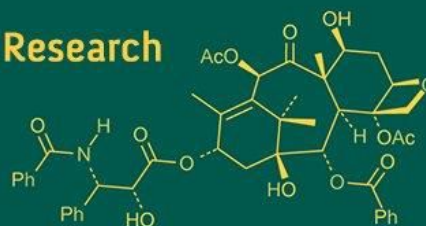


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating: 5.29
IJABR 2025; 9(4): 87-93
www.biochemjournal.com

Received: 16-02-2025
Accepted: 24-03-2025

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Influence of bio stimulants on production potentiality and nutrient uptake by different foxtail millet (*Setaria italica* L.) genotypes

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DOI: <https://www.doi.org/10.33545/26174693.2025.v9.i4b.4063>

Abstract

A field experiment was conducted at AHRS, Bavikere (Karnataka) during late *kharif* 2021 to study the "Influence of Bio stimulants on Production potentiality and nutrient uptake by different Foxtail Millet (*Setaria italica* L.) Genotypes". The experiment was laid out in a split plot design with 12 treatment combinations and replicated thrice. Main plot treatments include three genotypes%, SiA-3156 (G₁), HMT-100-1 (G₂) and DHFt-109-3 (G₃). Sub plot treatments include four levels of foliar nutrition of biostimulants%, humic acid @ 0.1% (F₁), panchagavya @ 3% (F₂), combination of humic acid @ 0.1% + panchagavya @ 3% at 30 and 60 DAS (F₃) and control (RDF only) (F₄). The results revealed that, among the genotypes, HMT-100-1(G₂) recorded significantly higher grain yield (1701.0 kg ha⁻¹) and straw yield (4066.0 kg ha⁻¹) with higher uptake of total nitrogen, phosphorus and potassium (46.37, 14.19 and 34.04 kg ha⁻¹, respectively). Among different foliar nutrition of bio stimulants, application of humic acid @ 0.1% + panchagavya @ 3% (F₃) recorded significantly higher grain yield (1781.2 kg ha⁻¹) and straw yield (4139.5 kg ha⁻¹). Further, significantly higher total nitrogen, phosphorus and potassium uptake (48.25, 15.23 and 38.33 kg ha⁻¹, respectively). Among the interaction effects, combination of HMT-100-1 with foliar application of humic acid @ 0.1% + panchagavya @ 3% has recorded significantly yield and nutrient uptake compared to other treatment combinations.

Keywords: Biostimulant, foxtail millet, nutrient uptake, yield, humic acid

Introduction

In India, the area under small millets is 4.44 lakh hectare with production of 3.46 lakh tonnes and productivity of 781 kg per hectare. In Karnataka, the area under small millets account for 0.26 lakh hectare with production of 0.20 lakh tonnes and productivity of 778 kg per hectare [3]. Among minor millets, foxtail millet (*Setaria italica* L.) is one of the oldest cultivated crop for grain, hay and pasture. It is native to China and regarded as an elite drought-tolerant crop. This crop ranks second in the total world production of millets and it continues to have a significant recognition in world agriculture providing food for millions of people in arid and semiarid regions. In India, it is largely grown in Andhra Pradesh, Telangana, Karnataka, Tamil Nadu and Rajasthan. In Karnataka, it is generally grown in Haveri, Dharwad, Chitradurga and Belgaum districts [8].

The productivity of foxtail millet in India is very low due to the inadequate application of fertilizers, conventional cultivation of low yielding cultivars and lack of good management practices. The maximum yield potential can be achieved by balanced application of nutrients which includes the four basic principles *i.e.*, right source, time, rate and method and this will ensure the higher economic returns while ensuring the sustainability. Apart from this poor nutrient uptake ability and nutrient use efficiency is another reason for lower yield. Foliar nutrition is a method of feeding fertilizers in liquid form as a spray on the foliage of plants to facilitate easy and quick nutrient absorption through their stomata and epidermis. Foliar application of nutrients has been shown to avoid the problem of leaching of nutrients from the soil. It has been broadly used and accepted as one of the effective techniques that could be six to twenty times more efficient than soil application to achieve higher crop productivity. Agronomic practices% use of growth regulators, PGPR and biostimulants *etc.*, are known to improve the yield and quality of the produce in several crops. Further, biostimulants are ecofriendly and their usage in millets is very meager.

