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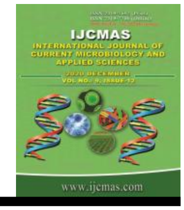

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Effect of Plant Growth Regulators and Zinc Fertilization on Growth of Pearlmillet [*Pennisetum glaucum* (L.) R. Br. emend Stuntz]

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A B S T R A C T

A field experiment were conducted during *Kharif* season 2018 on loamy sand soil at the OPJS University, Churu (Rajasthan) to study the effect plant growth regulators (PGRs) and Zinc fertilization on growth of pearlmillet comprised of three PGRs (1000 ppm triacontanol, 50 ppm naphthalene acetic acid (NAA) including water sprayed (control) with four levels of Zinc (0, 2, 4 and 6 kg ha^{-1}). It was conducted in factorial randomized block design and replicated thrice. The results revealed that foliar application 20 and 40 day after sowing (DAS) in pearlmillet of triacontanol and NAA significantly was recorded increased in plant height, dry matter accumulation over water sprayed. Triacontanol and NAA were gave significantly over water sprayed, whereas, plant stands was recorded not significant at 20 DAS and at harvest stage. Four Zn level application in soil was found significantly in plant height, dry matter accumulation, significantly increased with zinc fertilization @ 4 kg Zn/ha over control, which was remained at par with 6 kg Zn/ha.

Introduction

Pearlmillet [*Pennisetum glaucum* (L.) R. Br. emend Stuntz] is world's sixth and India's fourth important cereal food crop after rice, wheat and maize. India is the largest pearlmillet growing country contributing 50 percent of production in the world (FAO, 2020). Pearlmillet is globally cultivated on about 31 million ha, mostly in the arid and semiarid tropical regions of Asia, Africa and Latin America (Yadav *et al.*, 2012). India have been the largest area of about 6.93 million ha with production of 8.61 million tones and productivity of 1243 kg/ha during 2018-19 (Directorate of Millets Development, 2020). It is nutritionally better than many cereals. It is a good source of protein having higher digestibility (12.6%) with slightly superior amino acid profile, fat (5%), particularly iron (2.8%), carbohydrate (69.4%), minerals (2.3%), riboflavin (Vit B_2) and niacin (Vit B_4) (Chouhan *et al.*, 2018). It is the most widely cultivated pearlmillet in Rajasthan. In India, pearlmillet is pre-dominantly cultivated as a rain fed crop in diverse soils, climatic condition and indispensable arid zone. It is generally cultivated in area with rainfall ranging from 150 to 600 mm. Pearlmillet is supposed to be traditionally arid crop because; it is tolerant to drought and efficient in utilization of solar radiation. It is not only a quick growing short duration crop, but also of scant and uncertain distribution of rainfalls. Its propensity for high dry matter production at high temperature has made a mark in tropics and subtropics. It is growing on large-scale area due to its drought escaping mechanisms and lower water requirement as compared to other *Kharif* cereals like sorghum and maize. The plant growth regulators (PGRs) have potential for increasing crop productivity under environmental stress. PGRs are chemical substances, which can alter the growth and developmental processes leading to increased yield, improved grain quality or facilitated harvesting (Bisht *et al.,* 2020). Foliar application of PGRs improved drought tolerance of plants because of the unique role of sulphydryl group in photosynthesis and dry matter partitioning. PGRs are known to play a positive role in enhancing qualitative and quantitative characters in plants. Bio regulator presents a new possibility to break yield barrier, particularly imposed by the environment (Witter, 1971). Application of triacontanol (along chain aliphatic alcohol) based PGRs and naphthalene acetic acid (NAA) has been reported to induce physiological efficiencies, including photosynthetic ability of plants which resulted in better growth and yield of several crop without substantial increase in cost of production (Sumeriya *et al.,* 2000). Gurrala *et al.,* (2018) reported that the PGRs have potential for increasing crop productivity under environmental stress. PGRs are chemical substances, which can alter the growth and developmental processes leading to increased yield, improved grain quality or facilitated harvesting. Zinc plays are a vital important role in humankind health and functioning the various physiological and metabolic functions of plant (Alam *et al.,* 2010). The soils of arid region are moderately deficient in zinc and its external application is required for optimization of productivity. Out of applied zinc fertilizer, only 3 to 6 percent is utilized by first crop so the fertilizer added once to soil leaves significant residual effects for the succeeding crops. Zinc is most deficient among all the micronutrients in Indian soils. Zinc is essential element for crop production and growth development of plant (Ali *et al.,* 2008). The north-western parts of Indian states are having predominantly saline and alkaline soils with poor fertility. Poor availability of micronutrients mainly zinc (Zn) as well as poor agronomic practices further reduces the availability of these nutrients to plants which led to reduced growth and yield (Raja *et al.,* 2012). Therefore, the present investigation is designed to study the performance of nutrients and PGRs in pearlmillet.

