Indian Journal of Agronomy **50** (2) : 167–169 (June 2005)

Effect of nitrogen and zinc on growth characters, herbage yield, nutrient uptake and quality of fodder sorghum (*Sorghum bicolor*)

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Received : February 2004

ABSTRACT

A field trial was conducted at the Livestock Research Centre of the Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, during the rainy (*kharif*) season of 2001 and 2002, to study the effect of nitrogen and zinc on growth, herbage yield, nutrient uptake and quality of herbage in fodder sorghum [*Sorghum bicolor* (L.) Moench]. Increase in nitrogen application from 0 to 120 kg /ha increased the green herbage yield (434.9 q/ha) and dry fodder (157.9 q/ha) of sorghum, being 35.8 and 43.1% higher over the control respectively. The crop responded up to 5 kg zinc/ha which increased the yield of green herbage 8.6% and dry fodder 11.5% over no zinc. Crude protein and digestible dry-matter yield were significantly higher at 120 kg N/ha than other N levels. Zinc also significantly responded up to 5 kg /ha in respect of quality. Almost similar trend was also observed in N and Zn uptake. The optimum dose for N and Zn were calculated to be 108.3 kg and 1.36 kg /ha and maximum yields were with the application of 126.67 and 5.53 kg/ha respectively.

Key words : Fodder sorghum, Nitrogen, Zinc, Growth, Yield, Quality, Nutrient uptake

The productivity and availability of good-quality herbage is most important to fulfil the feeding requirement of dairy cattle. The high-yielding variety of crop and agronomic techniques may be helpful to achieve this goal. In agronomic techniques, fertilizer management is the most important aspect. It includes proper application of macro - and micro-nutrients to get maximum quality forage in nutrient deficient soils. However, limited information relating to nitrogen and zinc is available on the yield and quality of fodder sorghum. Keeping these points in view, a field experiment was conducted to study the effect of nitrogen and zinc on growth, herbage yield and quality of 'Pant Chari 5' fodder sorghum.

MATERIALS AND METHODS

A field experiment was conducted at Livestock Research Centre of the Govind Ballabh Pant University of Agriculture and Technology, Pantnagar (29°N, 79.3 E and 243.8m above mean sea-level) during the rainy seasons of 2001 and 2002. The experiment was laid out in split-plot design, comprising 5 main plots of nitrogen (0, 40, 80, 120 and 160 kg/ha) and 3 sub-plots of zinc (0, 5 and 10 kg/ha) with 4 replications. The soil was silty clay loam with a bulk density of 1.33 g/cm^3, pH 7.0 and cation-exchange capacity 3.5 meq/100 g soil. The soil had organic carbon 1.14%, 0.09% total nitrogen, 24.0 kg available P /ha and 342 kg available K/ha. Half dose of N as per treatment and full dose of phosphorus, potash and zinc was applied as basal and remaining nitrogen was applied in 2 splits at 25 and 50 days after sowing (DAS). Fodder sorghum (cv. 'Pant Chari 5') was sown on 1 July 2001 and 24 June 2002 with 35 kg seed/ha.

RESULTS AND DISCUSSION

Nitrogen

The pooled data indicated that significant increase in herbage was observed up to 120 kg N application, and further increase in dose decreased it significantly. The magnitude of increase in the green herbage was 35.8%, 18.9% and 11.8% higher over the control, 40 and 80 kg N /ha respectively. These results are in conformity with the findings of Gangwar and Singh (1992). Increase in herbage yield with the increase in N rate may be combined effect of more number of plants per unit area, taller plants and higher leaf-area index. Increase in the plant height might be due to cell elongation, cell enlargement and more chlorophyll synthesis, resulting better plant growth and ultimately resulted in higher herbage yield of sorghum. These yield attributes increased with the increase in N application (Singh, 1990). Almost similar trend was noticed in dry-matter yield.

Crude protein yield increased significantly with the increase in N level up to 120 kg/ha (Table 1). Higher crude protein yield with the increase in N application may be

Table 1. Effect of nitrogen and zinc on yield, yield-attributing characters and quality of fodder sorghum (2 years pooled data)

Treatment	Plants/m row length	Plant height (cm)	Leaf-area index	Green herbage yield (q/ha)	Dry-matter yield (q/ha)	Crude protein (%)	Crude protein yield (q/ha)	Digesti-bility (%)	Digesti-ble dry-matter yield (q/ha)
Nitrogen (kg /ha)									
0	11.5	274.8	6.1	279.3	89.9	4.4	3.9	48.0	43.3
40	13.9	287.4	7.0	352.7	117.8	5.0	5.9	49.6	58.5
80	14.4	296.0	7.6	383.7	134.0	5.4	7.3	50.5	67.7
120	15.1	320.0	8.3	434.9	157.9	5.8	9.1	51.4	81.4
160	15.1	321.8	8.3	393.5	139.7	5.9	8.3	51.7	72.1
CD (P=0.05)	1.1	2.0	0.2	2.2	2.5	0.1	1.0	0.9	2.3
Zinc (kg/ha)									
0	13.5	295.4	7.2	352.5	120.3	4.9	5.9	48.6	58.8
5	14.6	304.8	7.8	385.7	136.0	5.8	8.1	51.9	71.0
10	13.8	300.5	7.4	368.3	128.4	5.2	6.7	50.1	64.1
CD (P=0.05)	0.4	0.7	0.1	2.9	1.9	0.1	0.3	0.6	1.5