Hence, they are one of the most innovative and capable solution to address the important challenge of increasing foxtail millet productivity and nutrient uptake. Biostimulants are the materials which contain substances or microorganisms, whose function when applied to plants or the rhizosphere is to boost natural processes to enhance nutrient uptake, nutrient efficiency, tolerance to abiotic stress and crop quality, independent of its nutrient content. Foliar application of biostimulants like humic acid, panchagavya *etc.*, at critical growth stages like tillering and flowering stage not only improves the physiological efficiency. It also plays a significant role in raising the productivity of the crop ^[2]. Hence, considering the above facts, the present investigation was initiated to study the influence of Bio stimulants on Production potentiality and nutrient uptake by different Foxtail Millet (*Setaria italica* L.) genotypes.

Material and Methods

A field experiment was conducted at AHRs, Bavikere (Karnataka) during late *kharif* 2021 to study the “Influence of Bio stimulants on Production potentiality and nutrient uptake by different Foxtail Millet (*Setaria italica* L.) Genotypes”. The experiment was laid out in split plot design included twelve treatment combinations which are replicated thrice. Genotypes SiA-3156 (G1), HMT100-1 (G2) and DHFT-109-3 (G3) in main plots. Subplot treatment includes foliar application of biostimulants%, 0.1% humic acid (F1), 3% panchagavya (F2), 0.1% humic acid and 3% panchagavya (F3) at 30 and 60 DAS and RDF as control (F4). The land was well ploughed and harrowed to make a fine seed bed and foxtail millet was sown with spacing of 30 × 10cm. The crop was commonly supplied with recommended dose of fertilizer in the form of urea (N), Di ammonium phosphate (DAP) and Muriate of potash (MOP) as per the calculated amount to each plot as basal dose at the time of sowing to all the treatments. Foliar application of the biostimulants%, humic acid and panchagavya was done at 30 and 60 DAS. Protective irrigation was done as per the need of the crop and two hand weeding at 30 and 45 DAS were done to reduce crop-weed competition. Panicles from net plot were threshed and grain weight was recorded in kilogram and later converted to kg/ha. The data recorded on various observations on yield and soil parameters were subjected to analysis of variance (ANOVA) as outlined by ^[10]. The level of significance used in ‘F’ test was at 5%.

Study area: The experiment was conducted at Agricultural and Horticultural Research Station, Bavikere, Chikkamagalur district during late *kharif* 2021. It is situated in the Southern Transition Zone (Zone-7) of Karnataka state at 13°42' N latitude and 75°51' E longitude, with an altitude of 695 meters above the mean sea level. The soil of the experimental site was sandy loam in texture with acidic in reaction (6.12), medium organic carbon (0.52%), medium available nitrogen (315.64 kg/ha), medium available phosphorus (50.56 kg/ha) and medium in available potassium (340.58 kg/ha). During the crop growth period i.e., from September 2021 to December 2021 highest rainfall occurred during October (207.6mm) lowest in the December (0 mm). The mean monthly maximum temperature was highest during October (30.5°C), while it was lowest in November (28.2°C). The maximum relative humidity was observed in September (82.7%) and minimum

during December (57.3%). The sunshine hours were higher in November (7.9 hrs), while it was lowest in (6.3 hrs).

Yield observations recorded

Grain yield (kg ha⁻¹): Panicles in each treatment plots were harvested separately and sun dried for 4-5 days in threshing yard. Later panicles from net plot were threshed grain weight was recorded in kilogram and later converted to kg ha⁻¹.

Straw yield (kg ha⁻¹): Straw yield from the net plot area recorded after sun drying for 8-10 days after harvesting. The straw yield of foxtail millet was recorded after complete sun drying the stalks from each net plot and expressed in kg ha⁻¹

