Effect of Moisture Conservation Practices and Zinc Fertilization on Nutrient Status and Quality of Pearl millet *Pennisetum glaucum* (L.) under Rainfed Condition

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**ABSTRACT**

**Background:** Pearl millet growing areas in country are mostly confined to coarse texture soil suffering from the problem of poor moisture retention capacity, low soil fertility and zinc deficiency. The main problem of rainfed area is uncertainty and uneven distribution of rainfall and loss of water through runoff which lead to low and unstable productivity due to moisture stress at critical stage of crop growth. At present, widespread and acute deficiency of zinc is another serious problem in arid and semi-arid region. Hence, the current study aim to find out suitable moisture conservation practices and zinc fertilization to mitigate the water stress and zinc deficiency under rainfed condition.

**Methods:** A study on “Effect of moisture conservation practices and zinc fertilization on nutrient status and quality of pearl millet” was conducted at Agronomy farm, S.K.N. College of Agriculture, Jobner (Rajasthan) during kharif, 2017. The experiment was laid out in randomized block design (RBD) with 20 treatments and replicated thrice. The experiment consisted of five moisture conservation practices i.e. control, dust mulch, pusa hydrogel, stover mulch and pusa hydrogel + stover mulch and four zinc fertilization practices i.e. control, 2 kg Zn/ha, 4 kg Zn/ha and 6 kg Zn/ha.

**Result:** The perusal of data clearly indicated that among moisture conservation practices, stover mulch proved significantly superior to control, dust mulch, pusa hydrogel with respect to higher in N, P, K and Zn content, their total uptake and protein content in pearl millet but it was at par with pusa hydrogel + stover mulch. Under zinc fertilization treatments direct application of 6.0 and 4.0 kg Zn/ha being at par with each other and recorded significantly higher in nutrient content, protein content and total uptake of N, Zn and K over control.

**Key words:** Pearl millet, Pusa hydrogel, Stover mulch, Zinc fertilizer.

**INTRODUCTION**

Pearl millet [*Pennisetum glaucum* (L.) R. Br. emend Stuntz] cultivation is mainly confined to the dry regions of the Southern Asia (Mainly India) and Africa and serves as stable food for millions of people in the low productive soils of these areas. In India, annual planting area is 7.38 million hectares producing nearly 9.13 million tonnes of grains with 1237 kg/hactare productivity. In India major pearl millet producing state are Rajasthan (41%), Uttar Pradesh (19%) and Gujarat (10%), (GOI, 2018). It is nutritionally better than many cereals as it is a good source of protein having higher digestibility (12.1%), minerals (2.0-3.5%) particularly iron (284 mg/kg), fats (5%) and carbohydrates (69.4%). Pearl millet grains possess higher protein content (10.5-14.5%) with higher levels of essential amino acids. Pearl millet survives in rainfed areas because of its drought escaping mechanism. Moisture stress generally results in limited total nutrient uptake and their diminished tissue concentration in crop plant. Moisture conservation through organic residue application is a viable approach to retain soil moisture and nutrient under water scarcity situations (Sharma *et al.*, 2010). Mulching improved the efficient use of water resource thus phosphorous and potassium absorption by plant directly depends on the concentration of the soil solution. It was easily absorbed and reduces the nitrogen losses to reduce evapotranspiration. Higher nitrogen in grain is directly responsible for higher protein because it is a primary component of amino acids which constitute the basis of protein. These results are in agreement with the findings of Meena *et al.* (2006) in chickpea and Parihar *et al.* (2009) in pearl millet - mustard. Tetarwal and Rana (2006) reported that application of stover mulch recorded significantly higher nutrient uptake. Another problem associated with low productivity and poor quality of produce in dryland areas is occurrence of micronutrient deficiency especially zinc. Zinc deficiency reduces not only the grain yield, but also the nutritional quality of grain...
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(Cakmak, 2008) and ultimately nutritional quality of human diet. Zinc plays a vital role in synthesis of chlorophyll, protein and nucleic acid, regulating auxin concentration and its stimulatory effect on most of the physiological and metabolic process of plant, might have also helped to plants in absorption of greater amount of nutrients from the soil and finely translocation and assimilation into the grain and stover of the crop (Jakhari et al., 2006) in pearlmillet. The improvement in protein content by zinc fertilization ascribed to the role of Zn in nitrogen metabolism and protein synthesis. In contrast to N, K, Zn and content of P was decreased with increasing levels of zinc fertilization to pearlmillet. Increasing zinc concentration in food crops, resulting better crop production and improved human health is an important global challenge. Therefore, use of moisture conservation practices along with fertilizers especially micronutrients are effective in increasing the profitability, productivity and quality of pearlmillet through efficient utilization of moisture and nutrients. Thus, keeping these facts in view present study was undertaken to find out the nutrient content, uptake and quality of pearlmillet as influenced by different moisture management practices and zinc fertilization under rainfed conditions.

