Effect of Phosphorus and Zinc nutrition on growth and fodder yield of cowpea (*Vigna unguiculata* L. WALP)

ABSTRACT-

The field experiment was conducted during *Zaid* 2021 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj, (U.P). The soil of the experiment plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.2~~1~~), low in organic carbon (0.536%), available N (163.42 kg/ha), available P (21.96 kg/ha), available K (256.48 kg/ha). The treatments consists of three levels of phosphorus (50 kg/ha, 60 kg/ha and 70 kg/ha) and zinc (15 kg/ha, 20 kg/ha and 25 kg/ha). The experiment was laid out in Randomized Block Design which consists of 9 treatments ~~which are~~and replicated thrice. The results revealed that maximum ~~Green~~ green fodder yield (351.72 q/ha) and ~~Dry~~ dry matter yield (74.14 q/ha) were recorded with application of 70 kg/ha P_2O_5 + 25 kg/ha $ZnSO_4$. However, the maximum gross returns (41,964.07 INR/ha), net returns (61277.50 INR/ha) and benefit: cost ratio (2.04) were obtained highest in the treatment combination of 70 kg/ha P_2O_5 + 25 kg/ha $ZnSO_4$.

Keywords: Phosphorus, Zinc, Cowpea, Green fodder yield, Dry matter yield and Economics

INTRODUCTION

Cowpea (*Vigna unguiculata* Walp.) is one of the most important vegetable crops grown as pulse, vegetable and fodder. It is poor man's protein source and considered one of the most ancient human food sources and has probably been used as a crop plant since Neolithic times (Ng and Marechal 1985). Cowpea is an important multipurpose grain legume extensively cultivated in arid and semiarid tropics. It is an important source of nutrients and provides high quality, inexpensive protein to diet based on cereal grains and starchy foods. Cowpea is a good source of food, fodder, vegetables and certain snacks (Singh et al. 2012). It is a crop that can be used as catch crop, mulch crop, intercrop, mixed crop and green crop. It has ability to fix atmospheric N_2 in the soil @ 56 kg ha^{-1} in association with symbiotic bacteria under favourable conditions (Mandal *et al*. 2009).

The mature cowpea seed contains 24.8% protein, 63.6% carbohydrate, 1.9% fat, 6.3% fiber, 7.4 ppm thiamine, 4.2 ppm riboflavin and 28.1 ppm niacin (Ahlawat and Shivkumar 2005). The protein concentration ranges from about 3 to 4% in green leaves, 4 to 5% in immature pod and 25

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to 30% in mature seeds. The amino acid profile reveals that lysine, leusine and phenylanine contents are relatively high in cowpea. Trends in the production of pulse is adversely affected the per capita availability of pulses. In India, per capita/day availability of pulses had decreased from 69 g during sixties to 35g as against the FAO/WHO's current recommendation of 80 g per day (Ali and Gupta 2012).

Phosphorus as a constituent of cell nucleus is essential for cell division and development of meristematic tissue. Phosphorus deficiencies lead to reduction in the rate of leaf expansion and photosynthesis per unit leaf area hence reduction in fodder yield. The adequate supply of phosphorus to legumes is more important than that of ~~Phosphorus~~ phosphorus because it has beneficial effect on nodulation, growth and yield. Phosphorus is of paramount importance for increasing yield. Phosphorous plays important role in energy transfer in the living cells by means of high energy phosphate bond of ATP (Tisdale *et al*., 1984).

Zinc is one of the seventh plant micronutrient, involved in many enzymatic activities of the plant. It functions generally as a metal activator of enzymes. It is reported that, Zinc improves crop productivity almost as much as major nutrients. Besides increasing crop yield, it increases the crude protein content, amino acids, energy value and total lipid in chickpea, soybean, blackgram, etc. Zn deficiency can also adversely affect the quality of harvested products, plants susceptibility to injury by high light or temperature intensity and infection by fungal diseases can also increase. Zinc seems to affect the capacity for water uptake and transport in plants and also reduce the adverse effects of short periods of heat and salt stress~~.~~ (Chalak *et al*., 2018).