Chemical analysis of soil samples

During the field experiment during the field experimentation, a composite soil sample was collected from the experimental plot before sowing and after harvest of crop, soil samples were collected from each plot and were analysed with respect to N, P & K status. Then collected soil samples were dried under shade, powdered using pestle and mortar and passed through 2 mm sieve and preserved for analysis. For organic carbon analysis, the 2 mm sieved soil samples were subjected for further grinding and passed through 0.2 mm sieve. The samples were analysed for pH, EC, Organic carbon, nitrogen, phosphorus and potassium status using standard procedures. Soil pH was determined in 1:2.5 soil: water suspension using digital pH meter having the glass electrode developed by ^[12]. The electrical conductivity of soil was measured in 1:2 soil: Water extract using Conductivity Bridge by ^[12]. Organic carbon (%) was measured by taking known weight (0.5g) of 0.2 mm sieved soil was treated with a known excess volume of chromic acid (K₂Cr₂O₇ + H₂SO₄). After oxidation of organic carbon, the unreacted K₂Cr₂O₇ left in the content was back titrated against standard ferrous ammonium sulphate solution using diphenylamine indicator. The results expressed in percentage ^[24]. The alkaline potassium permanganate method developed by ^[22] was used for the estimation of available N content in the soil. The results expressed in kg ha⁻¹. The soil available phosphorus was determined by chloromolybdate blue colour method using Brays-I extractant as described by ^[6]. The intensity of the blue colour was determined at 660 nm using spectro photometer. The available P content was computed and expressed in kg ha⁻¹. Available K content was extracted using neutral N NH₄ OAC as described by Jackson (1973). The concentration of K in the extractant was determined by the Flame photometer. The available K content was computed and expressed in kg ha⁻¹ ^[12].

Digestion of plant samples with di-acid mixture

For analysis of phosphorus and potassium, plant samples were pre-digested with tri-acid mixture (HNO₃: HClO₄: H₂SO₄ at 9:4:1) which was used for digestion of composite plant samples.

Estimation of nitrogen, phosphorus and Potassium uptake

$$\text{Nitrogen uptake (kg ha}^{-1}\text{)} = \frac{\text{N concentration (\%)} \times \text{Dry matter (kg ha}^{-1}\text{)}}{100}$$

$$\text{Phosphorus uptake (kg ha}^{-1}\text{)} = \frac{\text{P concentration (\%)} \times \text{Dry matter (kg ha}^{-1}\text{)}}{100}$$

$$\text{Potassium uptake (kg ha}^{-1}\text{)} = \frac{\text{K concentration (\%)} \times \text{Dry matter (kg ha}^{-1}\text{)}}{100}$$

Results

The data on grain yield of foxtail millet as influenced by genotypes and foliar nutrition of biostimulants is presented in Table 1.

It is evident from the data that genotypes and foliar nutrition of bio stimulants had significant influence on grain yield. Among genotypes, HMT-100-1 recorded significantly higher grain yield (1701.0 kg ha⁻¹) followed by DHFt-109-3 (1538.7 kg ha⁻¹) which was on par with SiA-3156 (1408.2 kg ha⁻¹). Foliar nutrition of biostimulants showed significant influence on grain yield. Significantly higher grain yield was recorded with 0.1 per cent humic acid and 3 per cent panchagavya along with soil application of RDF (1781.2 kg ha⁻¹) followed by 0.1 per cent humic acid along with RDF (1550.6 kg ha⁻¹) which was on par with 3 per cent panchagavya along with RDF (1485.4 kg ha⁻¹). Significantly lower grain yield was observed in control (1380.1 kg ha⁻¹) which was supplied with RDF alone. Interaction between genotypes and foliar nutrition showed a significant difference in the treatments in which HMT-100-1 with 0.1 per cent humic acid and 3 per cent panchagavya along with soil application of RDF (2028.1 kg ha⁻¹) recorded significantly higher grain yield followed by DHFt-109-3 with 0.1 per cent humic acid and 3 per cent panchagavya along with soil application of RDF (1906.9 kg ha⁻¹). Significantly lower grain yield was recorded in SiA-3156 with control (1324.7 kg ha⁻¹) which was supplied with RDF alone.

