



RESEARCH ARTICLE

Assessment of row spacing and emitter flow rate for enhancing growth and yield of maize (*Zea mays* L.) under subsurface drip irrigation

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Abstract

Efficient irrigation management plays a critical role in enhancing maize productivity under water-limited conditions, particularly in semi-arid regions where limited water constrains yield potential. A field experiment was conducted during the Rabi season of 2025–26 at the SRM College of Agricultural Sciences, Baburayanpettai, Chengalpattu, Tamil Nadu, India, to evaluate the influence of row spacing and emitter discharge rate under subsurface drip irrigation (SDI) on the growth and yield performance of hybrid maize. The experiment was laid out in a randomised block design (RBD) with 3 replications, comprising 8 treatments involving combinations of row spacings (30/90, 45/75 and 60/60 cm) and emitter discharge rates [2 and 4 litre per hour (lph)] under SDI, along with surface drip and conventional furrow irrigation. Results revealed significant differences among treatments in all growth parameters, except 100-seed weight and harvest index, which were found to be non-significant. Treatment (T₂), comprising 45/75 cm row spacing with 2 lph emitter discharge under SDI, consistently recorded superior leaf area index, dry matter accumulation and yield attributes including 100-seed weight, kernel yield and stover yield. Consequently, T₂ achieved the highest grain yield of 7256 kg/ha and stover yield of 12797 kg/ha, followed by treatment (T₃) (45/75 cm row spacing with 4 lph emitter discharge). The improved performance was attributed to optimum crop geometry and precise moisture delivery to the root zone, which enhanced physiological processes and assimilate translocation. The study concludes that SDI with 45/75 cm row spacing and 2 lph emitter discharge offers an effective strategy for maximising hybrid maize productivity under water-scarce conditions, indicating that adopting this configuration can help farmers in semi-arid regions achieve higher yields with improved water-use efficiency and reduced irrigation input.

Keywords: emitter discharge; grain yield; hybrid maize; row spacing

Introduction

Maize (*Zea mays* L.) ranks among the most important cereal crops worldwide, serving as a principal source of food, feed and industrial raw materials. Increasing population growth, rapid urbanisation and expanding bioenergy demands have intensified the need to improve maize production sustainably. However, water scarcity continues to threaten agricultural productivity across many regions of the world. About 70 % of freshwater resources worldwide are used for agriculture and in some developing nations, that number can reach 80–90 %, highlighting the urgent need for efficient water management practices (1). Furthermore, researchers project that water shortages could reduce maize and wheat yields in Southeast Asia by 10–20 % by 2050. These challenges have encouraged scientists and farmers to adopt precision irrigation technologies.

Among the modern irrigation methods, subsurface drip irrigation (SDI) has gained considerable attention because it

delivers water and nutrients directly to the crop root zone. Unlike conventional irrigation systems, SDI places drip laterals beneath the soil surface, thereby reducing water losses through evaporation and runoff. As a result, crops can utilise water and nutrients more effectively (2). When compared to surface drip irrigation, SDI enhanced crop output, irrigation water productivity and overall water productivity by 5.39 %, 6.75 % and 3.97 %, respectively, according to a global meta-analysis that included 984 comparisons from 109 studies. Similarly, a reported that maize cultivated under SDI with the recommended nitrogen (N) dose produced a 15.8 % higher grain yield and saved nearly 55 % of irrigation water compared with conventional furrow irrigation in the Indo-Gangetic Plain (3). These findings demonstrate that SDI not only preserves water but also improves crop performance and productivity (3).

In addition to irrigation management, row spacing plays a critical role in maize production. Appropriate row spacing

improves canopy architecture, enhances light interception and promotes efficient utilisation of soil moisture and nutrients. Studies conducted under semi-arid conditions showed that optimised row spacing increased dry matter accumulation and improved crop growth by enhancing the interception of solar radiation (4). Likewise, researchers working on the Loess Plateau found that suitable combinations of plant density and row spacing improved both grain yield and grain quality by creating a more efficient canopy structure (5). Under SDI conditions, row spacings between 40 and 85 cm produced greater biomass and grain yield than wider row arrangements, emphasising the importance of proper crop geometry in maximising resource-use efficiency (6).