**MATERIALS AND METHODS**

The field study was conducted at Agronomy Farm of S.K.N. College of Agriculture, Jobner during kharif 2017 to find out the nutrient content, uptake and quality of pearlmillet influenced by moisture conservation practices and zinc fertilization under rainfed conditions. The experimental farm is situated at 26°05’ N latitude and 75°28’ E longitudes and at an altitude of 427 metres above mean sea level. The total rainfall received during the cropping season was 300 to 400 mm and is mostly received during the month of July to September. The soil was contained low in organic carbon (0.24%), low available nitrogen (125.7 kg N/ha) and Zn (0.4 mg/kg of soil), medium in available phosphorus (16.12 kg P2O5/ha) and in available potassium (151.24 kg K2O/ha). The experiment was laid out in randomized block design (RBD) comprised of five treatments of moisture conservation practices (control, dust mulch, pusa hydrogel, stover mulch and pusa hydrogel + stover mulch) and four treatments of zinc fertilization (control, 2.0 kg Zn/ha and 4.0 kg Zn/ha and 6.0 kg Zn/ha) in pearlmillet with three replications. The pearlmillet variety ‘RHB -173’ was taken for experiment and planted at 45 cm x 10 cm spacing. Pusa hydrogel was applied in respective plots as band and waste straw mulch of mustard @ 2.5 t ha⁻¹ was spread over the soil surface between the rows of crop. Zinc fertilization treatments were applied as per treatment through zinc sulphate (ZnSO₄·7H₂O) containing 21% zinc and 10% S at the time of sowing as basal dose. The crop was grown with recommended package of practices. The chemical analysis of plant samples for concentration of N, P, K and Zn were done as per standard procedures. Estimation of nitrogen was done by colorimetric method using Nesslers reagent to develop colour (Snell and Snell, 1949). Phosphorus concentration in grain and stover was determined by Vanado-molybdo phosphate yellow colour method. Digestion of samples was done by tri-acid mixture (Jackson, 1973). Potassium concentration in grain and stover was determined by “Flame photometer”. Digestion of samples was done by tri-acid mixture (Jackson, 1973). Zinc concentration in grain and stover was determined by “Atomic Absorption spectrophotometer” (Lindsay and norvell, 1978). The per cent Protein content in grain was calculated by multiplying per cent nitrogen of grain with a factor 6.25 (A.O.A.C., 1960). Statistical analysis of the data was carried out accordance with the “Analysis of Variance” technique suggested by (Fisher, 1950). Appropriate standard error for each of the factor was worked out.

**RESULTS AND DISCUSSION**

**Moisture conservation practices in pearlmillet**

Moisture management practices were also brought significant effect on nutrient content and total uptake of N, P, K and Zn in pearlmillet. Stover mulch recorded significantly higher in N, P, K and Zn content in grain and stover than control, dust mulch and pusa hydrogel but remained at par with pusa hydrogel + stover mulch (Table 1). Total uptake of N (83.81 kg/ha), P (14.12 kg/ha), K (109.75 kg/ha) and Zn (240.86 kg/ha) also recorded significant higher in stover mulch than control, dust mulch and pusa hydrogel but remained at par with pusa hydrogel + stover mulch (Table 2). This might be due to improved nutritional environment in the rhizosphere as well as in the plant system due to decomposition of crop residue leading to enhanced translocation of N, P and K in plant parts (Sharma et al., 2010 and Singh et al., 2011). Pearlmillet grown under stover mulch recorded significantly higher protein content (10.84%) than control, dust mulch and pusa hydrogel but remained at par with pusa hydrogel + stover mulch (Table 2). The improvement in protein content has been observed in the present investigation because of increased N content in seed which attributed to increased availability of nitrogen in the soil due to decomposition of crop residue. These results are in close conformity with the findings of Parihar et al. (2009). Use of stover mulch in pearlmillet produced significantly higher grain (2511 kg/ha), stover (5765 kg/ha) yield than control, dust mulch and pusa hydrogel but remained at par with pusa hydrogel + stover mulch. Extended period of moisture availability and lower weed incidence due to organic mulch and pusa hydrogel resulted in a higher dry matter accumulation and thereby, higher stover and biological yield. An increase in yield related attributes in the present study could be because of comparatively longer availability of water and indirectly nutrients supplied by the pusa hydrogel polymer to the plant under water stress condition, which in turn lead to better translocation of water, nutrients and photo assimilates and finally better plant development. Choudhary et al. (2017) find out that chickpea
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Table 1: Effect of moisture conservation practices and zinc fertilization on nutrient content in grain and stover of pearl millet.

