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Effect of different levels of potassium and zinc application on growth and yield attributes of Biofortified pearl millet [*Pennisetum glaucum* (L.) R. Br.] under medium black calcareous soils of south Saurashtra region of Gujarat

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Abstract
A field experiment was conducted at Instructional Farm, College of Agriculture, Junagadh Agricultural University, Junagadh during summer season of 2020 to evaluate effect of soil application of potassium and zinc on growth and yield components of biofortified pearl millet [*Pennisetum glaucum* (L.) R. Br.] under south Saurashtra region of Gujarat. The experiment comprising of four levels of potassium *viz*., 0, 40, 60 and 80 kg K2O ha-1 and three levels of zinc *viz*., 0, 10 and 20 kg Zn ha-1 and experiment was laid out in Factorial Randomized Block Design and replicated thrice. The results revealed that the growth, yield attributes and yields were significantly influenced by the various levels of potassium and zinc. The application of potassium 80 kg K2O ha-1 and zinc 20 kg Zn ha-1 significantly increased the plant height, total tillers per plant, effective tillers per plant, earhead length, earhead girth, test weight, grain yield and stover yield.

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, Maharashtra, 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) [2]. 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. wilt is being managed by using fungicide through seed and soil treatment. However, fungicides are more costly and pollutant to environment. Many plant extract are known to have antifungal activity. Therefore, keeping in view the importance of the crop, seriousness of the disease, non-availability of suitable management practices and gaps in our knowledge abo.

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) [5].

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) [9].

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) [7]. 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 present investigation entitled "Effect of different levels of potassium and zinc application on growth and yield attributes of biofortified pearl millet [*Pennisetum glaucum* (L.) R. Br.] under medium black calcareous soils of south Saurashtra region of Gujarat" was carried out during summer season of 2020 at Instructional Farm, College of Agriculture, Junagadh Agricultural University, Junagadh. The soil of the experimental field clayey in texture and alkaline in reaction (pH of 8.06 & EC of 0.41 dS m-1). The soil was medium in available nitrogen (254 kg ha-1), medium in available phosphorus (44 kg ha-1) and medium in available potash (250 kg ha-1), medium in iron (7.78 ppm), medium in zinc (0.51 ppm), medium in manganese (8.76 ppm) and medium in copper (0.33 ppm). The field experiment comprising total twelve treatment combination in which four levels of potassium *viz*., 0, 40, 60 and 80 kg K2O ha-1 and three levels of zinc *viz*., 0, 10 and 20 kg Zn ha-1 were laid out in Randomized Block Design having factorial concept with three replications. Pearl millet variety GHB-1129 a recommended variety for cultivation in summer season matures in 80-85 days. The fertilizer application was done with fixed doses of N and P was @ 120 and 60 kg ha-1, respectively. Half recommended dose of N and full of phosphorus were applied at the time of sowing. 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 source 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 experimental data recorded for growth and yield parameters were statistically analysed for level of significance.

Result and Discussion

Effect of Potassium Levels

Effect on growth attributes the growth attributes are significantly influenced by potassium application. The data (Table 1) revealed that Biometric parameters *viz*., plant height and total tillers per plant were significantly influenced by potassium levels. Significantly the highest values of these biometric parameters were observed with application of 80 kg K2O ha-1 (K3) in which plant height remained statistically at par with application of 60 kg K2O ha-1 (K2). While, significantly the lowest values were recorded under treatment K0 (control). The data summarized in Table - 1 revealed that significantly higher plant height (236 cm) and total tillers per plant (5.77) of pearl millet recorded at harvest with application of potassium K3 (80 kg K2O ha-1), while plant height remained at par with K2 (60 kg K2O ha-1) at harvest. Potassium plays a crucial role in meristematic growth through its effect on the synthesis of phytohormones. Among various plant hormones, cytokinin plays an important role in growth of plant. These results already collaborated reported by Kacha *et al*. (2011) [6], Sakarvadia *et al*. (2012) [20], Yadav *et al*. (2012) [13], Chauhan *et al*. (2017) [3].

