International Journal of Plant & Soil Science

Volume 36, Issue 8, Page 326-335, 2024; Article no.IJPSS.120881
ISSN: 2320-7035

Long Term Effect of Organic and Inorganic Sources of Nutrient on Growth of Pearl Millet (*Pennisetum glaucum*)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/ijpss/2024/v36i84861

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/120881

Original Research Article

Received: 24/05/2024
Accepted: 26/07/2024
Published: 29/07/2024

ABSTRACT

In today's era the farmers using traditional fertilizers in very high amount, so the soil fertility and productivity decreasing day by day. In this context the present study was planned using organic and inorganic sources of fertilizers with their long-term impact on soil fertility, productivity and soil heath. The present study carried out at Research Farm, department of Soil Science, Rajmata Vijayaraje Scindia Krishi Vishwavidyalaya, Gwalior during kharif season 2022 and 2023. The twelve

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Cite as: *Yadav, Indra Raj, S. K. Trivedi, Shashi S. Yadav, Amita Sharma, Priyadarshani A. Khambalkar, and N. S. Gurjar. 2024. "Long Term Effect of Organic and Inorganic Sources of Nutrient on Growth of Pearl Millet (Pennisetum Glaucum)". International Journal of Plant & Soil Science 36 (8):326-35. https://doi.org/10.9734/ijpss/2024/v36i84861.*

treatments combinations of organic and inorganic sources were used for the existing study. The data revealed that the higher pooled mean plant height (188.79 cm), length of cob (31.88 cm), dry matter accumulation (44.90 g) and grain weight per cob (10.87 g) was registered under T_{12}-100% NPK +FYM @ 10 t/ha/yr + {PSB+ Azotobacter (Seed treatment)}. It was concluded that treatment 100% NPK +FYM @ 10 t/ha/yr + {PSB+ Azotobacter (Seed treatment)} was found superior among remaining treatment.

Keywords: Azotobacter; cob length; dry matter accumulation; plant height.

1. INTRODUCTION

Pearl millet (*Pennisetum glaucum* L.), the world's hardiest warm season cereal crop. Pearl millet belong the Poaceae family. Globally it ranks sixth after rice, wheat, maize, barley and sorghum in terms of area [1] and share 42% of total world production [2]. In our nation, it ranks as the fifth most significant cereal grain crop, behind rice, wheat, maize, and sorghum. A crucial semi-arid and dry crop grown on about 7.57 million hectares for both food and feed, pearl millet is ranked fourth among all cereals [3]. In the research problem various organic like FYM and seed treatment with PSB and Rhizobium and inorganic nutrient sources like nitrogen, phosphorus, potassium, sulphur, zinc and ferrous containing fertilizer was used. Pearl millet became a more affordable alternative due to the recent spike in the costs of wheat, rice, and maize as well as the rising demand for non-food purposes (such as the starch, alcohol, and cow and poultry feed sectors) [4]. Furthermore, because this crop has a higher fiber content and is beneficial for cardiac and diabetic patients, its nutritional value presents significant opportunity for the development of value-added goods in new health-conscious customer segments. Due to its cultivation by small and marginal farmers, pearl millet is expected to have a substantial socioeconomic impact from increases in productivity [5]. Holistic management is essential to the improved growth attributes of the crop. Long-term application of inorganic fertilizers depletes the physical, chemical, and biological qualities of soil and pollutes the environment when combined with organic additions. In addition to providing the soil with nutrients and organic matter, organic manures also influence the soil's structure, turnover of nutrients, biodiversity, and activity of the microbial population, among many other changes pertaining to the physical, chemical, and biological characteristics of the soil. The physics-chemical qualities of soils can be enhanced by the use of organic manures alone or in conjunction with chemical fertilizers. Organic manures maintain a positive nutritional balance, provide a healthy substrate for the growth of microorganisms, and improve the physical characteristics of the soil [6].

