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Effect of Nitrogen and Zinc Levels on Growth, Yield and Economics of Pearl Millet (*Pennisetum glaucum* L.)

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Abstract

The field investigation entitled "Effect of nitrogen and zinc on growth, yield and uptake of Pearl millet (*Pennisetum glaucum* L.)" was conducted during *kharif* seasonof 2016-2017 at Agronomy Farm, COA, Latur. The experiment was laid out in Factorial Randomized Block Design with two factors and replicated thrice. Whereas first factor comprises levels of nitrogen *viz*. 0 (control), 45, 60 and 75 kg N ha^{-1} and second factor levels of zinc *viz*. 05, 10 and 15 kg Z ha^{-1}. The recommended dose of fertilizer was applied at time sowing (60:30:30 NPK kg ha^{-1} where N applied as per treatments). Processed seed sample were digested and N was determined by micro kjeldahal method as advocated by Piper (1966). Nitrogen content was calculated by multiplying N content by the factor 6.25. The application of nitrogen @ 75 kg N ha^{-1} recorded significantly higher growth and yield attributes, gross monetary return, net monetary return and B:C ratio over the rest of the levels of nitrogen. Whereas NMR was remained at par with 60 kg N ha^{-1}. The application of zinc @ 15 kg Z ha^{-1} produced significantly higher growth and yield attributes, gross monetary return, net monetary return and B: C ratio over the rest of the levels of zinc. Whereas, NMR was remained at par with 10 kg Z ha^{-1}.

Keywords: Growth, yield, economics, pearl millet, nitrogen, zinc

1. Introduction

Pearl millet (*Pennisetum glaucum* (L) is world's sixth and India's fourth important cereal food crop after rice, wheat and maize. It is commonly known as pearl millet, cat tail, spiked or bulrush millet and locally known as Bajara.Pearl millet is not only a quick growing short duration crop, but also a high tillering, drought and heat tolerant and well adapted to different soil types. Its propensity for high dry matter production at high temperature has made a mark in tropics and sub-tropics. It is a drought resistant cereal having maximum potentiality of grain production in adverse conditions. The share of Pearl millet in total food grain production is to the tune of 10.7 %. Pear millet is an annual tillering diploid (2n=14), belongs to family *gramineae*and subfamily *Peniceidae.* It is believed to be originated in Africa, where, the greatest diversity of morphological types exists.

In India, Pearl millet occupies an areas of 7.8 mha with production of 9.25 mt and productivity of 1270 kg ha^{-1} (Anonymous, 2016). The major growing states in India are Rajasthan, Maharashtra, Gujarat, Punjab, Haryana and Utter Pradesh where, it is grown both in *Kharif* and *summer* seasons. In Maharashtra, The crop is grown in the hilly and dry areas of the central plateau on poor soils in the districts of Beed, Nasik, Dhule, Satara, Pune, Sangli, Aurangabad, Solapur, Jalgaon and Ahmadnagar. In Maharashtra, pearl millet covers an area of 1035 thousand hectares producing 1123 thousand tones with productivity of 1086 kg ha^{-1} (Anonymous, 2016).

The nutritive value of grains of pearl millet is fairly high and used for human consumption. It contains about protein (9-15%), fat (5%) and mineral matters (2-7%). It is also rich in vitamins A and B, thiamin, riboflavin contents and imparts substantial energy to the body digestibility. Apart from grain, the forage and Stover is an important secondary product for resource poor farmer that can be used as animal feed and fuel.Pearl millet a tropical cereal and most drought resistant crop is extensively grown in the arid and semi-arid regions of the world (Fageria, 1992). Amongst the major cereals, pearl millet is highly tolerant to heat and drought, to saline and acid soils and is easy to grow in arid regions where rainfall is not sufficient for maize or even sorghum (FAO, 2004).