Effect on yield and yield attributes

The yield attributes are significantly influenced by potassium application. The data revealed that the yield attributes and yield *viz*., effective tiller per plant, earhead length, earhead girth, test weight, grain yield and stover yield are presented in Table - 1. All parameters are significantly influenced by various levels of potassium. Application of 80 kg K2O ha-1 (K3) recorded significantly the highest effective tiller per plant (3.26), earhead length (29.17 cm), earhead girth (10.24 cm), test weight (6.65 g), grain yield (5716 kg ha-1) and stover yield (8575 kg ha-1). in which effective tiller per plant, earhead girth, test weight, grain and stover yield remained statistically at par with the application of 60 kg K2O ha-1 (K2). Significantly the lowest values for these yield attributes and yield was observed in treatment K0 (control). 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. The present findings are in close agreement with Kacha *et al*. (2011) [6], Sakarvadia *et al*. (2012) [10], Yadav *et al*. (2012) [13], Chauhan *et al*. (2017) [13].

Table 1: Effect of potassium and zinc application on growth, yield attributes and yield of pearl millet

Treatments	Plant height (cm)	Total tillers per plant	Effective tillers per plant	Earhead girth (cm)	Earhead length (cm)	Test weight (g)	Grain yield (kg/ha)	Stover yield (kg/ha)
Potassium levels (kg K2O ha-1)								
K0 – 00	215	4.33	2.72	26.43	9.71	5.85	4574	6861
K1 – 40	221	4.67	2.80	26.62	9.81	6.14	4948	7422
K2 – 60	229	4.83	2.97	27.16	10.13	6.37	5352	8028
K3 – 80	236	5.77	3.26	29.17	10.24	6.65	5716	8575
S.Em±	5	0.13	0.10	0.30	0.14	0.13	141	218
C.D. at 5%	15	0.38	0.30	0.89	0.42	0.37	413	640
Zinc levels (kg Zn ha-1)								
Zn0 – 00	218	4.63	2.73	26.84	9.73	5.94	4899	7349
Zn1 – 10	224	4.90	2.87	27.29	9.94	6.32	5180	7769

Zn2 – 20	234	5.18	3.21	27.90	10.25	6.50	5364	8046
S.Em±	4	0.11	0.09	0.26	0.12	0.11	122	189
C.D. at 5%	13	0.33	0.26	0.77	0.37	0.32	358	554
Interaction (K X Zn)								
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS
C.V.%	6.81	8.02	10.45	3.32	4.33	6.06	8.21	8.47

Effect of zinc levels

Effect on growth attributes

The growth attributes are significantly influenced by zinc application. The data revealed that Biometric parameters *viz*., plant height and total tillers per plant were recorded at harvest were significantly affected with zinc levels. Significantly the highest values of these parameters was observed with application of 20 kg Zn ha-1 (Zn2). Both the parameters remained statistically at par with application of 10 kg Zn ha-1 (Zn1). While all biometric parameters were significantly lowest under treatment Zn0 (control). The data summarized in Table -1 revealed that plant height and total number of tillers per plant of pearl millet at harvest were increased with increase in levels of zinc, where in Zn2 (20 kg Zn ha-1) recorded significantly higher plant height (234 cm) and total number of tillers per plant (5.18) of pearl millet at harvest, both remained at par with Zn1 (10 kg Z ha-1) at harvest. Zinc involves in the moisture stress and biosynthesis of indole acetic acid (IAA) which helps in better development of growth attributes. These results already in agreement with those reported by Shekhawat and Kumavat (2017) and Singh *et al*. (2017) [12].

Effect on yield and yield attributes

The yield attributes are significantly influenced by zinc application. The data revealed that the yield attributes and yield *viz*., effective tiller per plant, earhead length, earhead girth, test weight, grain yield and stover yield were presented in Table - 1. All parameters were significantly influenced by various levels of zinc. Application of 20 kg Zn ha-1 (Zn2) recorded significantly highest effective tiller per plant (3.21), earhead length (27.90 cm), earhead girth (10.25 cm), test weight (6.50 g), grain yield (5364 kg ha-1) and stover yield (8046 kg ha-1), in which earhead length, earhead girth, test weight, grain and stover yield remained statistically at par with the application of 10 kg Zn ha-1 (Zn1). Significantly lowest values for these yield attributes and yield was observed in treatment Zn0 (control). Zinc improved the yield attributes by improving the source and sink relation due to increased translocation of photosynthates towards reproductive system. The present findings are in close agreement with Mehta *et al*. (2008) [8], Singh *et al*. (2017) [12] and Shekhawat and Kumavat (2017).

Conclusion

On the basis of findings of the present investigation it can be concluded that significantly the highest grain and stover yield, biometric parameters and yield attributes after harvest of pearl millet crop (summer, Variety GHB-1129) were obtained from fertilizing the crop with potassium 80 kg K2O ha-1 (K3) and zinc 20 kg Zn ha-1 (Zn2) in medium black calcareous soils of south Saurashtra region of Gujarat.

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