The integrated nutrient management advocates balanced and conjoint use of inorganic fertilizer, organic manure, green manure and biofertilizer in order to maintain or adjustment of soil fertility and plant nutrient supply to an optimum level for sustaining desired crop productivity. An important source of plant nutrients for raising agricultural productivity is fertilizer [7].

2. MATERIALS AND METHODS

The present investigation is a part of an on-going long-term field experiment on organic and inorganic sourced of nutrient on in pearl millet. The experiment was initiated in 2002 on permanent plots (latitude of 260 13'N and longitude 760 10'E with an altitude 197 meters). The climate of experimental site is semi-arid and subtropical with extreme weather conditions having hot and dry summer and cold winter, where maximum temperature goes up to 45 ^{0}C during summer and minimum as low as 2.80 ^{0}C. The mean annual rainfall of area is 700-800 mm. The soil of the experimental field is alluvial, sandy clay loam in texture and classified as Typic Ustochrepts at great group level. The experiment was laid out with randomized block design having three replications comprising of 12 treatments, *viz* T_1-Absolute Control, T_2-100% N, T_3-100% NP, T_4-100% NPK, T_5-100% NPK + 25 kg $ZnSO_4$/ha/yr, T_6-100% NPK + 50 Kg $FeSO_4$/ha/yr, T_7-100% NPK + $FeSO_4$ + $ZnSO_4$, T_8-100% NPK + 1% ($FeSO_4$ + $ZnSO_4$ Spray), T_9-50% NPK + FYM @ 10t/ha/yr, T_{10}-75% NPK + FYM @ 10t/ha/yr, T_{11}-100% NPK+ FYM @ 10t/ha/yr and T_{12}-100% NPK +FYM @ 10 t/ha/yr + {PSB+ Azotobacter (Seed treatment)}, respectively.

Area of single plot was 5m × 3m. The recommended dose of fertilizer for pearl millet was 80 N + 40 P_2O_5 + 20 K_2O kg/ha. Half of the

nitrogen was applied in the form of urea as a basal dose and remaining was top dressed after 1st irrigation at 30 DAS. Full dose of phosphorus and potash applied as single supper phosphate and murate of potash at the time of sowing. As per treatment FYM was added @10 tonnes/ha/year before sowing of crop contain 0. 5% N, 0. 25% P and 0.5% K. In inoculation treatments seeds were treated with Azotobacter and Phosphate Solubilising both @10 g/kg seed. Pearl millet "Hybrid (JBV-3)" was sown (seed rate 5kg/ ha) during the middle of July and harvested in second week of October. The growth parameters data were analysed treatment wise of pearl millet from (kharif) 2022-2023.

3. RESULTS AND DISCUSSION

The data furnished (Table1 and Fig. 1) that the significantly higher plant height in year 2022 and 2023 was recorded with T_{12}-100% NPK +FYM @ 10 t/ha/yr + {PSB+ Azotobacter (Seed treatment)} (188.52 and 189.32 cm). In the pooled data of both years showed the maximum plant height was recorded (188.79 cm) also treatment T_{12}-100% NPK +FYM @ 10 t/ha/yr + {PSB+ Azotobacter (Seed treatment)}, it was found at par with treatment T_{11} and T_{10}. The lowest plant height was recorded with control treatment. This result also supported by Rathore *et al.* [8], Singh *et al.* [9], Yadav *et al.* [10] and Susmitha *et al.* [11].

The data presented (Table 2 and Fig. 2) that the significantly higher length of cob in year 2022 and 2023 was recorded with T_{12}-100% NPK +FYM @ 10 t/ha/yr + {PSB+ Azotobacter (Seed treatment)} (31.91 and 31.85 cm). In the pooled data of both years showed the maximum length of cob (31.88 cm) with T_{12}-100% NPK +FYM @ 10 t/ha/yr + {PSB+ Azotobacter (Seed treatment), it was at par with T_{11}-100% NPK+ FYM @ 10t/ha/yr (30.44 cm). The minimum length of cob was recorded with control treatment. Similar findings also reported by Kumar *et al.* [12], Kumar *et al.* [13], Samruthi *et al.* [14], Khandelwal *et al.* [15] and Mahapatra *et al.* [16].

