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Effect of Deficit and Optimum Irrigation at various Growth Stages on Yield Attributes, Yield and Water Productivity of *Summer* Sesame

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ABSTRACT: Water is a limited asset and experiencing competition among agricultural, industrial and domestic sectors. Plants require ample quantities of water throughout the life cycle/cropping period and water is considered as key input for agricultural production. Among all the factors for crop production, water is found to be the major impediment in reducing the yields. Deficit irrigation is a water resource management strategy that optimize the water demand with increase in crop yield thereby improving water use efficiency (WUE). A field experiment was conducted at Agricultural college, Polasa, Jagtial during summer 2021. The experiment was laid out in a randomized complete block design with eight deficit and optimum irrigated treatments (T_1 to T_8). Results revealed that treatment provided with 5 irrigations each at vegetative, prebloom, flowering, capsule initiation and capsule filling stages (T_8) recorded higher yield attributes, yield and water productivity *i.e.*, number of capsules plant^{-1} (45), capsule length (2.5 cm), capsule width (0.59 cm), capsule weight (0.32 g), number of filled seeds capsule^{-1} (55), 1000 seed weight (3.0 g), seed yield (1150 kg ha^{-1}), stalk yield (1999 kg ha^{-1}) and crop water productivity (4.22). Field water productivity (2.62) was higher in treatment scheduled with 3 irrigations each at vegetative, flowering and capsule filling stages (T_4).

Keywords: Sesame, Deficit and optimum irrigation, Yield, Field water productivity, Crop water productivity.

INTRODUCTION

Oilseeds play a crucial role in the Indian economy, accounting for 5% of India's GDP and 10% of the value of agricultural commodities. Recently, due to the rising demand for invigorating vegetable oils, livestock feed, pharmaceuticals, biofuels and other oleochemical industrial uses, oilseeds have attracted more attention. In the past 30 years, there was an 82% expansion of oilseed crop cultivation area and an increase of approximately 240% in total world production (Farooq *et al*., 2016). Sesame (*Sesamum indicum* L.) (2n=26) being included in the order Tubiflorae and family Pedaliaceae is native of Africa and one of the earliest domesticated plants of India. It is cultivated in warm regions of the tropic and subtropics. India is one of the significant exporters of sesame with an acreage of 14.19 lakh hectares, production of 6.89 lakh tons and productivity of 485 kg ha^{-1} (Indiastat, 2018-19). Sesame is a rich wellspring of nutritive and medicinal properties (Biswas *et al*., 2018).

India is importing oilseeds to the extent of 15 million tonnes with foreign exchange of ₹ 7300 crores. There is need to increase the production of oilseeds especially cooking oil through developing high yielding varieties and agronomic management. Low productivity in sesame is primarily due to rainfed cultivation in marginal and submarginal lands with poor management and low inputs. Water is a limited asset and experiencing competition among agricultural, industrial and domestic sectors. Plants require ample quantities of water throughout the life cycle/cropping period and water is considered as key input for agricultural production. To solve the upcoming challenges and in view of the improving water use efficiency (WUE), precised water management strategies need to be formulated. Deficit irrigation is distinctly one of them. The prime objective of deficit irrigation is to elevate the WUE of a crop by eliminating the irrigations that have little impact on yield. It is therefore necessary to develop best water deficit irrigation strategy in most of the crops. Deficit irrigation is a path for amplifying water use efficiency (higher yields per unit of irrigation water applied) (Bekele and Tilahun, 2007). Deficit irrigation is a strategy which allows a crop to sustain some degree of water deficit in order to reduce irrigation costs and potentially increase revenues. Application of irrigation at branching, flowering and capsule development stages increased yield crediting characters and yield of *summer* sesame (Dutta *et al*., 2000 and Mekonnen and Sintayehu, 2020). Deficit irrigation additionally increase the water productivity by using precised water. The aim of this work is to design efficient irrigation schedule to *summer* sesame in Northern Telangana Zone. As the literature available is limited on above aspects, it is proposed to conduct a field experiment to develop optimum irrigation schedule to increase the productivity of *summer* sesame.

Hence, this experiment is proposed to conduct with an objective to study the effect of deficit and optimum irrigation at various growth stages on yield attributes, yield and to estimate crop water requirement and water productivity at different irrigations applied at various growth stages.