The success of SDI systems also depends on emitter discharge rate, which determines how water spreads within the soil profile and becomes available to plant roots. Different discharge rates influence soil wetting patterns, nutrient movement and root-zone moisture conditions, thereby affecting crop growth and yield. Previous studies have shown that water and nutrients supplied through subsurface drip fertigation move through the soil via capillary action and root uptake processes, creating complex interactions among emitter characteristics, soil properties and nutrient dynamics (7). Moreover, maintaining adequate moisture during critical growth stages supports post-silking leaf area retention, dry matter production and grain filling, which ultimately contribute to higher yield and water productivity.

Although many researchers have independently investigated the effects of row spacing and SDI parameters, relatively few studies have examined their combined influence on maize growth and productivity under tropical and subtropical conditions. Recent studies have shown that optimised row spacing under drip irrigation can increase maize yield by 15.6–18.2 % while simultaneously improving water-use efficiency (8). Therefore, understanding the interaction between row spacing and emitter discharge rate is essential for developing efficient irrigation strategies for maize cultivation. From this perspective, the present research evaluated the effects of different row spacings and emitter discharge rates on maize growth, yield attributes, grain yield and water-use efficiency under subsurface drip irrigation. The study aimed to identify the most effective treatment combination for achieving higher productivity under water-limited conditions.

Materials and Methods

The field experiment was conducted during the Rabi season of 2025–26 at the farm of SRM College of Agricultural Sciences, SRM Institute of Science and Technology, Baburayanpettai, Chengalpattu, Tamil Nadu, India (12.387030° N, 79.738104° E, 36 m above mean sea level). The experimental site was located in a tropical climatic region characterised by clay loam soil with a slightly alkaline reaction, with a pH of 7.6 and an electrical conductivity of 0.2 dS m⁻¹ measured using a digital pH meter and a conductivity bridge, respectively (9), indicating non-saline conditions and semi-arid to sub-humid conditions, with a mean annual rainfall of 1300 mm. The maximum temperature ranged from 31.1 to 38.7 °C, while the minimum temperature varied between 17.4 and 27.3 °C. Prior to the commencement of the experiment, composite soil samples were collected from the experimental field and analysed for their physico-chemical properties using standard procedures. The soil comprised 38 %

clay, 27 % silt and 35 % sand and was classified as clay loam according to Robinson's International Pipette Method (10). The bulk density, particle density and porosity of the soil were 1.35 g/cm³, 2.62 g/cm³ and 51 %, respectively and were determined by the core sampler method (11). The soil contained 0.31 % organic carbon as estimated by the chromic acid wet digestion method (12). The available nitrogen, phosphorus (P) and potassium (K) contents were 120, 8.2 and 152 kg/ha, respectively, determined by the alkaline permanganate method (13), 0.5 M sodium bicarbonate extraction method (14) and flame photometry (15).

The experiment was laid out in a randomised block design (RBD) with 3 replications and 8 treatments involving different combinations of row spacing and emitter discharge rates under subsurface drip irrigation, along with surface drip and conventional furrow irrigation treatments. The treatment details were as follows:

Maize hybrid NK 6802 was used as the test crop, which was sourced from an authorised local agricultural retailer, Kumaran Agro, with a duration of 110–115 days. Sowing was carried out on 6th February 2026. A uniform plant population of 83333 plants/ha was maintained across all treatments by adjusting the intra-row spacing within the respective row spacing configurations. All recommended agronomic practices were followed uniformly across treatments, except for the imposed irrigation treatments. The operating pressure of the drip irrigation system was 2.0 kg/cm².

The subsurface drip irrigation system was installed with laterals placed at a depth of 20 cm below the soil surface with a lateral spacing of 120 cm. Laterals having an emitter spacing of 60 cm with discharge rates of 2 and 4 litre per hour (lph) were used for the irrigation treatments. Single lateral per plot were provided and each plot measured 27 m in length and 1.2 m in breadth. The total experimental area was 1728 m², with gross and net plot size of 72 m² (20 × 3.6 m) and 46 m² (19.2 × 2.4 m) respectively. Fertigation was given through the SDI system using water-soluble fertilisers, viz., urea (46 : 0 : 0) and potassium nitrate (13 : 0 : 45), once every 3 days, based on the recommended fertigation schedule (150 : 75 : 75 kg of NPK/ha). The total quantity of phosphorus was applied as a basal dose using single super phosphate (0 : 16 : 0). Furthermore, nitrogen and potassium were applied separately through fertigation in 25 equal splits till 75 days after sowing (DAS) in the SDI and DI treatments. In the conventional furrow irrigation system, 25 % of NK and the full dose of phosphorus were applied as a basal application. The remaining 75 % of NK was applied as top dressing in two splits at 25 and 45 DAS (Table 1).

