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Influence of Growth Regulators on Growth and Yield of Finger millet (*Eleucine coracana* L.) varieties

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ABSTRACT: Growth regulators can improve the physiological efficiency including photosynthetic ability and may improve the physiological efficiency and may play a significant role in raising the productivity of the crop. A field experiment was conducted during *Kharif* season 2020 at Crop Research Farm (CRF), Department of Agronomy, SHUATS, Prayagraj (U.P.) on sandy loam soil to investigate the response of growth regulators on Finger millet (*Eleucine coracana* L.) varieties under eastern humid UP condition. The treatments consisted of three varieties *viz.*, GPU-28, MR-1 and ML-365 and Plant growth regulators *viz.*, Boric acid 3000 ppm, Salicylic acid 40 ppm and Gibberellic acid 50 ppm. The experiment was laid out in randomized block design with ten treatments replicated thrice. Study revealed that treatment ML-365 + Gibberellic acid 50 ppm was recorded significantly higher plant height (77.41 cm), number of tillers (243.95), dry matter accumulation (435.14 g/m^2), number of effective tillers (242.20), number of grains/finger (2078.17), grain yield (2.81 t/ha) and stover yield (4.56 t/ha). However, gross return (1,07,304.00 INR/ha), net returns (73,909.40 INR/ha) and B:C ratio (2.21) was also obtained maximum with application of ML-365 + Gibberellic acid 50 ppm.

Keywords*: Finger millet, Growth regulator, Varieties, Yield, Economic*

INTRODUCTION

Finger millet is believed to have originated in Uganda and Ethiopia of Africa (Seetharam, 2007) around 3,000 years BC and spread to India around 3,000 years ago. India is considered as a secondary center of genetic diversity. It is the most important small millet in tropics covered 12% of global millet area and cultivated in more than 25 countries in Africa and Asia. Among small millets, it ranks first in India by considering it's nutritional value. The grain contains 9.2% proteins, 1.29% fats, 76.32% carbohydrates, 2.2% mineral, 3.90% ash, 0.33% calcium. Vitamin A, B and phosphorus are also present in smaller quantity, iodine content in finger millet is reported to be the highest among food grain. In India finger millet is cultivated in an area of 1.27 million ha with a production of 2.61 million tonnes and productivity is 1489 kg/ha (Prasanna Kumar *et al.*, 2019). Karnataka, Tamil Nadu, Andhra Pradesh, Orissa, Jharkhand, Uttaranchal, Maharashtra, and Gujarat are the leading states of India in finger millet cultivation.

Plant growth regulators like salicylic acid (SA) and gibberellic acid (GA_3) are recognized endogenous regulator of plant metabolism, which are mainly involved in biotic and abiotic stress. Gibberellic acid (GA_3) works as a hormone in regulating plant growth, which can stimulate the rapid stem and root growth and increase speed of germination. Boric acid stimulates many growth aspects as plant height, leaf number, leaf area, haulm fresh and dry weight. Salicylic acid is ortho-hydroxy benzoic acid and it is a secondary metabolite acting as analogous of growth regulating substances. Foliar application of growth regulators exerted effects on plant growth metabolism when applied at physiological concentration, and thus acted as one of the plant growth regulating substances (Bekheta and Talaat, 2009). Varieties play an important role in crop production and the potential yield of a variety within genetic limit is determined by its environment. The release of high yielding varieties has contributed a great deal toward the improvement of finger millet yield. The yield of any crop depends on the production potential of the cultivar and climatic, edaphic and management practices to which the cultivar is exposed. The cultivar recommended earlier in the region or in different agro-climatic condition be tested with newly introduced or developed cultivar so as to understand the production potential of different cultivars to that region. Therefore, in view of the above, the present investigation were undertaken with an aim to evaluate the performance of finger millet varieties with different growth regulators foliar spray in order to achieve high yield and economic returns to encourage sustainable development under eastern Uttar Pradesh condition.

MATERIALS AND METHODS

A. Site Selection and Soil Analysis

The experiment was carried out during *Kharif* season of 2020 at Crop Research Farm (CRF), Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj (25° 39′42″N and 81°67′56″E and 98m altitude) on sandy clay loam soil of eastern Uttar Pradesh condition. The experimental soil was nearly neutral in soil reaction (pH – 7.1), low in organic carbon (0.28%), medium in available Nitrogen (225 kg/ha), medium in available Phosphorous (19.50 kg/ha) and medium in available Potassium (192.00 kg/ha).

