THE PATTERN OF SEED SET WITHIN THE CAPITULUM OF SUNFLOWER AND ITS INFLUENCE ON GERMINATION AND SEEDLING VIGOUR

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INTRODUCTION

In crop plants, the importance of seed size for high germination percentage and early seedling vigour is well established. Seed test weight was shown to influence plant growth, development and subsequent yield in many crop plants (Harpar and Obeid, 1967; Foxtes and Ohlrogge, 1972 and Trehan et al., 1975). Crop raised from large seeds was shown to have more leaf area, biological yield and seed yield in sunflover (Ashokkumar et al., 1979). More dry matter accumulation was observed in the seedling raised from heavier seeds in sunflower (Sivasubramanian and Ramakrishnan, 1997).

In a sunflower capitulum, the number of filled seeds and seed weight showed marked reduction from peripheral seed whorls to inner whorls. Besides, oil content and seed moisture content were also found to vary markedly in the seeds which were developed in different positions of the capitulum (Mathes and Ungaro, 1983). By using labelled $^{14}CO_2$, Udaya Kumar et al., (1976) have shown the differential sink capacity of the seeds at different zones of the capitulum resulting in differential translocation of photosynthates.

In the present study, the pattern of seed set, seed number and seed weight in relation to its position on the capitulum and its subsequent influence on germination and seedling vigour in Morden (Cernianka-66) sunflower variety is reported.

MATERIAL AND METHODS

The base material for the experiment was collected from Morden sunflower variety grown under fertile irrigated conditions during monsoon season (July to October, 1984). About 100 capitula of uniform size (14 to 16 cm in diameter) which had flowered on the same day were identified and labelled. Such capitula were harvested when the plants were fully matured. These capitula were dried for 96 hours in an oven maintained at 40°C. All seeds from each concentric seed whorls were removed carefully from periphery to the centre of the capitulum and were grouped separately. Total seed number, number of filled and unfilled seeds, weight of filled and unfilled seeds as well as that of kernels were recorded. Seeds from each concentric whorls were stored separately in an incubator kept at 25°C for 45 days. Germination and seedling vigour studies were made by germinating 20 seeds on filter paper medium in petriplates saturated with 5 ml of distilled water and replicated five times. The observations on germination percentage, shoot and root lengths of 10 seedlings were recorded at the end of 7 days of incubation at 30°C. Vigour index was calculated by multiplying germination percentage with mean shoot length.

Observations on all the characters under study were recorded for a minimum of 30 earheads. The experiment was repeated twice. The data of one such experiment are given in this paper. For graphical representations, the observations recorded on the seeds from 1st, 5th, 10th, 15th, 20th and 24th concentric whorl were used for husk percentage, kernel weight and whole seed weight, while it was only from 1st, 5th, 10th, 15th and 18th seed whorls for germination studies, since the subsequent whorls had contributed very little sample size.

RESULTS AND DISCUSSION

The pattern of seed distribution within a capitulum was studied in Morden sunflower variety. Capitula hawing average diameter range of 14 to 16 cm had shown mean 28 concentric whorls. The total seed number in each concentric whorls found to be constant (55 seeds) up to the 11th whorl from periphery of the capitulum. However, total seed number ranged from 54.93 in the 12th whorl to 2.43 in the 28 th whorl indicating a marked reduction in total seed number per whorl from periphery

