LR-5231
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RESEARCH ARTICLE

Legume Research- An International Journal

Exploring the Effective Management Strategy to Sustain Cowpea Production under High Temperature Stress

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10.18805/LR-5231

ABSTRACT

Background: Abiotic stress negatively impacts the morphological, physiological and biochemical characteristics of plants leading to loss of yield and quality. The substantial increase in population and global surface temperature extends to global food insecurity hence it is important to maintain a sustainable yield of crops. Cowpea being a protein-rich legume and a nodule-forming crop facilitates not only meeting food insecurity but also creates a sustainable environment. The objective of this study was to explore the suitable management practice for cowpea to attain sustainable yield under the elevated temperature of +2°C from ambient.

Methods: An experiment in cowpea variety Co 7 was carried out in Temperature Gradient Tunnel (TGT) located at Agro Climate Research Centre, Tamil Nadu Agricultural University, Coimbatore. The research trial was carried out during the year 2021 and 2022 with Factorial Completely Randomized Design (FCRD). In this study, we have investigated the effect of different treatments on growth, yield, quality and available nutrients in soil.

Result: The application of vermicompost with foliar spray of 3% *Panchagavya* at 30, 45 and 60 DAS stimulated the plant height, number of leaves and leaf area index (LAI). The increase in availability of soil nutrients exhibited higher dry matter production, pod length (10.46 cm), number of seeds per pod (7.56), test weight (12.56 g), seed yield (13.25 g plant^{-1}) and seed protein (21.82%). These results suggest that vermicompost application with 3% foliar spray of *Panchagavya* has a positive effect on improving the high-temperature tolerance of cowpea plants.

Key words: Cowpea, Elevated temperature, Nutrient availability, Panchagavya, Vermicompost, Yield.

INTRODUCTION

Legumes are known for their positive impacts, such as biological nitrogen fixation (BNF), weed suppression, erosion control such as cover crop, soil health improvement and most importantly the eradication of malnutrition in third-world countries (Brilhante *et al.,* 2021; Talucder *et al.,* 2024). Accordingly, Cowpea contains 23% protein and it is cultivated in India as sole, intercrop and also along with the agroforestry system. It has high nutritive content *viz.,* dietary fibre (2.5 g), carbohydrate (8.9 g), protein (4.5 g), Fe (1.1 mg), Mg (30 mg), Zn (0.4 mg), energy (287 kJ) respectively (Grande *et al.,* 2017). Such crops can contribute to achieving the objectives of sustainable food and environmental security (Meena *et al.,* 2018; Singh *et al.,* 2024). Owing to this, United Nations declared 2016 as the International Year of Pulses. In India, the available pulses were about 48 grams per capita daily which was 53 percent below the level suggested by the Food and Agriculture Organization's nutritional experts in 2019 (Anonymous, 2020).

In Tamil Nadu, the future climate under RCP 4.5 and RCP 8.5 indicates a 1.5°C rise in temperature by 2053 and 2035, respectively. It was indicated that 1.5°C warming has more negative impacts on plants with C3 compared to the C_4 pathway (Gowtham *et al.,* 2020). Temperature increase threatens global food security and negatively affects the productivity of the pulses in South East Asian Nations, accounting for more than 50% of the world's total pulses (Considine *et al.,* 2017; Teng, 2024).

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How to cite this article: Priyanka, P., Kokilavani, S., Geethalakshmi, V., Kalarani, M.K., Dheebakaran, Ga., Sathyamoorthy, N.K., Arthirani, B., Dharshini, S.D. and Pugazenthi, K. (2024).Exploring the Effective Management Strategy to Sustain Cowpea Production under High Temperature Stress. Legume Research. DOI: 10.18805/LR-5231.

Submitted: 17-08-2023 **Accepted:** 23-05-2024 **Online**: 24-07-2024

The impact of high temperature on plant growth and development was studied in various crops *via*., cereals [rice (*Oryza sativa*), wheat (*Triticum aestivum* L.) and maize (*Zea mays* L.)], legumes [greengram (*Vigna radiata*), blackgram (*Vigna munga* L.) and cowpea (*Vigna unguiculata*)], oilseeds [Soybean (*Glycine max* L.)] and vegetables [tomato (*Solanum lycopersicum* L)] (Vinitha *et al.,* 2020; Amrutha Vijayakumar *et al.,* 2021).