Pearl millet is nutritionally superior to maize and rice and it is known as a "high-energy" cereal with a 70% starch in the dry grain. Its protein content of 16% is higher than in maize with a good balance of amino acids. Further, it contains 5-7% fat, which is greater than the values in most maize varieties; and it is particularly high in calcium and iron. It has low contents of fiber and most vitamins, whereas it is rich in vitamin A (NRC, 1996; DeVries and Toenniessen, 2001). Mineral nutrition considered the limiting factor for plant productivity (Clark, 1990). Nitrogen is essential for plant growth and is known to be present in proteins, nucleic acids and chlorophyll. Adequate N nutrition is required for full development of tillers and leaves and also enables the plant to operate at peak photosynthetic capacity. N is the major nutrient required by pearl millet and has shown variable growth and yield response to N application (Gascho et al., 1995). Generally, pearl millet has been known for growing under low N management (Gascho et al., 1995) but, several studies showed that N application can increase millet production efficiency (Ayub et al., 2009; and Manan et al., 2006).

Hence, keeping in the view, the importance of nitrogen and zinc, the present investigation "Zinc is essential for the normal healthy growth and reproduction of plants (Marschner, 1995). When the supply of available zinc to the plant is inadequate, not only crop yields will be reduced but also the quality of crop products for use as food or feed can be expected to be sub-optimal. In plants, zinc plays a key role as a structural constituent or regulatory co-factor of a wide range of different enzymes in many important biochemical pathways. Zinc deficiency in the plant retards development and maturation of the panicles of grain crops (Alloway, 2004). As in soils and plants, Zn deficiency is also a common nutritional problem in humans, predominantly in developing countries where diets are rich in cereal-based foods and poor in animal products (Cakmak *et al.,* 1999). Enhancing Zn in plant derived food is one of the way to improve human health in developing countries where and when the local population cannot afford food sources from which zinc can be taken up easily in large enough quantities in the human gut.

2. Materials and Methods

The field investigation entitled "Effect of nitrogen and zinc on growth, yield and uptake of Pearl millet (*Pennisetum glaucum*L.)" was conductedduring kharif seasonof 2016-2017 at Experimental Farm, Agronomy Section, College of Agriculture, Latur. The experimental field was leveled and well drained.). The soil was medium and black in colour with good drainage. The soil was clayey loam in nature and slightly alkaline (7.8) in reaction, low in nitrogen (118.86 kg ha^{-1}), and medium in available phosphorus and rich in available potassium (485.89 kg ha^{-1}). The environmental conditions were favorably congenial for normal growth and maturity of pearl millet crop.

The experiment was laid out in Factorial Randomized Block Design with two factors and replicated thrice. Whereas first factor comprises levels of nitrogen viz. 0 (control), 45, 60 and 75 kg N ha^{-1} and second factor levels of zinc viz. 05, 10 and 15 kg Z ha^{-1}. The experimental site having gross and net plot size was 5.4×4.5 m^2 and 4.5×3.6 m^2 respectively. The recommended dose of fertilizer was applied at time sowing (60:30:30NPK kg ha^{-1} where N applied as per treatments). The sowing was done on 22nd June 2016 by dibbling and harvested on 1st oct 2016. All the cultural practices were followed as per package of practices. The yield data for grain and straw yield for all plots were collected at the end of experimentation. Processed seed sample were digested and N was determined by micro kjeldahal method as advocated by Piper (1966). Nitrogen content was calculated by multiplying N content by the factor 6.25. The fertilizers are applied as per treatments before sowing. The recommended cultural pratices and plant protection measures were under taken as per recommendation.

3. Results and Discussion

3.1. Growth parameters

The growth parameters such as plant height, number of tillers, dry matter production, leaf area are presented in Table 1. The higher plant height was recorded with the application of nitrogen @ 75 kg ha^{-1} found to be at par with nitrogen @ 60 kg ha^{-1} and found to be significantly superior over control at all growth stages except at 30 DAS. The results are confirmed by Chaudhari et al. (2002); Prasad et al. (2014).

