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Effect of Nutrient Levels and Plant Growth Regulators on Nutrient Uptake of N, P, K and Economics of Pearl Millet

Gurrala Suresh*, G. Guru and V. Ravichandran

Department of agronomy, Agricultural College and Research Institute,
Tamil Nadu Agricultural University, Coimbatore -641 003

*Corresponding Author E-mail: sureshagri333@gmail.com

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ABSTRACT

A field experiment was carried out to study the effect of nutrient levels and plant growth regulators on nutrient uptake of N, P, K and economics of pearl millet during rabi 2016 at TNAU, Coimbatore, Tamil Nadu, India. Ten treatments with nutrient levels and plant growth regulators were imposed with three replications using RBD. Growth regulators are chemical substances helps to enhance plant growth, development of for high yield and improved grain quality or facilitated harvesting. The uptake of nutrient increase in grain and stover due to higher N and P content. Application of 125 % RDF + foliar application of NAA @ 40 ppm at 20 and 40 DAS (T_7) enhanced the N uptake significantly at all the three stages of pearl millet i.e., 30 DAS, 60 DAS and at harvest (10.6, 54.6 and 70.6 kg/ha respectively) and uptake of phosphorus i.e., 3.04, 10.25 and 15.75 kg/ha at 30 DAS, 60 DAS and at harvest respectively. Application of 125 % RDF + foliar application of NAA @ 40 ppm at 20 and 40 DAS (T_7) had significantly more potassium uptake (20.3, 70.00 and 82.75 kg/ha) at 30 DAS, 60 DAS and at harvest respectively. Application of 100 % RDF + foliar application of NAA @ 40 ppm at 20 and 40 DAS (T_8) recorded higher net returns (₹ 34,410/ha) and B:C ratio (2.0)

Key words: *pearl millet, plant growth regulators, NAA, Chloromequat chloride, Nutrient uptake, Economics and B:C ratio*

INTRODUCTION

Pearl millet (*Pennisetum glaucum* (L.) is the staple cereal of arid and semi-arid drier regions of the country. India is the largest Pearl millet growing country contributing 42 per cent of production in the world. In India, pearl millet is pre-dominantly cultivated as a rainfed crop in diverse soils, climatic condition and indispensable arid zone. In India pearl millet was cultivated in 7.12 million hectares with 8.06 million tonnes production and productivity of 1132 kg/ha during 2015-16[13]. The major pearl millet producing states in India are Rajasthan, Maharashtra, Gujarat, Uttar Pradesh and Haryana. Land, which is not only thirsty but also hungry. The estimated nutrient removal by all dryland crops is to the tune of 7.4 million tonnes (excluding secondary and micro nutrients).

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Approximately drylands receive 10 per cent of total nutrients use in the country, which constitutes about 1.4 million tonnes. There remains a net negative balance of about 6.0 million tonnes[15].

The productivity of pearl millet is very low in India mainly due to poor plant stand and less use of fertilizers. Pearl millet removes 72 kg N, P_2O_5 and K_2O/ ha /annum, whereas only 10-20 kg of these nutrient are being supplied through fertilizers. Therefore, there is need to improve fertility management along with optimum plant density of current hybrids for sustainable production and productivity. The plant growth regulators (PGRs) have potential for increasing crop productivity under environmental stress. Growth regulators are chemical substances which can alter the growth and developmental processes[4] leading to increased yield, improved grain quality or facilitated harvesting. Nutrient levels and plant growth regulators had significant influence on, nutrient uptake and economics.

MATERIAL AND METHODS

Field experiment was conducted at Tamil Nadu Agricultural University, Coimbatore during *Rabi* 2016 to study the effect of nutrient levels and plant growth regulators on nutrient uptake of N, P, K, and economics of pearl millet (Cumbu hybrid CO 9). The farm is situated at 11^0 North latitude and 77^0 E longitude and at an altitude of 426.7 m above mean sea level. The experiment was laid out in randomized block design with three replications and ten treatments *viz*. T_1 - 125% RDF*, T_2 - 100 % RDF*, T_3 - 75% RDF*, T_4 - 125% RDF* + Foliar application of chlormequat chloride @ 250 ppm at 20 and 40 DAS, T_5 - 100 % RDF* + Foliar application of chlormequat chloride @ 250 ppm at20 and 40 DAS, T_6 - 75% RDF* + Foliar application of chlormequat chloride @ 250 ppm at 20 and 40 DAS, T_7 - 125% RDF* + Foliar application of NAA @ 40 ppm at 20 and 40 DAS, T_8 - 100 % RDF* + Foliar application of NAA @ 40 ppm at 20 and 40 DAS, T_9 - 75% RDF* + Foliar application of NAA @ 40 ppm at 20 and 40 DAS and T_{10} – Control.

