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Effect of Nutrient Levels and Plant Growth Regulators on Growth Parameters of Pearl Millet

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ABSTRACT

A field experiment was carried out during to study the effect of nutrient levels and plant growth regulators on growth and yield 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. All the growth and physiological parameters were recorded accordingly. 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 leading to increased yield, improved grain quality or facilitated harvesting. Nutrient levels and plant growth regulators application had significant influence on growth parameters of Pearl millet. The significantly highest plant height, total number tillers, leaf area index, dry matter production and chlorophyll index was recorded with T_7 - 125% RDF + Foliar application of NAA @ 40 ppm at 20 and 40 DAS.*

Key words: *Pearl millet, Plant growth regulators, NAA, chloromequat chloride, DMP, Plant height, Leaf area index, Relative water content.*

INTRODUCTION

Pearl millet (*Pennisetum glaucum* (L.) is the staple cereal of arid and semi-arid drier regions of the country. It is the most widely cultivated cereal in India after rice and wheat. 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. Pearl millet **(***Pennisetum glaucum* (L.) is the staple cereal of arid and semi-arid drier regions of the country. In India pearl millet was cultivated in 7.128 million hectares with 8.06 million tonnes production of and productivity of 1132 kg/ha during 2015-16[18]. The major pearl millet producing states in India are Rajasthan, Maharashtra, Gujarat, Uttar Pradesh and Haryana. Land, which is on mercy of rainfall, 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). 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[25].

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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[5] leading to increased yield, improved grain quality or facilitated harvesting. Nutrient levels and plant growth regulators had significant influence on growth parameters, physiological parameters, yield attributes, grain and stover yield, nutrient uptake and post-harvest soil analysis. The present research was designed to study the performance of nutrients and plant growth regulators in pearl millet.

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 growth and yield 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.,* plant height, tillers, LAI, DMP and physiological parameters like relative water content (30 and 60 DAS) and Chlorophyll index *etc.* The biometric observations were recorded at 30, 60 DAS and at harvest. The data collected were analysed statistically following the procedure given by Panse and Sukhatme. 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 AND DISCUSSION

The data pertaining to effect of nutrient levels and plant growth regulators on different growth parameters are presented and discussed here under

Plant height

Application of 125 % RDF + foliar application of NAA @ 40 ppm at 20 and 40 DAS (T_7) recorded higher plant height (107.3 cm) followed by 100 % RDF + foliar application of 40 ppm at 20 and 40 DAS 98.3 cm (T_8) and 125 % RDF (T_1) at 30 DAS treatments 92.1 cm. The same trend was observed from 60 DAS till harvest stage. The control plot (T_{10}) recorded the lower plant height at all the three stages (58.6 cm, 132.1 cm and 145.8 cm at 30, 60 DAS and at harvest, respectively).

This might be due to the release of nutrients in required quantity at critical crop growth periods at higher doses and also increased rate of photosynthetic activity and accelerated transport by the application of plant growth regulators. This is in accordance with the findings of Munirathnam and Gautam[9] on the favorable influence on N addition on pearl millet plant height. This could be attributed to effective utilization of nutrients through the extensive root system developed by crop plants under adequate P application[7].

Combined application of nitrogen, phosphorus and potassium which resulted in increased plant height, Rajput *et al*.[15] Munirathnam and Gautham[9]. This could also be attributed to the stimulating action of auxin which softens the cell wall by increasing its plasticity or may be the oxidative decarboxylation of synthetic auxins which could not be catalyzed by the enzyme peroxidase. Similar results have also been reported earlier[8].

The increase in plant height by the application of NAA is attributed to an increased rate of photosynthetic activity, accelerated transport and efficiency of utilizing photosynthetic products, thus resulting in cell elongation and rapid cell division in the growing portion of the plant. Similar results were reported by Sharma *et al.*[19] in brinjal and Pandey *et al.*[11] in garden pea, Purbey and Sen[13] in fenugreek, Sharma and Lashkari[20] in cluster bean.

