Int.J.Curr.Microbiol.App.Sci (2018) *7*(9): 3321-3328

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 7 Number 09 (2018)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2018.709.412

Studies on Flowering Pattern in Relation to Seed Filling and Seed Multiplication Rate in Groundnut (*Arachis hypogaea* L.)

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Keywords

Groundnut, Flowering pattern, Seed filling, Seed Multiplication rate, Days after sowing

Article Info

Accepted:
24 August 2018
Available Online:
10 September 2018

A B S T R A C T

The experiment was conducted in order to find out the effects of differential number of flowers plant^{-1} on pod and seed characteristics in the Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore. In this experiment, the different number of flowers plant^{-1} was retained by manual pinching of late formed flowers. The number of flowers retained plant^{-1} varied from 11.08 (25 to 35 DAS), 36.63 (25 to 45 DAS), 89.33 (25 to 55 DAS), 125.04 (25 to 65 DAS), 169.32 (25 to 75 DAS), to 244.89 flowers (control plants). The yield attributing pod and seed characters *viz.*, number of double seeded mature pods plant^{-1}, weight of double seeded mature pods plant^{-1}, number of mature seeds plant^{-1}, weight of mature seeds plant^{-1} were highly influenced by the flowers retained between 25 to 55 days after sowing over control.

Introduction

Groundnut (*Arachis hypogaea)* is an important leguminous oilseed crop and generally called as poor man's nut. Groundnut seed contains 44 to 56% oil and 22 to 30% protein on dry seed basis and is a rich source of minerals (P, Ca, mg and K) and vitamins (James *et al.*, 2014).

Flowering and flowers assume an essential part in all seed crops, yield is dependent largely upon the fundamental reproductive units available. Flowering started 25 days after sowing and the day by day flower production expanded progressively with variations of high and low production. The main flowering time frame spread over around 40 days after which sporadic flowering were recorded. The flowering pattern was comparable for every one of the varieties studied and consisted of two peak periods, one occurring during the first 3 weeks of flowering and the second in after 70 days of flowering (Craufurd *et al.*, 2000). Groundnut produces more number of flowers than the plant can sustain and develop into pods and < 15 % to 20 % of flowers produced into mature pods (Lim and Hamdan, 1984; Ramanatha and Murty, 1994).

For the most part, an extensive number of early formed flowers form into pods and flowers that appear 70 days after flowering do not form mature which result in low yield of

mature pods (Knauft and Gorbet, 1989; Putnam *et al.,* 1991; FAO, 1990). Groundnut flowers favor pod setting about 8 weeks to mature from the time of flowering and therefore, only the first 3 weeks of flowering may be considered to be useful (Bell *et al.,* 1991; Awal and Ikeda, 2003). Fruiting efficiency of plants mainly depends on the pattern of flowering (number of flowers production up to 60 days), which is more important than total number of flowers per plant.

The early formed flowers (10 to 30) are more important components of early maturity in groundnut and a high proportion of the first 25 flowers developed into mature pods (Bailey and Bear, 1973). Likewise, the change of flowers to mature pods was the most important factors contributing to high pod yield (Songsri *et al.,* 2009).

Indeterminate development habit in groundnut which results in overlapping of growth and development periods of the regenerative and vegetative organs prompting low fruiting efficiency. The latter is due to inter organ competition for nutrients and other metabolites. Subsequently, there is inappropriate partitioning of nutrients to the developing seeds. Most prominent limitation in the low yield is extended duration of flowering and variable seeds sizes. In this experiment, we hypothesised effect of flowering pattern in groundnut in relation to seed filling and seed multiplication rate.