MATERIAL AND METHODS

A field experiment was conducted at Agricultural college, Polasa, Jagtial during *summer* 2021. The experiment was laid out in a randomized complete block design with eight treatments (T_1 to T_8) and replicated thrice. The experimental soil was sandy clay loam in texture, slightly alkaline (7.99) and non-saline (0.31 dS m^{-1}) in reaction. Fertility status of the experimental soil was low in organic carbon (0.50%) and available nitrogen (157.0 kg ha^{-1}), high in available phosphorus (23.2 kg ha^{-1}) and potassium (297.0 kg ha^{-1}). Treatments comprised of varied number of irrigations scheduled at different crop growth stages *i.e.,* vegetative, prebloom, flowering, capsule initiation and capsule filling stages. The treatments were T_1- 2 irrigations each at vegetative and flowering stages; T_2- 2 irrigations each at vegetative and capsule filling stages; T_3- 2 irrigations each at flowering and capsule filling stages; T_4- 3 irrigations each at vegetative, flowering and capsule filling stages; T_5- 3 irrigations each at vegetative, prebloom and capsule filling stages; T_6- 4 irrigations each at vegetative, prebloom, flowering and capsule filling stages; T_7- 4 irrigations each at vegetative, flowering, capsule initiation and capsule filling stages and T_8- 5 irrigations each at vegetative, prebloom, flowering, capsule initiation and capsule filling stages. In sesame cultivation, recommended fertilizer dose of 60: 20: 40 kg N, P_2O_5 and K_2O ha^{-1} was followed (Vyavasayapadipantalu, PJTSAU). These nutrients were applied in the form of urea, single super phosphate (SSP) and muriate of potash (MOP), respectively. Complete dose of P_2O_5 was applied as basal dose. K_2O was applied in 2 splits at basal and at flowering stage and nitrogen was applied in 3 equal splits at basal, vegetative and at flowering stages. The available soil moisture in the soil was 91.6 mm and total evaporation during crop growth period was 366.1 mm. Total water applied in each irrigation treatment was calculated as detailed below.

Total water applied (mm) = sum of water applied in all irrigations (mm) + effective rainfall (mm).

6 cm depth irrigation is applied at each irrigation as per the schedule. Rainfall was not received during crop growth period. Irrespective of the stages, basal irrigation is commonly given to all the treatments immediately after sowing for better stand establishment.

Crop evapotranspiration of sesame was determined gravimetrically at each irrigation in four depths (0-15, 15-30, 30-45 and 45-60 cm) totaled over crop growth period.

Field water productivity is the proportion between marketable yield (grain yield) and total water applied in mm (irrigation and effective rainfall) and indicated as kg ha mm^{-1}.

$$\mathrm{FWP} = \frac{\text{Grain yield (kg ha}^{-1})}{\text{Quantity of total water applied (mm)}}$$

Crop water productivity is the ratio of yield obtained and amount of water utilized by crop in evapotranspiration (mm) and expressed as kg ha mm^{-1}.

$$\mathrm{CWP} = \frac{\text{Grain yield (kg ha}^{-1})}{\text{Crop evapotranspiration (mm)}}$$

Data is statistically analyzed as illustrated by Panse and Sukhatme (1954).

RESULTS AND DISCUSSIONS

Yield attributes. Number of capsules $plant^{-1}$ at harvest is an indispensable determinant of seed yield in sesame crop. The number of capsules $plant^{-1}$ was prominently influenced by deficit and optimum irrigation in *summer* sesame at various growth stages. Yield is a composite of number of capsules $plant^{-1}$, seeds $capsule^{-1}$ and seed weight and almost 85% of sesame yield variations were achieved by capsules $plant^{-1}$ or capsules unit $area^{-1}$ (Rao *et al.*, 1991). Increasing the number of irrigations increased the number of capsules $plant^{-1}$ and thus maximum number of capsules $plant^{-1}$ (45.0) were recorded when 5 irrigations were scheduled each at various growth stages *i.e.,* vegetative, prebloom, flowering, capsule initiation and capsule filling stages. This is followed by T_7, T_6, T_4, and T_5. Lowest number of capsules $plant^{-1}$ (10.4) were recorded in treatment provided with 2 irrigations each at vegetative and capsule filling stages (T_2). This might be due to prolonged moisture stress during the crop growing period especially at flowering. However, it was on par with same number of irrigations scheduled each at vegetative and flowering stages (T_1) (13.0) and 2 irrigations scheduled each at flowering and capsule filling stages (T_3) (13.3). Water stress at reproductive stage brought about an irreversible impact which could not be revoked during subsequent good soil moisture levels when the crucial processes of capsule development are still underway. The results obtained in the current investigation were supported by Sarkar *et al*. (2010); Puste *et al*. (2015); Mekonnen and Sintayehu, (2020).