Total number of tillers

Nutrient levels and foliar application of plant growth regulators had significant influence on the number of tillers. Among the treatments application of 125 % RDF + foliar application of NAA @ 40 ppm at 20 and 40 DAS (T_7) produced maximum number of tillers (6.00) but was on par with application of 125 % RDF + foliar application of Chloromequat chloride @ 250 ppm at 20 and 40 DAS (T_4) and 100 % RDF + foliar application of NAA @ 40 ppm at 20 and 40 DAS (T_8). The treatment control (T_{10}) recorded lowest number of tillers/plant (4.50) **Table 2.**

The number of tillers increased significantly with the application of phosphorus could be due to increase in soil micro-organism and also due to better moisture and nutrient availability Singh and Ram[23]. The major impact of cycocel on grain yield is mediated *via* initiation of more tillers per plant resulting in a greater number of grains. The work of Emam and Moaied[4] on winter barley as well as that of Shekoofa and Emam[21] on winter wheat confirmed that the increased grain yield was the result of higher grain number.

Leaf Area Index

LAI was significantly influenced by the treatments as compared to control. Application of 125 % RDF + foliar application of NAA @ 40 ppm at 20 and 40 DAS (T_7) recorded higher LAI at 30 DAS (1.79), 60 DAS (4.44) and at harvest (1.70). It was par with application of 125% RDF + foliar application of Chloromequat chloride @ 250 ppm (T_4) and 100 % RDF + foliar application of NAA @ 40 ppm at 20 and 40 DAS (T_8) **Table 1**.

Leaf area index is a major factor determining photosynthesis, enhancing photosynthesis capacity and assimilates production and dry matter accumulation. LAI is the reflection of the physiological efficiency of the crop for better photosynthesis and also indicator of sufficiency or deficiency of nitrogenous nutrition. One of the principle factors influencing canopy net photosynthesis is LAI[6], which increased rapidly and linearly up to the end of blooming, attaining maximum at 60 DAS thereafter, it declined due the abscission of lower leaves in soybean.

Application of growth promoters, *viz.*, NAA (20 ppm) had resulted in higher LAI probably due to their positive effect on cell division and cell elongation leading to enhanced leaf growth[16,2]. The increased LAI with increasing nitrogen supply might be due to the effect of nitrogen and plant growth regulator application on the rate of growth of meristem and the appearance and development of leaves[1]. These results are in agreement with those of Oscar and Tollenaar[10]. Increase in number of leaves per plant might be due to the reason that growth regulators have contributed enhanced source-sink relationship[24]. The increase in LAI, due to increased leaf area with increasing fertilizer levels was because of increased amount of cellular constituents, mainly protoplasm[22] and also due to the influence of phytochroms in promotion of cell division, cell enlargement, cell differentiation and cell multiplication resulting in consistent and statistically significant increase in total leaf area per plant and leaf area index[17].

Dry Matter Production

The results showed that nutrient levels and plant growth regulators applications influenced the DMP significantly at all the growth stages. The treatment 125 % RDF + foliar application of NAA @ 40 ppm at 20 and 40 DAS (T_7) recorded higher dry matter production than other treatments at 30 DAS (453 kg/ha), 60 DAS (3876 kg/ha) and at harvest (6263 kg/ha) and it was on par with 125 % RDF (T_1) and 100 % RDF + foliar application of NAA @40 ppm at 20 and 40 DAS (T_8). The lower dry matter production *viz.*, 278, 2411 and 3924 kg/ha were recorded by control plot (T_{10}) at 30 DAS, 60 DAS and at harvest respectively **Table 2.**

The amount of total dry matter produced is an indication of overall efficiency of utilization of resources and better interception of light. Enhanced dry matter production with increased nutrient application was due to role of NPK in determining the use efficiency of sunshine by the increased biomass and any inadequacy of nitrogen reduces the sunshine use efficiency or ability to photosynthesis, as reported by Wadsworth[26,27]. Similar results were also supported by Pradhan *et al.*[12]. The maximum photosynthetic rate with NAA application can be attributed to more number of leaves their length and breadth than in other treatments[14]. The increased availability of P increased the dry matter accumulation which was reflected in higher yield of pearl millet. Similar results were reported by Dashadi *et al.*[3].

Chlorophyll SPAD meter value

The results showed that nutrient levels and plant growth regulator applications influenced the chlorophyll index significantly at all the growth stages of pearl millet. The treatment 125 % RDF + foliar application of NAA @ 40 ppm at 20 and 40 DAS (T_7) recorded higher chlorophyll index than other treatments at all the three stages and it was at par with 125 % RDF (T_1), 125 % RDF + foliar application of Chloromequat chloride @ 250 ppm at 20 and 40 DAS (T_4) and 100 % RDF + foliar application of NAA @ 40 ppm at 20 and 40 DAS (T_8) **Table 3.**

The high chlorophyll content noticed with the application of NAA was attributed to the protection of chlorophyll molecule from photo oxidation and increased chlorophyll synthesis[16].

