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EFFECT OF NITROGEN AND ZINC FERTILIZER ON PEARL MILLET (*PENNISETUM GLAUCUM*) UNDER AGRI-HORTI SYSTEM OF EASTERN UTTAR PRADESH

S. K. PRASAD, M. K. SINGH[1]* AND RENU SINGH
Department of Agronomy, Institute of Agricultural Sciences,
Banaras Hindu University, Varanasi -221 005 (U.P.), INDIA
e-mail: manoj.agro@bhu.ac.in

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***Corresponding author**

ABSTRACT
A field experiment was conducted at RGSC farm of BHU, at Mirzapur (UP) during *kharif* season of 2010 with aim to find out suitable nitrogen and zinc fertilizer for pearl millet production under agri-horti system. The field experiment was laid out in a factorial randomized block design, with three replications, comprised with four nitrogen levels (0, 20, 40 and 60 kg N/ ha) and three levels of zinc (0, 5 and 10 kg Zn/ ha) with uniform rates of phosphorus and potassium at 40 and 30 kg/ha, respectively. Application of 60 kg N/ha and 10 kg Zn/ha recorded significant higher plant height, number of tillers, dry matter accumulation, number of panicle/plant, length of panicle, girth of panicle and yield. Grain/panicle and grain weight/panicle interact significantly with application of 40 kg N/ha × 10kgZn/ha. However, test weight interact significantly with 60 kg N/ha x 10kgZn/ha.

INTRODUCTION

Pearl millet (*Pennisetum glaucum* (L.) R. Br.), the world's hardiest warm season cereal crop (Reddy *et al.,* 2012). Globally it ranks sixth after rice, wheat, maize, barley and sorghum in terms of area (Khairwal *et al.,* 2007) and share 42% of total world production (*Ramesh et al.,* 2006). Pearl millet (*Pennisetum glaucum* [L.] R. Br.) is an indispensable arid and semi arid crop of India (Ramesh *et al.,* 2006) cultivated as dual purpose (food and feed) crop in over 8.3 m ha ranking fourth among total cereals (Yadav *et al.,* 2011). The recent spurt in prices of wheat, rice and maize and growing demand for non-food uses (cattle and poultry feed, alcohol and starch industries) pearl millet become cheaper alternative sources (Reddy *et al.,* 2013). Further, the nutritional value of these crops offers much scope to development of value added products in new health conscious consumer segments (Yadav *et al.,* 2011) as it contains more fibre and is good for diabetic and heart patients. Pearl millet is the richest sources of nutrition, especially iron, calcium and zinc among cereals and hence can provide all the nutrients at the least cost compared to wheat and rice (Parthasarathy Rao *et al.*, 2006)

Nitrogen 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 (Singh *et. al.,* 2010). Zinc is essential for the normal healthy growth and reproduction of plants (Marschner, 1995). Zinc deficiency in the plant retards development and maturation of the panicles of grain crops (Alloway, 2004) and also the inadequate application not only reduces the crop yields but also reduced quality of crop products.

Due to harsh and fragile ecology of arid and semi arid region, required to identify or develop economic and viable land use system. In such situation agri-horti system, particularly during initial 5-6 years have ample scope to exploit the interspaces of the fruit trees *viz*. guava and aonla for growing arable crops (Gill and Gangwar, 1992). The introduction of cereal crops with fruit tree have reported to mixed effect on crop production. The reduction of grain yield under agri-horticulture system was reported by Sharma and Chauhan (2003), however, Sharma *et al.,* (1996) observed that the crop yield increased with an increase of crop distance from the tree. Keeping the different view regarding cereals cultivation under the fruit crop, an experiment was conducted to assess the effect of nitrogen and zinc fertilizer on yield of pearl millet (*Pennisetum glaucum*) under agri-horti system of eastern Uttar Pradesh.