| Treatments                        | Grain content | Stover content |
|-----------------------------------|---------------|----------------|
|                                   | N (%) | P (%) | K (%) | Zn (ppm) | N (%) | P (%) | K (%) | Zn (ppm) |
| Moisture conservation practices   |       |       |       |          |       |       |       |          |
| Control                           | 1.12  | 0.191 | 0.492 | 29.11    | 0.42  | 0.105 | 1.107 | 19.85    |
| Dust mulch                        | 1.27  | 0.208 | 0.542 | 31.71    | 0.59  | 0.116 | 1.270 | 21.70    |
| Pusa hydrogel                     | 1.42  | 0.228 | 0.589 | 34.14    | 0.67  | 0.127 | 1.496 | 23.48    |
| Stover mulch                      | 1.58  | 0.247 | 0.637 | 36.89    | 0.75  | 0.138 | 1.618 | 25.33    |
| Pusa hydrogel + stover mulch      | 1.61  | 0.255 | 0.648 | 37.95    | 0.78  | 0.143 | 1.695 | 26.21    |
| SEM                              | 0.11  | 0.016 | 0.043 | 2.58     | 0.05  | 0.009 | 0.113 | 1.64     |
| Zinc level (kg Zn/ha)             |       |       |       |          |       |       |       |          |
| 0                                 | 1.21  | 0.231 | 0.536 | 28.35    | 0.52  | 0.132 | 1.297 | 19.68    |
| 2                                 | 1.35  | 0.229 | 0.571 | 32.85    | 0.60  | 0.129 | 1.460 | 22.41    |
| 4                                 | 1.51  | 0.224 | 0.594 | 36.67    | 0.71  | 0.124 | 1.486 | 25.12    |
| 6                                 | 1.56  | 0.219 | 0.627 | 37.97    | 0.75  | 0.118 | 1.508 | 26.05    |
| SEM                              | 0.03  | 0.005 | 0.014 | 0.81     | 0.02  | 0.003 | 0.035 | 0.51     |
| CD (P=0.05)                      | 0.10  | NS    | NS    | 2.31     | 0.05  | NS    | NS    | 1.47     |

Table 2: Effect of moisture conservation practices and zinc fertilization on total nutrient uptake and quality of pearl millet.

| Treatments                        | Total uptake | Protein content (%) | Grain yield (kg/ha) |
|-----------------------------------|--------------|---------------------|---------------------|
|                                   | N (kg/ha)    | P (kg/ha) | K(kg/ha) | Zn (g/ha) |
| Moisture conservation practices   |              |           |          |           |          |
| Control                           | 41.07        | 8.44      | 60.50    | 148.02    |
| Dust mulch                        | 56.78        | 10.14     | 74.95    | 176.54    |
| Pusa hydrogel                     | 69.57        | 12.06     | 94.55    | 207.06    |
| Stover mulch                      | 83.81        | 14.12     | 109.75   | 240.86    |
| Pusa hydrogel + stover mulch      | 88.01        | 15.05     | 116.83   | 255.94    |
| SEM                              | 2.13         | 0.33      | 2.71     | 6.51      |
| CD (P=0.05)                      | 6.11         | 0.96      | 7.75     | 18.63     |
| Zinc level (kg Zn/ha)             |              |           |          |           |          |
| 0                                 | 48.87        | 10.83     | 72.32    | 149.21    |
| 2                                 | 62.40        | 11.95     | 89.55    | 191.56    |
| 4                                 | 78.91        | 12.71     | 100.34   | 235.41    |
| 6                                 | 83.30        | 12.36     | 103.68   | 246.56    |
| SEM                              | 1.91         | 0.30      | 2.42     | 5.82      |
| CD (P=0.05)                      | 5.46         | 0.86      | 6.93     | 16.67     |

Planted under fl at bed with 5.0 t/ha crop residue recorded significantly higher equivalent yield, water use efficiency, higher protein yield and total uptake of N, P and K during both the years of study as compared to flatbed without crop residue and flat bed with 2.5 t/ha crop residue. Rajput et al. (2019) find out that application of green leaf manure with maize straw mulch increase the more number of tillers per plant, grain yield of pearl millet. Increased growth and yield of pearl millet in green leaf manure and straw mulch due to improve moisture holding capacity, reducing evapotranspiration due to mulching and improve nutrient status of soil. Stagnari et al. (2014) reported that 1.5 t/ha of straw added as mulching are enough to significantly produce higher yields, although to exert significant positive effect both soil and crop 2.5 t/ha of wheat straw necessary. However, increasing the amount of crop residues until 5t/ha, crop performances and soil characteristics continue to significantly improve.

