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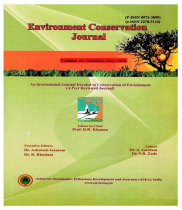

Impact of Zinc levels and sowing dates on Pearl Millet (*Pennisetum glaucum* L.)

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ABSTRACT

A field experiment was conducted at Central Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj, (U.P.) during *Zaid*-2020 to study about the impact of Zinc levels and sowing dates on the crop Pearl Millet. The soil of experimental site was sandy loam in texture and nearly neutral in soil reaction. The experiment was laid out in randomized block design and having nine treatment consisted of sowing dates *viz.*, D_1 (Sowing date of April 24th), D_2 (Sowing date of May 02nd), D_3 (Sowing date of May 11th) and Zinc *viz.*, Z_1 (15 kg/ha), Z_2 (20 kg/ha), Z_3 (25 kg/ha) which were replicated thrice and the impact was observed on Pearl Millet crop. The result revealed that, application of Zinc at 25kg/ha with the sowing date of May 11th recorded significantly higher plant height (215.97 cm), Dry weight (110.87 g), number of leaves/plant (15.9), Test weight (7.73 g), Grain yield (2.42 t/ha), Stover yield (7.62), net returns (₹ 67,293) and B:C ratio (2.84)

Introduction

Pearl millet (*Pennisetum glaucum* L.) is multipurpose cereal crop belongs to the Poaceae family. It is commonly called as Bajra, Bajri, Sajje, Kambu, Kamban, Sajjaluetc in variour Indian local languages. It is commonly used for food, feed, and forages purpose. Pearl millet, a tropical cereal and the world's most drought-resistant crop, is widely farmed throughout the world's dry and semi-arid regions (Fageria, 1992). Pearl millet is one of the most heat and drought tolerant cereals, as well as tolerant to saline and acid soils, and is easy to cultivate in dry places where rainfall is insufficient for maize or even sorghum (FAO, 2004). India produces over half of the world's pearl millet, accounting for 42% of global output (FAO, 2006). The fibre and most vitamins are low in pearl millet, although it is high in vitamin A. (NRC, 1996; DeVries and Toenniessen, 2001). Pearl millet is grown on 7.8 million hectares in India, with a yield of 9.25 million tonnes and a productivity of 1270 kg per hectare (Anonymous, 2016). Rajasthan, Maharashtra, Gujarat, Uttar Pradesh, and Haryana are the primary pearl millet farming states, accounting for more than 90% of the country's pearl millet acreage (Yadav, 2011). Zinc is required for plant development and reproduction to be normal and healthy (Marschner, 1995). Grain crop panicle growth and maturity are slowed by zinc deficiency in the plant (Alloway, 2004). Zinc is a necessary component for crop production and plant development (Ali *et al.*, 2008; Graham *et al.*, 2001). It increases growth hormone biosynthesis, starch creation, and grain production and maturation (Brady and Weil, 2002).

Pearl millet planting time recommendations are frequently depending on the calendar day or soil temperature (Andrews *et al.*, 1998). The delay in seeding resulted in lower results for all metrics (Iping, 1997). Yield may be boosted by identifying higher producing cultivars and planting at the right time (Khan *et al.,* 2009 and Arif *et al.*, 2001). The millet sowing date for direct planting has a big

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impact on how fast it grows and how much it yields (Farrell *et al.*, 2003). Planting crops on time allows for adequate root development and vegetative growth, allowing for the most efficient use of available soil nutrients and radiant energy (Soler *et al.*, 2008). As a result, in order to have a nice and healthy crop development, we must know when to sow Pearl millet.

Keeping these point in view, an experiment was conducted to find out the appropriate level of Zinc and date of sowing for maximizing the yield of Pearl Millet.