Materials and Methods

Freshly harvested pods of groundnut variety TMV 7 collected from Oilseeds Research Station, Tindivanam, Tamil Nadu Agricultural University, served as source material for the study. A field experiment was conducted at Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore during Kharif (2015) with groundnut variety TMV 7. The crop was maintained by following recommended package of practices (Crop Production Guide - 2012 Dept. of Agriculture). The crop was observed for flower initiation and daily production. Flower initiation was observed on 25^{th} day after sowing (DAS). The flowers that emerged for the predetermined number of days were maintained and the flowers that emerged subsequently were manually removed (Fig. 1). The details of the treatments (flower retention) are as follows. T_1 - Flowers produced from 25 to 35 days flowers retained, T_2 - Flowers produced from 25 to 45 days flowers retained, T_3 - Flowers produced from 25 to 55 days flowers retained, T_4 - Flowers produced from 25 to 65 days flowers retained, T_5 - Flowers produced from 25 to 75 days flowers retained, T_6 - control (continuous flowering for entire crop duration). The following observations were recorded under field condition No. of flowers retained plant^{-1}, No. of flowers removed plant^{-1}, Pod set (%), Total no. of pods plant^{-1}, No. of double seeded pods plant^{-1} (Mature and Immature), No. of single seeded pods plant^{-1} (Mature and Immature), No. of ill filled pods plant^{-1}, Total wt. of pods (g) plant^{-1}, Wt. of double seeded pods (g) plant^{-1} (Mature and Immature), Wt. of single seeded pods (g) plant^{-1} (Mature and Immature), Wt. of ill filled pods (g) plant^{-1}, No. of seeds plant^{-1}(Mature and Immature) and Wt. of seeds plant-^{1}(Mature and Immature). The data was collected from various experiments were analyzed statistically adopting the procedure described by Panse and Sukhatme (1985).

Results and Discussion

Field experiment on "studies on flowering pattern in groundnut in relation to seed filling and seed multiplication rate" was conducted during Kharif (2015) with groundnut variety TMV 7. In this experiment the desired number

of flowers plant^{-1} was retained by manual pinching of late formed flowers. The number of flowers retained plant^{-1} varied from 11.08 (25 to 35 days) to 244.89 flowers (Control plants). Among the treatments maximum pod set per cent (92.28 %), were recorded in plants which were maintained with 11.08 flowers (25 to 35 days) (Table 1).

Among the treatments maximum number and weight of double seeded mature pods plant^{-1} (16.57 and 20.12 g) were recorded in plants which were maintained with 89.33 flowers (25 to 55 days). As the number of flowers retained plant^{-1} increased further, these was reduction in number and weight of double seeded mature pods plant^{-1}, to a level of 38.92 % and 24.65 per cent in control

At the same time, the negative pod characteristics such as number and weight of double seeded immature pods plant^{-1}, number and weight of single seeded mature pods plant^{-1}, number and weight of single seeded immature pods plant^{-1} and number and weight of ill filled pods plant^{-1} were recorded to (8.31, 5.08 g), (7.60, 3.82g), (3.14, 1.71g) and (11.10, 1.31g) in control (Table 2 and 3).

The maximum number of mature seeds plant^{-1} (33.14) and weight of mature seeds plant^{-1} (16.99 g) were recorded in plants which were maintained with 89.33 flowers in 25 to 55 days. As the number of flowers retained plant^{-1} increased further, these was reduction in number and weight of mature seeds plant^{-1}, to a level of 40.06 % and 47.79 per cent in control (Fig. 2).

Field experiment on "studies on flowering pattern in groundnut in relation to seed filling and seed multiplication rate" was conducted during Kharif (2015) with groundnut variety TMV 7. In this experiment the desired number of flowers plant^{-1} was retained by manual pinching of late formed flowers. The number of flowers retained plant^{-1} varied from 11.08 (25 to 35 days) to 244.89 flowers (Control plants).

The maximum pod set per cent (92.28 %), were recorded in plants which were maintained with 11.08 flowers (25 to 35 days) (Fig. 3). The findings are in conformity with the results of Mondal *et al.,* (2011b) observed that increases in leaf chlorophyll and nitrogen content of mungbean at the time of early growth development period which help in early formed flowers getting more available assimilates then later formed flowers. These advantages in producing high number of pod set thereby high yield. That is the reason, the higher rates of flower generation within 10 to 15 days after flowering revealed higher number of mature pod and seed yields. Further, earlier formed flowers had a higher pod set than the latter may be due to most of the sugar produced by leaf is utilized in filling the pods that occurs at proximal position of raceme (Spollen *et al.,* 1986a).