Length of the capsule varied significantly as influenced by deficit and optimum irrigation at various growth stages in *summer* sesame. Greater capsule length (2.5 cm) was noticed in treatment which was provided with 5 irrigations each at vegetative, prebloom, flowering, capsule initiation and capsule filling stages. Length of the capsule decreased with increase in moisture stress predominantly at critical stages like flowering. It was statistically on par with T_7, T_6 and T_4 treatments which showed 2.5, 2.4 and 2.3 cm of capsule length, respectively. Lowest capsule length (1.8 cm) was noticed in treatment provided with 2 irrigations each at vegetative and capsule filling stages (T_2). Capsule length in treatment T_5 was noticed to be 2.1 cm and it was reduced drastically than T_4 with same number of irrigations and this might be due to moisture stress imposed at flowering stage. Treatment with 2 irrigations scheduled at vegetative and flowering stages (2.2 cm) and that provided with 2 irrigations each at flowering and capsule filling stages (2.3 cm) showed results which were at par in terms of capsule length. The results obtained were in conformity with Chauhan *et al*. (2016); Mallick, (2018).

Capsule width of *summer* sesame as influenced by deficit and optimum irrigated treatments was insignificant. Values of capsule width varied from 0.57 to 0.59 cm.

Table 1: Number of capsules plant^{-1}, capsule length (cm), capsule width (cm), capsule weight (g), No. of filled seeds capsule^{-1} and 1000 seed weight (g) of *summer* sesame as influenced by deficit and optimum irrigation at various growth stages.

	Treatments	No. of capsules plant^{-1}	Capsule length (cm)	Capsule width (cm)	Capsule weight (g)	No. of filled seeds capsule^{-1}	1000 seed weight (g)
T_1	2 irrigations each at vegetative and flowering stage	13.0	2.2	0.58	0.23	30.8	2.6
T_2	2 irrigations each at vegetative and capsule filling stage	10.4	1.8	0.57	0.21	29.5	2.6
T_3	2 irrigations each at flowering and capsule filling stage	12.3	2.3	0.57	0.22	31.4	2.7
T_4	3 irrigations each at vegetative, flowering and capsule filling stage	25.7	2.3	0.58	0.27	43.9	2.8
T_5	3 irrigations each at vegetative, prebloom and capsule filling stage	18.7	2.1	0.57	0.24	38.1	2.7
T_6	4 irrigations each at vegetative, prebloom, flowering and capsule filling stage	33.6	2.4	0.58	0.28	47.5	2.8
T_7	4 irrigations each at vegetative, flowering, capsule initiation and capsule filling stage	35.1	2.5	0.57	0.28	48.9	2.8
T_8	5 irrigations each at vegetative, prebloom, flowering, capsule initiation and capsule filling stage	45.0	2.5	0.59	0.32	55.0	3.0
SEm±		1.67	0.075	0.007	0.01	1.82	0.10
CD @5%		5.06	0.23	NS	0.03	5.53	NS
CV (%)		11.93	5.79	2.16	6.4	7.8	5.7

Significant variation in capsule weight of sesame was observed due to deficit and optimum irrigation at various growth stages with higher value (0.32 g) when provided with adequate irrigations (5) each at vegetative, prebloom, flowering, capsule initiation and capsule filling stages (T_8) and was higher than all other deficit irrigated treatments. This was followed by T_7, T_6 and T_4. Lowest capsule weight (0.21 g) was noticed in treatment provided with 2 irrigations each at vegetative and capsule filling stages (T_2) and it was statistically on par with T_1, T_3 and T_5 showing capsule weight of 0.23, 0.22, 0.24 g, respectively. This was supported by Mila *et al*. (2017); Eltarabily *et al*. (2020) in sunflower.