Table 1: Effect of nitrogen and zinc levels on growth attribute

Treatments	Plant height (cm)	No. of tillers plant^{-1} at 45 DAS	Dry matter plant^{-1}	Leaf area (dm^2)	Leaf area index (%)
Levels of nitrogen (kg ha^{-1})					
N_0: 00	157.82	2.76	26.88	5.64	0.84
N_1: 45	169.93	3.11	43.30	6.15	0.91
N_2: 60	170.84	3.48	49.40	6.95	1.03
N_3: 75	179.03	3.68	52.62	7.17	1.06
SEm±	3.20	0.083	0.92	1.3	
CD (p=0.05)	9.52	0.24	3.09	4.02	
Levels of zinc (kg ha^{-1})					
Z_1: 05	152.07	3.12	40.98	6.20	0.92
Z_2: 10	160.59	3.23	43.59	6.61	0.98
Z_3: 15	164.20	3.44	44.59	6.62	0.98
SEm±	2.81	0.071	0.91	1.1	
CD (p=0.05)	8.25	0.21	2.68	3.40	
Interaction (N×Z)					
SEm±	5.6	0.14	1.83	2.30	
CD (p=0.05)	NS	NS	NS	NS	
General mean	158.95	3.20	43.05	6.48	0.96

The number of tillers plant^{-1} were significantly increased with an increased in fertilizer level. The maximum tillers number plant^{-1} was found with N_3 level (75 kg N ha^{-1}) as at 45 DAS and thereafter, decreased. This may be due to mutual competition among the plants for light, nutrients and other growth input resulting in mortality of tillers after 45 DAS. Increase in nitrogen levels in general, increased the number of tillers significantly probably due to increasing the production of new meristemetic tissues. Increase in number of tillers due to application of nitrogen has also been reported by Yadav et al. (1991), Mesquita and Pinto (2000); Prasad et al. (2014).

The effect of nitrogen application on crop dry matter accumulation was influenced at all growth stages. The highest value of dry matter (52.62 kg) was recorded with application of 75 kg nitrogen (N3 level 75 kg N ha^{-1}). Similar result also reported by Heringer and Moojen (2002); Singh et al. (2000).

3.2. Yield parameters

The yield contributary attributes viz., Grain yield kg ha$^{-1,}$ no of ear head, ear head length, weight of grain plant-^{1}, ear head weight were significantly influenced with various levels of nitrogen and zinc and presented in Table 2.

Application of nitrogen @ 75 kg ha^{-1} (1892 kg ha^{-1}) was found to be significantly superior @ 45 kg N ha^{-1} (1354 kg ha^{-1}) and control (1247 kg ha^{-1}). However, it was at par with @ 60 kg N ha^{-1}.The finding of present investigation corroborates with the findings of Yakadri and Reddy (2009).Pearl millet yield results of various yield attributes and was significantly affected by zinc application. The maximum grain yield (1892.00 kg ha^{-1} was recorded with Z_3 (15 kg N ha^{-1}). This is in agreement will the finding of Yadav et al. (1991), Tukkur et al. (1988), Zong XuFung et al. (2011) and Prasad et al. (2014). Number of ear head plant^{-1} (1.73) was found to significantly increase with application of 75 kg of nitrogen. This finding corroborates the finding of Mcsquitas and Pinto (2000), Prasad et al. (2014)

Number of ear head plant^{-1} was found to significantly increase with increasing level of Zinc. The maximum number of ear head plant$^{-1\ (1.47)}$ was recorded at Z_3 level (15 kg Z ha^{-1}), it remained significantly higher than that of lower levels of zinc and this consequently led to more number of ear head bearing tillers and ear head. Significant increase in number of ear head plant^{-1} with increasing levels of zinc was also recorded by several workers Jain et al. (2001), Sharma et al. (2008); Prasad et al. (2014).

The nitrogen level 75 kg ha^{-1} recorded higher grain weight ear head (22.03 g) which is significantly higher than lower nitrogen levels and minimum Grain weight ear head (12.21) was recorded with 0 kg N ha^{-1}. However nitrogen level 60 kg ha^{-1} statistically at par with 75 kg ha^{-1} level. The lower weight of grain plant^{-1} was recorded by control treatment.Similar results were recorded by Alkaff and Saeed (2007) and Verma et al. (2006). The data clearly indicates that the zinc levels were significantly influenced the grain weight ear head. The zinc level 15 kg Z ha^{-1} and 05 kg ha^{-1} had the maximum (18.31 g) and the minimum (16.80 g) Grain weight ear head, respectively. This agreement will finding of Sammauria et al. (2010)

Table 2: Effect of nitrogen and zinc levels on yield and economics of pearl millet