The data furnished (Table 3 and Fig. 3) that the maximum dry matter accumulation in year 2022 and 2023 was recorded with T_{12}-100% NPK +FYM @ 10 t/ha/yr + {PSB+ Azotobacter (Seed treatment)} (44.85 and 44.95 g). In the pooled data of both years showed the maximum dry matter accumulation (44.90 g) with T_{12}-100% NPK +FYM @ 10 t/ha/yr + {PSB+ Azotobacter (Seed treatment), it was found at par with T_{11}-100% NPK+ FYM @ 10t/ha/yr (42.40 g). The minimum dry matter accumulation was recorded with control treatment. This result also confirmed by Moharana *et al.* [17], Divya [18] and Kumar *et al.,* [19].

The data presented (Table 4 and Fig. 4) that the maximum grain weight per cob in year 2022 and 2023 was recorded with T_{12}-100% NPK +FYM @ 10 t/ha/yr + {PSB+ Azotobacter (Seed treatment)} (10.85 and 10.89 g). In the pooled data of both years showed the maximum grain weight per cob (10.87 g) with T_{12}-100% NPK +FYM @ 10 t/ha/yr + {PSB+ Azotobacter (Seed treatment), closely followed by T_{11}-100% NPK+ FYM @ 10t/ha/yr (9.84 g). The minimum grain weight per cob was recorded with control treatment. Similar trends also stated by Kadam *et al.* [20], Khadadiya *et al.* [21], Rana and Prasad [22], Kumar *et al.* [23] and Kalaliya *et al.* [24].

Table 1. Effect of organic and inorganic sources on nutrient on plant height of pearl millet at harvest stage

Treatments	Plant height (cm)		
	2022	2023	Pooled
T_1-Absolute Control	164.25	165.25	164.75
T_2-100% N	171.55	172.05	171.80
T_3-100% NP	172.12	173.45	172.79
T_4-100% NPK	172.75	174.02	173.39
T_5-100% NPK + 25 kg $ZnSO_4$/ha/yr	174.36	174.85	174.61
T_6-100% NPK + 50 Kg $FeSO_4$/ha/yr	174.45	174.92	174.69
T_7-100% NPK + $FeSO_4$ + $ZnSO_4$	175.02	175.15	175.09
T_8-100% NPK + 1% ($FeSO_4$ + $ZnSO_4$ Spray)	174.05	174.88	174.47
T_9-50% NPK + FYM @ 10t/ha/yr	176.22	177.55	176.89
T_{10}-75% NPK + FYM @ 10t/ha/yr	182.05	183.22	182.64
T_{11}-100% NPK+ FYM @ 10t/ha/yr	185.52	186.14	185.83
T_{12}-100% NPK +FYM @ 10 t/ha/yr + {PSB+ Azotobacter (Seed treatment)}	188.25	189.32	188.79
S. Em. (±)	4.30	4.23	3.02
CD (0.05%)	12.63	12.41	8.60

Table 2. Effect of organic and inorganic sources on nutrient on length of cob of pearl millet

Treatments	Length of cob (cm)		
	2022	2023	Pooled
T_1-Absolute Control	25.56	25.52	25.54
T_2-100% N	26.00	25.96	25.98
T_3-100% NP	26.42	26.37	26.40
T_4-100% NPK	26.75	26.71	26.73
T_5-100% NPK + 25 kg $ZnSO_4$/ha/yr	26.83	26.80	26.82
T_6-100% NPK + 50 Kg $FeSO_4$/ha/yr	27.27	27.23	27.25
T_7-100% NPK + $FeSO_4$ + $ZnSO_4$	28.40	28.37	28.38
T_8-100% NPK + 1% ($FeSO_4$ + $ZnSO_4$ Spray)	27.62	27.59	27.60
T_9-50% NPK + FYM @ 10t/ha/yr	28.28	28.23	28.26
T_{10}-75% NPK + FYM @ 10t/ha/yr	28.72	28.66	28.69
T_{11}-100% NPK+ FYM @ 10t/ha/yr	30.47	30.41	30.44
T_{12}-100% NPK +FYM @ 10 t/ha/yr + {PSB+ Azotobacter (Seed treatment)}	31.91	31.85	31.88
S. Em. (±)	1.16	1.16	0.82
CD (0.05%)	3.41	3.39	2.33