Plant growth regulators (PGRs) are natural or synthetic substances that regulate the growth and differentiation of plant cells, tissues and organs. The exogenous application of PGRs has been recognized as a strong strategy for diminishing the negative effects of abiotic stresses in crop plants (Ashraf *et al.,* 2023). Among the PGRs, auxins (IAA, NAA), gibberellins, cytokinins and brassinosteroids have got the attention of researchers as a sustainable source to improve abiotic stress tolerance under changing climate (Sabagh *et al.,* 2021; Choudhary *et al.,* 2023).

The continuous use of chemical fertilizers leads to a reduction in crop yield and results in an imbalance of nutrients in the soil, which has adverse effects on soil health. The use of soil organic manures alone or in combination with liquid organic manures will help to improve the physio-chemical properties of the soils and efficient utilization of applied organic manures for improving seed yield and seed quality (Naskar *et al.,* 2024). Organic manures provide a good substrate for the growth of microorganisms and maintain a favourable nutritional balance and soil physical properties (Shariff *et al.,* 2017).

The development of stress-tolerant cultivars is a long-term method to nullify the effect of abiotic stress. The short-term strategy involves the use of agrochemicals, especially those which can avoid or decrease the effect of heat stress. Remembering the adverse effects of heat stress on cowpea plants, this research work was designed to evolve the effective management practice on the growth and yield-related parameters of cowpea under elevated temperature for mitigating the heat stress and promoting heat tolerance mechanisms. Furthermore, for the first time, our research compared the efficacy of vermicompost, *Panchagavya* and *Jeevamirtham* in mitigating cowpea plants grown under elevated temperature.

MATERIALS AND METHODS

Experimental details

The experiment was conducted during April-June (2021) at Field No. 36°C, Temperature Gradient Tunnel (TGT), Agro Climate Research Centre (ACRC), Tamil Nadu Agricultural University, Coimbatore. The concurrent trial was conducted again in April-June, (2022). Coimbatore is located at an elevation of 426.7 m with an annual rainfall of 674 mm within the Western Agro Climatic Zone and the geo-coordinates are 11°N latitude and 77°E longitude.

The experiment was laid out in Factorial Completely Randomized Design (FCRD) with three replications under ambient and elevated temperature (ambient+2°C) with six treatments *viz.,* Vermicompost+Soil drenching of 2 litres *Jeevamirtham* at 30, 45 and 60 DAS (T_1), Vermicompost + foliar application of 3% *Panchagavya* at 30, 45 and 60 DAS (T_2), RDF+foliar application of 40 ppm NAA at flower initiation and 50% flowering stage (T_3), RDF+foliar application of 0.2 ppm Brassinolide at flower initiation and 50% flowering stage (T_4), Vermicompost alone (T_5) and Recommended Dose Fertilizer (RDF)-Check (T_6).

The length, width and height of the TGT were 7 m×2.4 m ×2.4 m (Fig 1). It was constructed out of iron pipes, coated with polycarbonate sheets to maintain the temperature and relative humidity. To monitor the air temperature and relative humidity, the sensors were positioned within and outside the tunnel. *Jeevamirtham* and *Panchagavya* were prepared according to the procedure given by the Department of

