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Effect of potassium on soil fertility, yield and quality of pearl millet in inceptisol

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Abstract
A field experiment was conducted at Research Farm, Department of Soil Science and Agriculture Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during kharif season 2014-2015. The soil of experimental field was clayey in texture, moderately high in available nitrogen, moderate in available phosphorus, rich in available potassium with slightly alkaline in reaction. Five treatments with various combinations of fertilizer were compared with each other in Randomized Block Design with four replications. The treatments were- 1) NF (no fertilizer)), 2) RDF (recommended dose of fertilizer, 60:30:00 kg ha^{-1}), 3) RDF+15k$_2$O (60:30:00 + 15 kg K$_2$O ha^{-1}), 4) RDF+30k$_2$O (60:30:00 + 30 kg K$_2$O ha^{-1}), 5) RDF+45k$_2$O (60:30:00 + 45 kg K$_2$O ha^{-1}). Treatments were compared to evaluate the effect of different fertilizer levels on growth, yield and economics of pearl millet. Experiment results revealed that fertilizer treatments significantly influenced the growth and yield of pearl millet.
Maximum grain yield (16.90 kg ha^{-1}) was recorded with RDF+45k$_2$O. The second best treatment in this regard was RDF+30k$_2$O with grain yield of 16.60 kg ha^{-1}. Maximum potassium use efficiency (12.63 kg kg^{-1}) was recorded with RDF+30k$_2$O. The second best treatment in this regard was RDF+45k$_2$O with grain yield of 9.08 kg kg^{-1}. Both of these treatments were statistically similar with each other.
In nutshell it can be inferred that the treatments which received the fertilizer at the rate of 60:30:45 NPK kg ha-1 and 60:30:30 NPK kg ha^{-1}, both being at par with each other, improved the soil fertility status and profitability of the pearl millet crop.

Keywords: Pearl millet, potassium

1. Introduction
Soil fertility and its evaluation is one area which needs immediate attention since it is now established that an arrest in the productivity of several crops is due to ever decreasing soil fertility on one hand and an imbalanced application of plant nutrients on the other. The deficiency of several major and minor plant nutrients such as K, S, Ca, Zn. Fe and B are emerging in time and space (Srinivasa Rao, 2010; Srinivasa Rao and Vittal, 2007; Srinivasa Rao *et al*. 2010, 2007, 2003, 2000a, b, c) [1-5].
Among the essential plant nutrients, potassium assumes greater significance since it is required in relatively larger quantities by plants and besides increasing the yield, it immensely improves the quality of the crop produce. Although a part of this K gap is expected to be bridged from non-chemical sources like organic manures like composts, vermicompost and biological processes, still there is a distinct gap in nutrient removal and supply leading to nutrient mining from the native soil posing a serious threat to long term sustainability of crop production furthermore, the country like India can hope to achieve and sustain the desired level of agricultural production in the long run only if we can bridge the gap between nutrient removal and addition. Therefore, understanding the present status of K use and removal and the resultant K balances with varied agro-climatic conditions enable us for undertaking the corrective measures to bridge the nutrient gap and help to maintain soil health and ensure the food and nutritional security of present and future generations (Satyanarayana, 2010) [6]. In addition, the growing concern about poor soil health and declining factor productivity or nutrient use efficiency has raised concern on the productive capacity of agricultural systems in Maharashtra, especially in Vidarbha region.
Agriculture in Vidarbha region of Maharashtra state is mostly rainfed. In rainfed crops, the importance to K fertilization is not given the attention it deserves, despite significant economic benefits that can be obtained. This is because of farmer's lack of knowledge as well as their reluctance to increase inputs, given the uncertainty of crop cultivation in rainfed conditions. Moreover, as optimal K nutrition is of particular benefit to crops in providing drought tolerance during intermittent dry spells in the rainfed environment, application of K may introduce additional benefits to farmers, beyond remedying the deficient soil K status.
Pearl millet (*Pennisetum glaucum* (L.)) is one of the major coarse grain crop, and is consider

to be a poor man's food. In Vidarbha region, this crop is mostly identified as contingent crop. In Asia it is an important cereal crop of India, Pakistan, China, and south eastern Asia. Pearl millet grains contain about 11.6% protein, 5% fat, 67% carbohydrates and about 2.7% minerals. Its importance can't be ignored because it is the most drought tolerant and has the highest water use efficiency under drought stress.