B. Experimental Design and Treatment Combinations

The experiment was laid out in Randomized Block Design with 3 replications. Total 10 treatment comprised all possible combinations of 3 varieties (GPU-28, MR-1 and ML-365) and 3 plant growth regulators (Boric Acid, Salicylic Acid and Gibberellic Acid) foliar spray @ 3000 ppm, 40 ppm and 50 ppm respectively. (@ 40 and 60 DAS) along with control are given in Table 1. $T_{1.}$ Control plot, $T_{2.}$ GPU-28 + Boric acid 3000 ppm, T_3 GPU-28 + Salicylic acid 40 ppm, $T_{4.}$ GPU-28 + Gibberellic acid 50 ppm, $T_{5.}$ MR-1 + Boric acid 3000 ppm, $T_{6.}$ MR-1 + Salicylic acid 40 ppm, $T_{7.}$ MR-1 + Gibberellic acid 50 ppm, $T_{8.}$ ML-365 + Boric acid 3000 ppm, $T_{9.}$ ML-365 + Salicylic acid 40 ppm, $T_{10.}$ ML-365 + Gibberellic acid 50 ppm.

C. Fertilizer application and Trait Measurement

The amount of different fertilizers required to supply the needed quantities of nutrients were calculated on per plot basis. The field observation on plant height, no. of tillers, dry matter accumulation, grain and stover yields were recorded. In order to workout the most profitable treatment, the economics of each treatment was workout on the basis of prevalent market prices of the inputs and outputs.

Fig. 1. Preparation of Land, Sowing of Seeds, Foliar Application of Plant Growth Regulators, Crop at harvesting stage, Harvesting of crop, Drying of ear heads, Finger millet varietal difference (From left. GPU-28, ML-365, MR-1), With board of experiment details.

Table 1: Effect of Growth Regulators on Growth parameters of Finger millet Varieties.

Treatments	Plant height (cm)	No. of tillers/m^2	Dry matter accumulation (g/m^2)
Control Plot	72.08	182.53	385.31
GPU-28 + Boric acid 3000ppm	72.58	207.66	398.98
GPU-28 + Salicylic acid 40ppm	70.49	208.71	354.31
GPU-28 + Gibberellic acid 50ppm	74.76	202.39	393.46
MR-1 + Boric acid 3000ppm	72.68	204.16	379.56
MR-1 + Salicylic acid 40ppm	73.27	201.36	380.34
MR-1 + Gibberellic acid 50ppm	74.58	220.38	409.34
ML-365 + Boric acid 3000ppm	76.49	239.63	413.71
ML-365 + Salicylic acid 40ppm	75.97	231.23	418.45
ML-365 +Gibberellic acid 50ppm	77.41	243.95	435.14
SEm(±)	0.85	10.42	11.33
CD (P=0.05)	4.24	30.98	33.67

D. Statistical Analysis

The experimental data analysed statistically by applying the technique of analysis of variance (ANOVA) prescribed for the design to test the significance of overall difference among treatments by the F test and conclusion were drawn at 0.05% probability level (Gomez and Gomez, 1984).

RESULTS AND DISCUSSIONS

A. Growth Parameter

Data pertaining to Growth parameters of finger millet *viz.*, Plant height, Plant dry matter accumulation and Number of tillers were as influenced by growth regulators and different varieties on growth stages of Finger Millet.

The significantly highest plant height, number of tillers/m^2 and dry matter accumulation (g/m^2) at harvesting stage (Table 1) of finger millet were obtained with variety ML-365 + GA_3 50 ppm over the control and the other treatments. Data pertaining to plant height, variety ML-365 + GA_3 50 ppm significantly increased plant height (77.41 cm) at harvest but it remained at par with treatment GPU-28 + GA_3 50 ppm, MR-1 + Salicylic acid 40 ppm, MR-1 + GA_3 50 ppm, ML-365 + Boric acid 3000 ppm and ML-365 + Salicylic acid 40 ppm. Similarly, variety ML-365 + GA_3 50 ppm recorded significantly maximum number of tillers ($243.95/m^2$) at harvest. However, treatment combination MR-1 + GA_3 50 ppm, ML-365 + Boric acid 3000 ppm and ML-365 + Salicylic acid 40 ppm were statistically on par with treatment ML-365 + GA_3 50 ppm. Significantly maximum dry matter accumulation ($435.14\ g/m^2$) was recorded with ML-365 + Gibberellic acid 50 ppm but MR-1 + GA_3 50 ppm, ML-365 + Boric acid 3000 ppm and ML-365 + Salicylic acid 40 ppm were found statistically at par with ML-365 + Gibberellic acid 50 ppm. Gibberellic acid plays a role in growth and development, photosynthesis, ion uptake and transport. The suitable combination of variety with growth regulators maintained growth and productivity. Being a millet crop, it requires nutrient throughout the growing season and therefore, better growth and development under these treatments might be owing to increase the availability of nutrients to plants. Gibberellic acid play role in growth and development effectively by increasing of metabolic process and transport of nutrition. The result obtained in the present investigation are in close conformity with the findings of Jeyakumar *et al.* (2010). They reported that foliar application of salicylic acid (125ppm) on black gram increased the dry matter production.