MATERIALS AND METHODS

The experiment was carried out during *kharif* season of 2011-12 at the Agronomy farm of Rajiv Gandhi South Campus, Barkachha (BHU) which is situated in *Vindhyan* region of district Mirzapur (25º 10′ N, 82º 37′ E, 427 m asl), India. The climate is typically semi-arid with temperature ranges from 10 to 45°C and rainfall during crop period was 550 mm. The soil samples were collected from the experimental plot and prepared a mixed soil samples then air-dried and sieved through a 2 mm sieve. The soil of the experimental site was sandy clay loam (Typic Ustochrept), 57.61, 19.39, 23.50% sand, silt, clay respectively, organic carbon 0.24%, soil pH 6.04, available NPK 179.45, 10.89, 190.40 kg/ ha, respectively and available Zn 4.74 mg/kg. The pearl millet cultivar 'Kaveri Super Boss' was sown with 45 × 15 cm spacing. The experiment was designed as randomized block design (factorial) with three replications. The plots were fertilized with four nitrogen levels: 0, 20, 40 and 60 kg N/ha and three zinc levels: 0 (without zinc), 5 and 10 kg Zn/ha with constant levels of phosphorus and potassium fertilization @ 40 and 30 kg/ ha, respectively. The plants were divided into stems, leaves and panicles and a representative sub-sample (about 10 % of fresh weight) was devoted to dry matter determination. The crop was harvested separately from the net plots, threshed and winnowed and thereafter grain and straw yields were recorded. The observation recorded from the field experiment were subjected to statistical analysis as per procedure of Gomez and Gomez (1984). Differences among means and treatments were compared by the least significant differences (LSD) at $p < 0.05$.

RESULTS AND DISCUSSION

Semi-arid region of India have characteristically low in soil fertility, particularly nitrogen (Rego *et al.*, 2003) and micronutrient (especially zinc), which becomes constrain in crop production and productivity (Rego *et al.*, 2003). Nitrogen and zinc fertilization significantly influenced various growth and yield attributes (Table 1) of pearl millet under agri-horti system. Growth and yield parameter has significantly differed with nitrogen and zinc fertilizer. Application of 60 kg N/ha recorded significant higher plant height, number of tillers and dry matter accumulation than the lower level of nitrogen (Table 1). Nitrogen is the main component of the protoplasm involves in various metabolic processes *viz.* photosynthesis (Corsi, 1995), stimulation of cell division and elongation (Ali, 2010). These leads to increase in dry matter accumulation, greater plant height and tillers per plant (Ayub *et al.*, 2009). This result was in conformity with the findings of Shahin *et al.* (2013). There was progressive increase in plant height, number of tillers and dry matter accumulation with zinc fertilizer. However, significant maximum number of tillers (1.72) was recorded with 10 kg Zn/ha, but it was at par with 5 kg Zn/ha. Zinc involves in biosynthesis of indole acetic acid (IAA) which helps in better development of growth attributes (Ganapathy and Savalgi, 2006). This result corroborates the finding of

Table 1: Effect of nitrogen and zinc fertilizer on growth, yields attributes and yield of pearl millet

Treatments	Plant height (cm)	No. of tillers/ plant	Dry matter (g/plant)	No. of panicle/ plant	Length of panicle (cm)	Girth of panicle (cm)	No. of grain/ panicle	Grain weight/ panicle (g)	Test weight (g)	Grain yield (kg/ha)	Biological yield (kg/ha)
Nitrogen levels (kg/ha)											
0	140.84	1.24	54.82	1.16	17.47	1.90	1302.47	10.73	6.25	1428.76	5842.05
20	146.82	1.42	66.79	1.30	20.94	2.19	1774.60	14.74	6.79	1760.77	6591.24
40	148.06	1.44	72.52	1.42	21.79	2.41	1780.44	16.81	9.25	1966.32	6880.93
60	159.86	2.16	82.43	1.73	23.37	2.79	1959.36	19.51	10.10	2109.70	6740.99
Zinc levels (kg/ ha)											
0	145.17	1.44	65.19	1.34	18.79	2.00	1484.26	13.62	6.94	1551.30	5749.12
5	149.89	1.54	70.39	1.40	21.53	2.30	1715.20	15.96	7.87	1858.28	6675.64
10	151.62	1.72	71.84	1.47	22.35	2.68	1913.20	16.77	9.49	2039.59	7116.65
Significance CD (p = 0.05)											
Nitrogen (N)	18.34	0.23	8.82	0.08	3.04	0.30	150.56	1.42	1.08	149.93	784.32
Zinc (Zn)	NS	0.19	NS	0.07	2.63	0.26	130.39	1.23	0.93	129.84	679.24
N × Zn	NS	NS	NS	NS	NS	NS	**	**	**	NS	NS

** Significant at 0.05 level, NS - not significant

Table 2: Integrated effects of nitrogen and zinc levels on number of grain and test weight (g) in pearl millet