Table 3. Effect of organic and inorganic sources on nutrient on dry matter accumulation of pearl millet at harvest stage

Treatments	Dry matter accumulation per plant (g)		
	2022	2023	Pooled
T_1-Absolute Control	34.25	34.28	34.27
T_2-100% N	37.12	37.15	37.14
T_3-100% NP	38.02	38.58	38.30
T_4-100% NPK	38.85	38.95	38.90
T_5-100% NPK + 25 kg $ZnSO_4$/ha/yr	39.15	39.25	39.20
T_6-100% NPK + 50 Kg $FeSO_4$/ha/yr	39.25	39.35	39.30
T_7-100% NPK + $FeSO_4$ + $ZnSO_4$	39.85	39.90	39.88
T_8-100% NPK + 1% ($FeSO_4$ + $ZnSO_4$ Spray)	39.28	39.32	39.30
T_9-50% NPK + FYM @ 10t/ha/yr	38.45	38.58	38.52
T_{10}-75% NPK + FYM @ 10t/ha/yr	40.25	40.38	40.32
T_{11}-100% NPK+ FYM @ 10t/ha/yr	42.36	42.44	42.40
T_{12}-100% NPK +FYM @ 10 t/ha/yr + {PSB+ Azotobacter (Seed treatment)}	44.85	44.95	44.90
S. Em. (±)	1.62	1.61	1.14
CD (0.05%)	4.75	4.71	3.25

Table 4. Effect of organic and inorganic sources on nutrient on of grains weight per cob of pearl millet

Treatments	Grain weight per cob (g)		
	2022	2023	Pooled
T_1-Absolute Control	8.65	8.66	8.66
T_2-100% N	9.05	9.12	9.09
T_3-100% NP	9.20	9.22	9.21
T_4-100% NPK	9.32	9.30	9.31
T_5-100% NPK + 25 kg $ZnSO_4$/ha/yr	3.38	9.40	9.39
T_6-100% NPK + 50 Kg $FeSO_4$/ha/yr	9.45	9.48	9.47
T_7-100% NPK + $FeSO_4$ + $ZnSO_4$	9.52	9.50	9.51
T_8-100% NPK + 1% ($FeSO_4$ + $ZnSO_4$ Spray)	9.36	9.38	9.37
T_9-50% NPK + FYM @ 10t/ha/yr	9.30	9.33	9.32
T_{10}-75% NPK + FYM @ 10t/ha/yr	9.62	9.66	9.64
T_{11}-100% NPK+ FYM @ 10t/ha/yr	9.82	9.86	9.84
T_{12}-100% NPK +FYM @ 10 t/ha/yr + {PSB+ Azotobacter (Seed treatment)}	10.85	10.89	10.87
S. Em. (±)	0.35	0.35	0.25
CD (0.05%)	1.03	1.03	0.71