The data on straw yield (kg ha⁻¹) as influenced by genotypes and foliar nutrition of biostimulants is presented in Table 1. Treatments varied significantly with respect to straw yield of foxtail millet as influenced by genotypes and foliar nutrition of biostimulants. Among genotypes, HMT-100-1 recorded higher straw yield (4066.0 kg ha⁻¹) followed by DHFt-109-3 (3731.7 kg ha⁻¹) which was on par with SiA-3156 (3525.4 kg ha⁻¹). Foliar nutrition showed significant influence on straw yield. Significantly higher straw yield was recorded with 0.1 per cent humic acid and 3 per cent panchagavya foliar application along with soil application of RDF (4139.5 kg ha⁻¹) followed by 0.1 per cent humic acid along with RDF (3791.6 kg ha⁻¹) which was on par with 3 per cent panchagavya application along with RDF (3634.6 kg ha⁻¹). Significantly lower straw yield was recorded in control (3531.8 kg ha⁻¹) which was supplied with RDF alone. Interaction between genotypes and foliar nutrition showed a significant difference for straw yield. HMT-100-1 with 0.1 per cent humic acid and 3 per cent panchagavya along with soil application of RDF recorded significantly higher straw yield (4666.6 kg ha⁻¹) followed by HMT-100-1 with 0.1 per cent humic acid along with soil application of RDF (4111.7 kg ha⁻¹). Significantly lower straw yield was recorded in SiA-3156 with control (3399.7 kg ha⁻¹) which was supplied with RDF alone.

Nutrient uptake of foxtail millet as influenced by genotypes and foliar nutrition of bio stimulants

Nitrogen uptake at 60 DAS and at harvest as influenced by genotypes and foliar nutrition of biostimulants is furnished in Table 2.

Genotypes differed significantly for nitrogen uptake at 60 DAS and at harvest. HMT-100-1 recorded higher nitrogen uptake (28.34 kg ha⁻¹ at 60 DAS and 30.18 kg ha⁻¹ by straw, 16.19 kg ha⁻¹ by grain at harvest, respectively) followed by DHFt-109-3 (23.04 kg ha⁻¹ at 60 DAS and 26.39 kg ha⁻¹ by straw, 14.09 kg ha⁻¹ by grain at harvest, respectively). Whereas, significantly lower nitrogen uptake (19.95 kg ha⁻¹ at 60 DAS and 23.38 kg ha⁻¹ by straw, 11.68 kg ha⁻¹ by grain at harvest, respectively) recorded in SiA-3156. With respect to foliar nutrition of biostimulants, nitrogen uptake significantly differed at 60 DAS and at harvest. 0.1 per cent humic acid and 3 per cent panchagavya foliar application along with soil application RDF recorded significantly higher nitrogen uptake (33.04 kg ha⁻¹ at 60 DAS and 31.90 kg ha⁻¹ by straw, 18.21 kg ha⁻¹ by grain at harvest, respectively) followed by 0.1 per cent humic acid along with RDF (25.19 kg ha⁻¹ at 60 DAS and 27.83 kg ha⁻¹ by straw, 15.33 kg ha⁻¹ by grain at harvest, respectively). Significantly lower nitrogen uptake was recorded in control (16.54 kg ha⁻¹ at 60 DAS and 22.66 kg ha⁻¹ by straw, 10.18 kg ha⁻¹ by grain at harvest, respectively) supplied with RDF alone.

Interaction effect was found to be highly significant with respect to nitrogen uptake in at 60 DAS and at harvest. HMT-100-1 with 0.1 per cent humic acid and 3 per cent panchagavya along with soil application of RDF recorded significantly higher nitrogen uptake (40.53 kg ha⁻¹ at 60 DAS and 37.57 kg ha⁻¹ by straw, 21.20 kg ha⁻¹ by grain at harvest, respectively). While, significantly lower nitrogen uptake (14.28 kg ha⁻¹ at 60 DAS and 21.54 kg ha⁻¹ by straw, 9.35 kg ha⁻¹ by grain at harvest, respectively) was recorded in SiA-3156 with application of RDF alone.

Phosphorus uptake (kg ha⁻¹)

Phosphorus uptake at 60 DAS and at harvest as influenced by genotypes and foliar nutrition of biostimulants is furnished in Table 2.

