ASSESSING THE SYNERGISTIC EFFECTS OF DEFICIT IRRIGATION AND GROWTH RETARDANTS ON INSITU SPROUTING AND QUALITY PARAMETERS OF GROUNDNUT VRI 8

Original Research Article

Abstract:

Background: Groundnut is a crucial oilseed crop cultivated year-round, with seed dormancy controlled by genetic and environmental factors. Preventing pre-harvest sprouting is essential, as it is a common issue. To study the effect of deficit irrigation management and foliar application of growth retardant chemicals on pre-harvest sprouting control efficiency to achieve higher yield of groundnut.

Methodology: In a field experiment conducted during early summer 2024 at the Agricultural College and Research Institute, Madurai, the effectiveness of different growth retardant chemicals and deficit irrigation management on reducing in-situ sprouting of groundnut kernels was investigated. The experiment included three irrigation management strategies: conventional irrigation and two deficit irrigation treatments where irrigation was withheld from 90 to 105 DAS (Days After Sowing) and 85 to 100 DAS. Additionally, foliar sprays of growth retardant chemicals were applied at 75 and 90 DAS. The chemicals tested were maleic hydrazide (MH) @ 1250 ppm, cycocel (CCC) @ 1000 ppm, abscisic acid (ABA) @ 750 ppm, and salicylic acid (SA) @ 750 ppm. Proper agronomic practices were followed throughout the crop growth cycle.

Results: Among the growth retardant chemicals tested, MH @ 1250 ppm proved effective in inducing dormancy. Withdrawal of irrigation from 90 to 105 DAS also significantly contributed to dormancy induction, extending dormancy by more than 5 days post-harvest as well as reduced the pod loss which significantly increased pod yield. It was because of the reduction in soil moisture content during harvest stage and alteration in the hormonal activities. Specifically, the combined treatment of foliar application of MH @ 1250 ppm and no irrigation from 90 to 105 DAS reduced germination percentage by 12.6%, 36.8% and 60.5% immediately 5, 10 and 15 days after harvest respectively.

Conclusion: The reduction in soil moisture content during the harvest stage, coupled with changes in hormonal activities, significantly impacts seed sprouting. These factors can lead to stress conditions that hinder germination, ultimately affecting crop yields. Addressing these issues is crucial for ensuring optimal seed development and enhancing agricultural productivity.

Keywords: Bunch type, dormancy, Groundnut, Growth inhibitor, Pre-harvest sprouting

Introduction

A major legume crop from South America, groundnut (*Arachishypogaea* L.) is a member of the Leguminosae family. Because of ideal agro-climatic conditions for groundnut growing, India has become the world's leading producer of groundnut, with an annual production of 10.2 m t and an average productivity rate of 2703 kg ha^{-1}, across a cultivated area of 6.01 million hectares (Indiastat, 2021-22). Groundnut is mostly grown during the *kharif* season under rainfed condition in India. It is also grown as an irrigated crop in several states throughout the *rabi* and spring seasons. Grown on 0.41 m ha of land in Tamil Nadu, it yields 1.02 m t of production annually with 2.50 t ha^{-1} of productivity annually (Pooniа*et al*., 2022).

Groundnut seeds are rich in oil (42–52%) and protein (22–30%). It also has a high concentration of calcium, magnesium, potassium, and phosphorus. Haulms of groundnuts are a healthy way to feed livestock. Compared to cereal fodder, they include higher amounts of proteins (8–15%), lipids (1-3%), minerals (9–17%), and carbs (38–45%) (Akshaya*et al*., 2022). Further, being leguminous, they help improve soil fertility and health by burying organic residues.

A popular choice among farmers, the VRI 8 groundnut variety has a high yield potential, early maturity, disease resistance, adaptability, consistent pod features, nutritional quality, stress tolerance, and simplicity of maintenance. Comparing VRI 8 to other groundnut cultivars, it is well known for having a comparatively high production potential with marketable bold seeded. When growing conditions are ideal and management techniques are followed, VRI 8 can yield an average of 2,000–3,000 kg ha^{-1} of pods (Vishnuprabha*et al*., 2023). The oil content of VRI 8 groundnut typically ranges from 45% to 50% of the weight of the kernel. The main issue with this bunch groundnut variety is thought to be the seeds are non- dormant in nature. In order to get out of this kind of situation, it is crucial to look for a way to induce seed dormancy in majority of bunch groundnut growing areas in order to preserve the crop and prevent field sprouting.