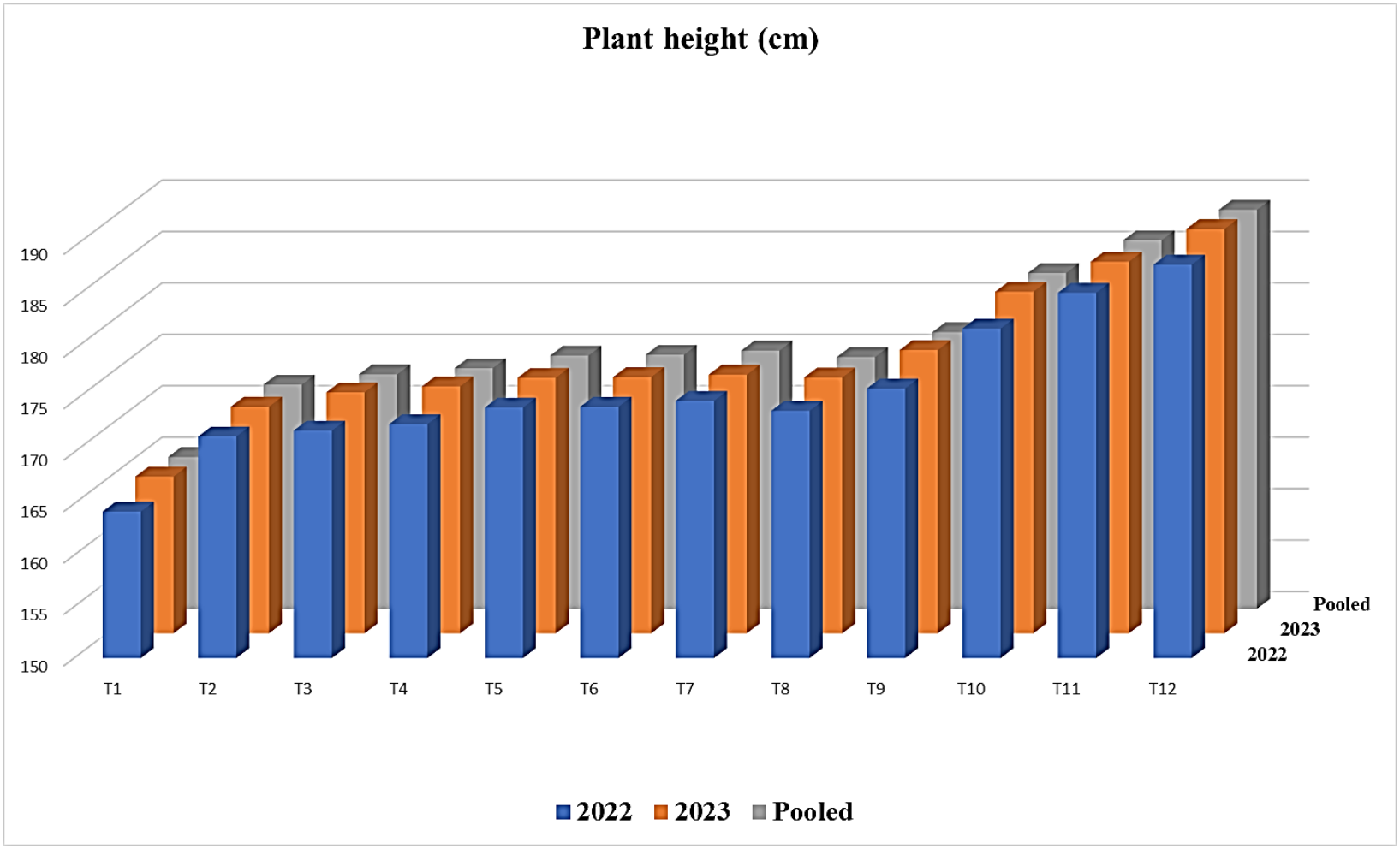

Fig. 1. Effect of organic and inorganic sources on nutrient on plant height of pearl millet at harvest stage

