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Effect of foliar supplementation of N, P and K fertilizers on growth attributes of pearl millet [*Pennisetum glaucum* (L.)]

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Abstract

A field experiment was laid out in randomized block design with three replication during rainy season of 2016 at Agronomy Farm of College of Agriculture, Bikaner (Rajasthan) to study the effect of foliar supplementation of N, P and K fertilizers on growth attributes of pearl millet [*Pennisetum glaucum* (L.)] hybrid RHB-177. The experiment comprised of 14 treatments of different N, P and K fertilizers applied as basal, top dressing and foliar application. Urea, DAP and KCl were used for basal application and urea as top dressing. Foliar spray of NPK (18:18:18) was done at 25 DAS and 35 DAS and urea (0.5, 1.0 and 1.5%) at 35 DAS. The growth (plant height and dry matter accumulation) and physiological attributes like crop growth rates (CGR), relative growth rate (RGR), leaf area index (LAI) and chlorophyll content significantly increased with application of fertilizers. Application of 75% N (50% basal+25% top dressing at 25 DAS):P:K+1.5% spray of NPK (18:18:18) at 35 DAS (T₁₁) resulted in highest plant height at 30 DAS, 60 DAS and at harvest (43.66, 160.4 and 172.4 cm, respectively) and dry matter accumulation 30 DAS, 60 DAS and at harvest (7.61, 44.11 and 69.01 g plant⁻¹). Likewise T₁₁ gave maximum CGR at 0-30 DAS and 30-60 DAS (3.76 and 18.02 g m⁻² day⁻¹, respectively), RGR at 30-60 DAS (58.52 mg g⁻¹ day⁻¹), LAI at 30 DAS (2.30) and 60 DAS (5.31) and chlorophyll content at 40 and 60 DAS (2.42 and 2.24 mg g⁻¹, respectively).

Keywords: pearl millet, N, P, K, foliar supplementation, growth

Introduction

Pearl millet [*Pennisetum glaucum* (L.)] popularly known as *Bajra* is an important cereal crop of arid and semi-arid regions of India. It is drought tolerant and dual purpose crop and generally grown as rainfed on marginal lands under low input management conditions. However, it responds well to good management practices and higher fertility levels. Rajasthan, though, ranks first in area (4.0mha) and production (4.4MT) but average productivity is only 10.93q ha⁻¹ (Anonymous, 2015-16) [1]. The main reasons of low productivity in Rajasthan are water and nutritional stresses. High soil pH, temperature stress, too low or too high moisture, weed infestation, presence of pests, etc. limit the uptake of applied nutrients by roots and also do not able to turn over the nutrients commensurate with crop nutritional requirement at different growth stages. One of the easiest ways for boosting productivity of pearl millet is the use of balanced fertilizers to the undernourished crop through foliar feeding. Integrated use of chemical fertilizers has been found to be quite promising in maintaining high productivity and providing greater stability to crop production (Pareek and Chandra, 2007) [7]. Foliar supplementation of N, P and K nutrients has, therefore, been accepted as an effective way to compensate for soil deficiencies and soil's inability to transfer nutrients to the plants. Moreover, because of higher efficiency, foliar supply of nutrients can further boost photosynthetic efficiency by delaying the onset of leaf senescence. Therefore, the present investigation was carried out to investigate the effect of foliar feeding of N, P and K nutrients alone and/ or in combination with soil application on growth attributes influencing yield of pearl millet.

Materials and Methods

The field experiment was conducted during rainy season of 2016 at Agronomy Farm of College of Agriculture, Bikaner (28°01'N and 73°02'E at 234.7 m above mean sea level). Soil of the experimental plot was loamy sand in texture, alkaline in reaction (pH 8.5) with low organic carbon (0.11%). The available soil N, P and K were 120.30, 20.12 and 223.70 kg ha⁻¹, respectively. The experiment was laid out in Randomized Block Design (RBD) with 3 replications. The treatments comprised 14 combinations viz., control, recommended dose of NPK (60:40:20 kg ha⁻¹), 0.5% spray of NPK (18:18:18) at 25 & 35 DAS, 1.0% spray of NPK