A crucial element in the commercial production of groundnuts is dormancy. It can be beneficial when dormancy prevents mature seeds from sprouting before harvest. But if dormancy lasts for a long time, it can cause problems and even make it difficult to grow a second crop right once after harvest (Kombiok*et al.*, 2012). Lack of dormancy in bunch types has been described as an inherent property of seeds. Due to the delay in harvesting, this issue becomes more apparent. It has been estimated that in situ germination in bunch type groundnut varieties can result in yield losses of 20–40% was concluded by Nautiyal, 2004. This investigation is about the non-conventional methods of inducing dormancy in bunch types to save the produce and to retain the seed quality. Deficit irrigation management during maturity stage (Tiwari *et al.*, 2019) and foliar application of different growth retarding chemicals (Jones *et al.*, 2018) has been successfully used.

With a focus on the PHS in groundnut, the current study attempts to ascertain how growth retardant treatment and deficit irrigation affect groundnut in-situ sprouting mitigation in this setting. Understanding the interplay between water management, hormonal regulation and crop physiology is crucial for developing resilient cultivation methods that enhance productivity while minimizing environmental impact.

Materials and methods:

The present investigation was conducted during early summer, 2024 in the Department of Agronomy, AC&RI, Madurai situated at 9˚ 96′ N latitude and 78˚ 20′ E longitude. Groundnut variety VRI 8 was grown in 3 x 4 m^2 plot with 30 x 10 cm spacing.

The experiment was laid in split plot design with three replications. Recommended cultivation method was adopted to raise the crop. The experiment included three irrigation management strategies: normal irrigation and two deficit irrigation treatments where irrigation was withheld from 90 to 105 DAS (Days After Sowing) and 85 to 100 DAS. Additionally, foliar sprays of growth retardant chemicalswere applied at 75 and 90 DAS. The chemicals tested were maleic hydrazide (MH) @ 1250 ppm, cycocel (CCC) @ 1000 ppm, abscisic acid (ABA) @ 750 ppm, and salicylic acid (SA) @ 750 ppm. Proper agronomic practices were followed throughout the crop growth cycle.

Irrigation practices

The experimental plots were irrigated immediately after sowing. Basically, groundnut crop require 10-12 irrigations.The life irrigation was given on 3 DAS to all the plots uniformly irrespective of irrigation scheduling treatment for the crop establishment and the following irrigations were given as per the requirements. The irrigations were stopped as per treatments to impose stress to the crops at 85 & 95 DAS in the selective treatmental plots in all the three replications.

Growth retardants application

Growth retardant chemicals, including maleic hydrazide at 1250 ppm, cycocel at 1000 ppm, abscisic acid at 750 ppm, and salicylic acid at 750 ppm, were systematically applied to groundnut crops during the critical maturity phase, specifically at 75 and 90 days after sowing (DAS). For uniform and effective distribution of these chemicals, a hand-operated knapsack sprayer equipped with a deflector-type nozzle was utilized, ensuring even coverage across the plants. To prepare the spray solutions, a precise method was employed: for 1 ppm concentration, 1 milligram of the respective chemical powder was thoroughly mixed in one liter of water. This meticulous preparation aimed to maximize the efficacy of the growth retardants, potentially enhancing physiological responses in the plants and improving overall yield.

Treatment details

MAIN PLOT

M_1 Irrigation as per the recommendation (Control)

M_2Withdrawal of irrigation from 90 to 105 DAS

M_3Withdrawal of irrigation from 85 to 100 DAS

SUB PLOT

S_1 No foliar application (Control)

S_2 Foliar application of Water at 75 & 90 DAS

S_3 Foliar application of Maleic Hydrazide @ 1250 ppm at 75 & 90 DAS

S_4 Foliar application of Cycocel @ 1000 ppm at 75 & 90 DAS

S_5 Foliar application of Abscisic acid @ 750 ppm at 75 & 90 DAS

S_6 Foliar application of Salicylic acid @ 750 ppm at 75 & 90 DAS

Observations: The parameters of number of single seeded pods plant^{-1}, number of double seeded pods plant^{-1}, total number of matured pods plant^{-1}, sprouting percentage (%), percentage pod loss (%), harvest index and quality parameters such as oil content (%) and protein content (%) were observed and presented in tables and figures.

No. of single-seeded pods plant^{-1}

The one-seeded pods plant^{-1}was counted at the time of harvest from five tagged plants at each plot. The average mean value was calculated and expressed as pods plant^{-1}.

No. of double-seeded pods plant^{-1}

The two-seeded pods plant^{-1}was counted at the time of harvest from five tagged plants at each plot. The average mean value was calculated and expressed as pods plant^{-1}.

Total no. of matured pods plant^{-1}

The total number of pods plant^{-1}was counted at the time of harvest from five tagged plants in each plot. The average mean value was computed.

