J. Soils and Crops 31 (2) 328-331, December 2021
ISSN 0971-2836 (Print)
ISSN 2582-2756 (Online)

INTERACTIVE EFFECT OF ZINC AND PIGEONPEA CULTIVARS ON YIELD, NUTRIENT UPTAKE AND QUALITY OF PRODUCE IN INCEPTISOL

S.S.Mane[1], K. T.Jadhav[2] and V.V.Sonwane[3]

ABSTRACT

A Field experiment was conducted during 2018-19 at experimental farm of College of Agriculture, Badnapur to study interactive effect of zinc on pigeonpea varieties in Factorial Randomized Block Design with sixteen treatment combinations. Four varieties and four fertilizer combinations were studied individually and in combination. Factor I includes 4 varieties of pigeonpea i.e (V1) BDN-711, (V2) BDN-716, (V3) BSMR-736 and (V4) BSMR-853 and Factor II includes 4 levels of fertilizer i.e (F1) Control (RDF-25:50:00 kg NPK kg ha^{-1}), (F2) RDF + zinc @ 25 kg ha^{-1} , (F3) RDF + 2 foliar sprays of ZnSO4 @ 0.5% at flowering and pod formation stage and (F4) RDF + zinc sulphate @ 25 kg ha^{-1} + 2 sprays of zinc sulphate @ 0.5% at 30 and 45 DAS with 2 replications .The results emerged out clearly indicated that application of treatment F4 improved protein content(20.71%) , seed yield (1821.63 kg ha^{-1}) and straw yield(4292.00 kg ha^{-1}) due to application of zinc. It was inferred from the results that application of RDF + zinc sulphate @ 25 kg ha^{-1} + 2 sprays of zinc sulphate @ 0.5% at 30 and 45 DAS showed synergistic effects on nutrients (N, P and K) uptake. Soil fertility was also found to be improved due to application of zinc to pigeonpea varieties.

(Key words : Zinc, varieties, protein , N,P,K uptake)

INTRODUCTION

Zinc is needed by crops especially pulses in sufficiently large quantity. Unfortunately, in India, about 50% of soils are deficient in zinc inducing Zn deficiency in human and animal due to reduction in concentration of zinc in edible plant parts (Singh and Sampath, 2011) .Nearly 65% of the pregnant women were deficient in Zn, mainly due to low intake of dietary Zn (less than 15mg daily). Zn deficiency is also known to cause several diseases like hypogonadism, anorexia, dwarfism, skin lesion, geophagia, loss of taste, skin lesion, and the like. The Zn related problems are more acute in woman of child bearing age and younger generations including children and livestock. The crops grown in Zn deficient soils are generally having lower zinc content (consequently lower Zn uptake) and intake of produce of such crops leads to health related problems in the humans and animals.(Zigler *et al*., 1996).

MATERIALS AND METHODS

The experiment was conducted in factorial randomized block design with two factors *viz.*, four varieties (V_1-BDN-711, V_2-BDN-716, V_3-BSMR-736 and V_4-BSMR-853) and four fertilizer levels (Control (RDF 25:50:00 kg NPK ha^{-1}) (F_1), RDF + zinc @ 25 kg ha^{-1} (F_2), RDF + 2 foliar sprays of zinc sulphate @ 0.5 % at flowering and pod formation stage (F_3), RDF + zinc sulphate @25 kg ha^{-1}+2 sprays of zinc sulphate @ 0.5% at 30 and 45 DAS (F_4) with 16 treatment combinations. Each experimental unit was replicated two times. The initial available N, P_2O_5, K_2O and Zn content was 167.57,13.20,630.38 kg ha^{-1}and 0.23 mg kg^{-1}respectively. Nitrogen concentration in plant samples was determined by the kjeldhal method (Piper,1966). Phosphorus was estimated by vanadomolybdophosphoric acid yellow colour method using spectrophotometer (Jackson ,1973) . Potassium was determined on flame photometer as described by Jackson (1973). The protein content in seed was calculated by multiplying by the factor 6.25 to per cent seed nitrogen . Nutrient uptake i.e. uptake of N, P, K, was calculated by using formula. Uptake (kg ha^{-1}) = Nutrient concentration % X (dry matter yield (kg ha^{-1}) /100. Available nitrogen in soil was determined by Alkaline Permanganate method (Subbiah and Asija,1956). The available phosphorus content was estimated by Olsen's method (Olsen's *et al*., 1954). The available potassium content from soil was established by using ammonium acetate extractant (Jackson,1967) and the available zinc content was determined by using DTPA extractant (Lindsay and Norvell , 1978).

