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Studies on the Effect of Seed Hardening and Clipping Management over different Sowing Window of Sesame at Karaikal Region

Sinouvassane Aruna*, A. L. Narayanan, S. Mala and S. Nadaradjan

Department of Agronomy, PAJANCOA & RI, Karaikal - 609 603, India

**Corresponding author*

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A B S T R A C T

A field experiment was conducted at Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal to identify a suitable sowing window along with efficient seed hardening and clipping practices in sesame during summer season of 2021 for Karaikal region. The experiment was laid out under Factorial concept of Randomized Block Design (FRBD) with twelve treatments and three replications. The treatments consisted of three factors *viz.*, date of sowing [15th February (D1), 22nd February (D2), 1st March (D3)], seed hardening [without seed hardening (S1) and seed hardening with two per cent moringa leaf extract (S2)] and clipping practices [without clipping (C1) and with clipping (C2)]. The earlier sowing on 15th February along with two per cent MLE seed hardening followed by clipping practices recorded higher growth parameters (plant height, leaf area index, dry matter production, number of branches plant^{-1}) and yield parameters (number of capsules plant^{-1}, number of seeds capsule^{-1}, capsule weight, seed weight plant^{-1}, test weight, seed yield [726 kg ha^{-1}] and stover yield). However, the growth and yield parameters reduced with delayed sowings (22nd February, 1st March). The correlation between weather parameters and seed yield revealed that the total bright sunshine hours, mean morning relative humidity, mean evening relative humidity and HUE during the total life span had a significant positive relationship with the seed yield, whereas the regression studies denoted that the seed yield was positively influenced by mean evening relative humidity, GDD and PTU. Therefore, sowing TMV-7 sesame variety on 15th February along with two per cent MLE seed hardening followed by clipping practices could be appropriate for maximizing yield and monetary returns from summer sesame under irrigated conditions in Karaikal region.

Introduction

Sesame (*Sesamum indicum* L.) is the oldest indigenous oilseed crop which belongs to the family *Pedaliaceae* and is a short-day plant with longest history of cultivation in India. It is one of the most important oil seed crops grown in the tropical and subtropical areas of the world. Indian people use both the oil and seeds of sesame for traditional cooking methods, religious rituals, ayurvedic medicine and topically for skin nourishment. The main reasons for low productivity of sesame are its rainfed cultivation in marginal and sub-marginal lands under poor management and input starved conditions. A well-managed crop of sesame can yield 1200 - 1500 kg ha^{-1} under irrigated and 800 - 1000 kg ha^{-1} under rainfed conditions. While, in Tamil Nadu, the area under sesame was 0.446 lakh hectares with the production of 0.244 lakh tonnes and productivity of 548 kg ha^{-1} in 2019-20 (Department of Economics and Statistics 2019-20, Government of Tamil Nadu). Agricultural production and productivity of any region is being regulated by the prevailing climate of that area through temperature, rainfall, radiation etc., The importance of temperature and humidity in enhancing plant nutrient availability and absorption is pronounced and also play a role in disease and pest infestation. Yield decreases progressively with the delay in sowing from optimum time (Cane, 1949) and also the grain yield of sesame is significantly influenced by sowing dates (Rahman *et al.*, 1994). Early sowing of sesame in any season can contribute to increased seed yield but sensitivity to lower temperatures at germination and seedling stages results in lower percentage and/or speed of emergence and poor stand establishment (Greaves, 1996). Delayed sowing exposes the crop to high temperature during flowering, severely affecting pod filling and yield. The performance of summer sesame can be improved by sowing at optimum dates to avoid extreme temperature stress. Uniform emergence and rapid growth are very important prerequisites to increase yield, quality and ultimately profits in annual crop production. Seed hardening is commonly used to reduce the time between seed sowing and seedling emergence (Parera and Cantliffe, 1994) and is one of the methods which shows its effectiveness in improving seed germination, seedling growth and crop stand against the negative impacts brought about by stress in the field. Among the different natural resources used, extracts of plants and their endogenous growth regulators like *Moringa oleifera* L. are gaining a lot of attraction as they have high plant growth promoting capabilities and often applied as exogenous plant growth enhancers (Foidl *et al.*, 2001). Clipping means removal or to clip off terminal bud which activates the dormant lateral buds to produce a greater number of branches. The terminal clipping arrests the vertical growth of the plant which leads to greater chances for development of source to sink feature relationship in sesame. Hence the present investigation was undertaken to identify a suitable sowing window along with efficient seed hardening and clipping practices in sesame for Karaikal region during summer.