Sprouting percentage

The number of sprouted kernels was counted in each replication from 1 DAH to 15 DAH, and sprouting percentage was calculated and expressed in percentage.

$$\text{Sprouting \%} = \frac{\text{Number of sprouted kernels plant}^{-1}}{\text{Total number of kerels plant}^{-1}} \times 100$$

Percentage pod loss

Percentage pod loss due to sprouting refers to the reduction in the quantity of kernels or pods because of sprouting.

$$\text{Percentage pod loss} = \frac{\text{Initial yield (kg ha}^{-1}\text{)} - \text{Post-sprouting yield (kg ha}^{-1}\text{)}}{\text{Initial yield (kg ha}^{-1}\text{)}} \times 100$$

Harvest Index

The ratio of yields of economic importance (Economic yield) to the biological yield in terms of dry matter was calculated as harvest index. The following formula was given by Yosidha*et al.*, (1971).

$$\text{Harvest Index} = \frac{\text{Economic yield (kg ha}^{-1}\text{)}}{\text{Biological yield (kg ha}^{-1}\text{)}}$$

Quality parameters

Oil content

For estimating the oil content, the kernels from each sample were dried in a hot air oven for 16 hrs and cooled down in a desiccator for half an hour. From this, about 5g kernels were ground in porcelain mortar and properly packed in a whatman No.1. Filter paper .After weighing (A) this was transferred to an extraction thimble. The thimble was then placed inside the soxhlet extractor to which sufficient quantity of petroleum ether solvent was added and heated for 6 hrs until 6 to 8 siphonings were completed. Then the filter paper packet was taken out and dried in a hot air oven maintained at $105^{o} \pm 2^{o}$C for 6hrs and cooled down in a desiccators for half an hour and weighed (B). The oil content was calculatedusing the following formula and expressed as percentage.

$$\text{Oil content (\%)} = \frac{A-B}{5} \times 100$$

Protein content

Kernel nitrogen content was estimated at a percent dry weight basis by the micro-Kjeldahl method (Humphries, 1956). The protein content was computed by multiplying the N content of kernels with the factor (6.25) and articulated as (%).

Statistical analysis

The data are subjected to statistical analysis by Analysis of Variance (ANOVA) using AGRES. Differences between mean values were statistically evaluated for significance using Least Significant Difference (LSD) at 1 or 5 per cent probability level as suggested by (Gomez and Gomez, 1984).

Results and discussion

Effect of deficit irrigation management and growth retardant chemicals application on the number of single and double seeded pods plant^{-1}

Deficit irrigation management and foliar application of growth retardant chemicals had influenced the number of single seeded and double seeded pods plant^{-1} significantly. The individual and the combination treatment effects were briefly shown in the table 1.Among all the main plot treatments, controlM_1 obtained the higher number of single seeded pods plant^{-1} with the value of 15.2 and the lower number of double seeded pods plant^{-1} with the value of 21.3. It was preceded by withdrawal of irrigation at 85 to 100 DAS (M_3) with the value of 14.0 single seeded pods and 28.6 double seeded pods. And the lower number of single seeded pods plant^{-1} as 23.9 and higher number of double seeded pods plant^{-1} as 31.9 were observed in withdrawal of irrigation at 90 to 105 DAS (M_2).Among all the foliar application of growth retardant chemicals,application of MH @ 1250 ppm at 75 and 90 DAS (S_3) had a notable effect and obtained the lowest number of single seeded pods plant^{-1} with 11.6 number of single seeded pods and the higher number of double seeded pods plant^{-1} with 32.8 number of double seeded pods. And the lower number of double seeded pods plant^{-1}(22.3) the higher number of single seeded pods plant^{-1} which was seen at control (S_1)(15.5).The interaction between deficit irrigation management and growth retardant chemicals application was established to be non significant. Previous research indicates that reduced soil moisture during the reproductive stage of groundnut leads to a significant changes in pod number due to stress, as noted by Rathod and Trivedi (2011). Additionally, it has been shown that the application of growth regulators can enhance the number of double seeded pods, demonstrating their efficacy in optimizing yield (Khan *et al.*, 2011).

Table 1. Effect of deficit irrigation management and foliar application of growth retardant chemicals on number single seeded pods plant^{-1} and number double seeded pods plant^{-1}

Treatment	Number single seeded pods plant^{-1}				Number double seeded pods plant^{-1}			
	M_1	**M_2**	**M_3**	**Mean**	**M_1**	**M_2**	**M_3**	**Mean**
S_1	17.2	14.1	15.2	**15.5**	15.9	27.2	23.8	**22.3**
S_2	16.9	13.3	15.2	**15.2**	13.4	27.4	29.5	**23.4**
S_3	12.9	10.0	11.8	**11.6**	29.3	38.7	30.3	**32.8**
S_4	14.9	12.9	14.2	**14.0**	22.9	31.4	29.2	**27.8**
S_5	13.5	10.9	13.0	**12.5**	26.4	36.8	30.5	**31.2**
S_6	15.7	13.6	14.6	**14.7**	19.8	29.6	28.5	**26.0**
Mean	**15.2**	**12.5**	**14.0**	**13.9**	**21.3**	**31.9**	**28.6**	**27.3**
	M	**S**	**M x S**	**S x M**	**M**	**S**	**M x S**	**S x M**
S. Ed	0.18	0.55	0.89	0.96	0.51	1.54	2.49	2.67

