NUTRIENT CONTENT, UPTAKE, QUALITY OF BIOFORTIFIED PEARL MILLET [*Pennisetum glaucum* (L.) R. Br.] AND FERTILITY STATUS OF SOIL AS INFLUENCED BY FERTILIZATION OF POTASSIUM AND ZINC

ABSTRACT

The experiment comprising of four levels of potassium *viz.,* 0, 40, 60 and 80 kg K_2O ha^{-1} and three levels of zinc *viz.,* 0, 10 and 20 kg Zn ha^{-1} and the experiment was laid out in Factorial Randomized Block Design and replicated thrice. The results revealed that the nutrient content, uptake, quality and yields were significantly influenced by the various levels of potassium and zinc. The application of potassium 80 kg K_2O ha^{-1} and zinc 20 kg Zn ha^{-1} significantly increased the nutrient content, uptake, quality and yield of pearl millet.

Keywords

Pearl millet, Potassium, Zinc.

INTRODUCTION

Pearl Millet [*Pennisetum glaucum* (L.) R. Br.] is the fifth most important and widely grown potential cereal crop in the world and is the fourth in India after rice, wheat, maize. It is a widely grown rainfed cereal crop in the arid and semi-arid regions of Africa and Southern Asia. India continues to be the single largest producer of pearl millet in the world. In india major pearl millet growing states are Rajasthan, Maharastra, Gujarat, Uttar pradesh and Haryana which account for more than 90% of pearl millet acreage in the country. It occupies an area of 6.93 million ha with an average production of 8.61 million tonnes and productivity of 1243 kg/ha (Directorate of Millets Development, 2020; Project Coordinator Review, 2020). Its grain is more nutritious and the protein content is not only high but it is also of good quality. The grain contains 11-19 % protein, 60-78 % carbohydrates and 3.0 - 4.6 % fat and also has good amount of phosphorus and iron (Bhanuchandar *et al.,* 2020). It has the maximum potential of all the millets and is mainly grown in drought prone areas and marginal soils. Because of its tolerance to difficult growing conditions such as drought, low soil fertility and high temperature, it can be grown in areas where other cereal crops would not survive. It also provides good quality fodder to cattle in the arid and semi-arid tropical regions, and recognized as valuable forage crop because of its robust and quick growth habit. Pearl millet is usually grown as a dryland dual-purpose grain and fodder crop although it is sometimes irrigated in India, particularly the summer crop grown mainly as a forage crop.

Biofortification is the process by which the nutritional quality of food crops is improved through agronomic practices, conventional plant breeding or modern biotechnology which is scientifically proven to be a sustainable and cost-effective approach to address malnutrition like Iron and zinc deficiencies. This approach targets the root cause of the malnutrition. Biofortified pearl millet has the potential to make significant contributions to the food-cum-nutritional security in dryland poor households (Govindaraj *et al.*, 2019).

Potassium is one of the chief plant nutrients for the growth and development of plants. In pearl millet potassium plays vital role in enzyme activities, water and energy metabolism, translocation of assimilates photosynthesis, protein and starch synthesis. Potassium involves in water uptake and efficiency and also impart resistant against drought, pest and diseases of pearl millet (Reddy *et al.*, 2021).

Zinc is an essential micro nutrient and it is well a known fact that zinc is now considered as fourth most important yield-limiting nutrient after nitrogen, phosphorus and potassium. It plays indispensable role in various plant physiological processes such as photosynthesis, protein and sugar synthesis, fertility and production of seeds, growth regulation and disease immune system (Khinchi *et al*., 2017). To decide as well as to evaluate the potential productivity of pearl millet in Gujarat state through levels of potassium and zinc and eventually for the benefit to farmers this experiment was conducted.

MATERIALS AND METHODS

The fertilizer application was done with fixed doses of N and P 120 and 60 kg ha^{-1}, respectively. Half recommended dose of N and full of phosphorus were applied at the time of sowing. The remaining half dose of N was applied one month after sowing. Potassium and zinc application was done according to treatment. The nutrient of N, P, K and Zn were applied by using sources of Urea, DAP, MOP and zinc sulphate, respectively. The crop was raised with all the standard package of practices and protection measures also timely carried out as they required.