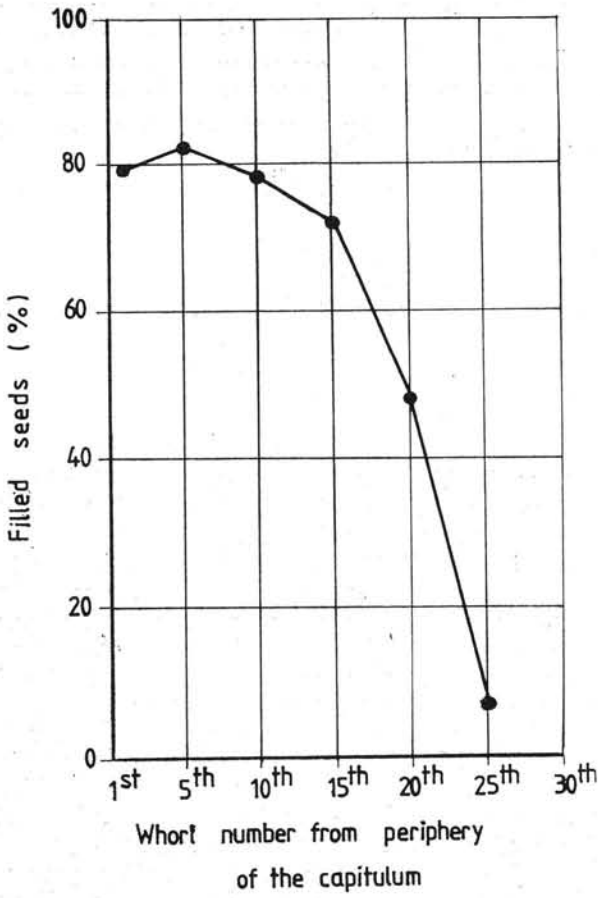

Fig. 1 — Percentage of filled seeds in different concentric whorls of sunflower capitulum

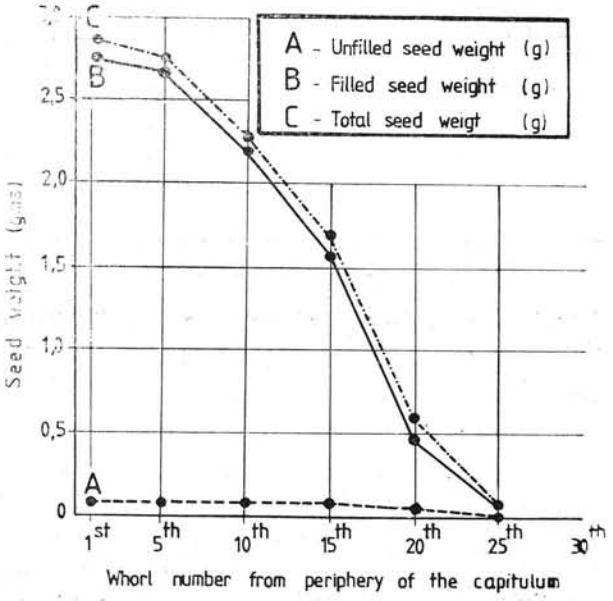

Fig. 2 — Weight of filled, unfilled and total seeds from different concentric whorls of the sunflower capitulum

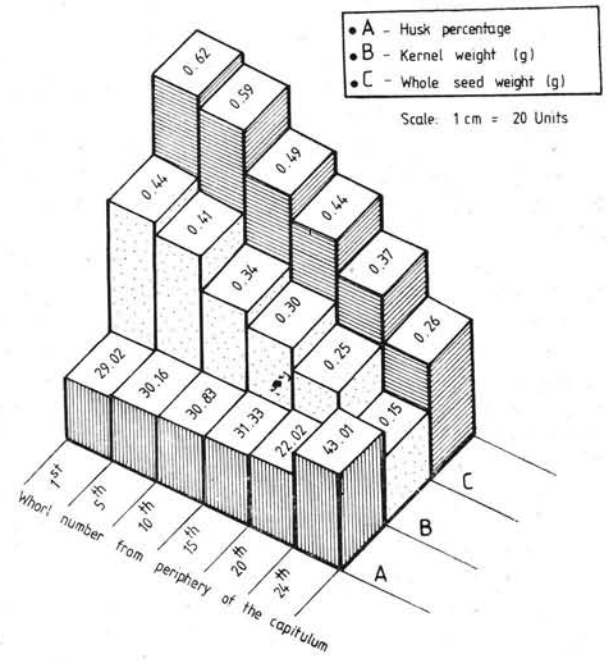

Fig. 3 — Husk percentage, kernel and whole seed weight of individual seeds from different concentric whorls of sunflower capitulum