Materials and Methods

Study Area

A field experiment was conducted at Agronomy farm of Department of Agronomy at Pandit Jawaharlal Nehru College of Agriculture and Research Institute (PAJANCOA & RI) Karaikal, Union Territory of Puducherry, India, during summer season from February to May, 2021 to identify the optimum dates of sowing and effect of seed hardening along with clipping practices on dry matter production (DMP) and yield of sesame at Karaikal region.

Karaikal is a tropical climate and receives a normal rainfall of 1437 mm in a year with an average maximum and minimum temperature of 35.8 and 26.4ºC, respectively. The experiment was laid out in a Randomized Block Design under Factorial concept and the treatments consist three dates of sowing *viz.*, 15th February (D1), 22nd February (D2), and 1st March (D3) along with two seed hardening [without seed hardening (S1) and seed hardening with two per cent moringa leaf extract (S2)] and clipping practices [without clipping (C1) and with clipping (C2)] were used for the experimental studies and the treatments were replicated thrice.

The seeds were sown continuously in the furrow on 15th February, 22nd February and 1st March as per the treatment schedule by adopting a spacing of 30 x 30 cm in the well prepared field. Irrigation was immediately given after sowing. Recommended fertilizer (35:23:23 N P2O5 K2O) was applied. Biometric observations were recorded in each plot. Initially five plants were selected and tagged at random in the net plot area for recording the biometric observations at various growth phases *viz.*, vegetative, reproductive and maturity phase and the yield attributes were recorded at the time of harvest.

Recording of Meteorological data

Meteorological data was obtained from the meteorological observatory of PAJANCOA&RI, Karaikal for various phenophases *viz.*, vegetative, reproductive and maturity phases of the respective treatments to study their influence on sesame growth and yield.

The Agro-meteorological indices like Growing Degree Day (GDD), Relative Temperature Disparity (RTD), Relative Humidity Disparity (RHD), Helio Thermal Units (HTU), Photo Thermal Units (PTU), Heat Unit Efficiency (HUE), Diurnal Variation Temperature (DVT) was calculated using the respective formulas.

Results and Discussion

Effect of weather parameters on growth attributes of sesame

From the experimental results, it was observed that the crop sown on 15th February (D1) recorded higher plant height, number of primary and secondary branches plant^{-1} and more leaf area index and Dry matter production during all the three phases. This may be due to the result of progressing trend of maximum and minimum temperature during the three phenophases in the first sown crop (15th February) which shall speed up a lot of plant physiological processes like enzymatic rates, diffusion and transport (Bruhn, 2002). However, the delayed sowings [22nd February (D2) and 1st March (D3)] recorded comparatively higher maximum and minimum temperature to early sowing (15th February). The higher dry matter accumulation (table 1) in early sowing (D1) would be as a consequence of stomatal conductance due to optimal rising temperature at every periodical growth stage which might have resulted in higher rate of cell division, cell elongation, accumulation of photosynthates and their higher mobilization from various plant parts. This is in confirmation with the findings of Chongdar *et al.,* (2015).

The reduction in total dry matter accumulation and its allocation to various plant parts under delayed sowing could be attributed to unfavourable higher temperature which may resulted in higher growth and yield attributes compared to other dates of sowing. The HTU and HUE (table 4 and 5) were slightly higher with the crop sown on 15th February and also influenced positively for the dry matter production which resulted in better growth attributes of sesame and this shows that the crop utilized the heat efficiently. Similar finding in rice was observed by Khavse *et al.,* (2015).

Effect of weather parameters on seed yield and stover yield

The 15th February sown crop produced higher yield attributes, seed yield (table 2) and stover yield (table 3) than that of minimum by 22nd February and 1st March. It might be attributed due to the fact that when the crop was sown late, there was a high temperature in beginning (vegetative phase) and the plants do not get sufficient favourable environment to express their full potentiality. Such observations were also reported by Patra (2001) and Ali *et al.,* (2005). In the delayed sowings (D2 and D3) yield decreased with increase in thermal heat unit availability up to certain level for establishment and vegetative stages. This indicated that these two stages require lower thermal heat units and that the vegetative stage was found to be most sensitive followed by reproductive stage. Increased growing degree days over normal will shorten the vegetative and reproductive stages as reported by Langham (2007).