Materials and Methods

The field experiment was conduct during *Kharif* season, 2018 at the Agronomy farm, OPJS University, Churu (Rajasthan). It is geographically in western side is 28·39, North latitude, 75.34 East longitude and altitude of 233 meters above mean sea level. The area of research is according agroecological classification lying under Agroclimatic Zone II A. Rajasthan is transitional plain of inland draining. The 12 treatment combinations of three PGPs treatment and four zinc treatments (Zero, 2, 4 and 6 kg /ha) were randomized in factorial randomized block design (FRBD) with replicated three times. In order to evaluate the effect of different treatments on plant growth, necessary periodical observations were record. The plant stand was counted at 20 DAS and at harvest stage as per meter, row length from five randomly selected spots in each plot and the average was worked out. Five plants were selected randomly from each plot and tagged. Height of individual plant was recorded at 30, 60 DAS and at harvest. The height was measure from base of the plant to the top of the main shoot by meter scale and expressed as average height in cm at respective stage. The periodical changes in dry matter per meter row length of pearlmillet were recorded at 30, 60 DAS and at harvest. The plant samples were taken from the sample rows. Samples were first dried in air and finally in an electric oven at 70^0C for 72 hours until a constant weight were achieved. The weight was recorded and expressed as average dry matter per meter (g) row length. Pearlmillet variety 'RHB-177' is suitable for well-drained soils. It is early maturing variety (72-74 days) and attains height of 150-160 cm. Days to 50% flowering are 44-46. It has thin stem with 2-3 tillers/plant. Leaf sheath length is 12.6 cm and leaf blade length is 65-70 cm. Grains are medium is size and average yield of variety is 18-25 q/ha under normal sowing and moderate level of management.

Results and Discussion

The observations pertaining to growth parameters of pearlmillet recorded during the course of investigation were statistically analyzed and significance of results tested. The interaction effects were found significant and hence results for all the main effects were being presented in succeeding paragraphs.

Plant stand

A perusal of data (Table 1) revealed that different PGRs and Zinc levels could be no significant variation on plant stand of pearlmillet per meters row length at both 20 DAS and at harvest stages.

PGRs: A critical examination of data (Table 1) revealed that foliar spray of triacontanol remaining at par with was found not significantly increased in per meter row length over water sprayed (control) to the extent of 7.31 and 7.28 per meters row length at 20 DAS and 6.94 and 6.86 per meters at harvest, respectively. however the PGRs was failed to bring about perceptible variation in per meters row length statistical.

Zinc fertilization: The results was presented in table 1 indicated that, the Zinc fertilization not influenced the per meters row length was found not significantly at 20 DAS and at harvest stage. However, Application of Zinc at 4 kg Zn/ha was recorded the per meter row length by 7.29 and 6.93 per meter row length at harvest and 7.3 and 6.92 per meter row length harvest over 2 kg Zn/ha and control, respectively.