Significantly higher number of filled seeds capsule^{-1} (55.0) was noticed in treatments provided with 5 irrigations each at vegetative, prebloom, flowering, capsule initiation and capsule filling stages (T_8). Maximum number of seeds capsule^{-1} were produced when sesame received irrigations at all the critical stages (Sarkar *et al*., 2010). Followed to this, scheduling of 4 irrigations each at vegetative, flowering, capsule initiation and capsule filling stages (T_7) produced higher number of filled seeds capsule^{-1} (48.9) and was at par with treatment T_6 (47.5) and with treatment T_4 (43.9). Significantly lower number of filled seeds capsule^{-1} (29.5) were recorded in treatment with 2 irrigations provided each at vegetative and capsule filling stages (T_2) and it was on par with treatments optimized with 2 irrigations scheduled at vegetative and flowering stages and flowering and capsule filling stages (30.8 and 31.4 in T_1 and T_3, respectively). Higher number of filled seeds capsule^{-1} with increasing number of irrigations might be due to higher number of capsules and effective translocation of photosynthates from source to sink in optimum irrigated treatments. The results obtained in the current investigation were supported by Mallick, (2018); Mekonnen and Sintayehu, (2020) in sesame and by Eltarabily *et al*. (2020) in sunflower and Rathore *et al*., (2020) in mustard.

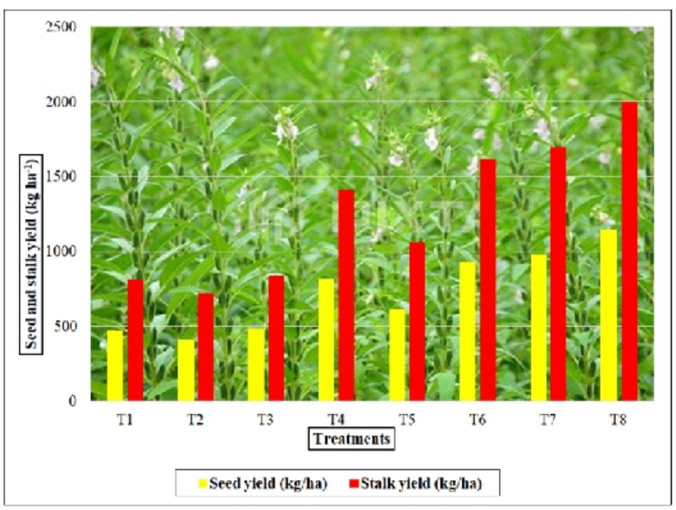
Test weight ranged from 2.6 to 3.0 g. 1000 seed weight of sesame increased with increasing irrigation levels (Mallick, 2018). Contrary to this, there was no significant effect of deficit and optimum irrigation at various growth stages on 1000 seed weight of *summer* sesame. Similar results were reported by Singh and Singh, (2014) in mustard.

Yield. Seed and stalk yield of *summer* sesame as influenced by deficit and optimum irrigation at various growth stages were presented in Table 2 and illustrated in Fig. 1. Highest seed yield (1150 kg ha^{-1}) was acquired by providing 5 irrigations each at vegetative, prebloom, flowering, capsule initiation and capsule filling stages (T_8). Higher seed yield of sesame with optimum irrigation schedule was supported by Khadse *et al*., (2017); Pereira *et al*. (2017); Mallick (2018); Hailu *et al*., (2018); Abdelraouf and Anter, (2020). This might be due to enhanced performance of all yield contributing characters because of uninterrupted soil moisture availability during entire crop growth period. Irrigation at early vegetative or branching stage perhaps had bought about the lively development of the crop while irrigation provided at flowering may have helped in maintaining size, duration and photosynthetic movement of the green plant parts after flowering and furthermore in movement of photosynthates to the sink (Wardlaw, 2002). Moreover, this is the period in which likely capsules and seed number is resolved.

