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# Effect of Bio-organic and Potassium on Yield attributes of Pearl millet *Pennisetum glaucum* (L.) R. Br. emend Stuntz

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**Abstract**
A field experiment entitled "Effect of Bio-organics and Potassium on Soil Fertility and Yield of Pearl millet [*Pennisetum glaucum* (L.) R. Br. emend Stuntz]" was conducted during *Kharif* season 2015 on loamy sand soil at Agronomy Farm, S.K.N. College of Agriculture, Jobner. The experiment consisted 20 treatments combination of five levels of bio-organics *viz.*, control, VC @ 2.5 t $ha^{-1}$, VC @ 2.5 t $ha^{-1}$ + *Azotobacter* + PSB, VC @ 5 t $ha^{-1}$ and VC @ 5 t $ha^{-1}$ + *Azotobacter* + PSB and four treatments of potassium *viz.*, control, 20, 40 and 60 kg $K_2O$ $ha^{-1}$ and replicated thrice in randomized block design. Pearl millet var. Raj-171 was taken as test crop. Results showed that the plant height, number of effective tillers and dry matter accumulation were observed significantly maximum at VC @ 5 t $ha^{-1}$ + *Azotobacter* + PSB level of bio-organics application over control, but in VC @ 2.5 t $ha^{-1}$ + *Azotobacter* + PSB found maximum in net return. Application of potassium @ 40 kg $ha^{-1}$ resulted in significant increase in plant height, number of effective tillers, dry matter accumulation.

**Keywords:** effect of bio-organic, potassium on yield attributes, pearl millet

## 1. Introduction

Pearl millet (*Pennisetum glaucum* (L.) R. Br. emend Stuntz) is one of the important millet crop of India. Among the millets, it comes next to sorghum in area and production. Rajasthan ranks first in area and production of pearl millet. Besides being a staple diet of about 10 per cent population of our country, it is an important fodder crop also. It is nutritionally better than many cereals as it is a good source of protein (12.6%), minerals, particularly iron (2.8%) and fat (5%). Rajasthan stand first in the country that produce 41.55 lakh tonnes from 44.34 lakh ha area. Average productivity is 1067 kg $ha^{-1}$ (Deptt. of Agriculture, Govt. of Rajasthan 2013-14). In fact the area, production and productivity of pearl millet, which is much below than its production potential, vary greatly with rainfall intensity and its distribution. Hence, our research effort should be diverted to remove the constraints that are responsible for its poor yield. Vermicompost contains nutrients in the readily available form to the plants such as nitrate, exchangeable soluble potassium, calcium and magnesium (Edwards and Burrows, 1988). The application of vermicompost not only add plant nutrients and growth regulators to the soil but also increases soil water retention, microbial population, humic substances of the soil, mineralization and release of nutrients, soil aeration and stimulates the microbial activity. Biofertilizers a component of integrated nutrient management are considered to be eco-friendly, having low cost of plant nutrient supplementing chemical fertilizers in sustainable agriculture system in India. *Azotobacter* is a free-living nitrogen fixing bacteria. It has bean reported that it fixed about 20 kg N $ha^{-1}$ per year in a field of non-legume crop and also secretes some growth promoting substances (Subba Rao, 1982) [15]. Phosphate solubilizing microorganism, particularly the soil bacteria belonging to the genera *Pseudomonas* and *Bacillus* and fungi belonging to the genera *Penicillium* and *Aspergillus* possess the capability to transform insoluble phosphate into soluble forms (Alexander, 1977) [1]. Potassium plays an important role in maintenance of cellular organization, permeability of cellular membrane and water balance in protoplasm. The formation of organic acids and vegetable oils is also promoted by sufficient supply of potash which indicates that it participate in oxidation process.

## 2. Materials and Methods

A field experiment entitled "Effect of Bio-organics and Potassium on Soil Fertility and Yield of Pearl millet (*Pennisetum glaucam* (L.) *R.Br.emend stunt*)" was conducted at Agronomy farm, S.K.N. College of Agriculture, Jobner (Raj.) during *kharif* season of 2015.

### 2.1 Location of experimental site

The Agronomy farm is situated at $75^0$ 28′ East longitude and $26^0$ 05 ′ North latitude at an altitude of 427 m above mean sea level (MSL).

### 2.2 Climate and weather conditions

The climate of the zone is typically semi-arid characterized by the aridity of the atmosphere, scarcity of water with extremity of temperatures, both during summer and winter. Maximum temperature in summer ranges between $28^0$ to 46 $^0$C, whereas, in winter temperature falls down to as low as –3 $^0$C. The average rainfall of this tract varies between 400 to 500 mm and most of which is received in rainy season from July to September. Wells are the only source of irrigation and water table is quite deep (about 25-30 m).