The present investigation's result was also in accordance with the earlier findings of Nagasubramaniam *et al.* (2007) and Jayalakshmi *et al.* (2010). Nagasubramaniam *et al.* (2007) reported that foliar application of salicylic acid (100ppm) on babycorn increased the plant height, leaf area, crop growth rate and dry matter production.

B. Yield attributes

Maximum number of effective tillers per m^2 (242.20) and number of grains per finger (2078.17) were recorded with treatment combination of ML-365 + GA_3 50 ppm were significantly superior over all other treatments (Table 2).

Maximum test weight (3.20 g) was recorded with treatment combination of ML-365 + GA_3 50 ppm but there was no significant difference among the treatments. Number of productive tillers of finger millet were appreciably influenced by foliar spray of nutrients and plant growth regulators. The foliar spray of GA_3 50 ppm recorded the more number of productive tillers than the other foliar spray treatments. A similar effect of Gibberelic acid was observed by number of fertile tillers in wheat (Abouziena and Abd El Wahed, 2013). Growth regulators promotes chlorophyll content in plant tissues hence increase in photosynthetic rate which leads to increase in number of seeds per ear head and the variety ML-365 responded positively and recorded maximum number of grains per finger among three different varieties. Similar findings were observed in Dawood *et al.* (2012).

Table 2. Effect of Growth Regulators on Yield attributing characteristics of Finger millet Varieties.

Treatments	No. of effective tillers/m^2	No. of grains/ finger	Test weight (g)
Control Plot	175.63	1638.83	2.59
GPU-28 + Boric acid 3000ppm	200.35	1745.50	2.67
GPU-28 + Salicylic acid 40ppm	205.73	1126.50	2.95
GPU-28 + Gibberellic acid 50ppm	198.53	1737.17	2.74
MR-1 + Boric acid 3000ppm	181.58	1637.17	2.58
MR-1 + Salicylic acid 40ppm	199.23	1782.83	3.09
MR-1 + Gibberellic acid 50ppm	190.21	1781.50	2.42
ML-365 + Boric acid 3000ppm	215.56	1927.83	2.87
ML-365 + Salicylic acid 40ppm	224.16	1941.83	2.91
ML-365 + Gibberellic acid 50ppm	242.20	2078.17	3.20
SEm(±)	6.36	74.22	0.18
CD (P=0.05)	18.89	220.54	NS

Yield. The grain and stover yield of finger millet were found in range of 2.23 – 2.81 t/ha and 4.34 – 4.56 t/ha respectively (Table 3). The highest grain yield (2.81 t/ha) was recorded with ML- 365 + GA_3 50 ppm which was found to be significantly superior over all treatments except treatment with ML-365 + Boric acid 3000 ppm and ML-365 + Salicylic acid 40 ppm found at par. Among three different varieties variety ML-365 recorded maximum grain yield and Spraying of growth regulators had significant influence on grain yield of finger millet. The plant sprayed with gibberellic acid at 50 ppm produced significantly higher grain yield. This was followed by foliar application of salicylic acid at 40 ppm. This might be due to application of growth regulator enhanced growth attributing characters like plant height, dry matter production and number of tillers and yield attributing characters like number of productive tillers, ear head weight and also the nutrient uptake by finger millet genotype effectively help to produce more yield. Similar finding was also observed by Dawood *et al.* (2012).

Treatment combination of ML-365 + GA_3 50ppm recorded maximum stover yield (4.56 t/ha) (Table 3.) which was significant over all the treatments. However, . Harvest index is the best measure of source and sink relationship indicating efficient uptake and utilization of nutrients to biological and economic yield. In this investigation, the foliar application of GA3 acid at 40 ppm recorded higher harvest index value and it was on par with gibberellic acid 50 ppm. This might be due to treatment with GPU-28 + Boric acid 3000ppm, GPU-28 + Salicylic acid 40ppm, ML-365 + Salicylic acid 40 ppm and ML-365 + Boric Acid 3000 ppm were statistically on par with treatment ML-365 + GA_3 50ppm.