The crop was sown at a spacing of 45 cm x 15 cm. The pearl millet hybrid of CO-9 was used for the experiment with 5 kg ha^{-1} seed rate. The soil of the experimental field was in slightly alkaline (8.07), normal in EC (0.86 dsm^{-1}), sandy clay loam in texture, low in OC (0.59 %), low in available nitrogen (260.0 kg ha^{-1}), medium in available P_2O_5 (20.4 kg ha^{-1}) and high in available K_2O (694.2 kg ha^{-1}). The nitrogen application was done in two splits, 50 % of N, full dose of P_2O_5 and K_2O were applied as a basal and remaining 50 % N at 30 days after sowing of pearl millet. Plants from each treatment in the plot were selected at random and tagged for taking the observation *viz,* nutrient uptake of NPK. The oven dried samples of plants material were ground in a willey mill and analyzed for N, P and K contents. The nitrogen, phosphorus and potassium uptake were calculated multiplying the nutrient content of the plant sample with corresponding total dry matter and expressed in kg/ha. The total nitrogen content in the plant sample was estimated by the Micro Kjeldal method as suggested by Humphries[5]. The total phosphorus content in the plant sample was estimated with triple acid digestion method by Jackson[6]. The total potassium content in the plant sample was estimated with triple acid digestion method using Flame Photo Meter as suggested by Jackson[6]. The expenditure incurred from sowing up to harvest was worked out and expressed in ₹/ha. Total income obtained from grain and stover yields were calculated for individual treatments. Gross returns and net returns and benefit-cost ratio were worked out based on total variable cost and returns**.** The data collected were analyzed statistically following the procedure given by Panse and Sukhatme[8] wherever the treatmental differences were significant, critical differences were worked out at five per cent probability level. Treatment differences that were not significant are denoted as NS.

RESULTS

The total nitrogen, phosphorus and potassium uptake by pearl millet crop was estimated at 30, 60 DAS and at harvest. The treatments

had marked influence on nutrient uptake by pearl millet at various stages of crop growth (30, 60 DAS and at harvest).

A. Nitrogen uptake of pearl millet

Application of 125 % RDF + foliar application of NAA @ 40 ppm at 20 and 40 DAS (T_7) enhanced the N uptake significantly at all the three stages of pearl millet *i.e.*, 30 DAS, 60 DAS and at harvest (10.6, 54.6 and 70.6 kg/ha respectively) but was at par with 125 % RDF + foliar application of chloromequat chloride @ 250 ppm at 20 and 40 DAS (T_4), 125 % RDF + foliar application of NAA @ 40 ppm at 20 and 40 DAS (T_7) and 125 % RDF (T_1) treatments. The control (T_{10}) recorded lower values of N uptake (4.85,24.05 and 32.36 kg/ha at 30 DAS, 60 DAS and harvest, respectively) Table1.

B. Phosphorus uptake of pearl millet

The uptake of phosphorus *i.e.*, 3.04, 10.25 and 15.75 kg/ha at 30 DAS, 60 DAS and at harvest was observed significantly more in the treatment application of 125 % RDF + foliar application of NAA @ 40 ppm at 20 and 40 DAS (T_7) than other treatments. The treatment of 125 % RDF + foliar application of chloromequat chloride @ 250 ppm at 20 and 40 DAS (T_4) and application of 100 % RDF + foliar application of NAA @ 40 ppm at 20 and 40 DAS (T_8) were at par among all the stages. Application of 100 % RDF + foliar application of NAA @ 40 ppm at 20 and 40 DAS (T_8) and 100 % RDF + foliar application of chloromequat chloride @ 250 ppm at 20 and 40 DAS (T_5) had the P uptake comparable to 125 % RDF (T_1) application at all the stages (Table 2).

C. Potassium uptake of pearl millet

Application of 125 % RDF + foliar application of NAA @ 40 ppm at 20 and 40 DAS (T_7) had significantly more potassium uptake (20.3, 70.00 and 82.75 kg/ha) at 30 DAS, 60 DAS and at harvest. NAA application with nutrient levels enhanced the K uptake similar to that of N and P uptake (Table 3).

D. Economic analysis

Application of 100 % RDF + foliar application of NAA @ 40 ppm at 20 and 40 DAS (T_8) recorded higher net returns (₹ 34,410/ha) and B:C ratio (2.0) than the treatments of 125 % RDF + foliar application of NAA @ 40 ppm at 20 and 40 DAS (T_7). Application of 125 % RDF + choromequat chloride @ 250 ppm at 20 and 40 DAS (T_4) recorded more net returns and B:C ratio than alone application of 125% RDF (T_1) alone. The treatment application of 75 % RDF (T_3) recorded the lower net returns (₹ 20,606/ha) and B:C ratio (1.65). The control recorded the least net returns (₹ 7,016/ha) and B:C ratio (1.24) Table 4.