Interaction effect: An examination of data revealed that interaction effect of PGRs and Zinc fertilization have no significant effect on per meter row length at 20 DAS and at harvest.

Plant height

The periodical plant height (cm) is recorded at 30 DAS, 60 DAS and at harvest as influenced by PGRs and Zinc fertilization is furnished in table 2.

PGRs: A critical examination of data (Table 2) revealed that foliar spray of triacontanol remaining at par with NAA was found significantly increased in plant height over water sprayed (control) at 30 and 60 DAS and at harvest stage, to the extent of 38.64 and 38.20 cm. however, at 30 DAS, 60 DAS and at harvest was recorded in plant height in 15.62 & 16.82 and 7.30 & 8.04 per cent increased, respectively.

Zinc fertilization: The results presented in table 2 indicated that, the Zinc fertilization the plant height of pearlmillet was recorded at 30, 60 DAS and at harvest influenced significantly through Zinc fertilization. At later stages of crop growth, increasing levels of Zinc fertilization was notice significantly increased the plant height upto 4 kg Zn/ha over preceding levels. Further increase in its level to 6 kg Zn/ha could not enhance the plant height upto the level of significance. Application of Zinc at 4 kg Zn/ha increased the plant height by 0.49 and 1.51 per cent at 60 DAS and 0.93 and 2.32 per cent at harvest over 2 kg Zn/ha and lower level control, respectively.

Interaction effect: An examination of data revealed that interaction effect of PGRs and Zinc fertilization has significant effect on plant height at 60 DAS and at harvest. However, 30 DAS did not show interaction between PGRs and Zinc levels.

Dry matter accumulation

The periodical dry matter accumulation is recorded at 30, 60 DAS and at harvest as influenced by PGRs and Zinc fertilization are furnished in table 3.

PGRs: A critical examination of data in (Table 3) showed that PGRs were found significant in dry matter accumulation per meter length row at 30 Das, 60 DAS and harvest stages. foliar application of triacontanol being at par with NAA was found significantly improved the dry matter accumulation over water spray (control) the extent of 2.85 and 0.46 at 30 DAS, 24.29 and 17.04 per cent at 60 DAS and 23.42 and 16.47 per cent at harvest, respectively over water sprayed (control). Maximum dry matter accumulation was recorded at triacontanol spray application treatment.

Table.1 Effect of PGRs and zinc on plant stand per meter row length of pearlmillet

Treatments	Plant stand	
	20 DAS	At harvest
PGRs		
NAA	7.282	6.942
Triacontanol	7.310	6.896
Water spray (control)	7.224	6.908
SE(m)	0.018	0.052
C.D.	N.S.	N.S.
Zinc levels (kg Zn/ha)		
0	7.246	6.861
2	7.253	6.948
4	7.290	6.932
6	7.298	6.921
SE(m)	0.021	0.061
C.D.	N.S.	N.S.
Factor (A x B)		
SE(m)	0.037	0.105
C.D.	NS	NS

NS =Non significant

Table.2 Effect of PGRs and zinc on plant height of pearlmillet

Treatments	Plant height (cm)		
	30 DAS	60 DAS	At harvest
PGRs			
NAA	38.203	142.417	157.903
Triacontanol	38.646	143.895	158.992
Water spray (control)	37.431	123.179	147.166
SE(m)	0.076	0.060	0.118
C.D.	0.225	0.178	0.349
Zinc levels (kg Zn/ha)			
0	37.805	135.257	152.321
2	37.957	135.922	153.744
4	38.259	137.304	155.861
6	38.352	137.505	156.821
SE(m)	0.088	0.069	0.137
C.D.	0.260	0.205	0.403
Factor(A x B) or			
SE(m)	0.153	0.120	0.237
C.D.	NS	0.355	0.699

NS =Non Significant

Table.3 Effect of PGRs and zinc on dry matter accumulation per metre row length of pearlmillet