Drip irrigation scheduling at 3 days interval was based on crop evapotranspiration (ET_c). The ET_c was calculated in two steps. First, reference evapotranspiration (ET_o; mm) was estimated using the Penman-Monteith method (Eqn. 1).

$$ET_o = E_p \times K_p \quad (\text{Eqn. 1})$$

where, E_p, daily pan evaporation (mm); K_p, pan co-efficient (0.7).

The daily pan evaporation data were recorded using a USWB Class A open pan evaporimeter at the Agrometeorological Observatory of SRM College of Agricultural Sciences (SRMCAS), Baburayanpettai. The average daily evaporation during crop growth season (from the 1st fortnight of February to the 1st fortnight of April) was 6.74 mm and 7.42 mm. Further, ET_c (Eqn. 2) was calculated using ET_o and crop coefficients (16):

Table 1. Summary of irrigation treatments imposed in the field experiment

Treatment	Maize row spacing (cm)	Emitter spacing (cm)	Emitter discharge (lph)	Irrigation scheduling	Irrigation method
T ₁	30/90 × 20 cm	60 cm	2	100 % ET _c	SDI
T ₂	45/75 × 20 cm	60 cm	2	100 % ET _c	SDI
T ₃	60/60 × 20 cm	60 cm	2	100 % ET _c	SDI
T ₄	30/90 × 20 cm	60 cm	4	100 % ET _c	SDI
T ₅	45/75 × 20 cm	60 cm	4	100 % ET _c	SDI
T ₆	60/60 × 20 cm	60 cm	4	100 % ET _c	SDI
T ₇	30/90 × 20 cm	60 cm	4	100 % ET _c	DI
T ₈	60 × 20 cm	–	–	1.0 IW/CPE ratio	Furrow irrigation

lph: litres per hour; SDI: subsurface drip irrigation; DI: drip irrigation; ET_c: crop evapotranspiration; IW: irrigation water; CPE: cumulative pan evaporation.

$$ET_c = ET_o \times K_c \quad (\text{Eqn. 2})$$

where, K_c, crop coefficient for maize.

The crop coefficient K_c values used during maize growth period were as follows:

The application rate of the drip system, the total amount of water applied and the irrigation duration were determined based on the wetted area concept (17).

$$\text{Total water applied (mm)} = \text{Crop evapotranspiration (mm)} \times \text{wetting area percentage (80 \%)} \quad (\text{Eqn. 3})$$

$$\text{Duration of irrigation (minutes)} = \frac{(\text{Total water applied (L)} \times 60)}{\text{No. of emitters} \times \text{emitter discharge (lph)}} \quad (\text{Eqn. 4})$$

At first a common irrigation was given to all the experimental plots after sowing to ensure uniform germination. To record observations, five plants were randomly selected and tagged from each net plot for periodic measurements. Plant height was measured from the ground level to the tip of the uppermost fully expanded leaf using a meter scale. The leaf area of individual plants was determined using a leaf area meter and the leaf area index (LAI) was calculated as the ratio of total leaf area to the corresponding ground area. Chlorophyll content was estimated using a soil and plant analysis development (SPAD) chlorophyll meter (SPAD-502 Plus, Konica Minolta, Japan). Dry matter production was determined by uprooting the sampled plants, oven-drying them at 65 ± 5 °C until a constant weight was attained and expressing the values on a dry weight basis. At harvest, important yield attributes such as 100-grain weight and harvest index were recorded. The 100-grain weight was determined by weighing 100 randomly selected kernels using an electronic balance, while the harvest index was calculated as the ratio of grain yield to biological yield and expressed as a percentage. Final yield parameters, namely grain yield and stover yield, were recorded from the net plot area and expressed on a hectare basis (kg/ha).