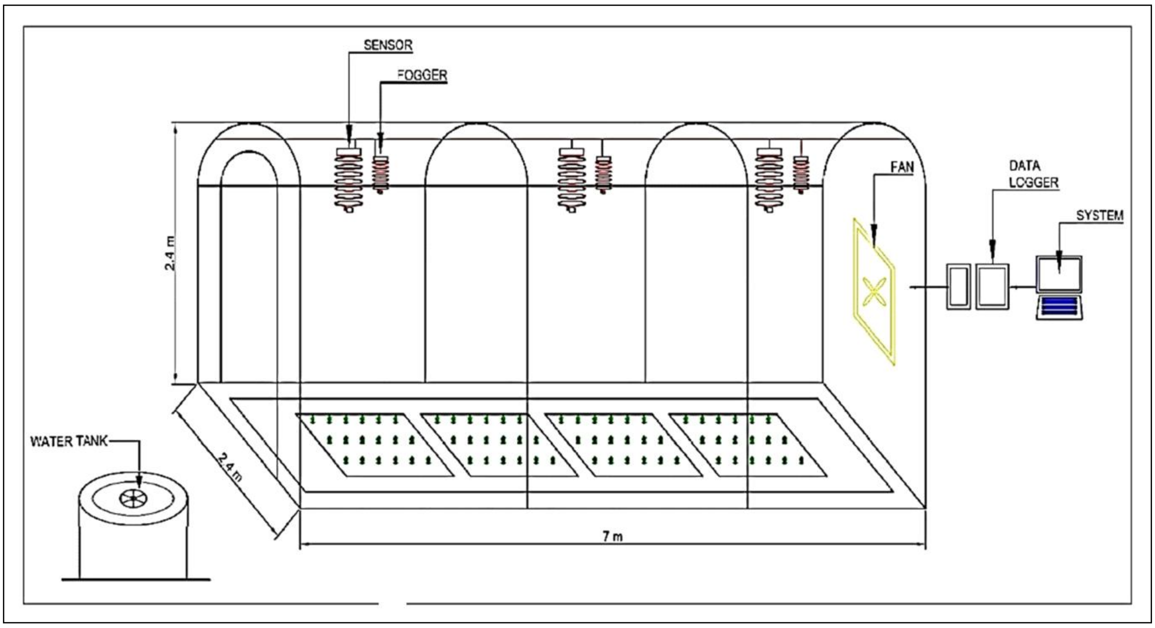

Fig 1: Layout of temperature gradient tunnel (TGT).

Sustainable Organic Agriculture (SOA), Tamil Nadu Agricultural University, Coimbatore.

Observations recorded

The variety Cowpea CO (CP) 7 was used for both the experiment with a duration of 70-75 days. The growth parameters *viz.,* plant height (cm), number of leaves, Leaf Area Index (LAI) and dry matter production (g/plant) were measured in tagged plants at 30, 45 and 60 DAS during both the seasons. The yield and yield-related attributes were also recorded during the harvest period. Soil samples from the experimental unit were collected at 30 DAS and after harvest which are air dried and analysed for available N, P and K. Protein content of seed were assessed by the colorimetric technique devised by Ali-Khan and Youngs (1973).

Statistical analysis

The data collected during (2021) and (2022) were pooled which has been statistically investigated using the Gomez and Gomez (2010) technique of Analysis of Variance (ANOVA) at a 5% level of significance.

RESULTS AND DISCUSSION

Influence of elevated temperature on growth attributes

The heat-stressed cowpea plants showed a considerable decrease in all growth parameters such as the number of leaves, LAI and dry matter production excluding plant height than the non-stressed plants. However, the plants treated with vermicompost together with foliar spray of 3% *Panchagavya* exhibited a considerable increase in these growth traits of cowpea plants under both ambient and elevated conditions. Particularly, in temperature stressed cowpea plants application of vermicompost together with 3% *Panchagavya* increased plant height (19.4%, 23.7% and 22.4%), LAI (54.5%, 58% and 56%), number of leaves (50%, 37.5% and 34.5%), dry matter production (28.5%, 23.5% and 17.2%) at 30, 45 and 60 DAS respectively. The positive effect on all growth traits in the treatment of vermicompost with 3% foliar spray of *Panchagavya* on stressed cowpea plants showed a significant increment of all studied growth parameters than the RDF-Check (Fig 2 and Table 1,2,3).

In our study, high-temperature stress had negative effects on cowpea plants as manifested by the significant reduction in growth and biomass when compared to non-stressed plants. This growth reduction eventually contributed to the significant yield loss of the cowpea plants. Similar findings were also reported in other legumes like a pea (Kumari *et al.,* 2019) and green gram (Singh *et al.,* 2021). On the other hand, the application of vermicompost along with the foliar application of 3% *Panchagavya* boosted the growth performance of heat-stressed cowpea plants as shown by improved morphological attributes. The application of organic amendment proved to improve the supply of inorganic nutrient elements like N, P, K, *etc.* in soil enhancing the uptake of nutrients by plants. The biological activity was also comparatively improved in this integrated application compared to other treatments. However, foliar spray of *Panchagavya* acts as a source of plant growth regulators like auxin, GA3 and cytokinin which increased the cell division and multiplication resulted in enhanced growth attributes *viz.,* plant height, number of leaves, LAI (Sanjutha *et al.,* 2008; Sagar *et al.,* 2023). The microbial metabolites contained in the *Panchagavya* helped in the opening of stomata for a long time resulting in more CO_2 diffusion and enhanced photosynthetic rate (Xu *et al.,* 2001). In addition to this, more nutrient availability increased the leaf number and LAI which intercepts more radiation (Kumawat *et al.,* 2009; Reddy *et al.,* 2023) and