Spollen *et al.,* (1986b) reported assimilate translocation pattern in soybean, which early formed and later pods represented 70 and 30% of the translocated ^{14}C, respectively. This information showed that grater part of the starch produced by leaf is used in filling the pods that set right on time at reproductive stage. Comparative phenomenon may have happened in the present experiment. Source constraint during seed filling appear to be moderately common as shown by starch and nitrogen levels in soybean leaves during seed filling (Egli and Bruening, 2003). Besides, several researchers (Saitoh *et al.,* 1998) detailed that soybean yield under most field conditions is assumed to be source limited during the late reproductive period. Further, rachis diameter and radial length of xylem and phloem and vascular tissues diminished at the distal end compared to proximal one (Mondal *et al.,* 2011b).

Table.1 Effect of number of flowers retained plant^{-1} on pod set (%) in groundnut var. TMV7

Treatments (T) Retention of flowers (Days)	No. of flowers retained plant^{-1}	No. of flowers removed plant^{-1}	Pod set (%)
T_1 - 25 to 35	11.08	202.23	99.28 (85.13)
T_2 - 25 to 45	36.63	187.57	38.54 (38.38)
T_3 - 25 to 55	89.33	143.38	22.60 (28.39)
T_4 - 25 to 65	125.04	109.19	22.89 (28.58)
T_5 - 25 to 75	169.32	63.55	20.08 (26.62)
T_6 - Control	244.89	0.00	16.57 (24.02)
Mean	**112.71**	**117.65**	**36.66 (37.26)**
SEd	7.2567	7.5093	1.7580
CD (P=0.05)	15.4675**	16.0059**	3.7472**

(Figures in parenthesis indicate arcsine values)

Table.2 Effect of number of flowers retained plant^{-1} on number of pods plant^{-1} in Groundnut var. TMV7

Treatments (T) Retention of flowers (Days)	Total no. of pods plant^{-1}	No. of double seeded pods plant^{-1}		No. of single seeded pods plant^{-1}		No. of ill filled pods plant^{-1}
		Mature	Immature	Mature	Immature	
T_1 - 25 to 35	11.01	11.01	0.00	0.00	0.00	0.00
T_2 - 25 to 45	13.81	13.81	0.00	0.00	0.00	0.00
T_3 - 25 to 55	19.57	16.57	0.50	2.50	0.00	0.00
T_4 - 25 to 65	27.86	14.75	4.07	2.89	1.12	5.04
T_5 - 25 to 75	33.71	13.09	5.93	5.00	1.40	8.29
T_6 - Control	40.27	10.12	8.31	7.60	3.14	11.10
Mean	**24.37**	**13.22**	**3.13**	**3.00**	**0.94**	**4.07**
SEd	1.9694	0.5933	1.0542	0.8869	0.4590	1.9422
CD (P=0.05)	4.1978**	1.2646**	2.2469**	1.8903**	0.9783**	4.1398**

Table.3 Effect of number of flowers retained plant^{-1} on weight of pods (g) plant^{-1} in Groundnut var. TMV7

Treatments (T) Retention of flowers (Days)	Total wt. of pods (g) plant^{-1}	Wt. of double seeded pods (g) plant^{-1}		Wt. of single seeded pods (g) plant^{-1}		Wt. of ill filled pods (g) plant^{-1}
		Mature	Immature	Mature	Immature	
T_1 - 25 to 35	16.02	16.02	0.00	0.00	0.00	0.00
T_2 - 25 to 45	17.25	17.25	0.00	0.00	0.00	0.00
T_3 - 25 to 55	22.42	20.12	0.34	1.96	0.00	0.00
T_4 - 25 to 65	23.62	18.58	2.22	1.97	0.41	0.45
T_5 - 25 to 75	24.40	16.36	3.28	2.78	0.87	1.11
T_6 - Control	27.08	15.16	5.08	3.82	1.71	1.31
Mean	**21.80**	**17.25**	**1.82**	**1.75**	**0.50**	**0.48**
SEd	1.6341	1.1005	0.7195	0.5445	0.2219	0.3393
CD (P=0.05)	3.4831**	2.3456**	1.5336**	1.1605**	0.4729**	0.7233**

Fig.1 Manual pinching of flowers

Fig. 2 . Effect of number of flowers retained plant^{-1} on number and weight seeds (g) in groundnut var. TMV7