Table.1 Effect of date of sowing, seed hardening, clipping practices and their interaction effect on dry matter production (kg ha^{-1}) of sesame at various growth stages

TREATMENTS	30 DAS	60 DAS	At harvest
Date of sowing (D)			
D1(15th Feb)	342.7	2570.4	**3804.0**
D2 (22nd Feb)	332.6	2123.1	**3256.3**
D3 (1st Mar)	124.3	1580.8	**3120.5**
S Ed	42.28	185.50	**295.71**
CD (p=0.05)	87.52	383.99	**NS**
Seed hardening (S)			
S1 (Non-hardened seeds)	195.7	1892.5	**3287.3**
S2 (hardened seeds)	337.3	2290.4	**3499.9**
S Ed	34.52	151.46	**241.44**
CD (p=0.05)	71.46	313.52	**NS**
Clipping practices (C)			
C1 (without clipping)	266.2	1856.6	**3221.6**
C2 (with clipping)	266.8	2326.3	**3565.6**
S Ed	34.52	151.46	**241.44**
CD (p=0.05)	NS	313.5	**NS**
D x S			
S Ed	59.79	262.34	**418.19**
CD (p=0.05)	NS	NS	**NS**
D x C			
S Ed	59.79	262.34	**418.19**
CD (p=0.05)	NS	NS	**NS**
S x C			
S Ed	48.82	214.20	**341.45**
CD (p=0.05)	NS	NS	**NS**
D x S x C			
S Ed	84.56	371.01	**591.41**
CD (p=0.05)	NS	NS	**NS**

***Mean values of non-significant interactions have not been represented in this table**

Table.2 Effect of date of sowing, seed hardening and clipping practices on seed yield (kg ha^{-1}) of sesame at harvest

Treatments	At harvest
Date of sowing (D)	
D1 (15th Feb)	725.9
D2 (22nd Feb)	504.1
D3 (1st Mar)	251.7
S Ed	49.79
CD (p=0.05)	103.07
Seed hardening (S)	
S1(Non-hardened seeds)	475.8
S2(hardened seeds)	511.9
S Ed	40.66
CD (p=0.05)	NS
Clipping practices (C)	
C1 (without clipping)	442.9
C2 (with clipping)	544.9
S Ed	40.66
CD (p=0.05)	84.16

Table.2a Interaction effect of date of sowing, seed hardening and clipping practices on seed yield (kg ha^{-1}) of sesame at harvest

D x S	At harvest
D1S1	704.7
D1S2	747.0
D2S1	615.0
D2S2	393.1
D3S1	216.1
D3S2	287.4
S Ed	70.42
CD (p=0.05)	145.77
S x C	At harvest
S1C1	520.4
S1C2	503.4
S2C1	365.3
S2C2	586.3
S Ed	57.50
CD (p=0.05)	119.02
D x C	
S Ed	70.42
CD (p=0.05)	NS
D x S x C	
S Ed	99.59
CD (p=0.05)	NS

*Mean values of non-significant interactions have notbeen represented in this table

Table.3 Effect of date of sowing, seed hardening, clipping practices and their interaction effect on stover yield (kg ha^{-1}) and harvest index of sesame at harvest*

Treatments	Stover yield (kg ha^{-1})	Harvest Index
Date of sowing (D)		
D1 (15th Feb)	1524.5	**0.3**
D2 (22nd Feb)	1096.2	**0.3**
D3 (1st Mar)	873.3	**0.2**
S Ed	206.19	**0.03**
CD (p=0.05)	426.82	**0.06**
Seed hardening (S)		
S1 (Non-hardened seeds)	1051.6	**0.3**
S2 (hardened seeds)	1277.7	**0.3**
S Ed	168.35	**0.02**
CD (p=0.05)	NS	**0.05**
Clipping practices (C)		
C1 (without clipping)	1144.2	**0.3**
C2 (with clipping)	1185.1	**0.3**
S Ed	168.35	**0.02**
CD (p=0.05)	NS	**0.05**
D x S		
S Ed	291.60	**0.04**
CD (p=0.05)	NS	**NS**
D x C		
S Ed	291.60	**0.04**
CD (p=0.05)	NS	**NS**
S x C		
S Ed	238.09	**0.03**
CD (p=0.05)	NS	**NS**
D x S x C		
S Ed	412.38	**0.06**
CD (p=0.05)	NS	**NS**