Relative water content

Nutrient levels and plant growth regulators did not significantly influence the relative water content of pearl millet crop **Table 3.**

No significant influence on relative water content was observed due to application of various nutrient levels and plant growth regulators application on pearl millet.

Table 1: Effect of nutrient levels and plant growth regulators on plant height of pearl millet

Treatment	Plant height (cm)		
	30 DAS	60 DAS	At harvest
T_1- 125 % RDF*	92.1	169.8	190.2
T_2- 100 % RDF*	85.2	160.2	180.8
T_3- 75 % RDF*	68.7	145.2	161.0
T_4- 125 % RDF* + foliar application of Chloromequat chloride @ 250 ppm at 20 and 40 DAS	83.3	157.6	175.1
T_5- 100 % RDF* + foliar application of Chloromequat chloride @ 250 ppm at 20 and 40 DAS	76.2	151.4	170.3
T_6- 75 % RDF* + foliar application of Chloromequat chloride @ 250 ppm at 20 and 40 DAS	64.9	140.1	160.2
T_7- 125 % RDF* + foliar application of NAA @ 40 ppm at 20 and 40 DAS	107.3	185.0	208.0
T_8- 100 % RDF* + foliar application of NAA @ 40 ppm at 20 and 40 DAS	98.3	178.1	198.5
T_9- 75 % RDF* + foliar application of NAA @ 40 ppm at 20 and 40 DAS	73.8	147.0	165.8
T_{10}- Control	58.5	132.1	145.8
S. Ed	**3.89**	**7.49**	**8.40**
C.D at 5 %	**8.18**	**15.74**	**17.64**

(*RDF 80:40:40 Kg N, P and K/ ha)

Table 2: Effect of nutrient levels and plant growth regulators on leaf area index (LAI) of pearl millet

Treatment	Leaf Area Index		
	30 DAS	60 DAS	At harvest
T_1- 125 % RDF*	1.51	3.29	1.12
T_2- 100 % RDF*	1.36	3.26	1.08
T_3- 75 % RDF*	1.13	2.71	0.77
T_4- 125 % RDF* + foliar application of Chloromequat chloride @ 250 ppm at 20 and 40 DAS	1.64	4.10	1.43
T_5- 100 % RDF* + foliar application of Chloromequat chloride @ 250 ppm at 20 and 40 DAS	1.55	3.98	1.32
T_6- 75 % RDF* + foliar application of Chloromequat chloride @ 250 ppm at 20 and 40 DAS	1.04	2.85	0.88
T_7- 125 % RDF* + foliar application of NAA @ 40 ppm at 20 and 40 DAS	1.79	4.44	1.70
T_8- 100 % RDF* + foliar application of NAA @ 40 ppm at 20 and 40 DAS	1.74	4.40	1.47
T_9- 75 % RDF* + foliar application of NAA @ 40 ppm at 20 and 40 DAS	1.20	3.06	1.05
T_{10}- Control	0.82	2.34	0.55
S. Ed	**0.06**	**0.16**	**0.05**
C.D at 5 %	**0.14**	**0.35**	**0.11**

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

Table 3: Effect of nutrient levels and plant growth regulators on dry matter production (kg/ha) of pearl millet

Treatment	Dry matter production (kg/ha)		
	30 DAS	60 DAS	At harvest
T_1- 125 % RDF*	423	3614	5869
T_2- 100 % RDF*	403	3417	5514
T_3- 75 % RDF*	348	2874	4823
T_4- 125 % RDF* + foliar application of Chloromequat chloride @ 250 ppm at 20 and 40 DAS	392	3286	5267
T_5- 100 % RDF* + foliar application of Chloromequat chloride @ 250 ppm at 20 and 40 DAS	374	3202	5193
T_6- 75 % RDF* + foliar application of Chloromequat chloride @ 250 ppm at 20 and 40 DAS	338	2825	4622
T_7- 125 % RDF* + foliar application of NAA @ 40 ppm at 20 and 40 DAS	453	3876	6263
T_8- 100 % RDF* + foliar application of NAA @ 40 ppm at 20 and 40 DAS	425	3631	5873
T_9- 75 % RDF* + foliar application of NAA @ 40 ppm at 20 and 40 DAS	359	3125	5082
T_{10}- Control	278	2411	3924
S. Ed	**18**	**154**	**251**
C.D at 5 %	**38**	**325**	**258**