Among genotypes, there was a significant variation in phosphorus uptake at 60 DAS and at harvest. Analysis of the data revealed that, HMT-100-1 recorded significantly higher phosphorus uptake (11.29 kg ha⁻¹ at 60 DAS and 9.97 kg ha⁻¹ by straw, 4.22 kg ha⁻¹ by grain at harvest, respectively) followed by DHFt-109-3 (9.42 kg ha⁻¹ at 60 DAS and 8.75 kg ha⁻¹ by straw, 3.63 kg ha⁻¹ by grain at harvest, respectively). Significantly lower phosphorus uptake (8.39 kg ha⁻¹ at 60 DAS and 7.45 kg ha⁻¹ by straw, 2.97 kg ha⁻¹ by grain at harvest, respectively) was recorded in SiA-3156. Among foliar nutrition of biostimulants, significant variation in phosphorus uptake at 60 DAS and at harvest was observed. 0.1 per cent humic acid and 3 per cent panchagavya along with soil application of RDF recorded significantly higher phosphorus uptake (13.19 kg ha⁻¹ at 60 DAS and 10.51 kg ha⁻¹ by straw, 4.71 kg ha⁻¹ by grain at harvest, respectively) followed by 0.1 per cent humic acid along RDF (10.07 kg ha⁻¹ at 60 DAS and 9.38 kg ha⁻¹ by straw, 4.10 kg ha⁻¹ by grain at harvest, respectively). Significantly lower phosphorus uptake was recorded in control (7.36 kg ha⁻¹ at 60 DAS and 7.20 kg ha⁻¹ by straw, 2.60 kg ha⁻¹ by grain at harvest, respectively) supplied with RDF alone.

Interaction effect was found to be highly significant with respect to phosphorus uptake at 60 DAS and at harvest. HMT-100-1 with 0.1 per cent humic acid and 3 per cent panchagavya along with soil application of RDF recorded significantly higher phosphorus uptake (15.62 kg ha^{-1} at 60 DAS and 12.85 kg ha^{-1} by straw, 5.72 kg ha^{-1} by grain at harvest, respectively). While significantly lower phosphorus uptake (6.26 kg ha^{-1} at 60 DAS and 6.40 kg ha^{-1} by straw, 2.44 kg ha^{-1} by grain at harvest, respectively) was recorded in SiA-3156 with application of RDF alone.

Potassium uptake (kg ha^{-1})

Potassium uptake 60 DAS and at harvest as influenced by genotypes and foliar nutrition of biostimulants is furnished in Table 2.

Data with respect to potassium uptake indicated significant variation among genotypes at 60 DAS and at harvest. HMT-100-1 recorded significantly higher potassium uptake (20.82 kg ha^{-1} at 60 DAS and 23.26 kg ha^{-1} by straw, 10.79 kg ha^{-1} by grain at harvest, respectively) followed by DHFT-109-3 (17.38 kg ha^{-1} at 60 DAS and 20.61 kg ha^{-1} by straw, 9.41 kg ha^{-1} by grain at harvest, respectively). While, significantly lower potassium uptake of (15.99 kg ha^{-1} at 60 DAS and 18.18 kg ha^{-1} by straw, 8.27 kg ha^{-1} by grain at harvest, respectively) was recorded in SiA-3156. Among foliar nutrition of biostimulants, significant difference in phosphorus uptake at 60 DAS and at harvest was observed. 0.1 per cent humic acid and 3 per cent panchagavya foliar application along with RDF recorded significantly higher potassium uptake (23.32 kg ha^{-1} at 60 DAS and 24.78 kg ha^{-1} by straw, 12.08 kg ha^{-1} by grain at harvest, respectively) followed by 0.1 per cent humic acid along with RDF (19.22 kg ha^{-1} at 60 DAS and 21.40 kg ha^{-1} by straw, 10.16 kg ha^{-1} by grain at harvest, respectively) and 3 per cent panchagavya along with RDF (15.97 kg ha^{-1} at 60 DAS and 18.73 kg ha^{-1} by straw, 8.39 kg ha^{-1} by grain at harvest, respectively). Significantly lower potassium uptake was recorded in control (13.74 kg ha^{-1} at 60 DAS and 17.82 kg ha^{-1} by straw, 7.35 kg ha^{-1} by grain at harvest, respectively) supplied with only RDF without any foliar nutrition. Potassium uptake in grain and straw at harvest differ significantly due to interaction between genotypes and foliar nutrition of biostimulants. Significantly higher potassium uptake (27.15 kg ha^{-1} at 60 DAS and 29.70 kg ha^{-1} by straw, 13.90 kg ha^{-1} by grain at harvest, respectively) was recorded in HMT-100-1 with 0.1 per cent humic acid and 3 per cent panchagavya along with soil application of RDF. SiA-3156 with only application of RDF recorded significantly lower potassium uptake (12.29 kg ha^{-1} at 60 DAS and 16.60 kg ha^{-1} by straw, 6.99 kg ha^{-1} by grain at harvest, respectively).