Seed yield decreased with diminishing water availability (Eskandari *et al*., 2009). There was reduction in seed yield (976 kg ha^{-1}) when provided with 4 irrigations each at vegetative, flowering, capsule initiation and capsule filling stages (T_7). However, it was statistically at par (931 kg ha^{-1}) when 4 irrigations were scheduled each at vegetative, prebloom, flowering and capsule filling stages (T_6). Reduced seed yield in the later treatment in comparison to prior one might be due to stress imposed at capsule initiation stage which led to aversion in capsule formation and seed development.

Table 2: Seed and stalk yield (kg ha^{-1}) of *summer* sesame as influenced by deficit and optimum irrigation at various growth stages.

	Treatments	Seed yield (kg ha^{-1})	Stalk yield (kg ha^{-1})
T_1	2 irrigations each at vegetative and flowering stage	469	810
T_2	2 irrigations each at vegetative and capsule filling stage	410	720
T_3	2 irrigations each at flowering and capsule filling stage	485	840
T_4	3 irrigations each at vegetative, flowering and capsule filling stage	818	1413
T_5	3 irrigations each at vegetative, prebloom and capsule filling stage	616	1059
T_6	4 irrigations each at vegetative, prebloom, flowering and capsule filling stage	931	1618
T_7	4 irrigations each at vegetative, flowering, capsule initiation and capsule filling stage	976	1695
T_8	5 irrigations each at vegetative, prebloom, flowering, capsule initiation and capsule filling stage	1150	1999
SEm±		33.36	39.16
CD @5%		101.20	118.78
CV (%)		7.9	5.3



T_1: 2 irrigations each at vegetative and flowering stages; T_2: 2 irrigations each at vegetative and capsule filling stages; T_3: 2 irrigations each at flowering and capsule filling stages; T_4: 3 irrigations each at vegetative, flowering and capsule filling stages; T_5: 3 irrigations each at vegetative, prebloom and capsule filling stages; T_6: 4 irrigations each at vegetative, prebloom, flowering and capsule filling stages; T_7: 4 irrigations each at vegetative, flowering, capsule initiation and capsule filling stages; T_8: 5 irrigations each at vegetative, prebloom, flowering, capsule initiation and capsule filling stages.

Fig. 1. Seed and stalk yield (kg ha^{-1}) in sesame as influenced by deficit and optimum irrigation at various growth stages.

Seed yield obtained with scheduling 3 irrigations each at vegetative, prebloom and capsule filling stages (T_5) was 616 kg ha^{-1}. With same number of irrigations each at vegetative, flowering and capsule filling stages (T_4), seed yield was noticed to be 818 kg ha^{-1}. The variance between the yield of both treatments could be attributed to termination of flowers and capsule formation due to stress imposed at flowering. Water deficiency during reproductive stage especially during flowering and capsule formation stage showed drastic reduction in seed yield (Ekom *et al*., 2019). Seed yield when provided with 2 irrigations each at vegetative and flowering stages was (T_1) 469 kg ha^{-1} and was at par with irrigation scheduled at vegetative and capsule filling stages (T_2) (410 kg ha^{-1}) and treatment provided with 2 irrigations each at flowering and capsule filling stages (T_3) (485 kg ha^{-1}) of seed yield. In this way, not providing irrigation at flowering and capsule development period may have caused flower abortion which in turn showed diminished number of capsules and seeds in deficit irrigated treatments. This load of adverse impacts on yield attributes might have reduced the seed yield. Distinct variation among yields obtained under optimum and deficit irrigation shows that there is clear cut impact of water stress imposed at various stages of sesame crop.