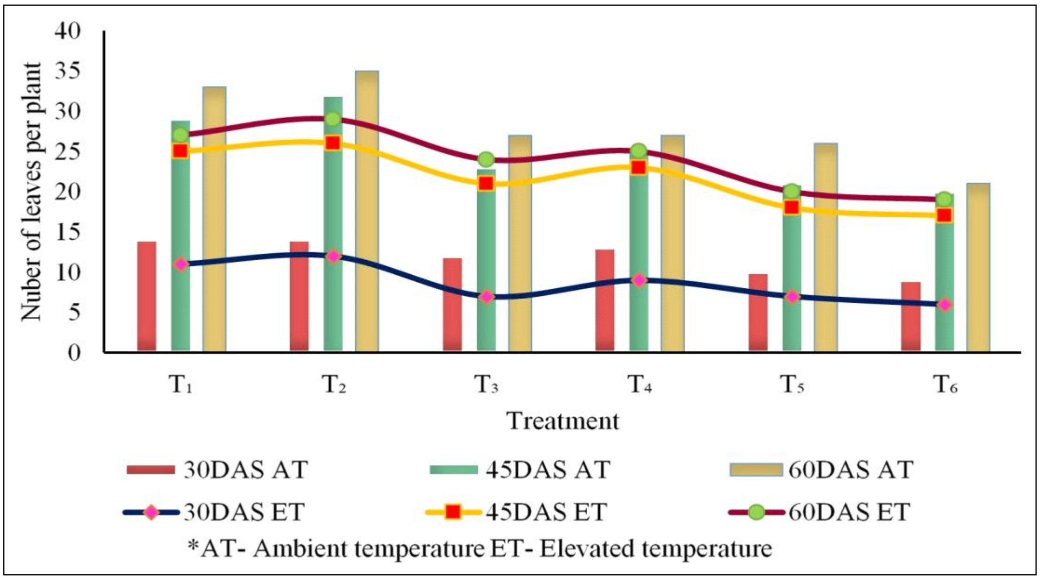

Fig 2: Influence of temperature and treatments on the number of leaves per plant.

Table 1: Influence of temperature and treatments on plant height (cm).

Treatment	30 DAS			45 DAS			60 DAS		
	AT	AT +2°C	Mean	AT	AT +2°C	Mean	AT	AT +2°C	Mean
T1	22.20^{c}	35.80^{a}	29.00^{a}	37.00^{ef}	57.30^{b}	47.15^{b}	38.60^{gh}	61.30^{b}	49.95^{b}
T2	22.60^{c}	36.00^{a}	29.30^{a}	38.10^{e}	59.80^{a}	48.95^{a}	42.10^{f}	64.20^{a}	53.15^{a}
T3	19.70^{d}	29.90^{b}	24.80^{b}	35.20^{g}	53.60^{c}	44.40^{c}	39.40^{g}	57.40^{cd}	48.40^{b}
T4	21.50^{c}	35.60^{a}	28.55^{a}	36.60^{f}	56.40^{b}	46.50^{b}	40.10^{fg}	59.20^{bc}	49.65^{b}
T5	19.70^{d}	29.50^{b}	24.60^{bc}	32.20^{h}	53.00^{c}	42.60^{d}	36.30^{h}	55.40^{d}	45.85^{c}
T6	18.70^{d}	29.00^{b}	23.85^{c}	27.40^{i}	45.60^{d}	36.50^{e}	30.90^{i}	49.80^{e}	40.35^{d}
Mean	20.73^{b}	32.63^{a}	26.68	34.42^{b}	54.28^{a}	44.35	37.90^{b}	57.88^{a}	47.89
	T	t	T*t	T	t	T*t	T	t	T*t
SED	0.24	0.41	0.58	0.24	0.42	0.59	0.48	0.82	1.17
CD (0.05)	0.49**	0.85**	1.20**	0.50**	0.86**	1.22*	0.98**	1.70**	2.41**

T-Temperature factor; t- Treatment factor; T*t- Interaction AT- Ambient Temperature.
NS- Non significant; *Significant at 5%; **Significant at 1%; AT+2°C- Ambient temperature +2°C.
Treatments with same letters are not significantly different.

