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Evaluation of nutrient levels and growth regulators on growth, productivity and available nutrient status in pearl millet (*Pennisetum glaucum*)

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Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is an exceptionally key and prospective cereal crop in dryland and rainfed areas. India is an important pearl millet rising nation, attributed to 45% of world production. This is grown in 7.14 Mha by 8.09 Mt in country production and also productivity of 1150 kg/ha (Seasons and Crop Report 2017–2018). Considering the crop yield recorded as lower in India normally due to more crop mortality rates and usage of smaller or imbalanced chemical fertilizers. Generally, the crop utilizes 2.55 kg nitrogen, 32.2 kg P_2O_5, and 18.6 K_2O per hectare per annually wherein only 15–25 kg of these nutrients is being supplied through fertilizers. The grains are a competent as well as main cause of seed protein comprising higher digestive characteristics (13.1%), carbohydrates (69.41%), minerals (2.31%), and vitamins stated by Sivakumar *et al*. (2002) and Chouhaan *et al*. (2018). Therefore, it is a necessity to proceed with fertility management with favourable crop density to recently released hybrid to maintain crop capability of yield and increase in productivity within the unit area. Generally, plant growth regulators contain naturally occurring hormones and synthetic substances for improving crop productivity under environmental stress conditions to increase the crop yield (Espindula *et al*. 2009), enhance grain quality, make it easy to harvest and reduce the environmental stress on crop growth (Azevedo *et al*. 2006) without any considerable improvement in cultivation expenses (Sumeriya *et al*. 2000, and Yadav *et al*. 2012). Keeping in mind the aforementioned facts, the current field study observed various nutrient levels and plant growth regulators lying in crop yield, quality and fertility positions of post-harvest experimental sites.

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The present experiment was conducted during winter (*rabi*) seasons of 2019–22 at Agricultural Research Station (Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu), Kovilpatti (109°N latitudes and 77°E longitude; an altitude of 425.8 msl), Tamil Nadu to study the significant impact of different levels of nutrients and plant growth regulators on crop yield, seed protein, and fertility content in pearl millet. The experiment was laid out in randomized block designs (RBD) having 10 treatments, viz. T_1, 125% recommended dose of fertilizer (RDF); T_2, 100% RDF; T_3, 75% RDF; T_4, 125% RDF + chlormequat chloride @250 ppm; T_5, 100% RDF + chlormequat chloride @250 ppm; T_6, 75% RDF + chlormequat chloride @250 ppm; T_7, 125% RDF + NAA (naphthaleneacetic acid) @40 ppm; T_8, 100% RDF + NAA @40 ppm; T_9, 75% RDF + NAA @40 ppm; and T_{10}, Control) in three replications. The crop was raised with 45.0 cm × 15.0 cm spacing and pearl millet variety taken for the experiment was CO 9 at 5 kg/ha seed rate and recommended dose of fertilizer (RDF) @80:40:40 kg NPK/ha. The experimental soil was slightly alkaline (*p*H 8.08), non-saline (EC = 0.86 dS/m), sandy clay loamy, low in organic carbon (4.3 g/kg), and low, medium, and high in available NPK (260:20:390 kg/ha), respectively. The crop was harvested treatment-wise and recorded the growth and yield attributes. After the entire freshening, the weight of the total dry matter in the net plot was measured. Subsequent to threshing, the harvested product was cleaned and weighed. Grain yield and stover yield/net plot area were counted on a hectare basis and noticed in kg/ha. Soil was serene and nitrogen (N) was analyzed beside alkaline permanganate technique as given by Subbiah and Asija (1956).

By utilizing Olsen method (1954) spectrophotometer, available soil phosphotic which had calculated and potassic substance of samples were analyzed through ammonium acetate extract and measured with flame photometric process developed by Stanford and English (1949).