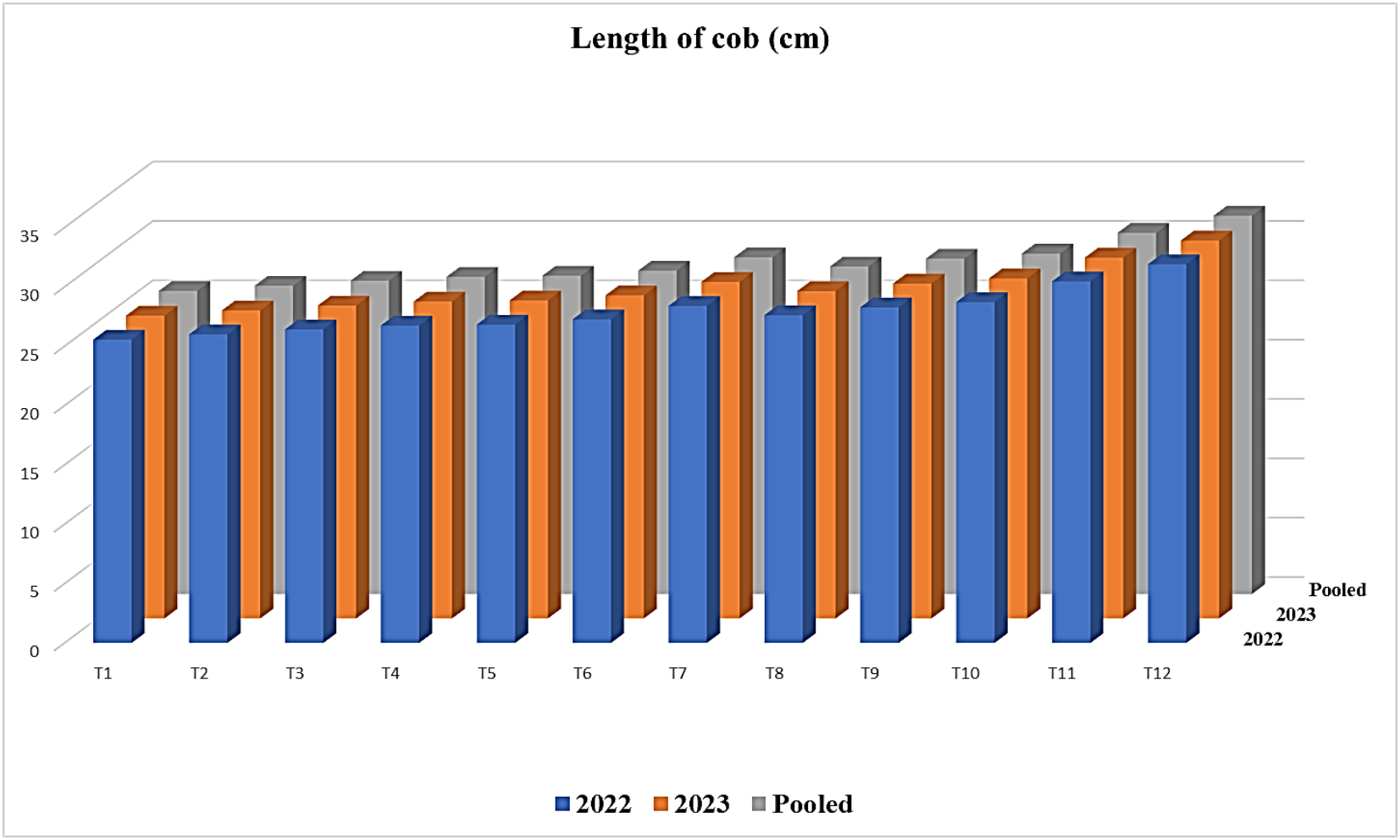

Fig. 2. Effect of organic and inorganic sources on nutrient on length of cob of pearl millet