Table 2: Influence of temperature and treatments on LAI.

Treatment	30 DAS			45 DAS			60 DAS		
	AT	AT +2°C	Mean	AT	AT +2°C	Mean	AT	AT +2°C	Mean
T1	0.64^{b}	0.30^{f}	0.47^{b}	4.11^{a}	2.46^{f}	3.29^{b}	4.20^{b}	2.50e^{f}	3.35^{b}
T2	0.71^{a}	0.33^{e}	0.52^{a}	4.11^{a}	2.86^{e}	3.49^{a}	4.50^{a}	3.00^{d}	3.75^{a}
T3	0.42^{d}	0.23^{h}	0.33^{d}	3.32^{c}	2.12^{h}	2.72^{d}	3.30^{c}	2.30^{g}	2.80^{d}
T4	0.50^{c}	0.27^{g}	0.39^{c}	3.87^{b}	2.32^{g}	3.10^{c}	4.10^{b}	2.41^{f}	3.26^{c}
T5	0.40^{d}	0.16^{i}	0.28^{e}	3.06^{d}	1.25^{i}	2.16^{e}	3.20^{c}	1.50^{h}	2.35^{e}
T6	0.27^{g}	0.15^{i}	0.21^{f}	2.11^{h}	1.20^{i}	1.66^{f}	2.58^{e}	1.32^{i}	1.95^{f}
Mean	0.49^{a}	0.24^{b}	0.37	3.43^{a}	2.04^{b}	2.73	3.65^{a}	2.17^{b}	2.91
	T	t	T*t	T	t	T*t	T	t	T*t
SED	0.00	0.01	0.01	0.02	0.04	0.06	0.02	0.04	0.05
CD (0.05)	0.01**	0.01**	0.02**	0.05**	0.09**	0.12**	0.04**	0.07**	0.10**

T- Temperature factor; t- Treatment factor; T*t- Interaction; AT- Ambient temperature.
NS- Non significant; *Significant at 5%; **Significant at 1%; AT+ 2°C-Ambient temperature +2°C.
Treatments with same letters are not significantly different.

Table 3: Influence of temperature and treatments on DMP (g plant^{-1}).

Treatment	30 DAS			45 DAS			60 DAS		
	AT	AT +2°C	Mean	AT	AT +2°C	Mean	AT	AT +2°C	Mean
T1	11.46	10.36	10.91^{b}	22.05	20.78	21.42^{a}	23.12	21.08	22.10^{ab}
T2	11.80	10.94	11.37^{a}	23.08	21.20	22.14^{a}	24.07	22.06	23.07^{a}
T3	10.77	9.25	10.01^{c}	20.97	19.06	20.02^{bc}	22.08	20.27	21.18^{cd}
T4	11.23	9.88	10.56^{b}	21.53	19.42	20.48^{b}	22.56	20.58	$21.57b^{c}$
T5	10.21	8.67	9.44^{d}	20.45	18.47	19.46^{c}	21.67	19.94	20.81^{d}
T6	9.70	7.82	8.76^{e}	18.78	16.21	17.50^{d}	20.63	18.26	19.45^{e}
Mean	10.86^{a}	9.49^{b}	10.17	21.14^{a}	19.19^{b}	20.17	22.36^{a}	20.37^{b}	21.36
	T	t	T*t	T	t	T*t	T	t	T*t
SED	0.07	0.12	0.17	0.19	0.34	0.48	0.21	0.36	0.51
CD(0.05)	0.14**	0.24**	NS	0.40**	0.69**	NS	0.43**	0.75**	NS

T- Temperature factor; t- Treatment factor; T*t-Interaction; AT- Ambient temperature.
NS- Non significant; *Significant at 5%; **Significant at 1%; AT + 2°C-Ambient temperature +2°C.
Treatments with same letters are not significantly different.

produced maximum dry matter in this treatment. The above-mentioned results indicate that the application of vermicompost with 3% *Panchagavya* has been proven as a promising tool in the alleviation of the adverse effects of high-temperature stress in cowpea plants.