to the centre of capitulum. The range of filled seeds per whorls was from 45.36 to 0.57 seeds over different concentric whorls. The number of filled seeds per whorl had increased marginally up to the 4th seed whorl from the periphery and further decreased gradually from 45.21 seeds in the 5th whorl to 1.36 seeds in 27th whorl (Table 1). Percentage of filled seeds per whorl also exhibited a similar trend (Fig. 1).

The mean weight of seeds in an whorl ranged from 2.925 to 0.016 g over different concentric whorls. Higher seed weight was evident up to the 3rd whorl from the periphery and subsequently there was considerable reduction in seed weight from 4th whorl to 28th whorl (Fig. 2).

The marginal increase in mean specific (single) seed weight per concentric whorl was seen up to the 3rd whorl from the periphery. It had decreased markedly between each successive whorls from 4th whorl to 28th whorl (Table 1 and Fig. 3).

Likewise, specific kernel weight also shown the similar trend as above. Specific kernel weight of 22nd whorl was found to be nearly half of that of first whorl (Fig. 3).

With respect to husk content, there was gradual marginal increase from periphery to the central whorls (up to 20th whorl). A higher husk content was apparent markedly from 21st whorl onwards (Fig. 3).

Seeds from the outer whorls of the head had shown generally higher germination rate as well as germination counts. Germination percentage of seeds was 98 per cent in the seeds from the outermost whorl of the head, but it decreased to 81, 66 and 47 per cent in the seeds raised from the 8th 14 th and 18th concentric whorls respectively. Thus, germination percentage had also decreased markedly in

Table 1

Variations in seed number and specific (single) seed weight in a concentric whorl from periphery to centre of the capitulum in Morden cultivar

Concentric whorl number from periphery	Number of seeds per whorl in a capitulum			Specific seed weight per whorl (mg)
	Filled seeds	Unfilled seeds	Total seeds	
1	43.86	11.14	55.00	63.00
2	44.29	10.71	55.00	63.00
3	45.07	9.93	55.00	63.14
4	45.36	9.64	55.00	62.21
5	45.21	9.79	55.00	60.00
6	43.14	11.86	55.00	56.86
7	43.71	11.29	55.00	55.21
8	42.71	12.29	55.00	54.36
9	43.50	11.50	55.00	52.50
10	43.29	11.71	55.00	51.57
11	42.64	12.36	55.00	49.79
12	42.79	12.14	54.93	48.29
13	42.36	10.86	53.22	46.57
14	41.50	10.07	51.57	45.21
15	36.86	12.57	49.43	43.00
16	34.21	11.93	46.14	41.07
17	31.43	12.57	44.00	39.43
18	25.50	14.79	40.29	37.64
19	20.21	15.79	36.00	34.14
20	14.79	15.71	30.50	31.93
21	10.14	13.57	23.71	26.45
22	6.50	12.57	19.07	18.57
23	4.00	11.14	15.14	13.36
24	2.86	8.64	11.50	10.64
25	2.29	7.64	9.93	6.07
26	2.29	5.36	7.65	5.50
27	1.36	3.64	5.00	1.36
28	0.57	1.86	2.43	1.50
Total	802.44	303.07	1105.51	—
Mean	28.66	10.82	39.48	38.66
LSD 5%	5.525	5.717	5.837	6.045

the seeds from the outer most whorl to the inner whorls within the head (Fig. 4).