The collected experimental data were subjected to statistical analysis using analysis of variance (ANOVA) following the procedure in previous study (18). The significance of treatment effects was evaluated at the 5 % probability level.

Results and Discussion

Growth parameters

Growth parameters such as plant height, LAI and dry matter production were significantly altered by irrigation methods and spacing. Subsurface drip irrigation treatments performed better due to uniform moisture availability, while the conventional method recorded comparatively lower values.

Plant height (cm)

Plant height was significantly influenced by the irrigation method and spacing configuration. The treatment with row spacing of 30/90 cm with 2 lph in SDI (T₁) recorded the highest plant height of 56.7 cm at 30 DAS and 167.3 cm at 60 DAS (Table 2). The greater plant height observed under T₁ may be attributed to increased interplant competition for light under narrower row spacing, resulting in enhanced stem elongation. These results support the findings of an earlier work (19). The lowest plant height was observed under conventional furrow irrigation (T₈) with 39.69 and 117.1 cm at 30 and 60 DAS respectively, due to its inconsistent and non-uniform moisture distribution, which restricted cell extension and vegetative development. The present results are in agreement with the findings of previous studies (20).

Leaf area index

The LAI was significantly influenced by the irrigation method and spacing configuration. The treatment (T₂) (45/75 cm row spacing combined with 2 lph under SDI) recorded the highest LAI (1.12 at 30 DAS and 3.38 at 60 DAS). The higher LAI under T₂ is attributed to closer row spacing and uniform moisture distribution under SDI, which promoted greater canopy development and enhanced light interception per unit ground area. A similar observation was documented in an earlier study (21). The lowest LAI was observed under conventional furrow irrigation (T₈) with values of 0.82 and 2.09 at 30 and 60 DAS respectively (Table 2), presumably due to inefficient and non-uniform moisture distribution, which restricted vegetative growth and canopy expansion. Comparable findings were described in previous research findings (22).

Dry matter production (kg/ha)

Dry matter accumulation was significantly influenced by irrigation methods and planting geometry. Among the treatments, subsurface drip irrigation with 45/75 cm row spacing and 2 lph (T₂) recorded the highest dry matter accumulation, registering 880 kg/ha at 30 DAS and 4228 kg/ha at 60 DAS (Table 2). This superior performance could be due to consistent moisture supply in the root zone and an optimal spacing arrangement, which improved water absorption

Table 2. Assessment of row spacing and emitter flow rate on growth of maize (*Zea mays*) under subsurface drip irrigation

Treatments	Plant height (cm)		Leaf area index (LAI)		Dry matter production (kg ha ⁻¹)		SPAD value	
	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS
T ₁	56.7	167.3	1.02	3.09	801	3847	30.20	53.94
T ₂	48.2	142.2	1.12	3.38	880	4228	31.80	56.62
T ₃	45.3	133.8	0.91	2.73	713	3425	27.60	49.35
T ₄	55.0	162.2	0.99	2.98	774	3721	29.40	52.38
T ₅	47.0	138.8	1.09	3.28	854	4101	31.00	55.23
T ₆	44.2	130.4	0.90	2.71	704	3382	26.70	47.63
T ₇	53.3	157.2	0.97	2.82	766	3678	28.60	51.11
T ₈	39.6	117.1	0.82	2.09	642	3086	25.80	46.17
SEd±	2.0	5.4	0.03	0.09	27	150	0.90	2.70
CD ($p = 0.05$)	4.5	12.5	0.08	0.24	65	345	2.09	6.17

T₁: row spacing of 30/90 cm with 2 lph in SDI; T₂: row spacing of 45/75 cm with 2 lph in SDI; T₃: row spacing of 60/60 cm with 2 lph in SDI; T₄: row spacing of 30/90 cm with 4 lph in SDI; T₅: row spacing of 45/75 cm with 4 lph in SDI; T₆: row spacing of 60/60 cm with 4 lph in SDI; T₇: row spacing of 30/90 cm with 4 lph in DI; T₈: conventional method.

lph: litre per hour; SDI: subsurface drip irrigation; DI: drip irrigation; SPAD: soil and plant analysis development; LAI: leaf area index; DMP: dry matter production; SEd: standard error of the difference; CD: critical difference.

and promoted greater biomass production (23). In contrast, conventional furrow irrigation (T₈) produced the lowest dry matter values, with 642 kg/ha at 30 DAS and 3086 kg/ha at 60 DAS, possibly due to non-uniform water distribution and increased surface evaporation losses that limited plant growth (24).