Discussion

The magnitude of increase in grain and straw yield with the superior genotype HMT-100-1 was to an extent of 20.80% in grain yield and 15.42% in straw yield over low yielding genotype SiA-3156. It might be due to the fact that genotypes are different in their yielding potential depending on many physiological processes taking place in different plant parts, and are controlled by both the genetic makeup of the plant and the environment. These results are in agreement with the findings of [7, 20, 13] in foxtail millet.

Among the foliar application treatments, there was an improvement in grain and straw yield to an extent of 29.05% in grain and 16.28% in straw respectively over

control. Soil application of nutrients provide scope for the development of the plant but is also subjected to various losses due to climate abnormalities like heavy or deficit rainfall etc. Hence, providing additional nutrient supply through the foliar application of biostimulants%, humic acid and panchagavya which facilitate easy and quick nutrient absorption through their stomata and epidermis. They contain growth promoting substances like Indole acetic acid (IAA), gibberellins and auxins in its structure along with beneficial microorganisms. When these liquid manures applied twice at critical stages of the plant growth and development, they act as a stimulus in the plant system increases the translocation of the photosynthates from source to sink and nutrient uptake by the crop ultimately leads to higher yield. These results are in conformity with the findings of [15] in foxtail millet, [17] in pearl millet, [23] in paddy and [9] in finger millet.

Combined effect of the genetic potential of the genotype to adopt for the climate of that area and additional supply of nutrient through the biostimulants along with the RDF made significant increase in the yield of the crop. The results are in conformity with the findings of (5) in foxtail millet and (1) in proso millet.

Nutrient uptake of foxtail millet as influenced by genotypes and foliar nutrition of biostimulants

Plants absorb the nutrients through roots and foliage by nutrient uptake mechanism which is essential for the normal growth and development. The extent of nutrient uptake by the crop is going to influence growth and development of photosynthetic apparatus ultimately yield and yield components. Increase in the nutrient uptake by plants may increase the metabolic activity in plants leads to more accumulation of dry matter ultimately improves the grain yield. Significant difference in nutrient uptake between genotypes was observed. Higher nitrogen uptake, phosphorus uptake and potassium uptake was recorded in HMT-100-1 compared to SiA-3156. Nitrogen uptake, phosphorus uptake and potassium uptake. This may be due to humic acids aid in correcting plant chlorosis, increase the permeability of the plant membranes and intensify enzyme systems of plants. They accelerate cell division, show greater root development, and decrease stress deterioration [11].

Among foliar nutrition of biostimulants, it is evident from the data that higher nitrogen uptake was recorded in 0.1 per cent humic acid and 3 per cent panchagavya foliar application along with RDF compared to application of RDF alone which recorded minimum nitrogen uptake. The improvement of 99.00% at 60 DAS, 40.77% in straw and 78.00% in grain at harvest with respect to nitrogen uptake in humic acid and panchagavya along with RDF over control which is supplied with RDF alone. The stimulation of nitrogen uptake in the treatment that received foliar application of humic acid attributed to the auxin-like activity of humic substances which stimulates plasma membrane by increasing its permeability, and thereby improving the cellular growth that leads to well-developed root system with lateral roots influencing better absorption of nutrients [2]. Panchagavya contains macro and micronutrients as well as growth regulators like auxins and GA which helped in producing higher biomass and better recovery of nitrogen and phosphorus in the plant and beneficial microorganisms present in panchagavya and humic acid favourably

influenced the regulation of stomata, which also enhanced the uptake of nutrients. ^[16]. Foliar application of panchagavya along with RDF enhanced the production of number of leaves due to the chemolithic autotrophic nitrifiers in panchagavya which contributed to vegetative growth, both directly and indirectly by increasing the ammonium uptake and thus enhancing the total N supply ^[21]. These findings are in conformity with ^[9] in finger millet and ^[4] in foxtail millet.