Material and Methods

P The experiment took place in the Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Science (SHUATS), Prayagraj, during the Zaid season of 2020. (UP). The Crop Research Farm is located at 25.57 degrees north latitude, 87.19 degrees east longitude, and 98 metres above mean sea level. The experiment was set up in a randomised block design that was repeated three times. The treatment comprised of three sowing dates noted as D_1 (Sowing on April 24), D_2 (Sowing on May 02) and D_3 (Sowing on May 11) and three Zinc levels Z_1 (15 kg per ha Zinc), Z_2 (20 kg per ha Zinc), Z_3 (25 kg per ha Zinc) through surface application and the possible combinations. During the developing season, the mean week by week most extreme and least temperature, relative humidity and rainfall were 36.60 ^{o}C, 24.90 ^{o}C, 76.40 %, 48.48 % and 4.72 mm, respectively. The Pearl millet variety 'Manipuri' was sown at a 40 cm X 10 cm spacing with a seed rate of 5 kg per hectare. On each of the sowing dates, the field was consistently watered one day before planting. The Recommended dose of fertilizer (RDF) i.e. Nitrogen (60 kg per ha) was applied in the form of Urea in two split doses, first as basal and the remaining dose at 45 DAS(Days after sowing), whereas full dose of Phosphorous (40 kg per ha) and full dose of Potassium (40 kg per ha) were applied through DAP(Di-ammonium Phosphate) and MOP (Murate of Potash). Zinc was applied in each plot according to the treatments before sowing of seed along with fertilizers during first split as basal. The recorded data were analysed statistically by ANOVA technique (Gomez and Gomez, 1984). Significant difference among the treatment mean was verified against the critical difference at five per cent level of significance. Relative economics was calculated as per the prevailing market prices of the inputs and produced during *Zaid* season.

Results and Discussion

Plant height

At 15 DAS, maximum plant height was recorded with application of 15 kg/ha Zinc with the sowing date of May 2nd (5.13 cm),there is no significant variance among the all the treatments. At 30 DAS, maximum plant height was recorded with application of 25 kg/ha Zinc with the sowing date of April 24th(10.23 cm), ,there is no significant variance among the all the treatments. At 45 DAS, maximum plant height was recorded with application of 25 kg/ha Zinc with the sowing date of May 11th (66.39 cm), which was considerably superior over all the treatments except 25 kg/ha Zinc with the sowing date of April 24th . At 60 DAS, maximum plant height was recorded with application of 25 kg/ha Zinc with the sowing date of May 11th (122.93 cm), which was considerably superior over all the treatments except 25 kg/ha Zinc with each the sowing date April 24th and May 2nd (Table 1). At 75 DAS, the greatest plant height was obtained with a 25 kg/ha Zinc application and a sowing date of May 11th (163.10 cm), which was considerably superior to all other treatments except 25 kg/ha Zinc with each of the sowing dates April 24th and May 2nd. At harvest, maximum plant height was recorded with application of 25 kg/ha Zinc with the sowing date of May 11th (215.97 cm), which was considerably superior over all the treatments except 25 kg/ha Zinc with the sowing date of May 2nd. Since Zinc is involved in the biosynthesis of Indole acetic acid (IAA), a growth hormone, involved in stem elongation, hence the increase in the plant height. Increase in plant height with sowing date of May 11th might have represented congenial weather conditions like prolonged photoperiod, optimum temperatures and sufficient amount of moisture levels at vegetative growth. Similar results were also observed by Prasad *et al.* (2014).

Dry weight

At 15 DAS, maximum dry weight was recorded with application of 15 kg/ha Zinc with the sowing date of May 2nd (0.17 g),there is no significant

Table 1 : Effect of Zinc levels and sowing dates on Plant height(cm) of Pearl millet

Treatment combination	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	At harvest
T_1: Sowing on April 24 + 15 kg/ha Zn (Control)	4.80	8.07	47.40	105.23	148.37	195.03
T_2: Sowing on April 24 + 20 kg/ha Zn	4.73	9.07	51.87	110.97	152.37	201.50
T_3: Sowing on April 24 + 25 kg/ha Zn	4.92	10.23	60.95	117.90	160.20	207.13
T_4: Sowing on May 2 + 15 kg/ha Zn	5.13	7.73	46.40	102.77	147.87	192.70
T_5: Sowing on May 2 + 20 kg/ha Zn	4.93	8.03	51.37	111.33	153.03	201.20
T_6: Sowing on May 2 + 25 kg/ha Zn	4.84	9.03	59.40	120.10	160.33	214.53
T_7: Sowing on May 11 + 15 kg/ha Zn	4.80	7.60	48.80	105.70	149.00	196.37
T_8: Sowing on May 11 + 20 kg/ha Zn	4.69	8.33	53.80	111.53	154.53	205.60
T_9: Sowing on May 11 + 25 kg/ha Zn	4.69	9.83	66.39	122.93	163.10	215.97
F-test	NS	NS	S	S	S	S
S.Ed.(±)	1.9930	0.8721	2.5819	2.5632	1.54	2.7905
CD at 5%	-	-	5.46	5.43	3.26	5.91