MATERIALS AND METHODS

A field experiment was conducted during Zaid season 2021, at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P) which is situated at 25^0 ~~degree~~ 39' 42''N latitude, 81^0 ~~degree~~ 67'56''E longitude and 98 m altitude above the mean sea level, during Zaid season 2021. The soil was sandy loam in texture, low in organic carbon and medium in available nitrogen, phosphorous and low in potassium. Nutrient sources were Urea, SSP, MOP to fulfill the requirement of ~~Nitrogen~~nitrogen, phosphorous and potassium. The treatment consisted 3 levels of phosphorus and 3 levels of zinc T_1: P_2O_5 - 50 kg/ha + Zinc 15 kg/ha, T_2: P_2O_5 - 50 kg/ha + Zinc 20

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kg/ha, T_3: P_2O_5 - 50 kg/ha + Zinc 25 kg/ha, T_4: P_2O_5 - 60 kg/ha + Zinc 15 kg/ha, T_5: P_2O_5 - 60 kg/ha + Zinc 20 kg/ha, T_6: P_2O_5 - 60 kg/ha + Zinc 25 kg/ha, T_7: P_2O_5 - 70 kg/ha + Zinc 15 kg/ha, T_8: P_2O_5 - 70 kg/ha + Zinc 20 kg/ha, T_9: P_2O_5 - 70 kg/ha + Zinc 25 kg/ha used. The Experiment was laid out in Randomized Block Design, with nine treatments and three replications. Seeds were sown in line manually on 12 April, 2021 at a depth of 4-5 cm in furrows with seed rate of 30-40 kg/ha. In the period from germination to harvest several plant growth parameters were recorded at frequent intervals along with it after harvest several yield parameters were recorded those parameters like Green fodder yield (q/ha) and Dry matter yield (q/ha) were recorded and statistically analyzed using analysis of variance (ANOVA) as applicable to Randomized Block Design (Gomez K.A. and Gomez A.A. 1984).

RESULTS & DISCUSSION

1. Yield attributes and Yield

a) Green fodder yield (q/ha)

Significantly highest green fodder yield (351.72 q/ha) was recorded with the treatment70 kg/ha P_2O_5 + 25 kg/ha $ZnSO_4$. However, the treatments 70 kg/ha P_2O_5 + 20 kg/ha $ZnSO_4$ (347.89 q/ha) and 60 kg/ha P_2O_5 + 25 kg/ha $ZnSO_4$ (342.31 q/ha) were found to be statistically at par with 70 kg/ha P_2O_5 + 25 kg/ha $ZnSO_4$ as compared to all other treatments.

The significant increase in green fodder yield is due to the favourable effect of phosphorous on yield may be ascribed to its role in the constitution of ribonucleic acid, deoxyribonucleic acid and ATP which regulate the vital metabolic processes in the plant, helping in the root formation, nitrogen fixation and finally the crop yield. Bhavya *et al*. (2014) observed that ~~Straw~~ straw yield is dependent on vegetative growth as use of balanced and optimum use of ~~Phosphorous~~ phosphorous increased plant height, green leaves per hill, and dry matter production, which finally resulted in higher straw yield. Application of zinc helped in enzyme activation, membrane integrity,

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chlorophyll formation, stomatal balance and starch utilization at early stages which enhanced accumulation of assimilate in the vegetative parts resulting in higher green fodder yield. These results are in agreement with the findings of Rana *et al*. (2014).

b) Dry matter yield (q/ha)

Maximum dry matter yield (74.14 q/ha) was recorded with the treatment with 70 kg/ha P_2O_5 + 25 kg/ha $ZnSO_4$. However, the treatments 70 kg/ha P_2O_5 + 20 kg/ha $ZnSO_4$ (70.80 q/ha) and 60 kg/ha P_2O_5 + 25 kg/ha $ZnSO_4$ (67.70 q/ha) were found to be statistically at par with 70 kg/ha P_2O_5 + 25 kg/ha $ZnSO_4$.

The increase in dry matter yield due to phosphorus application is attributed to source and sink relationship. It appears that greater translocation of photosynthates from source to sink might have increased dry matter yield. Phosphorus increases yield due to its well-developed root system, increased N fixation and its availability to the plants and favourable environments in the Rhizosphere. The results were similar with the findings of Bhilare and Patil (2002).

Table1. Effect of Phosphorous and Zinc nutrition on fodder Yield of Cowpea

S. No	**Treatment combinations**	**Green fodder yield (q/ha)**	**Dry matter yield (q/ha)**
1.	50 kg/ha P_2O_5 + 15 kg/ha $ZnSO_4$	261.33	44.74
2.	50 kg/ha P_2O_5 + 20 kg/ha $ZnSO_4$	280.63	49.15
3.	50 kg/ha P_2O_5 + 25 kg/ha $ZnSO_4$	298.10	58.53
4.	60 kg/ha P_2O_5 + 15 kg/ha $ZnSO_4$	282.17	53.37
5.	60 kg/ha P_2O_5 + 20 kg/ha $ZnSO_4$	302.17	61.93
6.	60 kg/ha P_2O_5 + 25 kg/ha $ZnSO_4$	338.20	67.70
7.	70 kg/ha P_2O_5 + 15 kg/ha $ZnSO_4$	305.03	64.87
8.	70 kg/ha P_2O_5 + 20 kg/ha $ZnSO_4$	338.70	70.80
9.	70 kg/ha P_2O_5 + 25 kg/ha $ZnSO_4$	365.13	74.14
F- test		**S**	**S**
S. EM (±)		4.12	2.33
C. D. (P = 0.05)		12.35	6.99