### 2.3 Experimental soil

To determine the physico-chemical properties of soil on experimental site, soil samples collected from different points of the experimental field randomly from 0-15 cm soil depth and representative composite sample was subjected to mechanical, physical and chemical analysis.

### 2.4 Experimental details

The experiment comprised five treatments and four levels of potassium, thus giving 20 treatment combinations were laid out in randomized block design (RBD) with three replications. The treatments were allocated randomly following random numbers using Fisher's and Yates table (Table 1).

**Table 1:** Treatments with their symbols

| Treatments | Symbols |
|---|---|
| Bio-organics | |
| Control | $B_0$ |
| Vermicompost@2.5 t ha$^{-1}$ | $B_1$ |
| Vermicompost@2.5 t ha$^{-1}$+*Azotobacter*+PSB | $B_2$ |
| Vermicompost@5 t ha$^{-1}$ | $B_3$ |
| Vermicompost@5 t ha$^{-1}$+*Azotobacter*+PSB | $B_4$ |
| Potassium | |
| Control | $K_0$ |
| Potassium @20 kg $K_2O$ ha$^{-1}$ | $K_1$ |
| Potassium @40 kg $K_2O$ ha$^{-1}$ | $K_2$ |
| Potassium @60 kg $K_2O$ ha$^{-1}$ | $K_3$ |

**The details of the experiment are as follows**

1. Season : *Kharif*, 2015
2. Crop : Pearl millet
3. Variety : Raj -171
4. Seed rate : 4 kg ha$^{-1}$
5. Spacing
   a. Row to row : 45 cm
   b. Plant to plant : 10 cm
6. Total no. of treatment Combinations : 5 x 4 = 20
7. Replications : 3
8. Plot size
   a. Gross : 4m x 3m = 12m$^2$
   b. Net : 3m x 1.8m = 5.4m$^2$
9. Experimental design : RBD

### 2.5 Biofertilizers inoculation

The seeds were inoculated with *Azotobacter and PSB* culture as per treatments. About 10-15 g of Jaggery was boiled in 100 ml water and then cooled and the required amount of *Azotobacter and PSB* culture was mixed separately in Jaggery solution. The required quantity of seed was thoroughly mixed with the paste of culture to inoculate them with *Azotobacter* + PSB, than the seeds were allowed to dry in shade before sowing.

### 2.6 Plant height

Five plants were selected randomly from each plot and tagged. Height of individual plant was recorded at 30, 60 DAS (days after sowing) and at harvest. The height was measured from base of the plant to the top of the main shoot by metre scale and expressed as average height in cm.

### 2.7 Dry matter accumulation

The periodical changes in dry matter per square meter were recorded at 30, 60 DAS and at harvest. The plant samples were taken from the sample rows. They were first dried in air and finally in an electric oven at 70 $^0$C for 72 hours till a constant weight were achieved. The weight was recorded and expressed as average dry matter per square meter.

### 2.8 Number of effective tillers at harvest

A meter scale was placed at five different rows marked randomly in each plot before harvesting. The tillers bearing ear heads were counted and their average was taken as effective tillers per meter row length.

## 3. Results

### 3.1 Plant height

The results pertaining to the plant height, dry matter accumulation at different growth stages of pearl millet and number of effective tillers per m$^2$ as influenced by different levels of bio-organics and potassium are presented in table 2 & 3 and fig 1.

**Table 2:** Effect of bio-organics and potassium on plant height at different stages of pearl millet

| Treatments | Plant height (cm) | | |
|---|---|---|---|
| | 30 DAS | 60 DAS | At harvest |
| Bio-organics | | | |
| $B_0$ | 48.64 | 126.22 | 147.40 |
| $B_1$ | 57.55 | 139.64 | 166.12 |
| $B_2$ | 64.25 | 151.15 | 182.03 |
| $B_3$ | 72.15 | 162.42 | 196.94 |
| $B_4$ | 77.12 | 173.17 | 211.40 |
| SEm$\pm$ | 1.70 | 3.40 | 4.78 |
| CD (P = 0.05) | 4.90 | 9.82 | 13.80 |
| Potassium | | | |
| $K_0$ | 54.70 | 130.12 | 154.63 |
| $K_1$ | 62.83 | 146.91 | 173.51 |
| $K_2$ | 67.70 | 158.28 | 190.39 |
| $K_3$ | 70.53 | 166.78 | 202.18 |
| SEm$\pm$ | 1.52 | 3.04 | 4.27 |
| CD (P = 0.05) | 4.34 | 8.70 | 12.23 |