Table 2: Effect of Zinc levels and sowing dates on Dry weight(g) of Pearl millet

Treatment combination	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	At harvest
T_1: Sowing on April 24 + 15 kg/ha Zn (Control)	0.14	2.85	24.53	60.43	84.50	90.40
T_2: Sowing on April 24 + 20 kg/ha Zn	0.16	3.28	26.87	62.17	86.57	95.83
T_3: Sowing on April 24 + 25 kg/ha Zn	0.12	3.39	28.37	64.90	91.43	105.77
T_4: Sowing on May 2 + 15 kg/ha Zn	0.17	2.75	23.80	55.40	82.63	91.40
T_5: Sowing on May 2 + 20 kg/ha Zn	0.12	2.77	23.43	62.33	83.83	95.07
T_6: Sowing on May 2 + 25 kg/ha Zn	0.14	3.28	28.33	64.07	90.80	104.23
T_7: Sowing on May 11 + 15 kg/ha Zn	0.14	2.99	21.30	60.77	82.40	93.60
T_8: Sowing on May 11 + 20 kg/ha Zn	0.14	2.87	23.23	61.13	88.30	100.37
T_9: Sowing on May 11 + 25 kg/ha Zn	0.14	3.25	29.30	65.37	93.60	110.87
F-test	NS	NS	S	S	S	S
S.Ed. (±)	0.01	0.34	1.51	1.98	1.56	1.46
CD at 5%	-	-	3.20	4.21	3.31	3.10

variance among the all the treatments. At 30 DAS, maximum dry weight was recorded with application of 25 kg/ha Zinc with the sowing date of April 24th(3.39 g), there is no significant variance among the all the treatments. At 45 DAS, maximum dry weight was recorded with application of 25 kg/ha Zinc with the sowing date of May 11th (29.30 g), which was considerably superior over all the treatments except 20 kg/ha, 25 kg/ha Zinc with the sowing date of April 24th and 25 kg/ha Zinc with the sowing date of May 2nd. At 60 DAS, maximum dry weight was recorded with application of 25 kg/ha Zinc with the sowing date of May 11th (65.37 g), which was considerably superior over all the treatments except 20 kg/ha, 25 kg/ha Zinc with the sowing date April 24th and May 2nd each and 20 kg/ha Zinc with the sowing date of May 11th (Table 2). At 75 DAS, maximum dry weight was recorded with application of 25 kg/ha Zinc with the sowing date of May 11th (93.60 g), which was considerably superior over all the treatments except 25 kg/ha Zinc with each of the sowing date April 24th and May 2nd. At harvest, maximum dry weight was recorded with application of 25 kg/ha Zinc with the sowing date of May 11th (110.87 g), which was significantly superior over all the treatments. The significant increase in dry matter yield may be attributed to the higher photosynthetic rate. Zinc is a constituent of carbonic anhydrase (An enzyme promotes carbon dioxide assimilation pathway in C_4 cycle of photosynthesis) and there is direct relationship between carbonic anhydrase activity and photosynthetic carbon dioxide assimilation on growth of a plants. Carbonic anhydrase activity is closely related to Zinc content as such Zinc increases photosynthetic efficiency and thereby dry matter production. Similar results were observed by Andhale *et al.* (2007), Upadhyay *et al.* (2001), Jain *et al.* (2001), and Jakhar *et al.* (2006).

Number of leaves per plant

At 30 DAS, maximum number of leaves/plant was recorded with application of 25 kg/ha Zinc with the sowing date of May 11th (12.78),there is no significant variance among all the treatments. At 45 DAS, maximum number of leaves/plant was recorded with application of 25 kg/ha Zinc with the sowing date of May 11th (15.48), which was significantly superior among the all the treatments except 25 kg/ha with the sowing date of April 24th and May 2nd. At 60 DAS, maximum number of leaves/plant was recorded with application of 25 kg/ha Zinc with the sowing date of May 11th (18), which was considerably superior over all the treatments except 20 kg/ha, 25 kg/ha Zinc with the sowing date April 24th and May 2nd each and 20 kg/ha Zinc with the sowing date of May 11th (Table 3). At 75 DAS, maximum number of leaves/plant was recorded with application of 25 kg/ha Zinc with the sowing date of May 11th (17.1), which was considerably superior over all the treatments except 20 kg/ha, 25 kg/ha Zinc with each of the sowing date April 24th and May 2nd and 20 kg/ha Zinc with the sowing date of May 11th. At harvest, maximum number of leaves/plant was recorded with application of 25 kg/ha Zinc with the sowing date of May 11th (15.9), which was considerably superior over all the treatments except 20 kg/ha, 25 kg/ha Zinc with the sowing date April 24th and May 2nd each and 20 kg/ha Zinc with the sowing date of May 11th**.** Zinc treatment may have influenced the leaf count, which grew with crop age and peaked at 60 DAS due to a consistent supply of nutrients, moisture, and light, before declining. This might be due to ageing, death, or leaf drying. The increase in growth parameters of Pearl millets due to application of Zinc have also been reported by Dhaka (1984), and Maliwal *et. at.* (1985) and Singh (1989).