Zinc fertilization to pearl millet

Direct application of 4 kg Zn/ha to pearl millet recorded significantly higher N and Zn content in grain and stover over lower levels but there is no any significant effect of zinc in P and K content in grain and stover (Table 1). Fertilization of pearl millet with 4.0 kg Zn/ha registered significantly higher total uptake of N (78.91 kg/ha). The increase in concentration of N by zinc fertilization might be due to the role of Zn in nitrogen metabolism which leads to increase in accumulation of nitrogen by plants and ultimately higher uptake of N. Phosphorus has antagonistic interaction
with Zn, so application of zinc resulted in to reduction in P uptake at higher levels. In case of K application of 4.0 kg Zn/ha recorded significantly higher total uptake of K but remained at par with 6 kg Zn/ha. The increased concentration and uptake of K might be due to greater absorption of Zn by the crop owing to higher availability in soil. The result of the present study was in line of the findings of Jain and Dahama (2005); Jakhar et al. (2006). Keram et al. (2014) found out that application of increasing levels of Zn @ 5.10 and 20 kg/ha significantly increased the Zn concentration in root, stem, leaves and earhead of wheat over NPK fertilization alone at different growth stages of wheat. Further, the grain and straw yields as well as harvest index increased with the increasing levels of Zn as compared to NPK alone. Choudhary et al. (2016) found out that under zinc fertilization treatments, application of 5.0 kg Zn/ha to pearlmillet recorded significantly higher system productivity, profitability, moisture use efficiency and total uptake of N, K and Zn over the lower levels. Fertilization of pearlmillet with 4.0 kg Zn/ha resulted into significantly higher total uptake of Zn (235.41 g/ha) as compared to lower levels (Table 2). The combined effect of increased zinc availability on yield and concentration finally reflected on total uptake of Zn (Gupta and Sahu, 2012). Content of protein were also increased significantly by direct applied zinc fertilization. Application of 6.0 kg Zn/ha remained at par with 4 kg Zn/ha recorded significantly higher protein content (9.75 and 9.44%) as compared to control and 2 kg Zn/ha (Table 2). The increase in protein content by zinc ascribed due to the role of Zn in nitrogen metabolism and protein synthesis. Jakhar et al. (2006) and Chauhan et al. (2014) were also reported similar findings. Fertilization of pearlmillet with 4.0 kg Zn/ha recorded significantly higher grain yield (2470 kg/ha) than lower levels of zinc being at par with 6 kg Zn/ha. Zinc plays an important role in nitrogen metabolism and formation of chlorophyll and carbohydrate, which leads to maintain photosynthetic activity for longer period and finally results in increasing the yield and yield attributes in pearlmillet (Mehta et al., 2008). Debnath et al. 2015 found out that a conjoint dose of 60 kg phosphorus and 5 kg Zn/ha gave the highest grain yield of wheat than control and agronomic efficiency of P in basmati rice can be increased by using 40 kg phosphorus with 2.5 kg Zn/ha.

**CONCLUSION**

On the basis of above finding, this may concluded that application of stover mulch significantly recorded higher nutrient content, uptake and protein in pearlmillet than control, dust mulch and pusa hydrogel and it was at par with pusa hydrogel + stover mulch. Under zinc fertilization application of 4.0 kg Zn/ha recorded significantly higher nutrient content, uptake and protein in pearlmillet than control. 2.0 kg Zn/ha and it was at par with 6.0 kg Zn/ha. As per data, the above result is based on one year trial, which need to be validation through further experimentation to formulate a concrete recommendation.

**REFERENCES**

A.O.A.C. (1960). Official method of analysis.18th Edn. Association of Official Agricultural Chemists, Washington.

Cakmak I. (2008). Enrichment of cereal grain with zinc: Agronomic and genetic biofortification. Plant and Soil. 302(1): 1-17.

Chauhan, T.M., Ali, J., Singh, H., Singh, N. and Singh, S.P. (2014). Effect of zinc and magnesium nutrition on yield, quality and removal of nutrients in wheat (Triticum aestivum). Indian Journal of Agronomy. 59(2): 275-280.

Choudhary, G.L., Rana, K.S., Bana, R.S. and Prajapat, K. (2016). Moisture conservation and zinc fertilization impacts on quality, profitability and moisture use indices of chickpea (Cicer Arietinum L.) under limited moisture conditions. Legume Research. 39(5): 734-740.