CD (p=0.05)	0.49	1.13	NS	NS	1.40	3.15	NS	NS

Total number of matured pods plant^{-1}

Deficit irrigation and foliar application of growth retardants had a significant impact on the total number of matured pods plant^{-1}, as summarized in Table 2. Among the irrigation treatments, the control (M_1) produced the lowest number of matured pods at 15.9, followed by irrigation withdrawal from 85 to 100 DAS (M_3) with 18.1matured pods. The highestmatured pod count was recorded withirrigation withdrawal from 90 to 105 days after sowing (DAS) (M_2), which yielded 23.4matured pods.Regarding growth retardants, maleic hydrazide applied at 75 and 90 DAS (S_3) resulted in the highest matured pod count of 24.9, followed by abscisic acid (S5) with 23.9 pods. The control (S_1), with no growth retardant application, had the lowest pod count of 13.5.The interaction between irrigation and growth retardants showed that the combination of no irrigation from 90 to 105 DAS and maleic hydrazide application at 75 and 90 DAS (M_2S_3) resulted in the highest number of matured pods as32.2. This was followed by no irrigation from 90 to 105 DAS with abscisic acid application (M_2S_5), yielding 30.8 matured pods. The lowest was observed with the combination of conventional irrigation and no foliar spray (M_1S_1), which resulted in only 9.44 matured pods per plant.These previous findings highlight that reduced soil moisture at the reproductive stage of groundnut decreases pod number due to imposed stress, as supported by previous research (Arunkumar*et al.*, 2017). Additionally, previous studies have confirmed that applying growth regulators can increase numbers of matured pods, underscoring their effectiveness in optimizing yield (Behera*et al.*, 2017).

Table 2. Effect of deficit irrigation management and foliar application of growth retardant chemicals on total number matured pods plant^{-1}

Treatment	M1	M2	M3	Mean
S1	9.44	17.5	13.5	13.5
S2	11.8	18.2	14.4	14.8

S3	21.6	32.2	20.8	24.9
S4	15.9	21.1	17.8	18.3
S5	22.0	30.8	18.8	23.9
S6	14.7	20.4	23.3	19.5
Mean	15.9	23.4	18.1	**19.1**
	M	**S**	**M x S**	**S x M**
S. Ed	0.76	0.88	1.59	1.53
CD (p=0.05)	2.12	1.81	3.52	3.13

Sprouting percentage

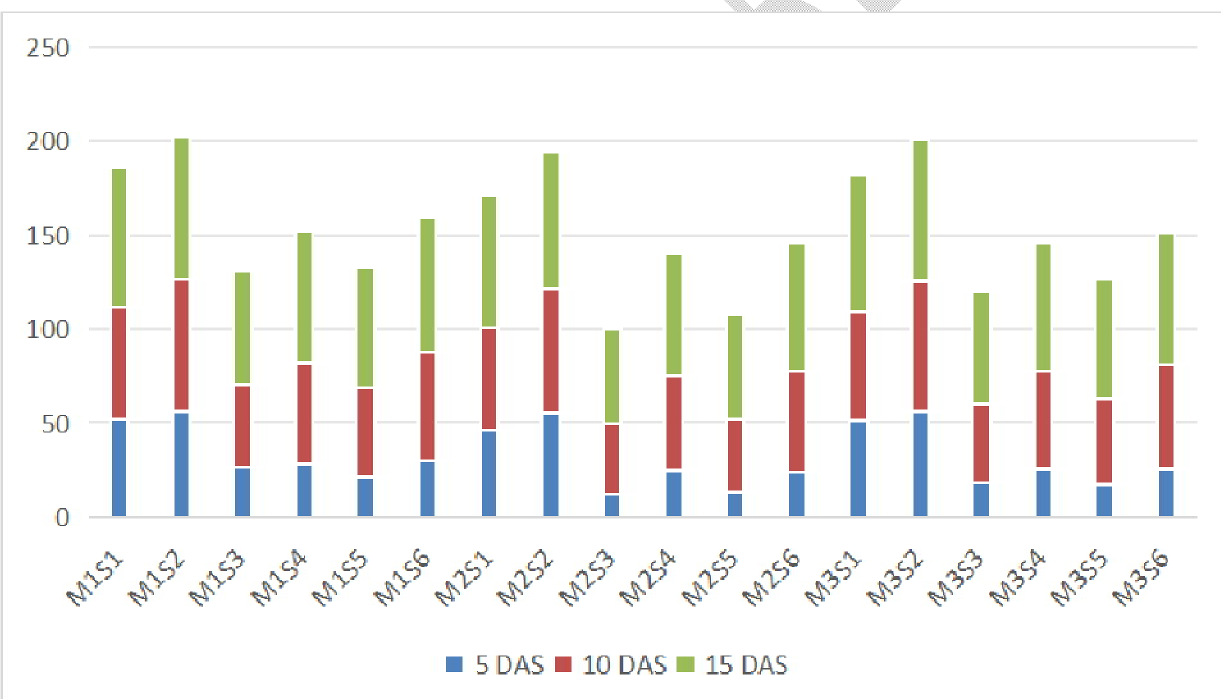
The data of percentage of sprouting pods on 5, 10 and 15 days after actual date of harvest were collected and analyzed. It indicated significant difference among the main and sub plot treatments as well as the interaction effects (Table 3). Among the irrigation management practices, significantly higher sprouting percentage was recorded in control (M_1) as 34.7%, 55.1%, 69.8% on 5, 10 and 15 days after harvest respectively followed by withdrawal of irrigation from 85 to 100 days after sowing (M_3) (32.2%, 53.8% and 68.0%) and withdrawal of irrigation from 90 to 105 days after sowing (M_2) (29.2%, 50.0% and 63.8%). Previous studies show that, high moisture content during maturity stage or at the time of harvest increase the sprouting percentage of groundnut pods (Singh *et al.*, 2013, Sezen*et al.*, 2019 and Rowland *et al.*, 2012). They confirmed that the effect of deficit irrigation on root development in mitigating sprouting risks under water limited condition. In terms of foliar application of growth retardant chemicals, the sprouting percentages varied significantly. The values ranged from higher as