Foliar application of 0.1 per cent humic acid and 3 per cent panchagavya along with soil application of RDF recorded significantly higher phosphorus uptake in comparison with alone application of RDF. There is an increase of 79.21% at 60 DAS, 45.97% by straw and 45.85% by grain, respectively with respect to phosphorus uptake by humic acid and panchagavya along with RDF over application of RDF alone. P solubility is low in the soil and gets converted to unavailable form. Humic substances as foliar application enhance phosphorus solubility by forming metal-humic complexes. Application of the water-soluble fraction of humic substances increased the solubility of phosphorus as well as its mobility in the plant. Panchagavya contains macro and micronutrients as well as growth regulators like auxins and GA which helped in producing higher biomass

and better recovery of N and P in plant. Similar findings have been reported by ^[18] in soybean and ^[4] in foxtail millet. Potassium uptake was significantly influenced by foliar application of biostimulants. Significantly higher potassium was recorded in 0.1 per cent humic acid and 3 per cent panchagavya along with soil application of RDF compared to application of RDF alone which recorded minimum potassium uptake. The improvement of 69.72% at 60 DAS, 39.05% in straw and 64.35% in grain at harvest with respect to potassium uptake in 0.1 per cent humic acid and 3 per cent panchagavya foliar application along with RDF over control which is supplied with RDF alone. The higher potassium uptake might be due to synergistic effect between nitrogen and potassium. The foliar application of biostimulants like humic acid and panchagavya along with RDF helped in better release of required nutrients as and when required by plant at different stages of crop growth. Presence of higher amount of phenolic and carboxylic hydroxyl groups in humic acid and lesser aromatic nature of humic acid increased the nutrient absorption by faster degradation and release of nutrients which leads to higher uptake of nutrients with greater efficiency by plants. The findings were supported by ^[14] in paddy; and ^[19] in paddy.

Table 1: Grain yield (kg ha⁻¹) and straw yield (kg ha⁻¹) of foxtail millet as influenced by genotypes and foliar nutrition of biostimulants.

Treatments	Grain yield (kg ha ⁻¹)	Straw yield (kg ha ⁻¹),
Main plots (G)		
G1: SiA-3156	1408.2	3525.4
G2: HMT-100-1	1701	4066
G3: DHFt-109-3	1538.7	3731.7
S.E.M. ±	39.5	55.6
C. D. at 5%	159.5	224.5
Sub plots (F)		
F1: Foliar application of 0.1% humic acid at 30 and 60 DAS	1550.6	3791.6
F2: Foliar application of 3% panchagavya at 30 and 60 DAS	1485.4	3634.6
F3: Foliar application of 0.1% humic acid and 3% panchagavya at 30 and 60 DAS	1781.2	4139.5
F4: Control	1380.1	3531.8
S.E.M. ±	31.7	55.6
C. D. at 5%	95.3	166.7
Interaction (GXF)		
G1F1	1423.5	3532
G1F2	1376.2	3460.2
G1F3	1508.5	3710.3
G1F4	1324.7	3399.7
G2F1	1719.2	4111.7
G2F2	1626	3840.1
G2F3	2028.1	4666.6
G2F4	1430.6	3645.6
G3F1	1509.2	3731.2
G3F2	1453.8	3603.8
G3F3	1806.9	4041.9
G3F4	1385	3550
S. Em. ±	55.03	96.43
C. D. at 5%	163.5	286.5

Note: RDF (40:20:20 kg N: P2O5: K2O ha⁻¹) was commonly applied to all the treatments. DAS-Days after sowing NS-Non significant

Table 2: Influence of bio stimulants on nitrogen, phosphorus and potassium uptake by foxtail millet genotypes