Treatment	Number of grain per panicle Nitrogen levels (N) (kg/ha)				Test weight (g) Nitrogen levels (N) (kg/ha)			
Zinc kg/ha	0	20	40	60	0	20	40	60
0	1188.2	1489.47	1410.56	1848.80	4.72	5.67	7.39	9.98
5	1378.78	1759.41	1700.99	2021.60	6.61	7.18	7.57	10.10
10	1340.42	2074.92	2229.75	2007.68	7.45	7.50	12.77	10.21
CD (0.05) of interaction N × Z			225.84				2.13	

Table 3: Integrated effects of nitrogen and zinc levels on grain weight per panicle (g)

Treatment	Grain weight per panicle (g) Nitrogen levels (kg/ ha)			
Zinc kg/ha	0	20	40	60
0	9.42	13.33	16.17	15.55
5	11.04	15.11	17.39	20.27
10	11.73	15.77	16.87	22.71
CD at (0.05) of interaction N × Z			2.13	

Malik *et al*. (2011).

Yield attributes and yield was significantly influenced by nitrogen and zinc levels. Application of 60 kg N/ha recorded significantly higher number of panicle/plant, length of panicle, girth of panicle, number of grain/panicle, grain weight/panicle and test weight (Table 1). However, 40 kg N/ha was statistically at par with 60 kg N/ha in case of length of panicle and test weight (Table 1).The number of panicle/plant was varied from 11 to 33 per cent with nitrogen levels compared to control. Application of 60 kg N/ha leads to increase in panicle length and girth to the tune of 25.24 and 32.00 per cent, respectively, as compared to control. The improvement of yield attributes with progressive increase of nitrogen levels was also reported by Ali, (2010). Zinc levels significantly influenced yield attributes, *viz*., number of panicle/plant, length and girth of panicle, number and weight of grain/panicle. Application of 10 kg Zn/ha showed higher number of number of panicle/ plant, length and girth of panicle, but the number of panicle/ plant and panicle length was statistically at par with 5 kg Zn/ ha. Zinc improved the yield attributes by improving the source and sink relationship due to increased translocation of photosynthates towards reproductive system (Sammauria and Yadav, 2010).

There were progressive increases of both the grain and biological yield in response to increasing N supply with Zn treatment. Nitrogen and zinc fertilization had significant effect on pearl millet grain and biological yield with 60 kg N/ha and 10 kg Zn/ha fertilizer level (Table 1). Grain yield increased up to 32.27% and 31.0 % from 0 to 60 kg N/ha and 0 to 10 kg Zn/ha, respectively. Kennedy *et al.* (2002) also observed linear increase in grain yield of pearl millet with increased nitrogen levels. Actually, nitrogen is an integral part of protein and thus all enzymes (Arif *et al.,* 2006), whereas, zinc involve in many metallic enzyme system, regulatory functions and auxin production (Muthukumararaja and Sriramachandrasekharan, 2012). Thus, it is hypothesized that, application of both the fertilizers (N and Zn) at optimum levels synergistically improve the grain yield.

The significant interaction was observed between nitrogen and zinc levels with number of grain/ panicle and test weight (Table2) and grain weight/panicle (Table 3). The treatment 40 kg N/ha $\times$ 10 kg Zn/ha interact significantly and recorded maximum number of grain/panicle (2229.75), however, number of grain/panicle recorded at 20 kg N/ha x 10 kg Zn/ ha was statistically at par with 40 kg N/ha x 10kg Zn/ha. Similar trend was recorded with the test weight, where, maximum test weight (12.77g) was recorded with 40 kg N/ha $\times$ 10 kg Zn/ha. The grain weight/panicle was significantly interacted and recorded maximum grain weight (22.71g) with 60 kg N/ha $\times$ 10 kg Zn/ha. Nitrogen nutrition of plants appears to be synergistic with zinc, which may leads to increase in many physiological and molecular activities which in turn improve yield attributing characters (Cakmak *et al*., 2010).

Experimental findings indicate that application of nitrogen and zinc fertilizers bring significant change in crop growth (plant height, number of tillers, dry matter accumulation), yield attributes (number of panicle/plant, length of panicle, girth of panicle, number of grain/panicle, grain weight/panicle, test weight) and yield of pearl millet. Yield attributes of pearl millet, *viz*., number of grain/panicle, grain weight and test weight, were significantly influenced with variable levels of nitrogen and zinc fertilization.

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