### 3.1.1 Effect of Bio-organics

Examination of the data (Table 1) on plant height of pearl millet revealed that application of treatment $B_4$ (VC @ 5 t ha$^{-1}$ + *Azotobacter* + PSB) significantly increased the plant height at 30, 60 DAS and at harvest as compared to control. The highest (77.12, 173.17 and 211.40 cm) plant height at 30, 60 DAS and at harvest were recorded under the treatment $B_4$ and lowest (48.64, 126.22 and 147.40 cm) were recorded under the treatment $B_0$ (Control). However, at harvest $B_3$ and $B_4$ were statically at par. The treatment $B_4$ registered 56.55, 34.0, 26.03, 6.88; 37.19, 24.01, 14.56, 6.61 and 43.41, 27.25, 16.14, 7.4 per cent higher plant height at 30, 60 DAS and at harvest over $B_0$ (Control), $B_1$ (VC @ 2.5 t $ha^{-1}$), $B_2$ (VC @ 2.5 t $ha^{-1}$ + *Azotobacter* + PSB) and $B_3$ (VC @ 5 t $ha^{-1}$), respectively.

### 3.1.2 Effect of Potassium
It is apparent from the data (Table 1) that there was a significant increase in plant height at 30, 60 DAS and at harvest with increase in levels of potassium up to 40 kg $K_2O$ $ha^{-1}$ ($K_2$) which was at par with 60 kg $K_2O$ $ha^{-1}$ ($K_3$), The application of treatment $K_2$ registered an increase of 18.28, 7.75; 21.64, 7.73 and 23.12, 5.72 per cent higher plant height at 30, 60 DAS and at harvest over $K_0$ (Control) and $K_1$ (20 kg $K_2O$ $ha^{-1}$), respectively.

### 3.2 Dry matter accumulation

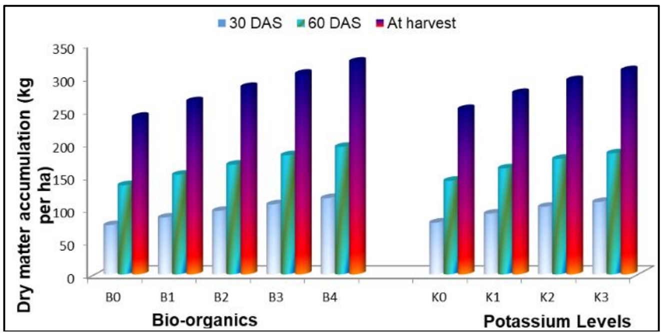


**Fig 1:** Effect of bio-organics and potassium on dry matter (kg per ha) accumulation at different stages

### 3.2.1 Effect of Bio-organics
The data presented in fig 1 revealed that the dry matter accumulation increased significantly with the application of different bio-organics at all the stages of crop growth. Application of VC @ 5 t $ha^{-1}$ + *Azotobacter* + PSB ($B_4$) significantly increased the dry matter accumulation over control ($B_0$), VC @ 2.5 t $ha^{-1}$ ($B_1$), VC @ 2.5 t $ha^{-1}$ + *Azotobacter* + PSB ($B_2$) and VC @ 5 t $ha^{-1}$ ($B_3$) at 30, 60 DAS and at harvest, indicating an increase of 54.87, 34.31, 20.21, 5.01; 42.90, 26.02, 16.22, 7.05 and 35.08, 22.93, 3.53, 6.08 per cent.

### 3.2.2 Effect of Potassium
It was observed from the data in fig 1 that there was significant and progressive improvement on dry matter accumulation at all the growth stages of pearl millet with increasing levels of potassium over control. The application of 40 kg $K_2O$ $ha^{-1}$ ($K_2$) significantly increased the dry matter accumulation at 30, 60 DAS and at harvest by 36.56, 11.26; 23.40, 6.93 and 17.54, 7.09 per cent over control ($K_0$) and 20 kg $K_2O$ $ha^{-1}$ ($K_1$), respectively. The treatment $K_2$ and $K_3$ remained statistically at par with each other.

### 3.3 Number of effective tillers per $m^2$
### 3.3.1 Effect of Bio-organics
The data presented in table 1 revealed that number of effective tillers per $m^2$ at harvest was significantly affected by all the treatments of bio-organics. Application of VC @ 5 t $ha^{-1}$ + *Azotobacter* + PSB ($B_4$) enhanced the number of effective tillers per $m^2$ (23.54) which were higher by 56.82, 29.26, 15.44 and 7.09 per cent over control (15.01), VC @ 2.5 t $ha^{-1}$ (18.21), VC @ 2.5 t $ha^{-1}$ + *Azotobacter* + PSB (20.39) and VC @ 5 t $ha^{-1}$ (21.98), respectively.