The stover yield enhancement due to the adoption of different treatments might be due to continuous supply of nutrients which in turn increased the plant height, dry matter production and number of tillers resulting in higher straw yield. The effect of growth regulator on genotype efficiently enhance physiological and biochemical processes that lead to amelionate in vegetative growth and yield attributes and ultimately yield increased. The results of the present study were in confirmation with the finding of Amin *et al.* (2008). He found that salicylic or ascorbic acid and their combinations increased dry weights of wheat plant and that might be attributed to an increase in number of tillers and spikes as well as leaf area, leading to increased photosynthetic activity.

Treatment combination of ML-365 + GA_3 50 ppm was recorded maximum harvest index of 34.69 % (Table 3) which was followed by control plot and there was no significant difference among treatments the increased mobilization of metabolites to reproductive sinks. The same results endorse the findings of Pramod kumar *et al*. (1999), Sujatha (2001) and Azizi *et al.* (2012) reported that foliar spray of gibberellic acid increased the harvest index in green gram.

Table 3: Effect of Growth Regulators on Yield related parameters of finger millets.

Treatment	Grain yield (t/ha)	Stover yield (t/ha)	Harvest index(%)
Control Plot	2.45	4.20	32.89
GPU-28 + Boric acid 3000ppm	2.23	4.34	28.43
GPU-28 + Salicylic acid 40ppm	2.36	4.49	29.50
GPU-28 + Gibberellic acid 50ppm	2.30	4.09	31.83
MR-1 + Boric acid 3000ppm	2.43	4.29	32.23
MR-1 + Salicylic acid 40ppm	2.46	4.23	32.67
MR-1 + Gibberellic acid 50ppm	2.38	4.28	31.72
ML-365 + Boric acid 3000ppm	2.54	4.33	31.39
ML-365 + Salicylic acid 40ppm	2.65	4.53	32.62
ML-365 +Gibberellic acid 50ppm	2.81	4.56	34.69
SEm(±)	0.08	0.08	1.26
CD (p=0.05)	0.24	0.25	NS

Economics. It is revealed from the data presented in (Table 4), that the mean cost of cultivation for treatment combination of finger millet production varied from INR 32455.00/ha to INR 33795.00/ha during experiment. Among all the treatments, highest Gross return (INR 107304.00/ha) and Net return (INR 73909.40/ha) and BC ratio (2.21) was evaluated under treatment combination of ML-365 + GA_3 50 ppm. Owing to the higher yields recorded under this treatment as discussed earlier, fetched INR 73,909.40/ha over treatment ML-365 + Salicylic acid 40ppm, INR 68,631.10/ha over ML-365 + Boric acid 3000ppm, INR 64,473.90/ha over 1. The same trend was observed under B:C ratio, mean B:C ratio was observed highest under treatment combination ML-365 + GA_3 50 ppm (2.21). It give 83.9% more return than control treatment. Similar findings observed by Revathi *et al.* (2018).

Table 4: Effect of Growth Regulators on economics of Finger millet varieties.

Treatment	Total cost of Cultivation (INR/ha)	Gross return (INR/ha)	Net return (INR/ha)	B:C ratio
Control Plot	32455.00	94492.00	62037.00	1.91
GPU-28 + Boric acid 3000ppm	33765.00	88786.90	55021.90	1.63
GPU-28 + Salicylic acid 40ppm	33795.00	93301.70	59506.70	1.76
GPU-28 + Gibberellic acid 50ppm	33635.00	89483.70	55848.70	1.66
MR-1 + Boric acid 3000ppm	33645.00	94438.60	60793.60	1.81
MR-1 + Salicylic acid 40ppm	33675.00	95051.10	61376.10	1.82
MR-1 + Gibberellic acid 50ppm	33515.00	92811.10	59296.10	1.77
ML-365 + Boric acid 3000ppm	33525.00	97998.90	64473.90	1.92
ML-365 + Salicylic acid 40ppm	33555.00	102186.00	68631.10	2.05
ML-365 + Gibberellic acid 50ppm	33395.00	107304.00	73909.40	2.21

CONCLUSION

As per findings of the experiment it is concluded that for better yield and return treatment combination of ML-365 + GA_3 50 ppm gave maximum growth and yield response, hence for better yield and economic return variety ML-365 with foliar application of Gibberellic acid 50 ppm is recommended for receiving higher yield and returns of finger millet under eastern UP condition.

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