Influence of elevated temperature on yield attributes

The heat-stressed cowpea plants showed a considerable decrease in all yield parameters such as length of the pod, number of seeds per pod, test weight and seed yield than the non-stressed plants. However, the plants treated with vermicompost together with foliar spray of 3% *Panchagavya* exhibited a considerable increase in these yield traits of cowpea plants under both ambient and elevated conditions. Principally, in temperature stressed cowpea plants application of vermicompost together with 3% *Panchagavya* increased the length of the pod by 18.2%, the number of seeds per pod by 17.9%, test weight by 8% and seed yield by 46.8% (Fig 3 and Table 4). The positive effect on all yield traits in the treatment of vermicompost with 3% foliar spray of *Panchagavya* on stressed cowpea plants showed a significant increment of all studied yield parameters than the RDF-Check.

The effect of applying vermicompost and 3% *Panchagavya* was observed in the study on yield and yield components are even more remarkable under elevated temperature compared to other treatments. Indeed, high-temperature normally impairs fertilization and reduces pollen viability. It can be hypothesized that the presence of growth hormones in *Panchagavya* increased the efficiency of the source-to-sink strength by accelerated photosynthetic mobility (Jayanthi *et al.,* 2014; Kumar *et al.,* 2023) that may have enhanced the conducive environment of cowpea plants to elevated temperature. The application of vermicompost in soil improved the supply of available nutrients and water holding capacity of soil for long period. Aside from nutrient supply, the growth hormones like IAA and Cytokinin stimulated the root morphology (Sendhilnathan *et al.,* 2019; Gorla *et al.,* 2023). This, in turn, would have improved the assimilation of nutrients by plants and that resulted in better yield and yield attributes of cowpea.

Influence of elevated temperature on soil available nutrients

Statistically analysed results for the available nutrient (N, P, K) in the soil as affected by ambient and elevated temperature are presented in Table 5. Results revealed that the application of vermicompost together with 3% foliar spray of *Panchagavya* has significantly improved the availability of N, P and K in soil by 36.2 and 36.5%, 73.6 and 74.3%, 33.4 and 25.4% at 30 DAS and at harvest respectively.

Plant-microbe interactions in the rhizosphere are the main factors for plant growth and soil fertility. The current study indicated that the plant growth, yield and seed quality of cowpea were positively affected by the application of vermicompost with 3% *Panchagavya*. The effective role of these organic amendments on plant growth could be related to the high temperature enabled favoured condition for microbial activity that promotes the decomposition of soil organic matter (Selsted *et al.,* 2012) and mobilization of soil available nutrients like N, P and K. Moreover, the organic manure application like vermicompost improved the symbiotic relationship between nodule bacteria and microorganisms in soil (Madukwe *et al.,* 2008; Bhadu *et al.,* 2023) and thus have the potential for N fixation and production of organic acids which help in P and K solubilization. In addition, liquid organic manure like *Panchagavya* stimulated the production of plant growth regulators and hormone which helped in improving soil biomass that act as a key for maintaining the soil's available nutrient for the crop growth period (Sutar *et al.,* 2019; Yogananda *et al.,* 2020; Yadav *et al.,* 2023).

Influence of elevated temperature on protein content

We determined the protein content of cowpea seeds to appraise the effect of different treatments applied under ambient and elevated temperature. In heat-stressed cowpea plants, the protein content was decreased significantly over the non-stressed plants. Further application of vermicompost with 3% *Panchagavya* as foliar spray significantly increased the seed protein content by 7% and 6.9% compared to RDF check plants grown under ambient and elevated temperature respectively (Table 4).