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(18:18:18) at 25 & 35 DAS, 1.5% spray of NPK (18:18:18) at 25 & 35 DAS, 50% as basal (NPK)+0.5% spray of NPK (18:18:18) at 35 DAS, 50% as basal (NPK)+1.0% spray of NPK (18:18:18) at 35 DAS, 50% as basal (NPK)+1.5 % spray of NPK (18:18:18) at 35 DAS, 75% N (50% basal+25% top dressing at 25 DAS):P:K as basal+0.5% spray of NPK (18:18:18) at 35 DAS, 75% N (50% basal+25% top dressing at 25 DAS):P:K as basal+1.0% spray of NPK (18:18:18) at 35 DAS, 75% N (50% basal+25% top dressing at 25 DAS):P:K as basal+1.5% spray of NPK (18:18:18) at 35 DAS, 50% N+100% (P & K) as basal+0.5% of urea at 35 DAS, 50% N+100% (P & K) as basal+1.0% of urea at 35 DAS and 50% N+100% (P & K) as basal+1.5% of urea at 35 DAS. The recommended dose was applied as basal (30 kg N ha⁻¹, 40 kg P₂O₅ ha⁻¹ and 20 kg K₂O ha⁻¹) through urea, DAP and KCl. The remaining 30 kg N ha⁻¹ was top dressed at 25 DAS through urea. Foliar spray of NPK (18:18:18) and urea was done at 25 DAS and 35 DAS in early morning hours with knapsack sprayer.

The pearl millet hybrid RHB-177 was sown on 2nd July 2016 with crop geometry of 45 x 12 cm using seed rate of 4 kg ha⁻¹. The rainfall received during growing period (July to September) was 335.3 mm in 20 rainy days. The mean weekly minimum and maximum temperature during the crop season of fluctuated from 23.5 to 40.8°C. Average relative humidity varied from 29.3 to 88.1%. Experimental crop was raised as per recommended package of practices. Two irrigations with sprinkler were applied during the dry spell observed at milking stage and pre maturing stage.

Periodic data on plant stand (20 DAS and at harvest), plant height (30 & 60 DAS), dry matter accumulation (30 DAS, 60 DAS and at harvest), crop growth rate (0-30 DAS, 30-60 DAS and 60 DAS-Harvest), relative growth rate (30-60 DAS and 60 DAS-Harvest), leaf area index (30 & 60 DAS) and chlorophyll content (40 & 60 DAS) were recorded. Plant stand was counted per meter row length from five randomly selected spots of each plot and averaged. Dry matter accumulation was recorded from the samples dried in oven at 60°C for 24 hours. Crop growth rates (CGR), relative growth rate (RGR), leaf area index (LAI) and chlorophyll content were calculated by standard procedures as suggested by Enyi (1962) [3], Blackman (1919) [2], Watson (1958) [10] and Hiscox and Israelstam (1979) [5], respectively. The data were statistically analyzed following standard procedure as suggested by Fisher (1950) [4].

Results and Discussion

Application of N, P and K fertilizers significantly increased

plant height and dry matter accumulation at 30 DAS, 60 DAS and at harvest over control (Tables 1). Maximum plant height (43.88 cm) at 30 DAS was obtained (33.74% high) with the application of recommended dose of NPK *i.e.* 60:40:20 kg ha⁻¹ (T₂) over control (T₁). Foliar supplementation of N, P and K further improved these growth parameters considerably. Application of 75% N (50% basal+25% top dressing at 25 DAS):P:K+1.5% spray of NPK (18:18:18) at 35 DAS (T₁₁) resulted in highest plant height at 60 DAS (160.4 cm) and at harvest (172.4 cm) which was significantly higher over control (T₁) and all other treatments. Similarly dry matter accumulation of pearl millet was found to be significantly increased at all stages *viz.*, 30, 60 DAS and at harvest (7.61, 44.11 and 69.01 g plant⁻¹) with application of 75% N (50% basal+25% top dressing at 25 DAS):P:K+1.5% spray of NPK (18:18:18) at 35 DAS (T₁₁) over control and other remaining treatments except T₂ and T₁₀.