RESULTS AND DISCUSSION

Interactive effect of zinc and pigeonpea cultivars on yield

Grain yield

Amongst various varieties, BDN-716 recorded maximum grain yield (1696.25 kg ha^{-1}) which was signifi-

1. Assoc.Professor, Dept. of Soil Science and Agril. Chemistry ,College of Agriculture, Badnapur 431202,M.S.
2. Assoc.Professor, Dept. of Agronomy,College of Agriculture, Badnapur-431202,M.S.
3. P.G..Student, Dept. of Soil Science and Agril.Chemistry ,College of Agriculture, Badnapur 431202,M.S.

cantly superior over BSMR-853 (1387.63 kg ha^{-1}), however it was at par with BSMR-736 (1550.75 kg ha^{-1}). Significantly lowest grain yield was recorded in variety BSMR-853 (1387.63 kg ha^{-1}) and was comparable with BSMR-736 (1550.75 kg ha^{-1}), BDN-711(1403.25 kg ha^{-1}). Data on grain yield was significantly influenced due to different fertilizer levels at harvest. Amongst treatments (F4) RDF + zinc sulphate @ 25 kg ha^{-1}+2 sprays of zinc sulphate @ 0.5% at 30 and 45 DAS recorded significantly highest grain yield (1821.63 kg ha^{-1}) than treatment (F1) Control (RDF-25:50:00 kg NPK ha^{-1}) (1194.88 kg ha^{-1}) and was at par with treatment (F2) RDF + zinc sulphate @ 25 kg ha^{-1} (1702.38 kg ha^{-1}) and treatment (F3) RDF + 2 foliar sprays of ZnSO4 @ 0.5% at flowering and pod formation stage (1319 kg ha^{-1}). Significantly lowest grain yield was recorded with treatment (F1) Control (RDF 25:50:00 kg NPK ha^{-1}) (1194.88 kg ha^{-1}).This was perhaps due to abundant supply of Zn nutrition, which increased the protoplasmic constituents, accelerates the process of cell division and elongation, photosynthesis processes, respiration other biochemical and physiological activities. This increases the values of all growth and yield attributing parameters, which finally reflected in increased both grain and straw yield. The grain yield of pigeonpea further increased with the soil application of zinc sulphate. The positive effect of zinc on crop yield might also be due to its requirement in carbohydrate synthesis and translocation of photosynthetics and also may be due to improved yield attributing characters, shoot growth and nodulation. This may be due fact that zinc is reported to enhance the absorption of native as well as added major nutrient such as N and P which might have been attributed to improvement in yield. Mukund Gowda *et al.*(2015) also recorded significantly higher number of pods plant $^{-1}$ (285.89) and 1390 kg ha^{-1} seed yield in pigeonpea with the application of $ZnSO_4$ @ 25 kg ha^{-1} along with foliar spray of 19:19:19 @ 0.4% .Yashona *et.al.* (2018) in his review observed higher grain yield (23-41%) due to 0.5% foliar application of $ZnSO_4$ in pigeonpea.