As such the present study indicated that the application of vermicompost with 3% *Panchagavya* has significantly

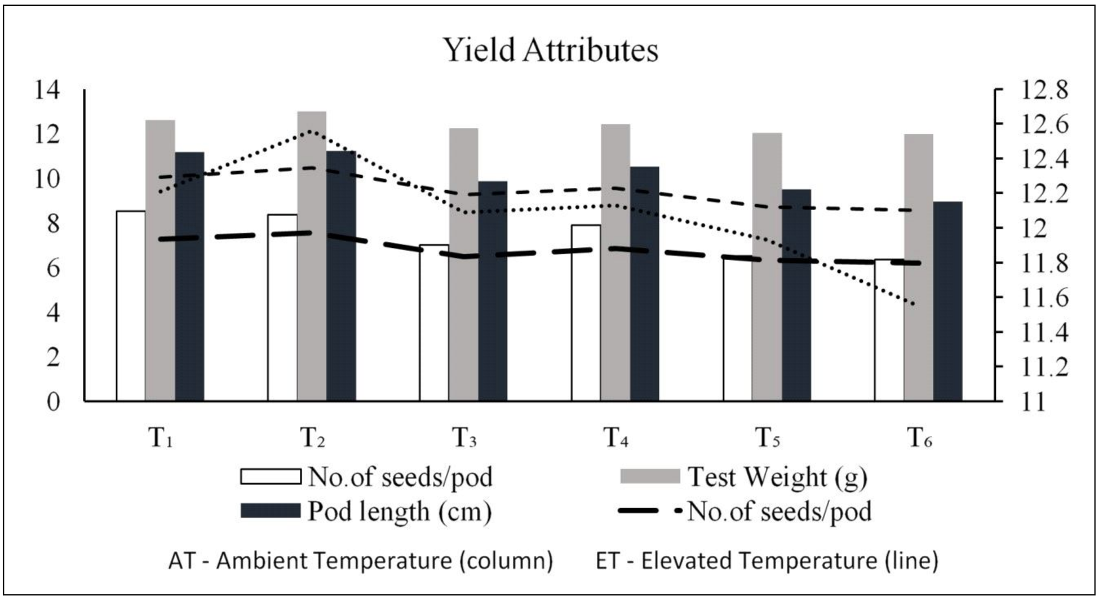

Fig 3: Influence of temperature and treatments on yield attributes.

Table 4: Influence of temperature and treatments on seed yield (g plant^{-1}) and seed protein content (%).

Treatment	Seed yield (g plant^{-1})			Seed protein content (%)		
	AT	AT+2°C	Mean	AT	AT+2°C	Mean
T1	13.99^a	11.15^c	12.57^b	22.25	21.43	21.84^{ab}
T2	14.36^a	12.14^b	13.25^a	22.67	21.82	22.25^a
T3	9.91^d	8.05^{fg}	8.98^d	21.64	20.56	21.10^c
T4	11.73^b	8.78^e	10.25^c	21.92	20.73	21.33b^c
T5	8.43e^f	6.97^h	7.70e	21.43	20.40	20.92^c
T6	7.93^g	6.46^i	7.20^f	21.08	20.31	20.70^c
Mean	11.06^a	8.92^b	9.99	21.83^a	20.88^b	21.35
	T	t	T*t	T	t	T*t
SED	0.09	0.16	0.22	0.20	0.34	0.48
CD (0.05)	0.19**	0.32**	0.46*	0.41**	0.70*	NS

T- Temperature factor; t- Treatment factor; T*t- Interaction; AT- Ambient temperature.

NS- Non significant; *Significant at 5%; **Significant at 1%; AT+ 2°C- Ambient temperature +2°C.

Treatments with same letters are not significantly different.

Table 5: Influence of elevated temperature on available nutrients in soil.