The physiological attributes like crop growth rates (CGR), relative growth rate (RGR), leaf area index (LAI) and chlorophyll content significantly increased with application of fertilizers (Table 2). Among the treatments application of 75% N (50% basal+25% top dressing at 25 DAS):P:K+1.5% spray of NPK (18:18:18) at 35 DAS (T₁₁) gave significantly higher CGR at 0-30 DAS and 30-60 DAS (3.76 and 18.02 g m⁻² day⁻¹, respectively), RGR at 30-60 DAS (58.52 mg g⁻¹ day⁻¹) and LAI at 30 DAS (2.30) and 60 DAS (5.31) over control and other treatments. Application of 75% N (50% basal+25% top dressing at 25 DAS):P:K+1.5% spray of NPK (18:18:18) at 35 DAS (T₁₁) gave maximum total chlorophyll content in plant leaves of pearl millet at 40 and 60 DAS (2.42 and 2.24 mg g⁻¹, respectively) which was found statistically at par with 75% N (50% basal+25% top dressing at 25 DAS):P:K+0.5% spray of NPK (18:18:18) at 35 DAS (T₉) and 75% N (50% basal+25% top dressing at 25 DAS):P:K+1.0% spray of NPK (18:18:18) at 35 DAS (T₁₀) and significantly higher over other remaining treatments.

It is concluded that foliar supplementation of N, P and K fertilizers was more efficient in improving growth and physiological parameters. Overall improvement in crop under T₁₁ treatment might be due to an adequate supply of nitrogen which promotes rapid vegetative growth, phosphorus for root proliferation and potassium to regulate opening and closing of stomata, photosynthesis and regulates translocation of photosynthates. The observed improvement in growth and physiological parameters due to basal as well as foliar feeding of N, P and K fertilizers are in close agreement with the findings of Sritharan *et al.* (2006) [9], Narolia and Poonia (2011) [6], Parihar *et al.* (2012) [8] and Zaki *et al.* (2016) [11]

Table 1: Effect of foliar supplementation of N, P and K fertilizers on plant stand, plant height and dry matter accumulation of pearl millet

Treatments	Plant stand (m ⁻¹ row length)		Plant height (cm)			Dry matter accumulation (g plant ⁻¹)		
	20 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest
Control (T ₁)	7.00	5.00	32.81	132.0	140.5	5.47	29.94	45.84
Recommended dose of NPK (60:40:20 kg ha ⁻¹) (T ₂)	7.67	7.00	43.88	157.6	169.3	7.41	42.70	65.53
0.5% spray of NPK (18:18:18) at 25 & 35 DAS (T ₃)	7.67	6.67	34.68	144.1	156.2	5.78	36.59	56.27
1.0% spray of NPK (18:18:18) at 25 & 35 DAS (T ₄)	7.33	7.00	34.82	146.4	157.6	5.80	37.45	57.48
1.5% spray of NPK (18:18:18) at 25 & 35 DAS (T ₅)	7.33	7.00	34.87	148.3	158.5	5.81	38.00	58.53
50% as basal (NPK)+0.5% spray of NPK (18:18:18) at 35 DAS (T ₆)	7.00	6.67	35.93	149.5	160.8	6.04	39.21	59.90
50% as basal (NPK)+1.0% spray of NPK (18:18:18) at 35 DAS (T ₇)	7.67	7.00	36.86	151.1	161.9	6.14	40.02	61.35
50% as basal (NPK)+1.5 % spray of NPK (18:18:18) at 35 DAS (T ₈)	7.33	7.00	36.79	152.1	162.5	6.40	41.00	62.74
75% N (50% basal+25% top dressing at 25 DAS):P:K+0.5% spray of NPK (18:18:18) at 35 DAS (T ₉)	7.33	7.00	41.63	155.8	167.3	7.27	42.38	65.00
75% N (50% basal+25% top dressing at 25 DAS):P:K+1.0% spray of NPK	7.67	7.33	43.12	158.8	168.3	7.52	43.32	68.12