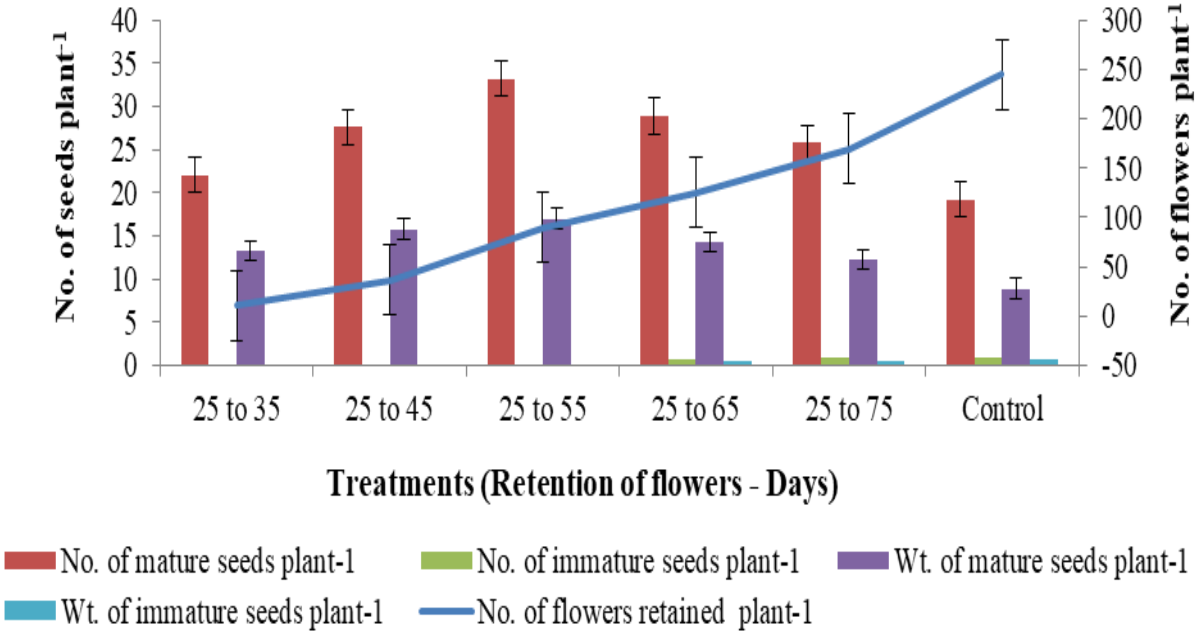
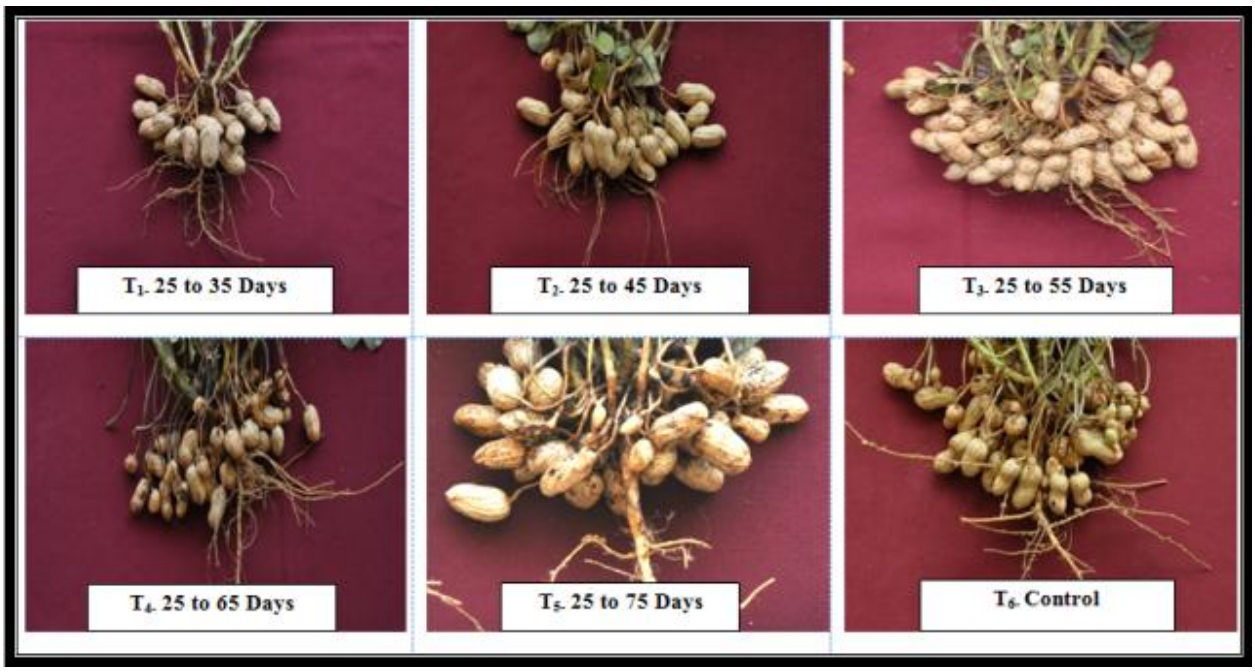