DISCUSSION

In general, the applications of nitrogen at higher doses increased the NPK uptake in plants. The results are in conformity with the findings of Roy *et al.*[12]. Raza *et al.*[11] reported that uptake and efficiency of NPK nutrients was increased due to their enhanced rate of application to maize crop. Application of P along with N considerably increased yield of pearl millet. A better supply of phosphorus has been associated with prolific root growth resulting in enhanced water and nutrient absorption. The application of K along with NP significantly increased the grain and straw yield of pearl millet[14]. It might be due to the fact that added nitrogen and phosphorus increased the N and P content in grain by providing favourable environment inside the plant and higher photosynthetic efficiency, which favoured better growth and crop yields. The uptake of nutrient increase in grain and stover due to higher N and P content[9]. These results are in conformity with those of Bhagchand and Gautam[2] and Yakadari and Gautam[16]. The increased supply of nitrogen and their higher uptake by plants might have stimulated the rate of various physiological processes in plant which led to increased growth and yield parameters and resulted in increased seed and stover yields. These results are in close conformity with the findings of Patel *et al.*[10]. Application of 125 % RDF + foliar application of NAA @ 40 ppm at 20 and 40 DAS (T_7) enhanced the N uptake significantly at all the three stages of pearl millet *i.e.*, 30 DAS, 60

DAS and at harvest (10.6, 54.6 and 70.6 kg/ha, respectively).

The higher nitrogen uptake by pearl millet under higher level of nitrogen is due to favorable effects of nitrogen on growth parameters and yield attributes which resulted in higher grain and stover yield. Application of 120 and 140 kg N/ ha were found equally effective in increasing nitrogen uptake by grain, stover and total nitrogen uptake by crop were significantly higher over lower level of 100 kg N/ha, however nitrogen and phosphorus uptake by grain and stover in pearl millet were not markedly influenced by different levels of phosphorus[3].

The uptake of phosphorus at 30 DAS, 60 DAS and at harvest was significantly more with application of 125 % RDF + foliar application of NAA @ 40 ppm at 20 and 40 DAS (T_7) than other treatments. NAA application with nutrient levels enhanced the K uptake similar to that of N and P uptake. Application of 125 % RDF + foliar application of NAA @ 40 ppm at 20 and 40 DAS (T_7) significantly enhanced the potassium uptake 20.3, 70.0 and 82.7 kg/ha on 30 DAS, 60 DAS and at harvest. Application of 100 % RDF + foliar application of NAA @ 40 ppm at 20 and 40 DAS (T_8) recorded higher net returns (₹ 34,410/ha) and B:C ratio (2.0) than the treatments of 125 % RDF + foliar application of NAA @ 40 ppm at 20 and 40 DAS (T_7). Application of 125 % RDF + choromequat chloride @ 250 ppm at 20 and 40 DAS (T_4) recorded more net returns and B:C ratio than alone application of 125% RDF (T_1) alone. The treatment application of 75 % RDF (T_3) recorded the lower net returns (₹ 20,606/ha) and B:C ratio (1.65). The control recorded the least net returns (₹ 7,016/ha) and B:C ratio (1.24). Similarly, Basavarajappa[1], reported significant increase in net returns and B:C with RDF + foliar application of NAA along with 0.5 % chelated micro nutrient due to higher productivity in terms of yield.

Table 1. Effect of nutrient levels and plant growth regulators on N uptake (kg/ha) of pearl millet

Treatment	N uptake (kg/ha)		
	30 DAS	**60 DAS**	**At harvest**
T_1- 125 % RDF*	7.92	40.27	59.29
T_2- 100 % RDF*	6.85	35.45	49.27
T_3- 75 % RDF*	5.95	29.17	40.77
T_4- 125 % RDF* + foliar application of Chloromequat chloride @ 250 ppm at 20 and 40 DAS	9.25	50.14	63.82
T_5- 100 % RDF* + foliar application of Chloromequat chloride @ 250 ppm at 20 and 40 DAS	8.02	39.75	58.72
T_6- 75 % RDF* + foliar application of Chloromequat chloride @ 250 ppm at 20 and 40 DAS	6.05	30.29	50.63
T_7- 125 % RDF* + foliar application of NAA @ 40 ppm at 20 and 40 DAS	10.67	54.65	70.65
T_8- 100 % RDF* + foliar application of NAA @ 40 ppm at 20 and 40 DAS	8.26	43.37	65.02
T_9- 75 % RDF* + foliar application of NAA @ 40 ppm at 20 and 40 DAS	6.55	37.29	59.19
T_{10}- Control	4.85	24.05	32.36
S. Ed	**0.36**	**1.86**	**2.66**
C.D at 5 %	**0.75**	**3.92**	**5.60**