Treatments	Nitrogen uptake (kg ha ⁻¹)				Phosphorus uptake (kg ha ⁻¹)				Potassium uptake (kg ha ⁻¹)			
	60 DAS	At harvest			60 DAS	At Harvest			60 DAS	At harvest		
Main plots-Genotypes (G)		Straw	Grain	Total		Straw	Grain	Total		Straw	Grain	Total
G1: SiA-3156	19.95	23.38	11.68	35.05	8.39	7.45	2.97	10.42	15.99	18.18	8.27	26.45
G2: HMT-100-1	28.34	30.18	16.19	46.37	11.29	9.97	4.22	14.19	20.82	23.26	10.79	34.04
G3: DHFt-109-3	23.04	26.39	14.09	40.57	9.42	8.75	3.63	12.32	17.38	20.61	9.41	30.19
S.EM±	0.77	0.49	0.28	0.82	0.29	0.29	0.07	0.41	0.38	0.46	0.22	0.65
C. D. at 5%	3.12	2	1.15	3.31	1.17	1.2	0.29	1.68	1.55	1.88	0.874	2.63
Sub plots-Foliar nutrition (F)												
F1: Foliar application of 0.1% humic acid at 30, 60 DAS	25.19	27.83	15.33	43.16	10.07	9.38	4.1	13.38	19.22	21.4	10.16	31.77
F2: Foliar application of 3% panchagavya at 30, 60 DAS	20.34	24.22	12.23	36.56	8.17	7.82	3.01	10.85	15.97	18.73	8.39	27.34
F3: Foliar application of 0.1% humic acid and 3% panchagavya at 30 and 60 DAS	33.04	31.9	18.21	50.11	13.19	10.51	4.71	15.22	23.32	24.78	12.08	36.86
F4: Control	16.54	22.66	10.18	32.84	7.36	7.2	2.6	9.8	13.74	17.82	7.35	24.94
S.EM±	0.54	0.63	0.35	1.07	0.24	0.21	0.13	0.38	0.38	0.58	0.28	0.78
C. D. at 5%	1.63	1.88	1.05	3.22	0.72	0.64	0.39	1.13	1.15	1.74	0.846	2.36
Interaction (G x F)												
G1F1	20.39	23.83	12.72	36.55	8.51	7.69	3.19	10.88	16.52	18.37	8.95	27.32
G1F2	17.7	21.28	10.23	31.52	7.39	7.44	2.78	10.22	14.74	17.41	7.4	24.81
G1F3	27.41	26.85	14.4	41.26	11.41	8.28	3.45	11.74	20.42	20.33	9.76	30.08
G1F4	14.28	21.54	9.35	30.89	6.26	6.4	2.44	8.85	12.29	16.6	6.99	23.59
G2F1	29.47	32.3	18.68	50.98	11.41	11	4.95	15.95	21.66	24.21	11.93	36.77
G2F2	25.13	27.17	14.34	41.51	9.83	8.3	3.4	11.7	19.04	20.07	9.6	29.67
G2F3	40.53	37.57	21.2	58.77	15.62	12.85	5.72	18.57	27.15	29.7	13.9	43.59
G2F4	18.24	23.68	10.54	34.23	8.28	7.73	2.82	10.55	15.42	19.05	7.74	26.13
G3F1	25.72	27.35	14.59	41.94	10.3	9.45	4.17	13.31	19.49	21.61	9.6	31.21
G3F2	18.18	24.19	12.12	36.64	7.3	7.72	2.85	10.64	14.12	18.7	8.17	27.54
G3F3	31.17	31.27	19.02	50.3	12.54	10.39	4.95	15.34	22.41	24.32	12.58	36.91
G3F4	17.1	22.75	10.65	33.4	7.54	7.45	2.55	10.01	13.51	17.8	7.31	25.11
S. Em±	0.94	1.09	0.6	1.86	0.41	0.37	0.22	0.65	0.67	1	0.49	1.36
C. D. at 5%	2.8	3.24	1.8	5.54	1.24	1.1	0.67	1.95	1.99	2.99	1.46	4.05

Note: RDF (40:20:20 kg N: P2O5: K2O ha⁻¹) was commonly applied

Conclusion

The results of the present investigation clearly indicated that providing additional supply of nutrients along with soil application of recommended dose of fertilizers increase the yield of foxtail millet. It has the potential to improve the productivity of the foxtail millet grown in medium to low fertile soils also. Foliar application of 0.1 per cent humic acid and 3 per cent panchagavya along soil application of RDF recorded significantly higher grain and straw yield (1781.2 kg ha⁻¹ and 4139.5 kg ha⁻¹, respectively) compared to only application of RDF (1380.1 kg ha⁻¹ and 3531.8 kg ha⁻¹, respectively). Also, it recorded significantly higher N, P and K uptake at harvest when compared with only application of RDF.

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