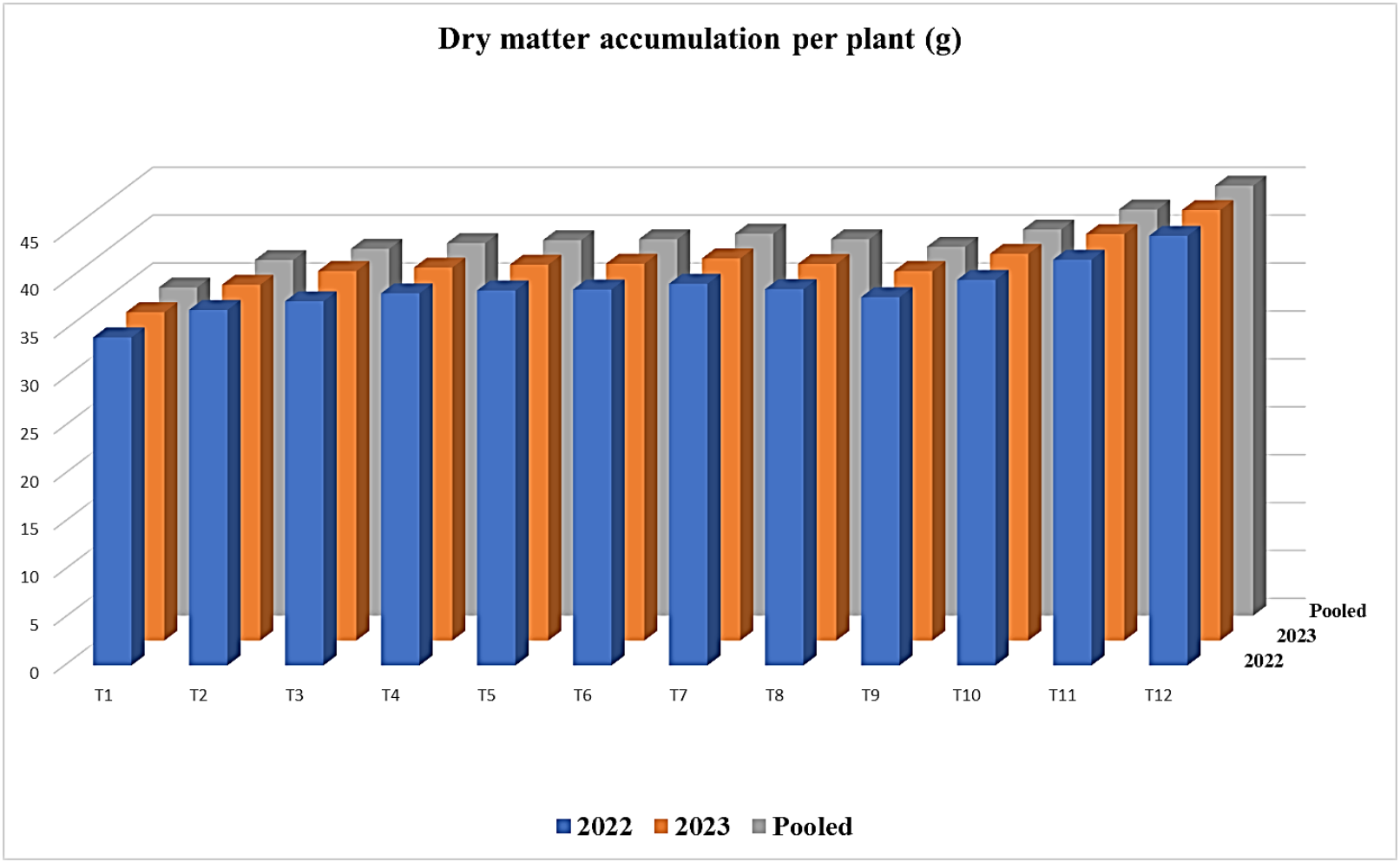

Fig. 3. Effect of organic and inorganic sources on nutrient on dry matter accumulation of pearl millet at harvest stage