(*80:40:40 kg of N, P and K /ha)

Table 2. Effect of nutrient levels and plant growth regulators on P uptake (kg/ha) of pearl millet

Treatment	P uptake (kg/ha)		
	30 DAS	60 DAS	At harvest
T_1- 125 % RDF*	6.25	14.89	20.73
T_2- 100 % RDF*	5.01	13.05	18.81
T_3- 75 % RDF*	3.75	11.65	16.25
T_4- 125 % RDF* + foliar application of Chloromequat chloride @ 250 ppm at 20 and 40 DAS	7.86	16.29	23.89
T_5- 100 % RDF* + foliar application of Chloromequat chloride @ 250 ppm at 20 and 40 DAS	6.15	14.01	21.03
T_6- 75 % RDF* + foliar application of Chloromequat chloride @ 250 ppm at 20 and 40 DAS	4.15	12.78	18.27
T_7- 125 % RDF* + foliar application of NAA @ 40 ppm at 20 and 40 DAS	8.14	18.31	25.75
T_8- 100 % RDF* + foliar application of NAA @ 40 ppm at 20 and 40 DAS	7.79	16.25	23.01
T_9- 75 % RDF* + foliar application of NAA @ 40 ppm at 20 and 40 DAS	4.16	14.78	20.12
T_{10}- Control	3.04	10.25	15.75
S. Ed	**0.27**	**0.68**	**0.97**
C.D at 5 %	**0.58**	**1.43**	**2.05**

(*80:40:40 kg of N, P and K/ha)

Table 3. Effect of nutrient levels and plant growth regulators on K uptake (kg/ha) of pearl millet

Treatment	K uptake (kg/ha)		
	30 DAS	60 DAS	At harvest
T_1- 125 % RDF*	14.35	53.59	64.85
T_2- 100 % RDF*	12.14	46.24	56.99
T_3- 75 % RDF*	10.02	38.77	49.23
T_4- 125 % RDF* + foliar application of Chloromequat chloride @ 250 ppm at 20 and 40 DAS	19.25	62.96	74.45
T_5- 100 % RDF* + foliar application of Chloromequat chloride @ 250 ppm at 20 and 40 DAS	15.07	51.38	60.64
T_6- 75 % RDF* + foliar application of Chloromequat chloride @ 250 ppm at 20 and 40 DAS	12.18	40.53	49.52
T_7- 125 % RDF* + foliar application of NAA @ 40 ppm at 20 and 40 DAS	20.3	70.00	82.75
T_8- 100 % RDF* + foliar application of NAA @ 40 ppm at 20 and 40 DAS	16.85	56.13	65.25
T_9- 75 % RDF* + foliar application of NAA @ 40 ppm at 20 and 40 DAS	13.57	45.25	53.09
T_{10}- Control	8.81	35.53	44.91
S. Ed	**0.69**	**2.41**	**2.89**
C.D at 5 %	**1.45**	**5.07**	**6.07**

(*80:40:40 kg of NPK/ha)

Table 4. Effect of nutrient levels and plant growth regulators on economics (₹/ha) of pearl millet

Treatment	Economics (₹/ha)			
	Gross returns	Cost of cultivation	Net returns	B:C ratio
T_1- 125 % RDF*	59439	34485	24954	1.72
T_2- 100 % RDF*	57883	33095	24788	1.75
T_3- 75 % RDF*	52311	31705	20606	1.65
T_4- 125 % RDF* + foliar application of Chloromequat chloride @ 250 ppm at 20 and 40 DAS	65381	35565	29816	1.84
T_5- 100 % RDF* + foliar application of Chloromequat chloride @ 250 ppm at 20 and 40 DAS	61813	34175	27638	1.81
T_6- 75 % RDF* + foliar application of Chloromequat chloride @ 250 ppm at 20 and 40 DAS	53782	33085	20697	1.63
T_7- 125 % RDF* + foliar application of NAA @ 40 ppm at 20 and 40 DAS	69365	35685	33680	1.94
T_8- 100 % RDF* + foliar application of NAA @ 40 ppm at 20 and 40 DAS	68870	34295	34575	2.01
T_9- 75 % RDF* + foliar application of NAA @ 40 ppm at 20 and 40 DAS	56435	33205	23230	1.70
T_{10}- Control	41941	28725	13216	1.46

(*80:40:40 kg of NPK/ha)

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