The samples of collected grain and straw at the time of harvest from each plot were grinded to fine powder and utilized for determination of K and Zn content as per the procedure adapted. The available potassium in soil after harvest and potassium content (%) in grain and straw of the pearl millet crop were analysed in laboratory as per standard procedure by flame photometer (Jackson, 1974), The available zinc in soil after harvest and zinc content (%) in grain and straw of the pearl millet crop were analysed by the atomic absorption spectrophotometer method (Lindsay and Norvell, 1969). The K and Zn content was expressed as per cent and its uptake in kg ha^{-1} was calculated by using following formula. Protein content in grain was determined by NRM instrument. The experimental data gathered in each observation were statistically analysed for level of significance.

$$\text{Potassium uptake (kg/ha)} = \frac{\text{Potassium content in grain \& straw (\%) X grain \& straw yield (kg ha}^{-1}\text{)}}{100}$$

$$\text{Zinc uptake (g/ha)} = \frac{\text{Zinc content in grain \& straw (ppm) X grain \& straw yield (kg ha}^{-1}\text{)}}{1000}$$

RESULTS AND DISCUSSION

Effect of potassium levels on nutrient content, uptake and yield of pearl millet

Potassium content and uptake by grain and stover of pearl millet increased significantly due to successive levels of potassium. Significantly maximum K content (0.769 % and 2.67 %) and Potassium uptake (43.93 kg ha^{-1} and 229.3 kg ha^{-1}) by grain and stover were recorded with 80 kg K_2O ha^{-1}. It showed superiority over the rest of the treatment. The better nutritional environment helped the plant to absorb more K from the soil consequently leading to higher photosynthetic and their translocation to different plant parts would have enhanced the K content in both seed and straw. Similar results have also been reported by Kacha *et al.* (2011), Sakarvadia *et al.* (2012), Yadav *et al*. (2012) and Chauhan *et al.* (2017).

A perusal of the data (Table 1) revealed that different levels of potassium exerted a significant influence on test weight. Application of 80 kg K_2O ha^{-1} recorded significantly higher test weight (6.65 g) which remained statistically at par with 60 kg K_2O ha^{-1}. Grain yield affected significantly by potassium level 80 kg ha^{-1} which remained statistically at par with 60 kg K_2O ha^{-1}. (Table 1). The highest grain yield (5716 kg ha^{-1}) and stover yield (8575 kg ha^{-1}) was obtained with 80 kg K_2O ha^{-1}. Potassium is a third major plant nutrient because of the large amount in which it is absorbed by plants and its significant place for the production of high yield. A similar result was concluded by Kacha *et al.* (2011), Sakarvadia *et al.* (2012).

Effect of zinc levels on nutrient content, uptake and yield of pearl millet

Fertilization of zinc significantly increased zinc content and uptake by grain and stover of pearl millet. Significantly maximum zinc content (46.73 ppm & 60.09 ppm) and zinc uptake (251.8 g ha^{-1} & 483.4 g ha^{-1}) by grain and stover of pearl millet were recorded with 20 kg Zn ha^{-1}. The beneficial role of Zn in increasing the CEC of roots helped in increasing the absorption of nutrients from the soil. Further, the favourable effect of Zn on photosynthesis and metabolic process augmented the production of photosynthetic and their translocation to different plant parts including seed which ultimately increased the Zn concentration in seed and straw. A similar result was also concluded by Shekhawat and Kumavat (2017) and Singh *et al.* (2017). Likewise, the application of 20 kg Zn ha^{-1} recorded significant test weight (6.50 g), which was statistically at par with 10 kg Zn ha^{-1}. Application of 20 kg Zn ha^{-1} recorded significantly the highest grain yield and stover yield (5364 kg ha^{-1} & 8046 kg ha^{-1}), which remained at par with 10 kg Zn ha^{-1}. Zinc improved the yield attributes by improving the source and sink relation due to the increased translocation of photosynthates towards the reproductive system. This result is also in conformity with those of Mehta *et al.* (2008) and Singh *et al.* (2017).