Among the deficit and optimum irrigated treatments, maximum stalk yield (1999 kg ha^{-1}) was noticed in treatment with 5 irrigations each at vegetative, prebloom, flowering, capsule initiation and capsule filling stages (T_8). Positive impact of optimum irrigation schedule on yield attributes fundamentally expanded seed and stalk yield of sesame over deficit irrigation schedule (Sarkar *et al*., 2010). The expanded straw yield at optimum irrigated systems may be attributed to expanded vegetative development (Chauhan *et al*., 2016). Higher straw yield was ascribed to higher dry matter accumulation because of higher photosynthetic movement bringing about creation of higher photosynthates prompting better growth variables (Kundu and Singh, 2006). Followed to above optimum irrigation treatment, stalk yield noticed by scheduling 4 irrigations each at vegetative, flowering, capsule initiation and capsule filling stages (T_7) was 1695 kg ha^{-1} and it was at par with treatment provided with same number of irrigations but at different growth stages (T_6) *i.e.,* vegetative, prebloom, flowering and capsule filling stages (1618 kg ha^{-1}). Stalk yield observed in treatment provided with 3 irrigations each at vegetative, flowering and capsule filling stages (T_4) was 1413 kg ha^{-1} whereas treatment even though provided with same number of irrigations each at vegetative, prebloom and capsule filling stages (T_5) showed significantly lower stalk yield (1059 kg ha^{-1}) than prior one as it was lacking irrigation at flowering stage which led to reduced flower and capsule formation which in turn reduced the biological yield. This was supported by Mila *et al*. (2017). Lowest stalk yield (720 kg ha^{-1}) was registered in treatment provided with 2 irrigations each at vegetative and capsule filling stages (T_2). However, it was significantly on par with treatment with 2 irrigations applied each at vegetative and flowering stages (810 kg ha^{-1}).

Water productivity (FWP and CWP). Field water productivity and crop water productivity of *summer* sesame as impacted by deficit and optimum irrigation at various growth stages were presented in Table 3 and depicted in Fig. 2. Field water productivity is the proportion of seed yield to aggregate sum of water applied to the field (including conveyance losses). The crop water productivity is the yield of crop per unit of water lost through evapotranspiration.

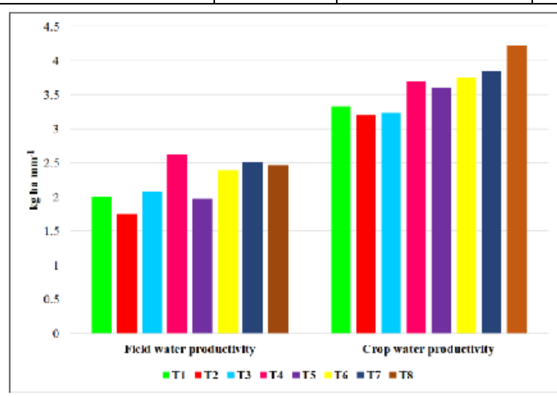
Higher irrigation water applied (468 mm) in adequate irrigated treatment (T_8) followed by 4 irrigations (T_6 and T_7), 3 irrigations (T_4 and T_5) and 2 irrigations (T_1, T_2 and T_3). An amount of 6 cm irrigation water was applied at each irrigation. Initial irrigation of 6 cm is commonly applied to all the treatments at sowing and up to crop establishment period (0-9 DAS). This was supported by Mekonnen and Sintayehu, (2020).

Water productivity as affected by deficit and optimum irrigation at various growth stages varied significantly. Field water productivity was higher in treatments provided with optimized level of irrigation that too at critical stages. Remarkably higher field water productivity (2.62 kg ha mm^{-1}) was noticed in treatment provided with 3 irrigations each at vegetative, flowering and capsule filling stages (T_4) and it was statistically at par with treatments provided with 4 irrigations (T_6 and T_7) and 5 irrigations (T_8) showing values of 2.39, 2.50 and 2.46 kg ha^{-1} mm^{-1}, respectively. Field water use efficiency was most elevated at optimized irrigation produced higher increment in yield with effective utilization of water (Sarkar *et al*., 2010). Field water productivity in treatments provided with 2 irrigations (T_1, T_2 and T_3) and 3 irrigations each at vegetative, prebloom and capsule filling stages (T_5) were at par and lowest (1.75 kg ha^{-1} mm^{-1}) was recorded in treatment provided with 2 irrigations each at vegetative and capsule filling stages (T_2). The results obtained were supported by Tantawy *et al*., (2007); Abdelraouf and Anter, (2020).