Straw yield

The straw yield was significantly influenced by different varieties. Amongst the varieties, BSMR-736 recorded maximum straw yield (4304.75 kg ha^{-1}) which was significantly superior over BDN-716 (3949.63 kg ha^{-1}), BDN-711 (3668.13 kg ha^{-1}) and BSMR-853 (3769.25 kg ha^{-1}). Significantly lowest straw yield was recorded due to BDN-711 (3668.13 kg ha^{-1}) and was comparable with BDN-716 (3949.63 kg ha^{-1}), BSMR-853 (3769.25kg ha^{-1}).Amongst fertilizer levels significantly maximum straw yield (4292 kg ha^{-1}) was observed in treatment F4 (RDF + RDF+ zinc sulphate @ 25 kg ha^{-1}+2 sprays of zinc sulphate @ 0.5%) at 30 and 45 DAS and was at par with treatment F2 (RDF+ zinc sulphate @ 25 kg ha^{-1} (4137 kg ha^{-1}). Lowest straw yield was recorded with treatment (F1) Control (RDF 25:50:00 kg NPK ha $^{-1}$) (3489.13 kg ha^{-1}) which was comparable with treatment F3 (RDF+2 foliar sprays of $ZnSO_4$ @ 0.5%) at flowering and pod formation stage (3773.63 kg ha^{-1}) at harvest. This might be due to enhancement in an enzymatic activity which effectively increased photosynthesis and translocation of assimilates to seed. The available soil zinc content was below critical level (0.4 mg Zn kg^{-1}), hence significant response was observed in terms of straw yield in treatment which received zinc. Generally, micronutrients play critical role in plant that lead to increase leaf area index and there by increase light absorption and increase the amount of straw yield. Similar results were found by Kobraee *et al*. (2011), who claimed that zinc application could be lead to higher dry matter production.

Protein content

There was a significant impact of zinc and different varieties on protein content .Amongst the varieties, BSMR-736 was recorded significantly maximum protein (19.72%) which was at par with variety BSMR-853 (19.70%) over remaining varieties. Significantly lowest protein was recorded in variety BDN-711 (19.33%). Amongst fertilizer levels significantly maximum protein (20.71%) was observed under treatment F4(RDF + zinc sulphate @ 25 Kg ha^{-1} + 2 sprays of zinc sulphate @ 0.5%) at 30 and 45 DAS which was followed by treatment F3 (RDF+2 foliar sprays of $ZnSO_4$ @ 0.5% at flowering and pod formation stage) and F2 (RDF+ zinc sulphate @ 25 kg ha^{-1}). Significantly lowest protein (18.17 %) was recorded in treatment F1 Control (RDF 25:50:00 kg NPK ha^{-1}). Increase in protein content might be due to zinc which is important element of structure of enzyme involved in amino acids synthesis ultimately in protein synthesis and there by protein content increased with the application of zinc. The available soil zinc (0.4 mg kg^{-1}) status was below critical level, hence there was significant response in term of protein content observed in treatment receiving zinc. These results are agreed with the findings of Mukund Gowda *et al*. (2015) , who recorded significantly higher protein content (22.47%) in pigeonpea with the application of $ZnSO_4$ @ 25 kg ha^{-1}along with foliar spray of 19.19.19 @ 0.4% . Raut *et al*. (2020) reported that 0.5% Zn + 200 ppm ascorbic acid caused significant increase in protein content (24%) and was comparable with 0.5% Zn +300 ppm ascorbic acid, 0.5% Zn + 400 ppm ascorbic acid and 0.5 % Zn +100 ppm ascorbic acid, respectively.

Uptake of nutrients

Significantly highest uptake of N (121.35 kg ha^{-1}) was recorded by treatment F4 (RDF + zinc sulphate @ 25 kg ha^{-1}+2 sprays of zinc sulphate @ 0.5%) at 30 and 45 DAS, which was at par with fertilizer level RDF + zinc sulphate @ 25 kg ha^{-1}(117.30 kg ha^{-1}).Significantly lowest uptake of N (78.88 kg ha^{-1}) was recorded due to treatment F1 control (RDF-25:50:00 kg NPK ha^{-1}). In presence of zinc, the increase in N uptake could be attributed to enhance vigour of crop growth with increased utilization and translocation of N into plant and synergetic effect between N and Zn in soil system resulting in the enhancement of yield. Similarly Jat *et al.* (2013) also reported higher uptake of N,S,K and Zn by 49.30,50.00,51.40, and 53.70 per cent respectively in wheat grain over control due to application of 9.00 kg zinc ha^{-1} .