Treatment	Potassium content (%)		Potassium uptake (kg/ha)		Zinc content (ppm)		Zinc uptake (g/ha)		Protein content in grain (%)	Available potassium (kg/ha)	Available zinc (ppm)	Test weight (g)	Grain yield (kg/ha)	Stover yield (kg/ha)
	Grain	Stover	Grain	Stover	Grain	Stover	Grain	Stover						
Potassium levels (kg K_2O ha^{-1})														
K_0 – 00	0.610	2.07	27.98	141.7	41.40	53.28	189.9	367.0	9.02	192.0	0.56	5.85	4574	6861
K_1 – 40	0.637	2.35	31.52	175.1	43.59	54.41	216.5	403.8	9.62	213.8	0.57	6.14	4948	7422
K_2 – 60	0.706	2.41	37.74	193.8	45.33	57.19	243.1	460.8	9.77	226.5	0.59	6.37	5352	8028
K_3 – 80	0.769	2.67	43.93	229.3	46.78	59.20	267.3	508.0	10.31	245.3	0.60	6.65	5716	8575
S.Em±	0.014	0.06	1.14	7.7	1.41	1.74	10.1	17.5	0.20	4.70	0.02	0.13	141	218
C.D. at 5%	0.042	0.18	3.35	22.7	NS	NS	29.7	51.4	0.59	13.78	NS	0.37	413	640
Zinc levels (kg Zn ha^{-1})														
Zn_0 – 00	0.668	2.31	33.08	171.8	40.97	51.03	202.1	376.6	9.19	214.4	0.55	5.94	4899	7349
Zn_1 – 10	0.674	2.32	35.17	182.0	45.13	56.93	233.6	444.7	9.63	216.7	0.59	6.32	5180	7769
Zn_2 – 20	0.699	2.49	37.63	201.1	46.73	60.09	251.8	483.4	10.22	227.2	0.60	6.50	5364	8046
S.Em±	0.012	0.05	0.99	6.7	1.22	1.51	8.8	15.2	0.17	4.07	0.01	0.11	122	189
C.D. at 5%	NS	NS	2.90	19.6	3.58	4.42	25.8	44.5	0.51	NS	0.04	0.32	358	554
Interaction (K X Zn)														
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
C.V.%	6.333	7.73	9.71	12.5	9.55	9.33	13.3	12.09	6.20	6.42	7.83	6.06	8.21	8.47

Table.1 Effect of levels of potassium and zinc on nutrient content and uptake, quality, yield of pearl millet and after harvest fertility status of soil

Effect of potassium and zinc levels on quality parameter of pearl millet

The increasing levels of potassium up to 80 kg K_2O ha^{-1} significantly increase protein content (10.31 %) in pearl millet. However, it remained at par with 60 kg K_2O ha^{-1} The application of 20 kg Zn ha^{-1} significantly increased protein content (10.22 %) in pearl millet over control. Potassium plays an important role in the synthesis of amino acid which constitutes building block of protein. The improvement in protein content by zinc fertilization ascribed to the role of Zn in nitrogen metabolism and protein synthesis. Similar result was concluded by Sakarvadia *et al.* (2012) and Singh *et al.* (2017).

Effect of potassium and zinc levels on after harvest soil fertility of status

The increasing levels of potassium up to 80 kg K ha^{-1} significantly increase available potassium (245.3 kg ha^{-1}) in soil after harvest. The significant build-up of available K status under this potassium level could be attributed to adequate supply of K to meet the crop demand The application of 20 kg Zn ha^{-1} significantly increased available zinc (0.60 ppm) after harvest in soil over control. The significant build-up of available Zn status under this zinc level could be attributed to adequate supply of Zn to meet the crop demand. Similar findings were reported by Sakarvadia *et al.* (2012), Patel *et al.* (2013) and Fulpagare *et al.* (2018).

CONCLUSION

It can be concluded that nutrient content and uptake, quality and yield parameter of pearl millet (*cv*. GHB-1129) and after harvest soil fertility status of soil should be increased with potassium 80 kg K_2O ha^{-1} and zinc 20 kg Zn ha^{-1} in medium black calcareous soils of South Saurashtra region of Gujarat.

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