***Mean values of non-significant interactions have not been represented in this table**

Table.4 Total Helio Thermal Unit (HTU) (°C days hr) prevailed at various phenophases of sesame*

Treatments	D1 (15th Feb)	D2 (22nd Feb)	D3 (1st Mar)	Mean
Non-hardened seeds without clipping (S1C1)				
Vegetative	4444.5	4529.7	4219.8	**4398.0**
Reproductive	7062.3	7211.7	8415.7	**7563.2**
Maturity	2872.2	2694.5	1992.6	**2519.8**
Total life span	14381.0	14435.9	14628.0	**14481.6**
Non-hardened seeds with clipping (S1C2)				
Vegetative	4113.8	4361.0	4045.6	**4173.5**
Reproductive	7051.3	7583.9	8344.9	**7660.0**
Maturity	3039.6	2499.5	1763.3	**2434.1**
Total life span	14204.7	14444.4	14153.8	**14267.6**
Hardened seeds without clipping (S2C1)				
Vegetative	4113.8	4361.0	4397.4	**4290.7**
Reproductive	6735.4	7583.9	8061.7	**7460.3**
Maturity	3286.9	2261.0	1935.0	**2494.3**
Total life span	14136.2	14205.8	14394.0	**14245.3**
Hardened seeds with clipping (S2C2)				
Vegetative	4282.6	4361.0	4219.8	**4287.8**
Reproductive	6694.0	7280.2	7811.9	**7262.0**
Maturity	3228.1	2774.2	1786.4	**2596.2**
Total life span	14204.7	14415.3	13818.0	**14146.0**
***Data statistically not analysed**				

Table.5 Total Heat Unit Efficiency (HUE) ($gm^{-2}day^{-1}$) prevailed at various phenophases of sesame*

Treatments	D1 (15th Feb)	D2 (22nd Feb)	D3 (1st Mar)	Mean
Non-hardened seeds without clipping (S1C1)				
Vegetative	0.05	0.04	0.01	**0.03**
Reproductive	0.24	0.19	0.13	**0.19**
Maturity	0.90	0.80	1.19	**0.96**
Total life span	0.31	0.27	0.28	**0.29**
Non-hardened seeds with clipping (S1C2)				
Vegetative	0.06	0.05	0.03	**0.05**
Reproductive	0.33	0.23	0.14	**0.23**
Maturity	1.10	0.95	1.05	**1.03**
Total life span	0.42	0.32	0.27	**0.34**
Hardened seeds without clipping (S2C1				
Vegetative	0.09	0.10	0.03	**0.07**
Reproductive	0.28	0.23	0.17	**0.23**
Maturity	1.07	1.23	0.80	**1.03**
Total life span	0.40	0.36	0.24	**0.3**
Hardened seeds with clipping (S2C2)				
Vegetative	0.08	0.09	0.03	**0.07**
Reproductive	0.39	0.29	0.21	**0.30**
Maturity	1.09	1.08	1.08	**1.08**
Total life span	0.45	0.39	0.31	**0.38**
***Data statistically not analysed**				

The derived weather parameters like HTU and HUE (table 4 and 5) were higher during this period, however GDD, RTD and HTU were found to have a positive influence over the production of dry matter. This fact well agrees with the result obtained by Padmalatha *et al.*, (2006) that pod growth rate and pod yield were significantly positively correlated with heat unit efficiency in groundnut due to better metabolic activity. Also, optimum sowing window leads to better conversion of light into dry matter for higher yield component as evidenced by Khavse *et al.*, (2015) in rice. Also, in addition to this, the seed yield recorded by 15th February sown crop recorded higher seed yield which was 31 and 65 per cent higher than 22nd February and 1st March sown crops, respectively.

Sowing of sesame on 15th February involving seed hardening with two per cent moringa leaf extract along with clipping practices shall be one of the best economically viable options for the farming community to achieve higher yield in irrigated sesame during summer season for improving the sesame productivity in Karaikal region.

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