When ICTP-8203, an open-pollinated variety of pearl millet developed at ICRISAT in 1982 from selection within an iniadi landrace from northern Togo. ICTP-8203 is still cultivated on over 200,000 ha, mostly in Maharashtra, but also in Andhra Pradesh, Karnataka, Rajasthan and Uttar Pradesh. This variety was found to have the highest level of iron density.

Due to intensive cropping, continuous mining and limited use of K fertilizers, soils have begun to show response to K fertilizers along with N, P fertilizers. In view of the above, it was proposed to study the effect of various levels of potassium on soil frtility status, nutrient uptake, yield and quality of pearl millet. The present study examines the impact of increasing levels of K fertilization on productivity, nutrient uptake and quality of rainfed pearl millet in Vidarbha region of Maharashtra state.

2. Material and Methods

A field experiment was conducted during *kharif* season of 2014-15. The field experiment was carried out at the Research farm of the, Department of Soil Science and Agricultural Chemistry, Dr.Panjabrao Deshmukh Krishi Vidyapeeth, Akola.

Akola is situated in the subtropical region at $22^0 42'$ North latitude and 77^0 02' East longitudes and at an altitude of 307.42 m (Agromet observatory) above mean sea level. The climate of Akola is semi-arid and characterized by three distinct seasons viz., hot and dry summer from March to May, warm and rainy monsoon from June to October and mild cold winter from November to February. Average annual precipitation was 740 mm (Average of 30 years). During crop growing period, the actual maximum temperature was 34.2^0C during the hottest month of September while the minimum temperature was 9.8^0C in the coldest month of December. The mean daily evaporation reaches as high as 5.7 mm in the month of September and was 2.6 mm in the month of July. The mean wind velocity varies from 11.6 km hr^{-1} during August to 0.8 km hr^{-1} during October. Relative humidity attains the maximum value (89-95%) during July-August and the minimum (21-76%) during December January.

The experimental site was fairly leveled and uniform in depth and topography. In order to know the soil fertility status of the experimental site, the soil samples from 15 to 30 cm depth were randomly collected from different locations of the experimental field before the start of the experiment and a composite sample was prepared and analyzed for various soil properties. The methods adopted to determine the important initial properties and data pertaining to them are presented in Table 1.

Table 1: Physical and chemical properties of experimental soil at the start of experiment

Sr. No.	Soil properties	Value
1	pH	8.17
2	EC dSm^{-1}	0.28
3	Organic Carbon, kg kg^{-1}	4.82
4	Available N, kg ha^{-1}	151.1
5	Available P, kg ha^{-1}	12.88
6	Available K,kg ha^{-1}	307

The experiment was laid out in Randomized Block Design with five treatments each replicated four times. The treatments were allotted randomly in each replication. The gross plot size was 4.5 m x 8.85 m. The net plot size was 3.6 m x 5.85 m.

3. Result and Discussion

Table 2: Grain yield and straw yield of pearl millet as influenced by various treatments

Sr. No.	Treatments	Grain Yield (q ha^{-1})	Straw Yield (q ha^{-1})	KUE (kg kg^{-1})
1)	T1-Control	7.07	17.65	_
2)	T2-RDF(60:30:00)	12.81	28.83	_
3)	T3-RDF+ 15kg K_2O ha^{-1}	13.80	30.48	6.6
4)	T4-RDF+30 kg K_2O ha^{-1}	16.60	35.60	12.63
5)	T5-RDF+45 kg K_2O ha^{-1}	16.90	35.91	9.08
	SE(m)±	0.86	1.50	
	CD (5%)	0.258	4.512	