Effect on yield attributes and yield

Application of 25 kg/ha Zinc with the sowing date of May 11th, recorded maximum test weight (7.73 g), which was significantly superior to all the treatments except 25 kg/ha Zinc with each of the sowing date April 24th and May 2nd(Table 4). Also the application of 25 kg/ha Zinc with the sowing date of May 11th, recorded maximum grain yield (2.42 t/ha), which was significantly superior to all the treatments except 25 kg/ha Zinc with each of the sowing date April 24th and May 2nd and 20 kg/ha with the sowing date May 11th. Application of 25 kg/ha Zinc with the sowing date of May 11th, recorded maximum Stover yield (7.62 t/ha), which was significantly superior to all the treatments. Zinc improved the yield and yield attributes by improving the source and sink relation due to increased translocation of photosynthates towards reproductive system. The results are in agreement with those of Jan *et al.* (2015), Maurya *et al.* (2016).

Table 3: Effect of Zinc levels and sowing dates on Number of leaves/plant of Pearl millet

Treatment combination	30 DAS	45 DAS	60 DAS	75 DAS	At harvest
T_1: Sowing on April 24 + 15 kg/ha Zn (Control)	12.17	13.21	14.7	13.8	12.5
T_2: Sowing on April 24 + 20 kg/ha Zn	12.41	14.19	16.4	15.3	14.2
T_3: Sowing on April 24 + 25 kg/ha Zn	12.64	15.07	17.3	16.4	15.1
T_4: Sowing on May 2 + 15 kg/ha Zn	12.22	13.29	14.2	13.3	12.0
T_5: Sowing on May 2 + 20 kg/ha Zn	12.34	14.81	16.8	15.5	14.1
T_6: Sowing on May 2 + 25 kg/ha Zn	12.54	15.08	17.5	16.2	15.0
T_7: Sowing on May 11 + 15 kg/ha Zn	12.29	13.09	14.2	13.0	11.9
T_8: Sowing on May 11 + 20 kg/ha Zn	12.42	14.68	16.5	15.4	14.5
T_9: Sowing on May 11 + 25 kg/ha Zn	12.78	15.48	18.0	17.1	15.9
F-test	NS	S	S	S	S
S.Ed.(±)	0.54	0.26	1.04	0.90	0.86
CD at 5%	--	0.56	2.02	1.90	1.83

Table 4: Effect of Zinc levels and sowing dates on yield attributes, yield and economics of Pearl millet

Treatment	Test weight (g)	Grain yield (t/ha)	Stover yield (t/ha)	Net returns (INR/ ha)	B:C ratio
T_1: Sowing on April 24 + 15 kg/ha Zn (Control)	6.50	1.56	6.04	40,123	1.74
T_2: Sowing on April 24 + 20 kg/ha Zn	7.12	1.82	6.46	47,978	2.05
T_3: Sowing on April 24 + 25 kg/ha Zn	7.48	2.25	7.24	61,523	2.59
T_4: Sowing on May 2 + 15 kg/ha Zn	6.62	1.50	6.09	38,823	1.68
T_5: Sowing on May 2 + 20 kg/ha Zn	7.29	1.93	6.49	50,848	2.17
T_6: Sowing on May 2 + 25 kg/ha Zn	7.56	2.28	7.27	62,393	2.63
T_7: Sowing on May 11 + 15 kg/ha Zn	6.67	1.62	6.14	42,023	1.82
T_8: Sowing on May 11 + 20 kg/ha Zn	7.06	2.06	6.61	54,578	2.33
T_9: Sowing on May 11 + 25 kg/ha Zn	7.73	2.42	7.62	67,293	2.84

Economics

Higher Net return (INR 67,293) and B:C ratio (2.84) was obtained with the application of 25 kg/ha Zinc with the sowing date of May 11th (Table 4). Higher Net return in the given treatment was primarily due to higher seed and Stover yields obtained from Pearl millet.

Conclusion

Pearl Millet is generally a *Kharif* season crop but can also be grown during *Zaid* season as it consumes less water than the other cereal crops. So, for obtaining higher yield in Pearl millet during the late *Zaid* season, application of 25 kg/ha Zinc can be more beneficial than 15 kg/ha or 20 kg/ha Zinc. While in case of sowing date, mid-May period could provide more congenial weather condition (warm and humid i.e. better utilization of minerals and nutrients) to the Pearl millet crop than late April or May starting period.

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