Growth and yield parameters, and yield: An assessment of data showed that influence of the effect of plant growth

Table 1 Effect of different nutrients and growth regulators on growth, yield attributes, yield and economics of pearl millet (mean of 3 years)

Treatment	Plant height (cm)	Leaf area index	Dry matter Production (kg/ha)	Ear head Length (cm)	Ear head Girth (cm)	Protein content (%)	1000-seed weight (g)	Grain yield (kg/ha)	Stover yield (kg/ha)	Net return (₹/ha)	Benefit: Cost ratio
T_1, 125% RDF	190.2	1.12	5869	26.36	11.39	12.31	11.22	2838	5370	24954	1.72
T_2, 100% RDF	180.8	1.08	5514	22.10	10.23	12.14	10.22	2763	5227	24788	1.75
T_3, 75% RDF	161.0	0.77	4823	20.80	9.17	10.01	10.63	2498	4722	20606	1.65
T_4, 125% RDF + chlormequat chloride @250 ppm	208.0	1.70	6263	29.30	13.05	12.64	12.70	3310	6390	34575	2.01
T_5, 100% RDF + chlormequat chloride @250 ppm	175.1	1.43	5267	25.67	11.26	12.18	12.36	2951	5581	27638	1.81
T_6, 75% RDF + chlormequat chloride @250 ppm	160.2	0.88	4622	20.00	9.09	10.12	11.55	2568	4856	20697	1.63
T_7, 125% RDF + NAA @40 ppm	198.5	1.47	5873	26.50	11.65	12.50	12.39	3121	5902	33680	1.94
T_8, 100% RDF + NAA @40 ppm	170.3	1.32	5193	23.50	9.95	12.20	11.73	3276	6370	29816	1.84
T_9, 75% RDF + NAA @40 ppm	165.8	1.05	5082	21.50	9.37	10.32	11.35	2694	5098	23230	1.70
T_{10}, Control	145.8	0.55	3924	17.60	8.33	9.24	9.21	1698	3561	13216	1.46
S.Ed	8.40	0.05	251	1.11	0.49	0.54	0.56	281	255	-	-
CD (P=0.05)	17.64	0.11	258	2.35	1.04	1.01	NS	NS	537	-	-

RDF, Recommended dose of fertilizer (i.e. 80:40:40 kg NPK/ha); NAA, Naphthaleneacetic acid.

regulators (PGR) and fertilizers had significant effect on growth and yield parameters (Table 1). Application of 125% RDF with chlormequat chloride at 250 ppm (T_4) on 20 and 40 days after sowing (DAS) recorded significantly higher plant height, leaf area index (LAI), number of tillers/plant, dry matter production besides exerting a major persuade on yield parameters of pearl millet, viz. productive tillers/plant, ear head length, ear head girth, test weight and grain yield followed by treatment T_7 i.e. 125% RDF + NAA @40 ppm. Similar findings were reported by Knowles and Ries (1991), Kumar *et al*. (2018) and Chandrashekhara *et al*. (2018).

Soil nutrient status: Significantly higher available nitrogen, phosphorus and potassium (214, 20 and 457 kg/ha) in post-harvest soils were registered in T_1 be on par with the treatment T_7 (125% RDF + NAA @40 ppm) that recorded 195 N, 18.9 P_2O_5 and 422.1 K_2O kg/ha (Table 2). Improved dry matter production (DMP) with increased application of nutrients was owing to the function of NPK in influencing and efficient use of sunlight via enhanced biological and insufficiency of nitrogen decreases the sunlight utilize efficiency or the facility to photosynthesise as already reported by Venketa Laksmi (2001) and Panchal *et al.* (2018).

Protein content and 1000-seed weight: Owing to protein content and seed test weight, 125% of RDF + chlormequat chloride @250 ppm in 20 and 40 DAS (T_4) provided in higher seed protein content (12.65%) and 1000-seed weight (12.70 g) for the duration of the crop (Fig. 1). It may be owing to collective application of NPK fertilizers that improved the N and P_2O_5 inside into grain further generated a suitable environment for the plants and more photosynthesis competences provided higher values of grain and straw yield in pearl millet which is an alignment with the findings of Menon *et al*. (1984) and Swarnima *et al*. (2016). An improvement with biotic parameters in the course of the PGRs shows to be owed to its function in altering a diversity of physio-chemical processes in plant system (Ravindran 1992, Shewry *et al*. 2002 and Perveen *et al*. 2014).

Net returns and benefit: cost (B:C) ratio: 125% RDF + chlormequat chloride @250 ppm (T_4) with 20 and 40 DAS was recorded highest net returns and B:C ratio and it was on par with treatment T_7 (125% RDF + NAA @40 ppm).