Table 3. Effect of deficit irrigation management and foliar application of growth retardants on different intervals on sprouting percentage of groundnut

	Days after actual harvest date											
	5				10				15			
Treatment	**M1**	**M2**	**M3**	**Mean**	**M1**	**M2**	**M3**	**Mean**	**M1**	**M2**	**M3**	**Mean**
S1	52.0	45.8	50.8	49.5	59.8	54.6	58.0	57.4	74.5	71.0	72.8	72.8
S2	56.5	55.5	56.3	56.1	69.7	66.0	69.5	68.4	76.7	72.5	75.0	74.7
S3	26.4	12.6	17.8	16.9	43.5	36.8	42.8	41.0	60.5	50.8	59.0	56.8
S4	28.2	24.9	25.5	26.2	53.5	50.0	51.8	51.8	70.5	65.8	68.0	68.1
S5	21.7	12.7	17.5	17.3	46.6	39.5	45.5	43.8	64.5	54.9	63.3	60.9
S6	29.7	24.2	25.5	26.5	57.7	53.5	55.6	55.6	72.3	67.9	70.2	70.1
Mean	34.8	29.2	32.2	**32.1**	55.1	50.1	53.8	**53.0**	69.8	63.8	68.0	**67.2**
	M	**S**	**M x S**	**S x M**	**M**	**S**	**M x S**	**S x M**	**M**	**S**	**M x S**	**S x M**
S. Ed	0.46	0.80	1.34	1.38	0.29	0.52	0.89	0.92	0.53	0.95	1.60	1.65
CD (p=0.05)	1.27	1.63	2.86	2.82	0.80	1.09	1.89	1.88	1.48	1.95	3.40	3.38

56.1%, 68.4% and 74.7% with the distilled water spray treatment (S_2) to lower sprouting percentages as 16.9%, 41.0% and 56.7% with the application of maleic hydrazide at 75 & 90 DAS (S_3). From the data it is evident that, the sprouting percentages were significantly influenced by concentration of maleic hydrazide and confirmed by previous researches (Kumar *et al*., 2010 and Reddy *et al.*, 2015). The interaction effects between irrigation management and foliar application of growth retardants further highlighted significant variations in germination percentages. Conventional irrigation with distilled water spray (M_1S_2) recorded higher percentage of sprouting as 56.5%, 69.6% and 76.7%. This sprouting percentage has declined to an impressive range as 12.5%, 36.7% and 50.7% in the combination of withdrawal of irrigation from 90 to 105 DAS with MH application at 75 & 90 DAS (M_2S_3) (Figure 1).