### 3.3.2 Effect of Potassium
Data (Table 3) further indicated that increasing levels of potassium significantly increased the number of effective tillers per $m^2$ of pearl millet as compared to control ($K_0$). Application of 40 kg $K_2O$ $ha^{-1}$ recorded significantly higher (21.80) number of effective tillers per $m^2$ at harvest over control (15.20) and 20 kg $K_2O$ $ha^{-1}$ (19.29) indicating an increase of 43.42 and 13.01 per cent, respectively. However, the treatment $K_2$ (40 kg $K_2O$ $ha^{-1}$) and $K_3$ (60 kg $K_2O$ $ha^{-1}$) were found at par.

**Table 3:** Effect of bio-organics and potassium on effective tillers per $m^2$, number of grains per ear and test weight of pearl millet

| Treatments | Effective tillers/$m^2$ | Number of grains per ear | Test weight (g) |
|---|---|---|---|
| Bio-organics | | | |
| $B_0$ | 15.01 | 970.45 | 7.13 |
| $B_1$ | 18.21 | 1128.79 | 7.18 |
| $B_2$ | 20.39 | 1259.19 | 7.24 |
| $B_3$ | 21.98 | 1367.07 | 7.29 |
| $B_4$ | 23.54 | 1459.09 | 7.34 |
| SEm± | 0.53 | 32.73 | 0.13 |
| CD (P = 0.05) | 1.53 | 94.53 | NS |
| Potassium | | | |
| $K_0$ | 15.20 | 1010.55 | 7.15 |
| $K_1$ | 19.29 | 1150.50 | 7.22 |
| $K_2$ | 21.80 | 1361.38 | 7.27 |
| $K_3$ | 23.02 | 1425.24 | 7.30 |
| SEm± | 0.47 | 29.28 | 0.12 |
| CD (P = 0.05) | 1.36 | 83.82 | NS |

## 4. Discussion
### 4.1 Effect of Bio-organics
*Growth parameters*

the results reveled that application of VC @ 5 t $ha^{-1}$ + *Azotobacter* + PSB significantly increased plant height, dry matter accumulation at 30, 60 DAS and at harvest, number of effective tillers per $m^2$ at harvest over control (table 1, 2 and fig 1). it is well established fact that vermicompost improves the physical and biological properties of soil including supply of almost all the essential plant nutrients for the growth and development of plant. Thus, balanced nutrition under favourable environment might have helped in production of new tissues and development and ultimately increased the plant height, dry matter accumulation, and number of effective tillers per $m^2$. Nutritional condition as evident from increased in plant height might be due to combined application of *Azotobacter* + PSB as seed inoculation was also superior with vermicompost in growth parameters at all the growth stages. This might be directly associated with the increased availability of phosphorus through biological fixation and solubility in soil to be readily utilized by the plants as they are atmospheric nitrogen fixers and phosphate solubilizers. Nitrogen and phosphorus are the major plant nutrients and combined inoculation of nitrogen fixer and phosphorus solubilizer benefit the plant more than either group of organism alone due to synergistic nature and thus might have additional advantages in the degraded agro ecosystem. The investigation is in conformity with those of Rathore and Gautam (2003) [12], Rajput (2008) [11], Narolia *et al*. (2009) [8], Choudhary *et al.* (2014) [4], and Rinku *et al.* (2014) [13] in pearl millet, Patidar and Mali (2004) [10] in sorghum, Chandra *et al.* (2014) [3], Amdemarium *et al.* (2014) [2] and Verma *et al.* (2014) [17] who supported increased plant height, dry matter accumulation and number of effective tillers per $m^2$.

### 4.2 Effect of Potassium

***Growth parameters***

the results revealed that application of potassium @ 40 kg $ha^{-1}$ significantly increased plant height, dry matter accumulation at 30, 60 DAS and at harvest, number of effective tillers per $m^2$ at harvest (table 1, 2 and fig 1). The positive effect of potassium on growth character due to its favourable effect on growth and augmenting cell division and cell expansion. Potassium plays a crucial role in meristematic growth through its effect on the synthesis of phyto-hormones. Among various plant hormones, cytokinin plays important role in growth of tillers and buds (Yadav *et al.* 2012) [18]. Potassium nutrition improves germination of pollen in the florets which leads to high spikelet fertility (Uexkull 1978) [16]. Such increase may also be due to the sufficient availability of potassium in soil plant root system increased availability of potassium to plants leading to greater photosynthesis, production of metabolitic and enzymetic activity (Jat *et al*. 2013) [6]. Potassium increases the potential capacity of the plant against the diseases and insect pest (Kumar *et al.* 2014) [7]. Beneficial effects of K on growth have been reported by Patel and Kotecha (2006) [9] and Singh *et al*. (2015) [14].

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