Treatments	Dry matter accumulation (g)		
	30 DAS	60 DAS	At harvest
PGRs			
NAA	18.242	122.935	165.208
Triacontanol	18.676	130.545	175.072
Water spray (control)	18.159	105.035	141.850
SE(m)	0.012	0.016	0.075
C.D.	0.036	0.047	0.223
Zinc levels (kg Zn/ha)			
0	15.986	108.053	145.782
2	16.906	114.607	155.427
4	19.486	124.810	165.474
6	21.059	130.550	176.157
SE(m)	0.014	0.018	0.87
C.D.	0.041	0.054	0.257
Factor (A x B)			
SE(m)	0.024	0.032	0.151
C.D.	0.072	0.093	0.446

NS =Non significant

Zinc fertilization: Further references to data (Table 3) revealed that successive addition in level of Zinc from 0 to 4 kg Zn/ha were found significantly increased the crop dry matter accumulation at 30 DAS, 60 DAS and at harvest over lover Zinc levels. The level of Zinc at 4 kg Zn/ha registered was recorded dry matter accumulation of 19.49, 124.81 and 165.47 g/m row length at 30 DAS, 60 DAS and harvest stages, respectively. Thus improved it to the extent of 5.76 and 21.89 per cent at 30 DAS, 6.07 and 15.51 per cent at 60 DAS and 6.62 and 13.51 per cent at harvest stage over 4 kg Zn/ha and lower level control, respectively. However, it was showed statistical resemblance with 6 kg Zn/ha, wherein the maximum dry matter at 30 DAS, 60 DAS and at harvest was recorded 20.06, 130.55 and 176.157 g/m row length.

Interaction effect: An examination of data revealed that interaction effect of PGRs and Zinc fertilization did has been significant effect on dry matter accumulation at 30, 60 DAS and at harvest.

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 PGRs. The increase in plant height by the application of triacontanol and NAA was 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. The amount of total dry matter produced was an indication of overall efficiency of utilization, resources and better interception of light. Enhanced dry matter production with increased nutrient application was found due to role of NPK in determining the use of sunshine by the increased biomass and any inadequacy of nitrogen reduces the sunshine use efficiency or ability to photosynthesis. The improvement in growth characters with these PGRs seems to be due to their role in modifying various physiological and metabolic processes in the plant system. The foliar spray of triacontanol and NAA caused a favourable influence on the growth of crop, when summer and environment wet condition temperature was occurred during the growing period of pearlmillet. Knowles and Ries (1981) ascribed positive influence of triacontanol on carbon cycle in plants by virtue of increase in chlorophyll content leading towards higher Co_2 fixation and photosynthetic rate. While, Menon and Srivastava (1984) attributed improvement in dry matter accumulation by PGRs due to reduction in photorespiration, further, it is well established fact that the dry matter accumulation is the balance between photosynthesis and respiration process in the plant system. An increase in plant growth might be due to higher quantity of chlorophyll synthesis in the leaf tissue and delayed senescence of plant leaves. It is also probable that photosynthetic efficiency might have sustained for longer duration following the foliar application of growth regulators partly due to higher rate of Co_2 fixation by treated plants and partly due to greater translocation of photosynthates from source of various sinks as reported by king *et al.,* (1967). Singh (2007) reported that foliar application of triacontanol and NAA was prove significantly increased the plant height, dry matter accumulation in leaves. Gurrala *et al.,* (2018) evaluated those PGRs on growth of pearlmillet had significant influence on growth parameters like plant height, total number tillers, dry matter production and chlorophyll content were recorded foliar application. In addition several researchers (Sivakumar *et al.,* (2002) in pearlmillet, Eleiwa *et al.,* (2013) in barley, Perveen *et al.,* (2014) in wheat, Chandrashekhara *et al.,* (2018) in maize and Pal *et al.,* (2009), Kumar *et al.,* (2018) and Goutam *et al.,* (2018) in rice) also can be recorded significant improvement in growth characters of various crops due to application of NAA and triacontanol based PGRs.

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