Figure 1. Effect of deficit irrigation management and foliar application of growth retardants on different intervals on sprouting percentage of groundnut



Percentage pod loss

The analysis of the percentage pod loss revealed significant differences among both main plot and subplot treatments, as well as their interactions (Table 4). Among the irrigation management practices, the control treatment (M_1) exhibited the highest percentage pod loss

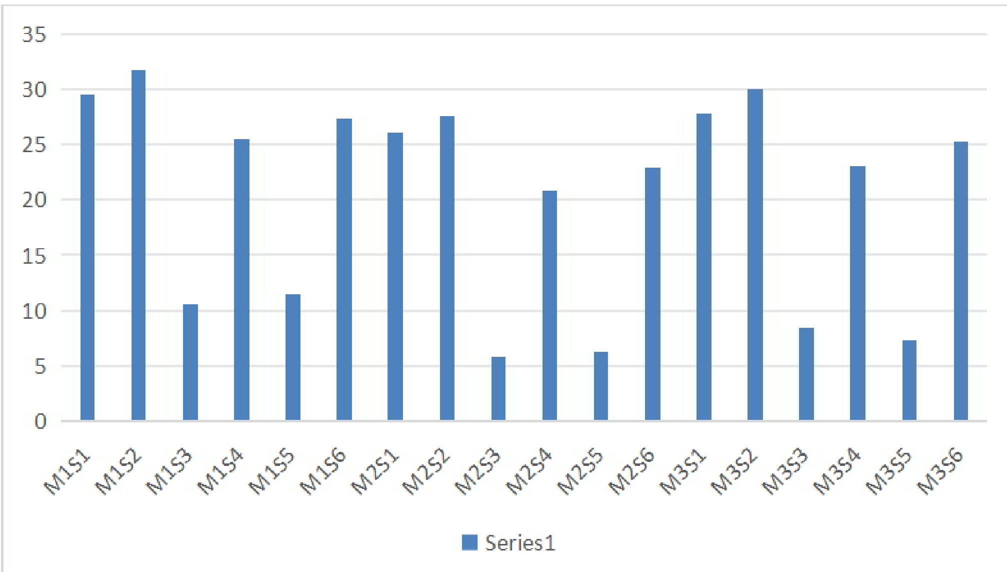
(22.6), followed by the withdrawal of irrigation from 85 to 100 days after sowing (M_3) (20.3), and then the withdrawal of irrigation from 90 to 105 days after sowing (M_2) (18.2). The percentage of pod loss varied significantly depending on the foliar application of growth retardant chemicals. The percentages varied from 27.7% with the control (S_1) to 8.2% with the use of maleic hydrazide at 75 & 90 DAS (S_3). The interaction effects of irrigation management and foliar spray treatments revealed additional variations in percentage pod loss, with values ranging from 31.6% in the combination of conventional irrigation with distilled water spray (M_1S_2) to an astounding 5.75% in the combination of irrigation withdrawal from 90 to 105 DAS and maleic hydrazide spraying at 75 & 90 DAS (M_2S_3) (Figure 2). As Zuza*et al.* (2017) pointed out, heavy rainfall during harvest stage has been linked to a high incidence of groundnut pod germination which leads to the pod loss up to 40 % in the field itself. As well as 20–50% of pods have been shown to be lossed due to the high soil moisture during maturity stage (Finch-Savage and Leubner-Metzger, 2006). The research evidence showed that, the decline in pod loss due to dormancy induction through the application of MH at 60 and 90 DAS demonstrating the effectiveness of maleic hydrazide (Gowda *et al.*, 2015 and Gadhave*et al.*, 2017).

Table 4. Effect of deficit irrigation management and foliar application of growth retardants on different intervals on percentage pod loss of groundnut

Treatment	M1	M2	M3	Mean
S1	29.5	26.0	27.8	27.8
S2	31.7	27.5	30.0	29.7
S3	10.5	5.8	8.4	8.2
S4	25.5	20.8	23.0	23.1
S5	11.5	6.2	7.3	8.3
S6	27.3	22.9	25.2	25.1
Mean	22.7	18.2	20.3	**20.4**

	M	S	M x S	S x M
S. Ed	0.10	0.19	0.31	0.32
CD (p=0.05)	0.28	0.38	0.66	0.65

Figure 2. Effect of deficit irrigation management and foliar application of growth retardants on different intervals on percentage pod loss of groundnut



Harvest index

The analysis of variance revealed significant variations in harvest index among groundnut crops, attributable to the individual effects of main and subplot treatments, as well as their interaction effects. These results are detailed in Table 5.Among the irrigation management practices, the highest harvest index was observed with the withdrawal of irrigation from 90 to 105 days after sowing DAS (M_2), with the value of 0.35. This was followed by the withdrawal of irrigation from 85 to 100 DAS (M_3), producing 0.31. In contrast, conventional irrigation (M_1) resulted in the lowest harvest index of 0.29.Regarding foliar application of growth retardant chemicals, harvest index varied significantly. The application of MH at 1250 ppm at 75 and 90