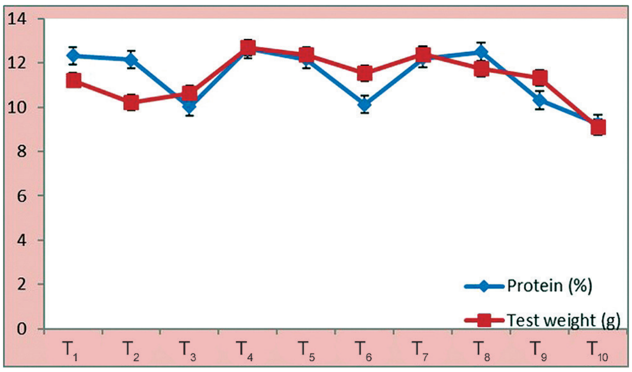

Fig. 1 Response of nutrient and growth regulators on protein content and test weight of pearl millet grains.
Refer to methodology for Treatment details.

Table 2 Available soil nutrients in post-harvest soils of pearl millet (Mean of 3 years)

Treatment	Soil available nutrient status (kg/ha)		
	N	P	K
T_1,125% RDF	219.1	15.1	504.2
T_2,100% RDF	200.2	18.6	480.1
T_3,75% RDF	194.9	14.8	452.1
T_4,125% RDF + chlormequat chloride @250 ppm	214.0	20.1	557.0
T_5, 100% RDF + chlormequat chloride @250 ppm	208.3	18.0	492.0
T_6, 75% RDF + chlormequat chloride @250 ppm	179.2	14.3	479.0
T_7, 125% RDF + NAA @40 ppm	195.5	18.9	522.1
T_8, 100% RDF + NAA @40 ppm	201.3	15.6	468.2
T_9,75% RDF + NAA @40 ppm	182.8	17.9	432.2
T_{10}, Control	123.6	12.7	404.3
S.Ed	9.19	0.79	22.87
CD (*P*=0.05)	19.32	1.64	48.03

RDF, Recommended dose of fertilizer (i.e. 80:40:40 kg NPK/ha); NAA, Naphthaleneacetic acid.

The treatment of 125% RDF + chlormequat chloride @250 ppm (T_4) at 20 and 40 DAS also registered an average increase in yield of 94.9 and 19.7% over control (T_{10}) and T_2 respectively and registered more net returns (34,575/ha) and B:C ratio of 2.01. This aught be due to release of the nutrients in necessary quantity during crucial time of growth through fertilizers as well as fastening the transport of solutes due to the PGRs (Singh 2007) ensuing in better crop productivity and enhanced quality of grain (Espindula *et al.* 2009). However, the lower values of growth, yield and quality parameters was recorded with 75% RDF + chlormequat chloride @250 ppm (T_6), 75% RDF + NAA @40 ppm (T_9) and in control (T_{10}).

From the field study it could be concluded that, application of 125% RDF along with chlormequat chloride at 250 ppm at 20 and 40 DAS recorded significantly higher growth and yield parameters, grain yield, grain protein content, test weight and available NPK in the post harvest soil samples and also recorded higher net returns (34575/ha) and B:C ratio (2.01). Hence, this management practice can be practiced by the pearl millet growers to increase the grain quality, test weight and for maximizing the yield of pearl millet.

SUMMARY

Field experiment was conducted to evaluate nutrient levels and growth regulators on soil fertility status, yield and quality of pearl millet during winter (*rabi)* season of 2019–22. Among the treatments imposed, application of 125% (RDF) with chlormequat chloride at 250 ppm on 20 and 40 DAS showed significantly higher plant height, LAI, number of tillers/plant, besides exerting a considerable involvement on yield characters of pearl millet, *viz.* effective tillers, ear head length, ear head girth, dry matter production, maximum grain protein content, test weight, crop nutrient uptake and higher soil available nutrient status in post-harvest soils. Application of 125% RDF with chlormequat chloride at 250 ppm on 20 and 40 DAS significantly influenced the yield which was also found to be on par with 125% RDF + NAA @250 ppm at 20 and 40 DAS. 125% RDF with chlormequat chloride at 250 ppm on 20 and 40 DAS registered an average increase in yield of 94.9 and 19.7% over control (T_{10}) and 100% RDF (T_2), respectively and recorded higher net returns (34,575/ha) and B:C ratio (2.01).

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