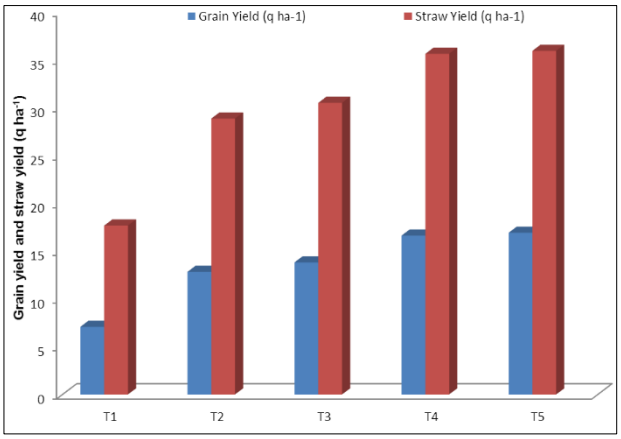

Fig 1: Grain yield and straw yield of pearl millet as influenced by various treatments

Grain yield

The data pertaining to the grain yield of pearl millet is presented Table 2.

The grain yield of pearl millet ranged from 7.07 to 16.90 q ha^{-1}. Significantly highest grain yield of 16.90 q ha^{-1} was registered with RDF+45kg K_2O ha^{-1}.However, the grain yield (16.60 q ha^{-1}) received from the treatment T4,where the recommended dose of NPK (60:30:00),were applied with 30 kg K_2O ha^{-1}were found at par with T5(16.90 q ha^{-1}).

Grain yield of pearl millet obtained with lower dose of K_2O i.e. 15 kg K_2O ha^{-1} along with RDF (13.80 q ha^{-1}) was significantly lower than the grain yield received by the treatment T4 and T5 (16.60qha^{-1} and 16.90 q ha^{-1} respectively).Similar trend in the grain yield were also noted where only RDF i.e. 60:30:00 kg NPK ha^{-1}(12.81 q ha^{-1}) was given to the pearl millet. The grain yield were significantly reduced as the fertilizer K_2O dose were reduced from 45 kg K_2O ha^{-1} to no K_2O application. However,the grain yield received from the treatments T2 and T3 were found statistically at par. Significantly lowest grain yield was recorded in the treatment where no fertilizers were applied (T1).

Similar trend was also reported by Marschner (1995) [7] and Yadav *et al*. (2011) [8].

Straw yield

The data pertaining to the straw yield of pearl millet is presented Table 2.

The Straw yield of pearl millet ranged from 17.65 to 35.91 q ha^{-1} significantly highest straw yield (35.91 q ha^{-1}) was noted in the treatment of application of RDF (60:30:00kg NPK ha^{-1}) +45kg K_2O ha^{-1}(T5). However, the straw yield recorded in the treatment of application of RDF+30kg K_2O ha^{-1} i.e. T4 (35.60 q ha^{-1}) were found statistically at par with treatment T5.
Application of potassium in the tune of 15 kg K_2O ha^{-1} along with RDF i.e. T3 (30.48 q ha^{-1}) reported significantly lower straw yield as compaired to T4 and T5.
Significantly lowest straw yield (1765 q $ha^{-1)}$ was noted in the control treatment (T1).
These results are in conformity with Marschner (1995) [7], Almodares (2008) [9], Yadav *et al.* (2011) [8] and Singh and Majumdar (2012) [10].