Treatment	Available N (kg ha^{-1})						Available P (kg ha^{-1})						Available K (kg ha^{-1})					
	30 DAS			Harvest			30 DAS			Harvest			30 DAS			Harvest		
	AT	AT+2°C	Mean	AT	AT +2°C	Mean	AT	AT +2°C	Mean	AT	AT +2°C	Mean	AT	AT +2°C	Mean	AT	AT +2°C	Mean
T1	199^{c}	218^{b}	208.5^{b}	204^{c}	237^{b}	220.5^{b}	30^{c}	34^{b}	32.0^{b}	24^{d}	25^{c}	24.5^{b}	209^{c}	252^{b}	230.5^{b}	178^{d}	212^{b}	195.0^{b}
T2	220^{b}	249^{a}	234.5^{a}	237^{b}	252^{a}	244.5^{a}	35^{b}	38^{a}	36.5^{a}	28^{b}	35^{a}	31.5^{a}	246^{b}	287^{a}	266.5^{a}	183c^{d}	236^{a}	209.5^{a}
T3	174^{e}	185^{d}	179.5^{c}	176^{f}	191de	183.5^{d}	17^{f}	25^{d}	21.0^{d}	10^{h}	18^{f}	14.0^{d}	168^{f}	201^{cd}	184.5^{d}	158^{f}	189^{c}	173.5^{d}
T4	182de	187^{d}	184.5^{c}	190^{e}	196^{d}	193.0^{c}	21^{e}	26^{d}	23.5^{c}	17^{g}	21^{e}	19.0^{c}	190^{e}	250^{b}	220.0^{c}	169^{e}	208^{b}	188.5^{c}
T5	151^{f}	158^{f}	154.5^{d}	160^{h}	168^{g}	164.0^{e}	10^{g}	11^{g}	10.5^{e}	9i	10^{h}	9.5^{e}	166^{fg}	193de	179.5^{de}	151^{fg}	180^{d}	165.5^{e}
T6	139^{g}	154^{f}	146.5^{e}	142i	160h	151.0^{f}	8^{h}	10^{g}	9.0^{f}	7j	9i	8.0^{f}	159^{g}	191^{e}	175.0^{e}	145^{g}	176^{d}e	160.5^{e}
Mean	177.5^{b}	191.8^{a}	184.6	184.8^{b}	200.6^{a}	192.7	20.1^{b}	24.0^{a}	22.1	15.8^{b}	19.6^{a}	17.7	189.6^{b}	229.0^{a}	209.3	164.0^{b}	200.2^{a}	182.1
	T	t	T*t	T	t	T*t	T	t	T*t	T	t	T*t	T	t	T*t	T	t	T*t
SED	1.80	3.11	4.40	1.14	1.98	2.79	0.23	0.39	0.56	0.09	0.16	0.22	1.76	3.06	4.32	1.46	2.53	3.58
CD (0.05)	3.71**	6.42**	NS	2.35**	4.08**	5.77**	0.47**	0.81**	1.15**	0.19**	0.33**	0.46**	3.64**	6.31**	8.92*	3.01**	5.22**	7.38*

T- Temperature factor; t- Treatment factor; T*t- Interaction; AT- Ambient temperature.

NS- Non significant; *Significant at 5%; **Significant at 1%; AT+ 2°C- Ambient temperature +2°C.

Treatments with same letters are not significantly different.

increased the seed quality. This study is consistent with a previous study suggesting that organic additives play a role in the balance of carbon and nitrogen metabolism and thus improve the seed amino acid content (Tang *et al.,* 2019). Moreover, increased N uptake of leaves induces phytohormone production which stimulates the photosynthesis process and consequently increases the protein content. Thus, the application of vermicompost and *Panchagavya* may have the potential to improve the seed quality *via* improving the photosynthetic and the nutrient uptake which ultimately translocate to the seed and contribute to improving the seed protein content (Gao *et al.,* 2020).

CONCLUSION

High-temperature stress greatly affected the plant's morphological and yield parameters. Based on the results obtained, the application of vermicompost together with 3% *Panchagavya* has improved the studied parameters. The application of vermicompost enhanced the availability of nutrients N, P and K in soil by enriched microbial activity which enables the roots activity that promoted the plant height, number of leaves and LAI which ultimately resulted in increased yield and its attributes. The foliar application of 3% *Panchagavya* which is rich in essential plant nutrients and plant growth regulators aids in alleviating the effects of high-temperature stress. They played a vital role in improving the seed quality by enhancing the nutrient translocation from vegetative to reproductive parts of the plant. Thus, it is concluded that the combined application of vermicompost and 3% foliar spray of *Panchagavya* diminish the adverse effects of heat stress and increased better adaptation to produce a sustained yield in cowpea plants.

Conflict of interest

The authors declare that they have no competing interest.

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