DAS (S_3) achieved a significantly higher harvest index of 0.37, which was followed by the harvest index obtained from the application of Abscisic Acid (S_5), with the value of 0.33. The control treatment (S_1) recorded lower HI at 0.28.The interaction between irrigation management and foliar application treatments further highlighted substantial differences in harvest index. The highest harvest index of 0.42 was achieved with the combination of irrigation withdrawal from 90 to 105 DAS and the application of MH (M_2S_3), a yield statistically comparable to that of the combination of the same irrigation withdrawal period and the application of Abscisic Acid (M_2S_5), with the value of 0.37. Conversely, the combination of conventional irrigation and no foliar application (M_1S_1) resulted in the lowest harvest index of 0.26.Research has shown that groundnut harvest index increases with reduced moisture regimes, suggesting improved crop performance with deficit irrigation (Ramakrishna *et al.*, 2006). They suggested that reduced irrigation water application led to increased consumptive use, which improved harvest index by imposing stress. Yogendrakumar*et al.*, 2014, evaluated the performance of plant growth retardants on groundnut and revealed that two foliar sprays of growth retardant chemicals achieved higher harvest index and it was statistically superior over control and water sprays.

Table 5. Effect of deficit irrigation management and foliar application of growth retardant chemicals on harvest index

Treatment	Harvest Index			
	M_1	**M_2**	**M_3**	**Mean**
S_1	0.26	0.30	0.28	**0.28**
S_2	0.26	0.29	0.27	**0.27**
S_3	0.33	0.42	0.35	**0.36**
S_4	0.29	0.36	0.33	**0.32**
S_5	0.30	0.37	0.31	**0.33**

S_6	0.29	0.36	0.31	**0.32**
Mean	**0.29**	**0.35**	**0.31**	**0.32**
	M	**S**	**M x S**	**S x M**
S. Ed	0.01	0.01	0.01	0.01
CD (p=0.05)	0.01	0.02	0.03	0.03

Quality parameters

Oil content

The oil content is an important quality parameter of groundnut and it showed significant variation due to deficit irrigation management and growth retardant chemicals application (Table 6). With regards to the deficit irrigation management, significantly the highest oil content of 45.3 % was measured with withdrawal of irrigation from 90 to 105 DAS (M_2) followed by withdrawal of irrigation from 85 to 100 DAS (M_3) with 43.4 % of oil content which is on par with M_2. Control (M_1) (Conventional irrigation) produced plants with lower oil content (41.6 %). Among the foliar application of growth retardant chemicals, higher oil content (47.4 %) was recorded with foliar application of MH @ 1250 ppm at 75 & 90 DAS (S_3) and it was followed by foliar application of ABA @ 750 ppm at 75 & 90 DAS (S_5) with the value of 46.3 % and lowest oil content of 40.3 % was documented with the control (S_1) (Figure 3). The interaction between deficit irrigation management and growth retardant chemicals application was established to be non significant.