The root and shoot lengths of seedlings at the end of 7th day after germination had shown that seedlings from outer most whorls of head had longer roots as well as shoots as compared to those from inner whorls. In general, a marked reduction in total seedling length was observed in seedlings raised from first whorl to 18th whorl (Fig. 4). Likewise, vigour index of the seedlings developed from the seeds of different whorls had also exhibited similar trend. Vigour index was reduced by 34.17, 57.76 and 84.22 per cent in the seedlings raised from seeds collected from 6th, 12th, and 18th whorls respectively as compared to the first concentric whorl in the periphery (Fig. 4).

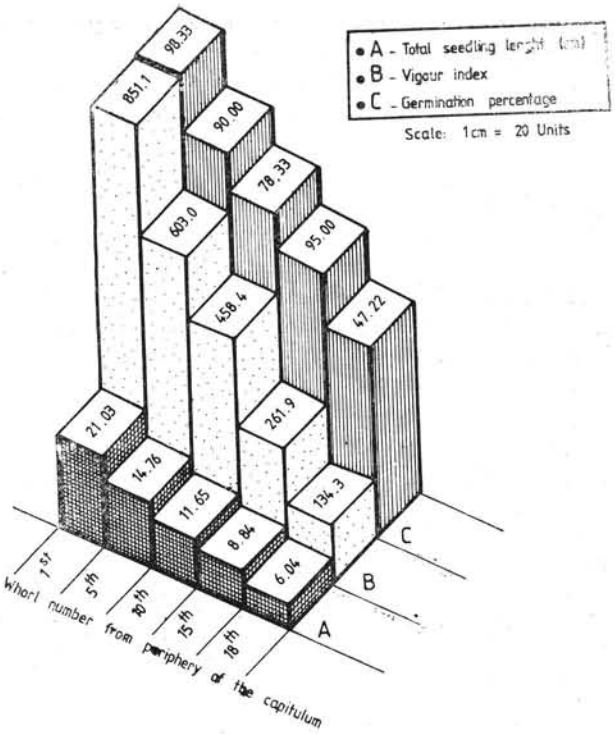

Fig. 4 — Germination percentage, seedling length and vigour index of the seed from different concentric whorls of sunflower capitulum

Anthesis of sunflower florets starts from the outermost whorl of the capitulum and duration for complete anthesis of head takes about 7 to 10 days. Under fertile and irrigated conditions, more number of florets in the outer zone of the head would develop into bolder seeds and subsequently, the percentage of filled seed would also be more.

An analysis of nature of distribution of seeds within a capitulum had shown that total number of seeds per concentric whorl remained constant up to the 11th whorl from periphery (55 seeds) which may be ascribed to genetic factors, but number of filled seeds in a whorl had differed marginally in the outer region of the capitulum. However, total number of florets initiated per whorl and also filled seed number had reduced markedly from 12th whorl to 28th whorl of the capitulum. Total seed weight, specific seed weight and kernel weight had also decreased drastically from 4th seed whorl onwards in the capitulum. Reduction in the number of filled seeds, specific seed weight and kernel weight in the inner whorls was mainly due to physiological reasons. An imbalance in the distribution of adequate photosynthates to the seeds situated in the inner whorls might have resulted in lesser number of filled seeds as well as considerable reduction in the specific seed weight per whorl. Uday a Kumar et al. (1976) and Prasad et al. (1977) have reported differential translocation of labelled photosynthates to the seeds situated at different position of sunflower head. Prasad and Krishna Sastry (1978) have

shown the importance of sink capacity for translocation of photosynthates to the head and the role of phytochromes in mobilization of photosynthates which results in increased number of filled seeds and also specific seed weight.

A drastic reduction in percentage of filled seeds per whorl and a larger ratio of husk weight to total seed weight observed in this study have suggested that seed filling might have affected to a greater extent in the seeds developed in the inner whorls of the capitulum, thus giving rise to seeds of inferior quality.

