sub>5</sub> levels. Similar improvements in yield attributes like no. of pods plant<sup>-1</sup> and the seed yield plant were also observed with an increase in P<sub>2</sub>O<sub>5</sub> levels. Highest The highest seed yield was recorded with 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>. All P<sub>2</sub>O<sub>5</sub> levels were significantly superior over control [15]. On the pooling of data, the number of pods per plant, seeds/pod, 100-seed weight, and seed yield increased significantly with 100% RDF + 2% urea spray during both the years. [16] stated that increasing levels of phosphorus-Phosphorus increased seed yield plant<sup>-1</sup> of Chickpea and mustard both significantly up to 60 kgP<sub>2</sub>O<sub>5</sub>ha<sup>-1</sup>. [17] observed that the foliar application of urea apart from the basal application of a recommended dose of fertilizers increased grain yield, and yield attributes were recorded with 2 % urea spray at 75 days after sowing (DAS). [18] found that application of 25 kg ZnSO<sub>4</sub> ha<sup>-1</sup> increased grain yield significantly over no application of zinc sulphate [19] observed that application of Phosphorus at 60 kg P<sub>2</sub>O<sub>5</sub>/ha significantly increased yield attributes. The increasing above value was progressively related to P doses from 0-60 kg P<sub>2</sub>O<sub>5</sub>/ha.

**Table 1. Effect of Phosphorous management and drought-mitigatingmitigating drought strategies on yield of Chickpea**

Treatment combination	Number of pods per plant	Number of seeds per pod	Test weight (g)	Seed yield (Kg/ha)	Stover yield (Kg/ha)	Harvest Index (%)
1	53.80	1.34	21.21	1716.33	4011.00	29.79
2	54.50	1.38	21.89	1814.00	4134.33	30.13
3	54.16	1.36	21.55	1742.67	4071.66	29.66
4	54.70	1.42	22.13	1887.33	4196.67	30.61
5	55.50	1.48	22.72	2037.33	4324.33	31.74
6	55.30	1.46	22.61	1960.00	4260.00	31.22
7	55.66	1.51	22.93	2104.67	4387.00	32.12
8	58.66	1.58	23.37	2246.33	4510.00	33.01
9	58.00	1.54	23.18	2169.33	4448.67	32.50
10	59.10	1.66	23.48	2332.00	4571.33	33.51
F-test	S	S	S	S	S	S
SEm(±)	2.97	0.18	1.31	319.50	298.09	2.19
CD 5%	1.00	0.06	0.44	107.53	100.33	0.74

**Table 2. Effect of Phosphorous management and drought-mitigatingmitigating drought strategies on the economics of Chickpea**

Treatment combination	Gross Return (INR/ha)	Net Return (INR/ha)	B: C ratio
1	89538.5	58631.5	1.89
2	94581.17	63464.17	2.03
3	90911.83	57004.83	1.68
4	98352.33	64235.33	1.88
5	106066.20	74741.67	2.38
6	102090.00	67975.50	1.99
7	109531.50	75207.00	2.19
8	114353.00	81936.00	2.50
9	112860.30	77653.33	2.20
10	124481.70	89064.67	2.51

**Economic analysis of Chickpea.** As can be seeshown in Table 2, all the economic parameters, viz., gross return, the net return, and B: C ratio gross return, net return, and B: C ratio are summarized. Maximum gross return (INR 1,24,481.70 /ha) recorded in P<sub>2</sub>O<sub>5</sub> 60 kg /ha along with 25 kg ZnSO<sub>4</sub>/ ha and 1 % KCl and 0.5 % sodium selenite spray. Minimum-The minimum gross return (INR 89,538.50 /ha) was recorded in Control-control plot with a recommended dose of fertilizer. Maximum net return (INR 89,064.67 /ha) recorded in P<sub>2</sub>O<sub>5</sub> 60 kg /ha along with 25 kg ZnSO<sub>4</sub>/ ha and

1 % KCl and 0.5 % sodium selenite spray. ~~Minimum~~ The minimum net return (INR 58,631.50 /ha) was recorded in the Control-control plot with a recommended dose of fertilizer. Higher B: C ratio (2.51) recorded in P<sub>2</sub>O<sub>5</sub> 60 kg /ha along with 25 kg ZnSO<sub>4</sub>/ ha and 1 % KCl and 0.5 % sodium selenite spray. Minimum B:C ratio (1.89) was recorded in the Control-control plot with a recommended dose of fertilizer. (Sam et al., 2022) [20] The higher dose of 40 kg/ha phosphorus along with seaweed extract had given higher gross return, the net return, and B: C ratio in black gram crop at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U-P). [21] It is evident from the pooled analysis data that the application of various treatments markedly increased gross return, net return, and B: C ratio of the cropping system over control.

## CONCLUSION

Based on my research trial, the treatment combination of P<sub>2</sub>O<sub>5</sub> 60 kg /ha ~~along with 25 kg ZnSO<sub>4</sub>/ ha and 1 % KCl and 0.5 % sodium selenite spray was found to be more productive and alsend 25 kg ZnSO<sub>4</sub>/ ha and 1 % KCl and 0.5 % sodium selenite spray was more productive and~~ economically feasible.

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