Protein content

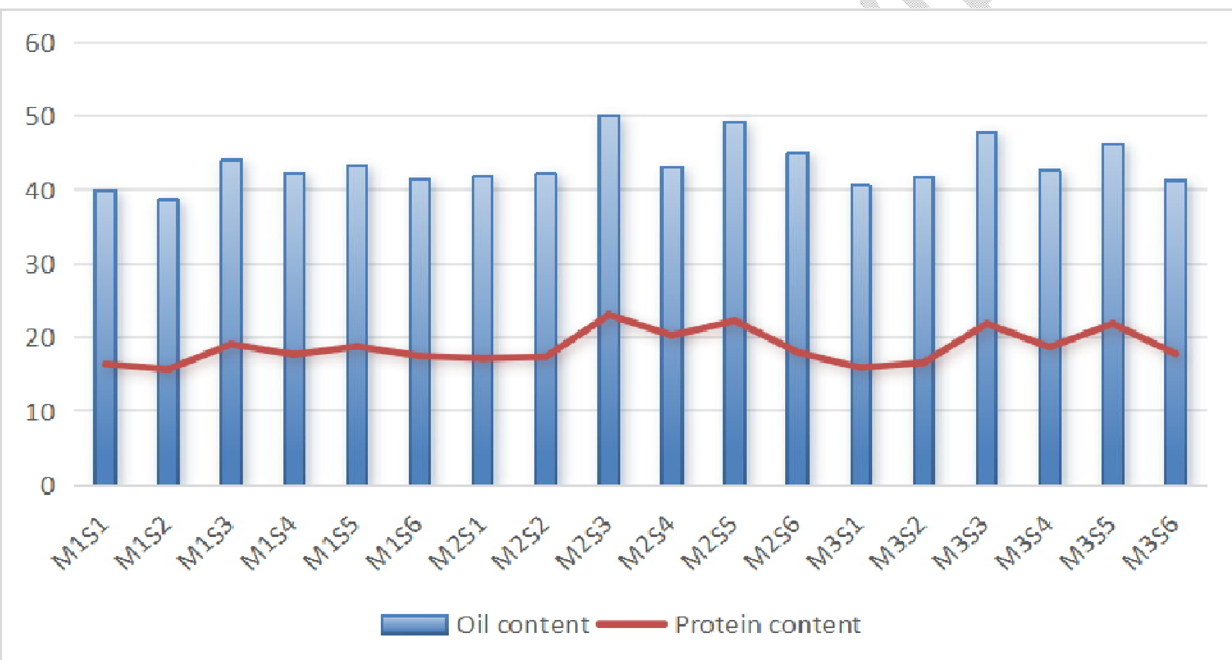
The protein content is also an important quality parameter and it exhibited significant difference among the deficit irrigation management and growth retardant chemicals application tested in the present study (Table 6). With regards to the deficit irrigation management the highest protein content (19.7 %) was recorded in the withdrawal of irrigation from 90 to 105 DAS (M_2). Withdrawal of irrigation from 85 to 100 DAS (M_3) is on par with 18.8 % of protein content. The plants raised with conventional irrigation (M_1) registered lesser protein content (17.5 %). A significant difference was observed in the protein content of groundnut due to growth retardants application. The higher protein content of 21.4 % was recorded in foliar application of MH @ 1250 ppm at 75 & 90 DAS (S_3). It was followed by foliar application of ABA @ 750 ppm at 75 & 90 DAS (S_5) and on par with S_3 with the value of 21.0 % and the least protein content (16.3 %) was recorded with No spray (Control) (S_1) (Figure 3). Interaction effect was found to be non significant on protein content in groundnut kernels. Total oil and total protein were affected by end-of-season drought. This increase was progressive, corresponding to the intensity of water deficit. Differences in oil and protein content became significant only under moderate to intense water deficit (Dwivedi*et al.*, 1996). Both oil and protein content was slightly increased because of foliar spray of chemicals was reported by Poonguzhali and Kanagarasu, 2016.

Table 6. Effect of deficit irrigation management and foliar application of growth retardant chemicals on oil content and protein content of groundnut

Treatment	Oil content (%)				Protein content (%)			
	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean
S_1	39.9	41.8	40.6	40.3	16.4	17.2	15.9	16.3
S_2	38.6	42.2	41.7	41.3	15.7	17.4	16.6	16.8
S_3	44.1	50.1	47.9	47.4	19.1	23.1	21.9	21.4
S_4	42.3	43.1	42.7	42.7	17.7	20.3	18.7	18.9
S_5	43.2	49.3	46.3	46.3	18.8	22.3	21.9	21.0
S_6	41.5	45.0	41.3	42.6	17.5	18.0	17.8	17.8
Mean	41.6	45.2	43.4	43.4	17.5	19.7	18.8	18.7

	M	S	M x S	S x M	M	S	M x S	S x M
S. Ed	0.90	1.59	2.68	2.77	0.41	1.56	2.50	2.70
CD (p=0.05)	2.49	3.26	NS	NS	1.15	3.18	NS	NS

Figure 3. Effect of deficit irrigation management and foliar application of growth retardant chemicals on oil content and protein content of groundnut



Summary and conclusion

The present investigation was conducted during summer, 2024 at Agricultural college ad Research Institute, Madurai to study the impact deficit irrigationmanagement and foliar application of growth retardant chemicals induced dormancy on yield and yield attributes of groundnut. The experiment was laid in Split plot with three different irrigation management, six treatments with growth retardant chemicals and three replications. On the other hand, significant variations among the treatments were observed in number of single seeded pods plant^{-1}, number of double seeded pods plant^{-1}, total number of matured pods plant^{-1}, sprouting percentage (%),

percentage pod loss (%), harvest index and quality parameters such as oil and protein content (%). Among the irrigation management practices, withdrawal of irrigation from 90 to 105 days after sowing combined with foliar application of MH @ 1250 ppm at 75 and 90DAS (M_2S_3) recorded the lowest sprouting percentage, percentage pod loss with highest oil and protein content than other treatment plots. In the present investigation, it is apparent that foliar application of dormancy inducing chemical i.e, MH @ 1250 ppm at 75 and 90DAS combined with withdrawal of irrigation from 90 to 105 days after sowing enhanced pod yield by reducing the pod loss by means of *insitu* sprouting.

Research content: Formulated based on the advancement of technologies on pre-harvest sprouting control

Data availability:

- All data generated or analysed during this study are included in this published article.
- The datasets used and/or analysed during the current study are available from the corresponding author upon reasonable request.

Disclaimer (Artificial intelligence)

Option 1:

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

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