SPAD

The SPAD value, an indicator of leaf chlorophyll content and nitrogen status, was significantly affected by irrigation method and row spacing. Among the treatments, T₂ (45/75 cm row spacing with 2 lph under subsurface drip irrigation) recorded the highest SPAD values of 31.80 at 30 DAS and 56.62 at 60 DAS throughout the crop growth period. The higher SPAD values under T₂ suggest improved chlorophyll retention and nitrogen uptake resulting from a more favorable soil moisture regime under SDI (25). In contrast, T₈ (furrow irrigation) recorded the lowest SPAD values of 25.80 at 30 DAS and 46.17 at 60 DAS (Table 2), due to uneven moisture availability and periodic water stress, which reduced chlorophyll retention and nutrient absorption. Similar trends have been reported in earlier investigations (26).

Yield parameters of maize

100-seed weight (g)

Treatment effects on 100-seed weight were non-significant, although numerically higher values were observed under T₂. The treatment T₂ (45/75 cm row spacing with 2 lph under subsurface drip irrigation) recorded the highest value (23.40 g) (Table 3), due to the continuous and uniform moisture supply during cob development and grain filling stages, which enhanced assimilate translocation and seed development (27), while T₈ (conventional furrow irrigation) recorded the lowest value (22.45 g). However, the differences among treatments were statistically non-significant [critical difference (CD) at $p = 0.05$ = non-significant], indicating that variations in row spacing, emitter discharge and irrigation methods did not exert a significant influence on seed weight. The relatively narrow range of values suggests that 100-seed weight is primarily governed by genetic characteristics and is less responsive to irrigation treatments and crop geometry under the prevailing experimental conditions. Similar observations have been reported in earlier studies (28).

Harvest index

Harvest index (HI) was significantly influenced by irrigation method and row spacing. The treatment T₂ (45/75 cm row spacing with 2

lph under subsurface drip irrigation) recorded the highest HI (0.43) (Table 2), indicating more efficient partitioning of assimilates towards seed production. The uniform moisture availability under SDI and favourable spacing enhanced dry matter accumulation and reproductive growth, resulting in improved harvest efficiency. Similar findings have also been reported in previous studies (29). In contrast, T₈ (furrow irrigation) recorded the lowest HI of about 0.39 due to uneven water distribution and reduced assimilate allocation to reproductive organs. Similar observations substantiate the findings of previous studies (30).

Kernel yield (kg/ha)

Among the treatments imposed, kernel yield was significantly influenced by irrigation method and spacing configuration. The treatment T₂ (45/75 cm row spacing with 2 lph under SDI) recorded the highest kernel yield, with a value of 7256 kg/ha. The higher kernel yield under T₂ may be attributed to favourable plant geometry and uniform root-zone moisture availability, which promoted vegetative growth and grain filling (31). The lowest kernel yield was recorded under T₈ (conventional furrow irrigation) exhibiting 5294 kg/ha (Table 3), primarily due to inefficient water application, high surface evaporation losses and non-uniform moisture distribution that imposed intermittent soil water stress during silking and grain-filling, adversely affecting kernel number per row and kernel weight. Similar trends were described in past research (32).

Stover yield (kg/ha)

Stover yield was significantly influenced by the irrigation method and row spacing. The treatment T₂ at a row spacing of 45/75 cm with 2 lph recorded the highest stover yield, totaling 12797 kg/ha (Table 3), among all treatments. The greater stover yield under T₂ is attributed to the favorable microenvironment created by closer row spacing combined with SDI, which promoted taller plants, higher leaf area, greater stem girth and prolific vegetative biomass production owing to uninterrupted moisture and nutrient availability throughout the crop growth period, as also reported in previous studies (33). The lowest stover yield was observed under T₈ (conventional furrow irrigation), registering 9336 kg/ha, due to poor and uneven moisture distribution under furrow irrigation, which limited canopy development, reduced stem and leaf biomass and ultimately resulted in inferior total above-ground dry biomass at harvest. Similar findings were indicated in previous literature reports (34).