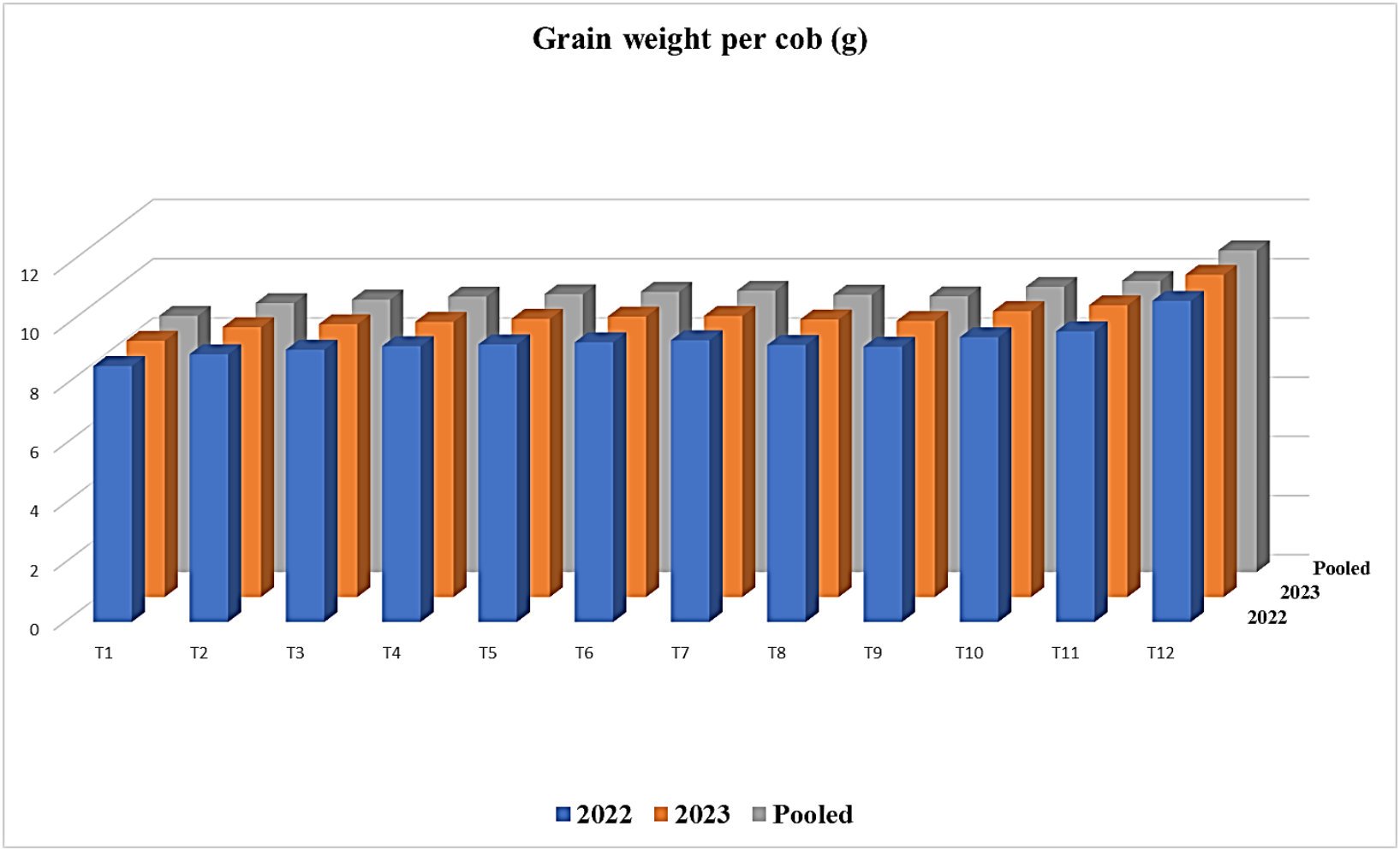

Fig. 4. Effect of organic and inorganic sources on nutrient on grain weight per cob of pearl millet

4. CONCLUSION

It is concluded that treatment receiving organic manure along with optimal dose of chemical fertilizer in combination with Azotobacter and PSB provide higher growth attributes of pearl millet. These findings showed that treatment 100% NPK +FYM @ 10 t/ha/yr + {PSB+ Azotobacter (Seed treatment)}is superior among remaining treatment.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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