Choudhary, G.L., Rana, K.S., Bana, R.S. and Prajapat, K.C. (2017). Impact of moisture management and zinc fertilization on performance of pearlmillet (Pennisetum glaucum) under rainfed condition. International Journal of Current Microbiology and Applied Science. 6(4): 1098-1107.

Debnath, S., Pachauri, S.P. and Srivastava, P.C. (2015). Improving use efficiency of applied phosphorus fertilizer by zinc fertilization in basmati - wheat cropping system. Indian Journal of Agriculture Research. 49(5): 414-420.

Fisher, R.A. (1950). Statistical Methods for Research Workers. Oliver and Boyd, Edinburg, Landon pp. 57-63.

GOI. (2018). Agricultural Statistics at a glance. Directorate of Economics and Statistics, Department of Agriculture, Cooperation and farmer welfare. Ministry of Agriculture and farmer welfare. Government of India, New Delhi.

Gupta, S.C. and Sahu, S. (2012). Response of chickpea to micronutrients and bio- fertilizers in vertisol. Legume Research. 35(3): 248-251.

Jackson, M.L. (1973). Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd. New Delhi, pp. 498.

Jain, N.K. and Dhama, A.K. (2005). Residual effect of phosphorus and zinc on yield, nutrient content and uptake and economics of pearlmillet (Pennisetum glaucum) – wheat (Triticum aestivum) cropping system. Indian Journal of Agricultural Sciences. 75(5): 281-284.

Jakhar, S.R., Singh, M. and Balai, C.M. (2006). Effect of farm yard manure, phosphorus and zinc levels on growth, yield, quality and economics of pearlmillet (Pennisetum glaucum). Indian Journal of Agricultural Sciences. 76(1): 58-61.

Keram, K.S., Sharma, B.L., Sharma G.D. and Thakur, R.K. (2014). Impact of zinc application on its translocation into various plant parts of wheat in a vertisol. The Bioscan. 9(2): 491-495.

Lindsay, W.I. and Norvell, W.A. (1978). Development of DTPA soil test for zinc, iron, manganese and copper. Soil Science Society of America Journal. 42: 421-448.

Meena, L.R., Singh, R.K. and Gautam, R.C. (2006). Effect of moisture conservation practices, phosphorus levels and bacterial inoculation on growth, yield and economics of chickpea (Cicer arietinum). Legume Research. 29(1): 68-72.

Mehta, A.C., Khafi, H.R., Bunsa, B.D., Dangaria, C.J. and Davada, B.K. (2008). Effect of soil application and foliar spray of zinc sulphat on yield, uptake and net returns of pearlmillet (Pennisetum glaucum). Research on Crop. 9(1): 31-32.

Parihar, C.M., Rana, K.S. and Parihar, M.D. (2009). Crop productivity,
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quality and nutrient uptake of pearl millet (*Pennisetum glaucum*) – Indian mustard (*Brassica juncea*) cropping system as influenced by land configuration and direct and residual effect of nutrient management. Indian Journal of Agricultural Sciences. 79(11): 927-930.

Rajput, R.L. and Bhadouriya, N.S. (2019). Effect of moisture conservation practices on growth and yield of pearl millet + pigeonpea intercropping system. Legume Research. 42(4): 547-549.

Sharma, A.R., Singh, R., Dhyani, S.K. and Dube, R.K. (2010). Effect of line mulching with annual legumes on performance of maize (*Zea mays*) and residual effect on following wheat (*Triticum aestivum*). Indian Journal of Agronomy. 55(3): 177-184.

Singh, R., Sharma, A.R., Dhyani, S.K. and Dube, R.K. (2011). Tillage and mulching effect on performance of maize (*Zea mays*) – wheat (*Triticum aestivum*) cropping system under varying land slope. Indian Journal of Agricultural Sciences. 81(4): 330-335.

Snell, P.D. and Snell, G.T. (1949). Colorimetric methods of analysis, 3rd Edn. II D Van Nostrand Co., Inc. New York.

Stagnari, F., Galieni, A., Speca, S., Cafiero, G. and Pisante, M. (2014). Effect of straw mulch on growth, yield of durum wheat during transition of conservation agriculture in Mediterranean environment. Field Crop Research. 167: 51-63.

Tetarwal, J.P. and Rana, K.S. (2006). Impact of cropping system, fertility level and moisture conservation practices on productivity, nutrient uptake, water use and profitability of pearl millet under rainfed condition. Indian Journal of Agronomy. 51(4): 263-266.