Crop water productivity in sesame as influenced by deficit and optimum irrigation at various growth stages varied from 3.20 to 4.22 kg ha^{-1} mm^{-1}. Highest crop water productivity (4.22 kg ha mm^{-1}) was noticed in treatment supplied with 5 irrigations each at vegetative, prebloom, flowering, capsule initiation and capsule filling stages (T_8). It was at par with treatments provided with 4 irrigations each at vegetative, flowering, capsule initiation and capsule filling stages (T_7), 4 irrigations each at vegetative, prebloom, flowering and capsule filling stages (T_6) and 3 irrigations each at vegetative, flowering and capsule filling stages (T_4) with values of 3.84, 3.75 and 3.70 kg ha mm^{-1}, respectively. It was supported by Mekonnen and Sintayehu, (2020) who stated that optimized deficit irrigation showed less significant effect on seed yield of sesame. Crop water productivity was lowest (3.20 kg ha mm^{-1}) in treatment provided with 2 irrigations each at vegetative and capsule filling stages (T_2). It was on par with treatments provided with 2 irrigations each at vegetative and flowering stages (T_1), 2 irrigations each at flowering and capsule filling stages (T_3) and 3 irrigations each at vegetative, prebloom and capsule filling stages (T_5). The results obtained were in resemblance with findings of Mila *et al*. (2017) in sunflower and Damdar *et al*. (2014) in sesame. These results feature that in stage wise deficit irrigation, imposing water stress at flowering and capsule initiation produced higher yield depletion in sesame (Mekonnen and Sintayehu, 2020) as manifested in treatments provided with 2 irrigations each at vegetative and capsule filling stages (T_2) and 3 irrigations each at vegetative, prebloom and capsule filling stages (T_5).

Table 3: Field water productivity (FWP) and crop water productivity (CWP) in *summer* sesame as influenced by deficit and optimum irrigation at various growth stages.

	Treatments	Total ET_c	Irrigation water applied (mm)	FWP (kg ha^{-1} mm^{-1})	CWP (kg ha^{-1} mm^{-1})
T_1	2 irrigations each at vegetative and flowering stage	141	234	2.00	3.33
T_2	2 irrigations each at vegetative and capsule filling stage	128	234	1.75	3.20
T_3	2 irrigations each at flowering and capsule filling stage	150	234	2.07	3.23
T_4	3 irrigations each at vegetative, flowering and capsule filling stage	221	312	2.62	3.70
T_5	3 irrigations each at vegetative, prebloom and capsule filling stage	171	312	1.97	3.60
T_6	4 irrigations each at vegetative, prebloom, flowering and capsule filling stage	248	390	2.39	3.75
T_7	4 irrigations each at vegetative, flowering, capsule initiation and capsule filling stage	254	390	2.50	3.84
T_8	5 irrigations each at vegetative, prebloom, flowering, capsule initiation and capsule filling stage	272.6	468	2.46	4.22
SEm ±		-	-	0.11	0.18
CD @ 5%		-	-	0.33	0.55
CV (%)		-	-	8.60	8.70



T_1:2 irrigations each at vegetative and flowering stages; T_2: 2 irrigations each at vegetative and capsule filling stages; T_3: 2 irrigations each at flowering and capsule filling stages; T_4: 3 irrigations each at vegetative, flowering and capsule filling stages; T_5: 3 irrigations each at vegetative, prebloom and capsule filling stages; T_6: 4 irrigations each at vegetative, prebloom, flowering and capsule filling stages; T_7: 4 irrigations each at vegetative, flowering, capsule initiation and capsule filling stages; T_8: 5 irrigations each at vegetative, prebloom, flowering, capsule initiation and capsule filling stages.

Fig. 2. Field water productivity (kg ha mm^{-1}) and crop water productivity (kg ha mm^{-1}) in sesame as influenced by deficit and optimum irrigation at various growth stages.

Plate 1. Performance of adequately irrigated treatment (T_8) and T_2.

CONCLUSION

It is experimentally confirmed that scheduling 5 irrigations each at vegetative, prebloom, flowering, capsule initiation and capsule filling stages along with one basal irrigation after sowing is recommended to attain higher yield parameters, yield and crop water productivity of *summer* sesame. At times of deficit water supply, scheduling of 3 irrigations each at vegetative, flowering and capsule filling stages is recommended to attain optimum economic yield of *summer* sesame with higher field water productivity.

FUTURE SCOPE

1. Study on varied levels of irrigation at different growth stages of sesame in cropping system approach need to be studied.
2. Performance of existing popular varieties of sesame under different irrigation regimes at various growth stages for their suitability in different agroclimatic zones.
3. Study on deficit and optimum irrigation and critical analyses of water use parameters in organically cultivated sesame.

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Conflict of Interest. The authors declare no conflict of interest.

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