owing to more crude protein content, higher dry-matter yield and higher leaf-area index (Table 1). These results confirm the findings of Singh *et al.* (1998). Almost similar trend was also observed in disgestible dry-matter yield of crop (Table 1). Similar results were also reported by Rana *et al.* (1990). Nitrogen uptake increased significantly with the increase in N application up to 120 kg /ha and further it decreased significantly with increase in N from 120 to 160 kg/ha. The magnitude of increase was 54.9, 34,5, 20.3 and 5.1% higher over 0, 40 and 80 and 160 kg N /ha (Table 2). This might be owing higher nitrogen content in plant tissues (Table 2) and dry-matter yield (Table 1). Similar reasons were also reported by Shinde *et al.* (1993). Zinc uptake also increased significantly with the increase in N level up to 120 kg/ha and further increase was not significant in increasing Zn uptake. Higher zinc uptake might be owing to higher zinc content in plant tissue and dry-matter yield. The lower uptake of zinc at 160 kg N/ha was due to lodging of the crop, which ultimately declined dry-matter yield and zinc content in plant.

Zinc

Application of zinc @ 5 kg/ha produced significantly higher green herbage (385.7 q/ha) over no zinc and 10 kg Zn/ha (Table 1). The increase in yield was 8.61 and 4.50% higher over no zinc and 10 kg Zn /ha respectively. Dry-matter yield was also significantly higher with the application of 5 kg Zn /ha. Increase in green as well as dry herbage yields owing to application of zinc might be attributed to increase in plant height, leaf-area index (Table 1) and dry-matter accumulation. Similar results were also reported by Patel and Patel (1994).

Application of 5 kg Zn/ha resulted in significantly higher crude protein yield than other treatments. The magnitude of increase was 27.1 and 17.3% higher over 0 and 10 kg Zn/ha respectively. Higher crude protein yield may be a combined effect of more crude protein content in plant, dry-matter yield (Table 1) and leafiness of plants. Digestible dry-matter yield also increased significantly with the increase in zinc application up to 5 kg /ha (Table 1). Higher digestible dry-matter yield might be owing to higher digestibilty % and higher dry-matter yield (Table 1).

Nitrogen uptake increased significantly with the increase in zinc application up to 5 kg /ha and further it decreased significantly. The increase was 16.1% and 9.5% over the control and 10 kg Zn/ha respectively. This might be due to higher N content in plant and higher dry-matter yield (Table 1). Zinc uptake also increased significantly with the increase zinc up to 5 kg/ha and further increase was non-significant. Higher zinc uptake might be due to

Table 2. Effect of nitrogen and zinc on nutrient content in plants and their uptake in fodder sorghum (2 years pooled data)

Treatment	Nitrogen content (%)	Nitrogen uptake (kg/ha)	Zinc content (ppm)	Zinc uptake (kg/ha)
Nitrogen (kg/ha)				
0	0.65	58.4	45.0	4.0
40	0.72	84.8	51.2	6.0
80	0.77	103.2	54.0	7.2
120	0.82	129.5	57.0	9.0
160	0.88	122.9	54.3	7.6
CD (P=0.05)	0.01	4.0	2.5	0.7
Zinc (kg/ha)				
0	0.75	90.2	42.0	5.1
5	0.79	107.4	54.4	7.4
10	0.76	97.2	60.5	7.8
CD (P=0.05)	0.01	2.1	1.8	0.5

higher zinc content in plant tissues and dry-matter yield, which had combined effect on zinc uptake. Similar results were also observed by Bhardwaj and Prasad (1979).

Response functions

The relationship between dry-matter yield of sorghum and levels of nitrogen and zinc was studied from mean data of 2 years by fitting response equations. Regression equations for nitrogen and zinc were as follows:

Nitrogen : $Y = 88+38.0x-6.0x^2$
Zinc : $Y = 120+ 36.5x -16.5 x^2$

where Y, dry-matter yield of sorghum (q/ha); X, dose of nitrogen or zinc (kg/ha).

The response to nitrogen and zinc in relation to dry - matter yield was quadratic. The maximun yield of dry matter (148.17 and 140.18 q/ha) was obtained by applying 126.67 kg N/ha and 5.53 kg Zn/ha respectively. The optimum dose of N and Zn also calculated, being 108.3 and 1.364 kg/ha and their dry-matter yields were 146.9 and 128.73 q/ha respectively.

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