Fig.3 Effect of number of flowers retained plant^{-1} on pod set (%) in groundnut var. TMV7



These outcomes recommended that phloem was ineffectively developed in the distal part of the raceme and consequently giving potentially insufficient amount of photosynthate to the later formed flowers, which may have caused more flower shedding at the distal end of the raceme. This further demonstrates irrespective of yield capacity, the mungbean genotype conceivably confer a vascular tissue constraint in the distal part of the rachis. Comparative outcomes were additionally found in soybean (Wiebold and Panciera, 1990), in lignosus bean (Bari and Prodhan, 2001) and in pigeonpea (Begum *et al.,* 2007). Consequently, earlier formed flowers had a higher pod set than the latter. Saitoh *et al.,* (1999) additionally observed that with increasing number of flowers per raceme, the rate of pod set per raceme diminished (Table 1).

Effect of number of flowers retained plant^{-1} on number and weight of pods and seeds plant^{-1}. The findings are in similarity with the results of Yoshida *et al.,* (1983) found that the magnitude and duration of flowering is more important since > 70 % pods plant^{-1} are formed from the initial 10 days of flowering in determinate type and 15 days in indeterminate kind of soybean. Comparable outcomes were documented by Mondal *et al.,* (2011a), who examined flowering pattern in groundnut and mung bean and observed expanded number of flower generation within 15 to 20 days after flowering (DAF) in groundnut and 10 to 15 DAF in mung bean, likewise produced higher yield in groundnut and mung bean. However it is thoroughly thought out that the genotypes, which produced expanded number of flowers within shorter period of time especially at early development stages will permit them more time for assimilate accumulation and this accomplish more sink strength than the later-formed flowers (Biswas *et al.,* 2005) (Table 2 and 3). The arresting of late formed flowers could have led to high sink potential and led to acceleration of assimilate translocation from source to sink there by enhanceing resulting in extended in seed filling period (25 to 55 days of flowers) when compared to control.

Differential retention of flowers significantly influenced the number and weight of matured pods produced per plant. As the number of flowers retained decreased, there was an increase in the number of mature pods and its weight, number of mature seed and its weight. From the results it could be concluded that retention of flowers that were produced from 25 to 55 days were optimum for realizing enhanced source – sink relationship in groundnut.

Acknowledgements

Words are mere the verbal expression of one's thoughts and feelings. But there the words are poor substitute of expressing my deep sense of gratitude to my chairman, Dr. R. Vijayan and my member of the advisory committee, Dr. R. Umarani for his/her dexterous, meticulous and altruistic guidance, valuable suggestions and words of wisdom during my work. This research received no specific grant from any funding agency, commercial or not-for-profit sectors.

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How to cite this article:

Vinothini, N., R. Vijayan and Umarani, R. 2018. Studies on Flowering Pattern in Relation to Seed Filling and Seed Multiplication Rate in Groundnut (*Arachis hypogaea* L.). *Int.J.Curr.Microbiol.App.Sci.* 7(09): 3321-3328. doi: https://doi.org/10.20546/ijcmas.2018.709.412