Table 3: Quality parameter as influenced by various fertilizer treatments after harvest of pearlmillet

Sr. No.	Treatment	Ash content (%)	Crude protein (%)
1	T1-Control	0.3	6.70
2	T2-RDF(60:30:00)	0.5	7.53
3	T3-RDF+15kg K_2O ha^{-1}	0.8	9.12
4	T4-RDF+30kg K_2O ha^{-1}	1.1	9.60
5	T5-RDF+45kg K_2O ha^{-1}	1.3	10.65

Sr. No.	Treatment	Starch content (%)	Test weight(g)
1	T1-Control	56	11.24
2	T2-RDF(60:30:00)	58	12.93
3	T3-RDF+15kg K_2O ha^{-1}	59	12.95
4	T4-RDF+30kg K_2O ha^{-1}	61	12.99
5	T5-RDF+45kg K_2O ha^{-1}	65	13.07

Effect of potassium fertilization on Ash content
The data pertaining to the ash content of pearl millet in presented Table 3.
The highest ash content (1.3%) was recorded in the treatment where recommended dose of fertilizer (60:30:00 kg NPK ha^{-1}) were combined with 45 kg K_2O ha^{-1} i.e.T5,followed by the treatment of application of RDF + 30 kg K_2O ha^{-1} i.e. T4 (1.1%).
The lowest ash content was noted in control treatment where no fertilizers were applied. As the potassium fertilization increased from 0 to 45 kg K_2O the ash content were also increased with the increament of potassium application.
Similar trend of ash content was also reported by Abdulla *et al.* (1998) [11] and Singh *et al.* (2010) [12].

Effect of potassium fertilization on Crude protein
The data pertaining to the crude protein of pearl millet is presented in Table 3.
The highest crude protein (10.65%) was noted in the treatment where recommended dose of fertilizer (60:30:00 kg NPK ha^{-1}) were together with 45 kg K_2O ha^{-1} i.e.T5, followed by the treatment of application of RDF (60:30:00) + 30 kg K_2O ha^{-1} i.e. T4 (9.60%)
The lowest crude protein was reported in control treatment where no fertilizers were applied. As the potassium fertilization increased from 0 to 45 kg K_2O the crude protein were also increased with the increased potassium application.
Similar trends of crude protein was also noted by Selma *et al.* (2001) [13] and Kharade *et al.* (2010) [14].

Effect of potassium fertilization on Starch content
The data pertaining to the starch content of pearl millet is presented in Table 3. The highest starch content (65%) was recorded in the treatment where recommended dose of fertilizer (60:30:00 kg NPK ha^{-1}) were combined with 45 kg K_2O ha^{-1} i.e.T5,followed by the treatment of application of RDF + 30 kg K_2O ha^{-1} i.e. T4 (61%).However the starch content were reduced numerically as the potassium application was reduced.
The lowest starch content was noted in control treatment where no fertilizers were applied. As the potassium fertilization increased from 0 to 45 kg K_2O the starch content were also increased with the increased potassium application.
Similar trend of starch content was also reported by Abdulla *et al.* (1998) [11] and Kharade *et al.* (2010) [14].

Effect of potassium fertilization on Test weight
The data pertaining to the test weight of pearl millet is presented in Table 3.
The highest test weight (13.07 g) was noted in the treatment where recommended dose of fertilizer (60:30:00 kg NPK ha^{-1}) with 45 kg K_2Oha^{-1} i.e.T5, followed by the treatment of application of RDF (60:30:00) + 30 kg K_2O ha^{-1} i.e. T4 (12.99 g).
The lowest test weight was reported in control treatment where no fertilizers were applied. As the potassium fertilization increased from 0 to 45 kg K_2O the test weight were also increased with the increased potassium application
Similar findings were also reported by, Sarma (1993) [16], Brar *et al.* (2007) [17], Khushwaha *et al.* (2007) [18], Yadav (2007) [21] Paramasivan *et al.* (2012) [19] and Yadav (2012) [20].

4. Conclusion
From the above observations it is conclude that, significantly highest grain, straw yield,KUE, and quality parameters of pearl millet were recorded by the applications of RDF(60:30:00 NPK kg ha^{-1}) along with 45 kg K_2O ha^{-1}.However the grain, straw yield,KUE, and quality parameters were at par with RDF(60:30:00 NPK kg ha-1) along with 30 kg K_2O ha^{-1}.

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