Table 3. Assessment of row spacing and emitter flow rate on yield of maize (*Zea mays*) under subsurface drip irrigation

Treatments	100 seed weight (g)	Harvest index	Kernel yield (kg/ha)	Stover yield (kg/ha)
T ₁	23.56	0.42	6605	11647
T ₂	23.40	0.43	7256	12797
T ₃	22.98	0.40	5879	10367
T ₄	23.15	0.41	6382	11255
T ₅	23.32	0.42	7042	12420
T ₆	22.85	0.40	5805	10238
T ₇	22.71	0.40	6316	11140
T ₈	22.45	0.39	5294	9336
SEd±	0.48	0.02	265	401
CD ($p = 0.05$)	NS	NS	605	917

T₁: row spacing of 30/90 cm with 2 lph in SDI; T₂: row spacing of 45/75 cm with 2 lph in SDI; T₃: row spacing of 60/60 cm with 2 lph in SDI; T₄: row spacing of 30/90 cm with 4 lph in SDI; T₅: row spacing of 45/75 cm with 4 lph in SDI; T₆: row spacing of 60/60 cm with 4 lph in SDI; T₇: row spacing of 30/90 cm with 4 lph in DI; T₈: conventional method.

lph: litre per hour; SDI: subsurface drip irrigation; DI: drip irrigation; LAI: leaf area index; DMP: dry matter production; SEd: standard error of the difference; CD: critical difference.

The superior performance of T₂ was associated with higher LAI, SPAD value and dry matter accumulation, reflecting improved canopy development and biomass production. These responses contributed to enhanced grain filling and final grain yield. The results demonstrate that optimising both crop geometry and emitter discharge rate is essential for maximising the benefits of subsurface drip irrigation in hybrid maize.

Water use and water saving

The total water use under all SDI and DI treatments (T₁–T₇) was 481 mm, whereas the conventional furrow irrigation treatment (T₈) recorded a higher total water use of 600 mm. The lower water consumption under SDI and DI treatments indicates more efficient utilisation of irrigation water through localised application and reduced conveyance and evaporation losses compared with the conventional method (35). The drip-based irrigation systems reduced the total water use by 119 mm, corresponding to a water saving of 36.9 % over conventional irrigation. These findings demonstrate the potential of drip irrigation technologies to substantially reduce the water requirement of maize cultivation while maintaining higher productivity.

Conclusion

The present study demonstrated that SDI significantly improved the growth and yield of hybrid maize compared to conventional irrigation. Among the treatments, 45/75 cm row spacing with 2 lph emitter discharge (T₂) consistently recorded superior performance in growth traits, yield attributes and final yield. The enhanced performance is attributed to optimal plant spacing combined with precise and uniform water and nutrient supply in the root zone, which promoted efficient resource utilisation and biomass production. Furthermore, the SDI and DI treatments reduced total water use by 19.83 % compared with the conventional method. Therefore, SDI with 45/75 cm row spacing and a 2 lph emitter discharge rate may be recommended for achieving higher maize productivity under similar agro-climatic conditions. The findings provide useful guidance for optimising crop geometry and emitter discharge rate in SDI maize production systems. Future research should focus on validating these findings across multiple locations, seasons and soil types to confirm their broader applicability. Long-term studies are also needed to assess the effects of SDI on soil health, root distribution and emitter clogging under continuous use. Further investigations combining SDI with fertigation scheduling, deficit

irrigation strategies and different maize hybrids would help optimise water and nutrient use efficiency further. Additionally, economic and life-cycle cost analyses of SDI systems compared to surface drip and furrow irrigation are recommended to support large-scale adoption by farmers.

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Authors' contributions

PCJ conducted the field experiment, collected data and drafted the manuscript. RS conceived and designed the study, supervised the work and critically revised the manuscript. RA assisted with experimental setup and data collection. KA participated in statistical analysis. All authors have read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interest to declare.

Ethical issues: None

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this manuscript, the authors used ChatGPT (OpenAI) solely to assist with grammar checking, spelling corrections, language refinement and improving the clarity and organisation of the text. The tool was also used to obtain general background information and to support the presentation of content. All scientific interpretations, analyses, results and conclusions were conceived, verified, critically reviewed and edited by the authors. After using this tool/service,

the authors reviewed and edited the content as needed and takes full responsibility for the content of the publication.

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