Table 1. Yield, quality , nutrient uptake and availability of N,P,K of pigeon pea after harvest as influenced by various verities and fertilizer levels

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Protein (%)	N Uptake (kg ha^{-1})	P Uptake (kg ha^{-1})	K Uptake (kg ha^{-1})	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})
Varieties									
V_1 BDN-711	1403.25	3668.13	19.33	96.03	12.75	54.06	178.15	16.68	670.17
V_2 BDN-716	1696.25	3949.63	19.52	106.48	14.08	60.95	182.67	16.88	673.14
V_3 BSMR-736	1550.75	4304.75	19.72	110.51	15.30	62.83	179.86	16.33	679.28
V_4 BSMR-853	1387.63	3769.25	19.70	96.66	12.75	66.20	185.66	16.33	681.97
SE±(m)	52.28	66.53	0.05	1.43	0.31	1.24	2.50	0.67	6.89
CD at 5 %	155.80	198.92	0.14	4.23	0.93	3.72	-	-	-
Fertilizer levels									
F_1 Control (RDF -25:50:00 kg NPK ha^{-1}	1194.88	3489.13	18.17	78.88	10.66	45.73	168.87	13.27	624.09
F_2 RDF+ zinc sulphate @ 25 kg ha^{-1}	1702.38	4137.00	19.43	117.30	15.54	63.31	187.83	17.99	708.58
F_3 RDF+2 foliar sprays of $ZnSO_4$ @ 0.5% at flowering and pod formation stage	1319.00	3773.63	19.96	92.16	12.23	50.26	177.72	15.68	650.21
F_4 RDF+ zinc sulphate @ 25 kg ha^{-1}+2 sprays of zinc sulphate @ 0.5% at 30 and 45 DAS	1821.63	4292.00	20.71	121.35	18.45	73.74	191.93	19.29	721.67
SE±(m)	52.28	66.53	0.07	1.43	0.31	1.24	2.20	0.44	5.19
CD at 5 %	156.31	198.25	0.21	4.26	0.93	3.70	6.60	1.30	15.51
Interaction (VXF)									
SE± (m)	104.55	133.05	012	2.85	0.81	2.48	4.38	0.88	10.38
CD at 5 %	-	-	-	-	-	-	-	-	-
General Mean	1509.46	3922.93	19.56	102.42	13.71	58.26	181.58	16.55	676.13

Similarly significantly highest uptake of P was recorded by BSMR-736 (15.30 kg ha^{-1}) than BDN-716 (14.08 kg ha^{-1}), BDN-711 (12.75 kg ha^{-1}) and BSMR-853 (12.75 kg ha^{-1}). The highest uptake of P (18.48 kg ha^{-1}) was recorded due to application of RDF + zinc sulphate @ 25 kg ha^{-1}+ 2 sprays of zinc sulphate @ 0.5% at 30 and 45 DAS , which was followed by treatment F2 (RDF+zincsulphate@ 25 kg ha^{-1} (15.54 kg ha^{-1}). While, lowest uptake of P (10.66 kg ha^{-1}) was recorded due to treatment F1 Control (RDF-25:50:00 kg NPK ha^{-1}). Chalak *et al.* (2018) also reported higher uptake of N, P, K i.e.59.48 , 9.21, 29.99 kg ha^{-1} respectively and Zn 78.56 mg ha^{-1} in seed due to application of RDF + 30 kg K_2O + 15 kg $ZnSO_4$ha^{-1} , which was superior over control and RDF . Similarly the highest uptake of K was recorded by variety BSMR-853 (66.20 kg ha^{-1}) followed by BSMR-736 (62.83 kg ha^{-1}), BDN-716 (60.95 kg ha^{-1}) and lowest uptake of P was recorded in variety BDN-711 (54.06 kg ha^{-1}). The highest uptake of K (31.90 kg ha^{-1}) was recorded due to treatment F4 (RDF+ zinc sulphate @ 25 kg ha^{-1}+2 sprays of zinc sulphate @ 0.5%) at 30 and 45 DAS which was followed by treatment F2 (RDF + zinc sulphate @ 25 kg ha^{-1} (63.31 kg ha^{-1}).Vis-a-vis lowest uptake of K (45.73 kg ha^{-1}) was recorded due to treatment F1 Control (RDF-25:50:00 kg NPK ha^{-1}). It might be due to the synergistic effects of zinc with other nutrients. The application of increased levels of potassium and zinc favoured higher root and shoot development which might have also increased the concentration of K. The combination between levels of potassium with zinc may enhance utilization of nutrients by plants which was reflected in a good growth and biological yield. Similar results were also observed by Chalak *et al*. (2018). They reported highest uptake with combined application of 30 kg K_2O_5 + 15 kg $ZnSO_4$ along with RDF.