(18:18:18) at 35 DAS (T ₁₀)									
75% N (50% basal+25% top dressing at 25 DAS):P:K+1.5% spray of NPK (18:18:18) at 35 DAS (T ₁₁)	7.67	7.33	43.66	160.4	172.4	7.61	44.11	69.01	
50% N+00 % (P & K) as basal+0.5% urea at 35 DAS (T ₁₂)	7.33	7.00	39.33	150.3	163.2	6.55	38.35	60.98	
50% N+100 % (P & K) as basal+1.0% urea at 35 DAS (T ₁₃)	7.33	7.00	40.86	151.2	164.9	6.81	39.85	61.62	
50% N+100% (P & K) as basal+1.5% urea at 35 DAS (T ₁₄)	7.33	7.00	41.08	152.0	165.9	6.85	40.41	62.25	
SEm±	0.24	0.30	0.96	2.65	2.68	0.15	0.89	1.65	
CD (0.05)	NS	NS	2.79	7.71	7.80	0.44	2.58	4.79	

NS: Non significant

Table 2: Effect of foliar supplementation of N, P and K fertilizers on CGR, RGR, LAI and chlorophyll content of pearl millet

Treatments	CGR (g m ⁻² day ⁻¹)			RGR (mg g ⁻¹ day ⁻¹)		LAI		Chlorophyll content (mg g ⁻¹)	
	0-30 DAS	30-60 DAS	60 DAS-Harvest	30-60 DAS	60 DAS-Harvest	30 DAS	60 DAS	40 DAS	60 DAS
Control (T ₁)	2.70	12.08	6.73	56.78	12.17	1.74	3.96	1.78	1.55
Recommended dose of NPK (60:40:20 kg ha ⁻¹) (T ₂)	3.66	17.42	9.66	58.39	12.24	2.18	4.95	2.11	2.06
0.5% spray of NPK (18:18:18) at 25 & 35 DAS (T ₃)	2.85	15.21	8.33	61.50	12.29	1.85	4.56	1.96	1.74
1.0% spray of NPK (18:18:18) at 25 & 35 DAS (T ₄)	2.86	15.62	8.48	62.10	12.25	1.88	4.62	2.01	1.77
1.5% spray of NPK (18:18:18) at 25 & 35 DAS (T ₅)	2.87	15.89	8.69	62.60	12.30	1.90	4.65	2.04	1.82
50% as basal (NPK)+0.5% spray of NPK (18:18:18) at 35 DAS (T ₆)	2.98	16.37	8.76	62.36	12.09	2.00	4.87	2.16	1.96
50% as basal (NPK)+1.0% spray of NPK (18:18:18) at 35 DAS (T ₇)	3.03	16.72	9.03	62.62	12.18	2.05	5.00	2.20	2.00
50% as basal (NPK)+1.5 % spray of NPK (18:18:18) at 35 DAS (T ₈)	3.16	17.08	9.20	61.97	12.09	2.09	5.05	2.26	2.04
75% N (50% basal+25% top dressing at 25 DAS):P:K+0.5% spray of NPK (18:18:18) at 35 DAS (T ₉)	3.59	17.33	9.57	58.69	12.20	2.17	5.24	2.33	2.14
75% N (50% basal+25% top dressing at 25 DAS):P:K+1.0% spray of NPK (18:18:18) at 35 DAS (T ₁₀)	3.71	17.67	10.49	58.42	12.86	2.20	5.28	2.37	2.18
75% N (50% basal+25% top dressing at 25 DAS):P:K+1.5% spray of NPK (18:18:18) at 35 DAS (T ₁₁)	3.76	18.02	10.54	58.52	12.81	2.30	5.31	2.42	2.24
50% N+100 % (P & K) as basal+0.5% urea at 35 DAS (T ₁₂)	3.24	15.69	9.58	58.88	13.24	2.03	4.98	2.15	1.97
50% N+100 % (P & K) as basal+1.0% urea at 35 DAS (T ₁₃)	3.36	16.31	9.21	58.85	12.43	2.08	5.04	2.20	2.01
50% N+100% (P & K) as basal+1.5% urea at 35 DAS (T ₁₄)	3.38	16.57	9.24	59.11	12.43	2.10	5.07	2.27	2.06
SEm±	0.08	0.44	1.04	1.04	0.69	0.05	0.13	0.04	0.04
CD (0.05)	0.22	1.28	NS	3.04	NS	0.14	0.38	0.11	0.12

NS: Non significant

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