Economics

Data in table 2 tabulated Experimental results revealed that maximum gross return, net return and benefit cost ratio (91282.50 INR/ha, 61277.50 INR/ha and 2.04) was recorded in treatment (T_9) in which (70 kg/ha P_2O_5 + 25 kg/ha $ZnSO_4$). The minimum gross return, net profit and benefit cost ratio were recorded in treatment (T_1) which is (50 kg/ha P_2O_5 + 15 kg/ha $ZnSO_4$).

Table.2 Effects of phosphorus and zinc nutrition on economics of fodder cowpea

S. No	Treatment combinations	Cost of Cultivation (INR/ha)	Gross return (INR/ha)	Net Return (INR/ha)	B:C ratio
1.	50 kg/ha P_2O_5 + 15 kg/ha $ZnSO_4$	25546.70	65332.50	39785.80	1.55
2.	50 kg/ha P_2O_5 + 20 kg/ha $ZnSO_4$	27213.30	70157.50	42944.20	1.57
3.	50 kg/ha P_2O_5 + 25 kg/ha $ZnSO_4$	28880.00	74525.00	45645.00	1.58
4.	60 kg/ha P_2O_5 + 15 kg/ha $ZnSO_4$	26109.10	70542.50	44433.40	1.70
5.	60 kg/ha P_2O_5 + 20 kg/ha $ZnSO_4$	27775.80	75542.50	47766.70	1.71
6.	60 kg/ha P_2O_5 + 25 kg/ha $ZnSO_4$	29442.50	84550.00	55107.50	1.87
7.	70 kg/ha P_2O_5 + 15 kg/ha $ZnSO_4$	26671.60	76257.50	49585.90	1.85
8.	70 kg/ha P_2O_5 + 20 kg/ha $ZnSO_4$	28338.30	84675.00	56336.80	1.98
9.	70 kg/ha P_2O_5 + 25 kg/ha $ZnSO_4$	30005.00	91282.50	61277.50	2.04

CONCLUSION

It is concluded that application of treatment 70 kg phosphorus and 25 kg zinc/ha was recorded significantly higher fodder yield (365.13 q/ha), dry matter yield (74.14 q/ha), higher gross returns (91282.50 INR/ha), net returns (61277.50 INR/ha) and benefit cost ratio (2.04) as compared to other treatment.

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References

IPS Ahlawat & BG Shivakumar 2005 Kharif Pulses. In Textbook of Field Crops Production (R. Prasad, Ed.) ICAR, New Delhi, India.

M Ali & Gupta S 2012 Carrying capacity of Indian Agriculture: pulse crops: *Current Science*, 102, 874-881.

Bhavya, M R, Palled YB, Pushpalatha Ullasa MY & Nagaraj R 2014 Influence of seed rate and fertilizer levels on dry matter distribution and dry matter yield of fodder cowpea (cv. Swad). *Trend in Biosciences*, **7**: 1516-1521.

Bhilare RL & Patil VS. 2002. Response of forage cowpea varieties to phosphorus application. Forage Research, 28: 179-180.

Chalak AL, Vaikar SL& Barangule Sanjivani 2018. Effect of varying levels of potassium and zinc on yield, yield attributes, quality of pigeon pea (*Cajanuscajan* L. Millsp.*)*. *International Journal of Chemical Studies*, 6(5): 1432-1435.

Mandal MK, Pati R, Mukhopadhyay D & Majumdar K 2009. Maximizing yield of cowpea through soil test based nutrient application in Terai alluvial soils. *Better Crops*, 3, 28-30.

Ng NQ & Marechal R 1985. Cowpea taxonomy, origin, germplasm. In Cowpea Research Production and Utilization (R.S. Singh and K.O. Rachie, Eds.), *John Wiley and Sons*, New York, pp. 11-22.

Rana DS, Singh B, Gupta K, Dhaka AK and Arya S 2013. Response of fodder sorghum (*Sorghum bicolour* L. Moench) to zinc and iron. *Forage Research*, 39 (1): 45-47

Singh AK, Bhatt BP, Sundaram PK, Kumar S, Bahrati RC, Chandra N & Rai M. 2012. Study of site specific nutrient management of cowpea seed production and their effect on soil nutrient. *Journal of Agricultural Sciences*, 4, 191-198.