Treatments	Grain yield kg ha^{-1}	No. of ear head plant^{-1}	Weight of grain plant^{-1} (g)	Ear head weight (g)	Ear head breadth (cm)	GMR (₹)	NMR (₹)
Levels of nitrogen (kg ha^{-1})							
N_0: 00	1247	1.16	12.21	13.96	6.90	29354	10475
N_1: 45	1354	1.30	14.94	30.44	8.80	31504	11868
N_2: 60	1833	1.42	20.95	33.93	9.26	41460	20870
N_3: 75	1892	1.73	22.03	36.42	9.68	42624	21736
SEm±	31.81	0.04	0.45	1.08	0.24	560.73	517
CD (p=0.05)	93.29	0.12	1.34	3.18	0.71	1424.00	1313.00
Levels of zinc (kg ha^{-1})							
Z_1: 05	1526	1.34	16.80	26.29	7.98	33999	15166
Z_2: 10	1583	1.40	17.50	29.80	8.90	36285	16281
Z_3: 15	1635	1.47	18.31	29.98	9.16	38422	17264
SEm±	27.55	0.03	0.39	0.94	0.21	484.60	447.83
CD (p=0.05)	80.79	0.09	1.16	2.75	0.61	1424.11	1313.34
Interaction (N×Z)							
SEm±	55.10	0.06	1.16	1.88	0.42	971.21	895.67
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS
General Mean	1581	1.40	17.53	28.69	8.68	36235	16237

The length of ear head increased significantly due to increase in the levels of nitrogen (75 kg N).

The length of ear head increased significantly due to increase in the levels of zinc. The increase in length of ear head at higher level of zinc (15 kg Zn) might be attributed to better nutrition of ear head primodia. Maximum length of ear head (19.57 cm) was recorded with Z_3 (15 kg Zn). These findings corroborate the finding of Sharma et al. (2008); Choudhary et al. (2003), Prasad et al. (2014). The nitrogen levels had significant effect on variations in ear head weight of pearl millet. The higher (36.42 g) ear head weight was recorded in nitrogen @ 75 kg ha^{-1}level which is significantly higher in compare to 60 kg N ha^{-1} (33.93 g), 45 kg ha^{-1} (30.44 g) and control. . However nitrogen level 60 kg ha^{-1} statistically at par with 75 kg ha^{-1} level. The lower ear head weight was recorded by control treatment.

The maximum (29.98 g) ear head weight was recorded by (15 kg Zn ha^{-1}) and the minimum (26.29 g) ear head breadth was recorded 05 kg Zn ha^{-1}. However application of zinc @ 10 kg ha^{-1} was found to be at par with application of Zinc @ 15 kg ha^{-1}.

3.3. Economics

Net monetary returns, benefit cost ratio of pearl millet was significantly influenced by different levels of nitrogen and zinc. Application of nitrogen 75 kg ha^{-1} (21736 kg ha^{-1} recorded significantly higher net monetary returns than control (10475 kg ha^{-1}). However, it was at par with nitrogen 60 kg ha^{-1} (20870 kg ha^{-1}). Application of zinc @ 15 kg ha^{-1} (17264 kg ha^{-1}) recorded significantly higher net monetary returns than zinc @ 05 kg ha^{-1} (15166 kg ha^{-1}). But if was at par with application of zinc @ 10 kg Zn ha^{-1} (16281 kg ha^{-1})

Application of nitrogen @ 75 kg ha^{-1}, highest benefit cost ratio was recorded (1.04) as compared to nitrogen @ 60 kg ha^{-1} (1.01), 45 kg ha^{-1} (0.60) and control (0.55) recorded lowest benefit cost ratio than rest of nitrogen levels. Application of zinc @ 15 kg ha^{-1}, highest benefit cost ratio was recorded (0.80) as compared to zinc 10 kg ha^{-1} (0.81) and 05 kg ha^{-1} (0.80) recorded lowest benefit cost ratio over rest of zinc levels.

4. Conclusion

Application of nitrogen (75 kg N ha^{-1}) and zinc (15 kg Zn ha^{-1}) resulted highest grain yield of 1892.00 kg N ha^{-1}, net return (₹ 21736 ₹ ha^{-1}) as well as B:C ratio of 1.04 %.

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