Significant reductions in germinability parameters were observed in the seeds collected from inner whorls of the head. The germinability and seedling vigour seem to depend on the amount of storage materials availble per seed. The higher germination percentage and seedling vigour noticed in the seeds from the outer whorls might be related to the higher rate of availability, metabolism as well as translocation of metabolites from the storage organs to actively growing parts of the seedlings (Mathur et al., 1982 ; Muniswami Naidu and Narayanan, 1981).

The present study has clearly brought out the importance of higher test weight (around 50 g/1,000 seeds) in realising better germinability and higher seedling estabishment under the field conditions.

CONCLUSIONS

The pattern of seed set, seed number and seed weight in different concentric whorls in a capitulum of sunflower cv. Morden were studied. The total number of seeds in an whorl was 55 up to 11th whorl from periphery in the capitulum having diameter range of 14 to 16 cm. A drastic reduction in total number of seeds was seen from 12th whorl onwards. Number of filled seeds, seed weight per whorl, specific seed weight and kernel weight in a whorl showed significant reduction in the successive whorls from 4th peripheral whorl onwards.

Germination percentage, seedling growth, vigour index of the seedlings raised from seeds from different concentric whorls were studied. Seeds having specific seed weight of more than 49 mg per seed up to 11th whorl from periphery had higher germination percentage, more seedling growth and also higher vigour index.

ACKNOWLEDGEMENT

This work was carried out under the Project "Super Elite and Elite Sunflower Seed Production", financed by the Indian Council of Agricultural Research, New Delhi.

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LE MODÈLE DE DISTRIBUTION DES GRAINES SUR LE CAPITULE DE TOURNESOL ET SON INFLUENCE SUR LA GERMINATION ET LA VIGUEUR DES PLANTULES

Résumé

Le cultivar-population à pollinisation libre Cernianka 66 a été utilisé comme matériel biologique, cultivé dans un sol fertile, en conditions d'irrigation, pendant la saison moussonique de juillet—octobre 1984.

Les groupes de graines provenues de chaque cercle concentrique des capitules ont été étudiés. Le nombre total de graines d'un cercle concentrique a été de 55 jusqu'à l'onzième cercle, dénombré de la périphérie du capitule, ayant des diamètres de 14 à 16 cm. À partir du 12-ème cercle, le nombre total de graines s'est réduit considérablement. En commençant par le 4-ème cercle de la périphérie vers le centre du capitule, une réduction successive du nombre des graines pleines, du poids des semences pleines d'un cercle concentrique, de la masse de 1 000 graines et de la masse des noyaux a été enregistrée. Les akènes dont la masse de 1 000 graines était supérieure à 49 g, obtenues des 11 premiers cercles concentriques de la périphérie du capitule ont eu une meilleure germination, une croissance plus rapide des plantules et également un index de vigueur plus élevé.

MODELO DE LA DISTRIBUCION DE SEMILLAS POR EL CAPITULO DE GIRASOL Y SU INFLUENCIA SOBRE LA GERMINACIÓN Y EL VIGOR DE LAS PLANTAS

Resúmen

Se utilizó como material biológico la variedad-población con polinización libre Cerneanka 66, cultivada en un suelo fertil, en condiciones de regadio, en la estación musónica Julio—Octobre, 1984.

Se estudiaron los grupos de semillas provinientes de cada círculo concéntrico de los capítulos. El número total de semillas de un círculo concéntrico fue de 55 hasta el undécimo círculo, contado desde la periferia del capítulo, teniendo los diametros de 14 hasta 16 cm. Empezando con el duodecimo círculo, el número total de semillas se redujo considerablemente. Empezando con el cuatro círculo desde la periferia hasta el centro del capítulo se registró una reducción succesiva de : el número de semillas llenas, la masa de las semillas llenas de un círculo concéntrico, la masa de 1 000 granos y la masa de los corazones. Las semillas con la masa de 1 000 granos mayor a 49 g, que se obtuvieron de los primeros 11 círculos concéntricos de la periferia del capítulo mostraron una germinación mejor, un crecimento más rápido de las plantas y a la vez un índex de robustez más elevado.