Interaction effect

Interaction effect due to different varieties and fertilizer levels was found to be non -significant in respect of grain and straw yield , protein content, nitrogen , phosphorus and potassium uptake by pigeonpea at harvest.

Soil fertility status

Application of treatment F4 (RDF+ zinc sulphate @ 25 kg ha^{-1}+2 sprays of zinc sulphate @ 0.5%) at 30 and 45 DAS resulted in increase in available N, P, K and Zn (i.e. 191.93,19.29,721.67 kg ha^{-1} respectively) and it was superior over control and treatment F3.

REFERENCES

Chalak,A.L., S.L.Waikar and Mahesh Ajabe , 2018 . Effect of potassium and zinc on nutrient uptake on pigeonpea (*Cajanus cajan* L. Millsp.) IJCS.**6** (5) :1474-1477.

Jackson, M.L. 1973. Soil Chemical Analysis .Prentice, Hall Inc., New Jersey.

Jackson, M.L. 1967. Soil Chemical Analysis.Prentice, Hall of India Private Ltd., New Delhi. pp. 498.

Jat,G., S.P.Majumdar, N.K.Jat , 2013. Effect of potassium and zinc fertilizer on crop yield nutrients and distribution of potassium and zinc in typic Ustipsamment. Ind. J. Agric.Sci.**84** (7) : 44-50.

Lindsay, W.L and W.A.Norvell, 1978. Development of a DTPA soil test for zinc, iron, manganese and copper. J . Amer. Soc. Soil Sci. **42**:421-428.

Kobraee, S., G. Normohamadi , F. Heidarisharifabad, R. Darviskajori and B.Delkhush ,2011. The important micronutrient fertilizer on soybean nutrient composition .Indian J. Sci. and Technol. **4**: 26- 29.

Mukund Gowda K., A.S.Halepyati , B.G. Koppalkar and Satyanarayana Rao , 2014. Response of pigeonpea (*Cajanus cajan* L. Millsp.) to application of micronutrients through soil and foliar spray of macronutrients on yield, economics and protein content .Karnataka J. Agric. Sci.**27** (4): (460-463).

Olsen, S. R., G.V. Cole, F. S. Watanable and L. A. Dean, 1954. .Estimation of available P in soils by extraction with sodium bicarbonate USDA.CRIC. pp. 939.

Piper, C.S. 1966 . Soil and plant analysis .Hans publishers, Bombay.

Raut, Dnyaneshwar A., Rajesh D. Deotale, A. Blesseena, Satish E. Pise and Vishal S. Hivare , 2020. Changes in chemical, biochemical parameters, yield and yield attributing characters in chickpea through exogenous application of ascorbic acid and zinc sulphate. J. Soils and Crops.**30** (1) : 84-89.

Singh ,M.V. and K.T. Sampath , 2011.Micronutrient status in farms of India and their effect on health and productivity. Proceedings of 10th NAAS Congress, Luknow. pp.11-13.

Subbiah, B.V. and G.L. Asija, 1956. Rapid method for estimation of available nitrogen in soills, Cure. Sci. **25** : 259-260.

Yashona, D. S., U. S. Mishra and S. B. Aher, 2018. Response of pulse crops to sole and combined mode of Zinc application: a review. J Soils and Crops.**28** (2) :249-258.

Zigler, E.E., L.J. Filer and J.R. Eds , 1996. Present knowledge in nutrition.7thed. Washington, DC,USA : Int. Life Sci. Inst. Press. pp. 293-306.

Rec. on 25.06.2021 & Acc. on 20.07.2021