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

Table 4: Effect of nutrient levels and plant growth regulators on Chlorophyll SPAD Meter Value of pearl millet

Treatment	Chlorophyll SPAD Meter Value		
	30 DAS	60 DAS	At harvest
T_1- 125 % RDF*	52.2	59.1	37.9
T_2- 100 % RDF*	48.3	54.5	33.0
T_3- 75 % RDF*	42.2	48.7	31.0
T_4- 125 % RDF* + foliar application of Chloromequat chloride @ 250 ppm at 20 and 40 DAS	54.3	61.3	40.2
T_5- 100 % RDF* + foliar application of Chloromequat chloride @ 250 ppm at 20 and 40 DAS	50.0	57.7	35.0
T_6- 75 % RDF* + foliar application of Chloromequat chloride @ 250 ppm at 20 and 40 DAS	45.3	52.0	31.6
T_7- 125 % RDF* + foliar application of NAA @ 40 ppm at 20 and 40 DAS	56.0	63.0	42.3
T_8- 100 % RDF* + foliar application of NAA @ 40 ppm at 20 and 40 DAS	51.2	58.4	36.4
T_9- 75 % RDF* + foliar application of NAA @ 40 ppm at 20 and 40 DAS	47.3	53.4	32.3
T_{10}- Control	38.3	44.6	28.1
S. Ed	**2.3**	**2.6**	**1.7**
C.D at 5 %	**4.9**	**5.5**	**3.5**

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

Table 5: Effect of nutrient levels and plant growth regulators on Relative Water Content (%) of pearl millet

Treatment	Relative Water Content (%)	
	30 DAS	60 DAS
T_1- 125 % RDF*	82.7	87.9
T_2- 100 % RDF*	81.9	86.5
T_3- 75 % RDF*	80.3	85.5
T_4- 125 % RDF* + foliar application of Chloromequat chloride @ 250 ppm at 20 and 40 DAS	84.6	88.9
T_5- 100 % RDF* + foliar application of Chloromequat chloride @ 250 ppm at 20 and 40 DAS	81.6	87.1
T_6- 75 % RDF* + foliar application of Chloromequat chloride @ 250 ppm at 20 and 40 DAS	81.3	85.9
T_7- 125 % RDF* + foliar application of NAA @ 40 ppm at 20 and 40 DAS	84.7	89.6
T_8- 100 % RDF* + foliar application of NAA @ 40 ppm at 20 and 40 DAS	83.2	88.0
T_9- 75 % RDF* + foliar application of NAA @ 40 ppm at 20 and 40 DAS	81.5	87.9
T_{10}- Control	80.9	84.9
S. Ed	**1.5**	**1.2**
C.D at 5 %	**NS**	**NS**

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

CONCLUSION

Growth regulators and nutrients which can alter the growth and developmental processes leading to increased yield, improved grain quality or facilitated harvesting. Application of nutrients and plant growth regulators (PGRs) significantly improves the growth and yield of pearl millet. Application of 125 % RDF + foliar application of NAA @ 40 ppm at 20 and 40 DAS (T_7) recorded significantly higher plant height, number of tillers/plant and dry matter production whereas followed by 100 % RDF + foliar application of NAA @ 40 ppm at 20 and 40 DAS (T_8) and 125 % RDF (T_1) treatment. Application of 125 % RDF + foliar application of NAA @ 40 ppm at 20 and 40 DAS (T_7) recorded more leaf area index but was par with the application of 100 % RDF + foliar application of NAA @ 40 ppm at 20 and 40 DAS (T_8) and 125 % RDF + foliar application of chlormequat chloride @ 250 ppm at 20 and 40 DAS (T_4). The application of 125 % RDF + foliar application of NAA @ 40 ppm at 20 and 40 DAS (T_7) recorded higher chlorophyll index and it was at par with 125 % RDF (T_1) and 125 % RDF + foliar application of chlormequat chloride @ 250 ppm at 20 and 40 DAS (T_4) at 30 and 60 DAS and at harvest. Regarding relative water content there was no significant influence with the treatments at 30 and 60 DAS.

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