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Reproductive And Yield Related Variation Studies In Different Species Of Carthamus

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ABSTRACT

In India the genus Carthamus commonly called as Safflower is known by a number of vernacular names. The plant is a minor oil seed crop, and has many other beneficial aspects. In the present work various species of Carthamus were subjected to reproductive and yield related variation studies. Considerable variation was found in various characters studied amongst various species of the genus C. glaucus, C. lanatus, C. oxycantha, C. palaestinus and C. tinctorius. The mean number of heads per plant varied from 15-27 in different species. The fertile and sterile florets per flower varied from 38-57 and 7-10 respectively. The mean number of seed set per plant varied from 762 to 1412 amongst different species. The diameter of head varied from 2 to 3 cm.

KEYWORDS: Reproductive, yield related characters, Species of Carthamus.

INTRODUCTION

Safflower is one of humanity's oldest crops. It was first cultivated in Mesopotamia, with archaeological traces possibly dating as early as 2500 BC (Pearman 2005). Carthamus L. belongs to the tribe cynareae (thistle), sub family tubifloreae of the family Compositae. Carthamus is the latinized version of the Arab word 'quartum' or 'gurtum' which alludes to the colour of the dye obtained from the flower heads. In ancient India, Sanskrit authors described the plant under the name ' 'kusumbha' from which the most common modern name of ‘kusum’ is derived. The various vernacular names of Carthamus_in India are 'kusumful' (Assamese and Bengali) 'kusumbo' (Gujarati) 'kusumbe' (Kannad) 'sinduram' (Malayalam) 'kardai' (Marathi) 'kusuma' (Oriya) and 'agnisikha' (Telugu).

C. tinctorius commonly called safflower is the only cultivated species of this genus Carthamus is a native of old world. The plants of this species have been grown for centuries over a vast area from China to the Mediterranean region and along the Nile Valley as far as the Ethiopia. The main use of this plant was a dye (Carthamin, a red dye extracted from the flowers) for food and clothing. The development of this plant as an oil crop came later (Weiss, 1971). The important safflower growing countries are India, Mexico, USA, Australia and Spain. In India its large scale cultivation is confined to areas located between latitudes of 14 degree and 22 degree north and longitudes 73.5 degree and 79

degree east. Over 98% area is concentrated in the states of Maharashtra (73%) Karnataka (23%) and Andhra Pradesh (2.8%). It occupies 70.1 thousand hectares with the production of 186 thousand tones. India ranks first in the world in respect of acreage accounting for about 50% of the world.

The classification of the genus has been a matter of great dispute. The genus has about 34 species with varying chromosome number of 2n=20 to 22n=64 (Gupta and Srivastava, 2008) and has a wide range of adaptation. As the plant is a minor oil seed production, the main thrust of research in this plant is always related with improvement of varieties for seed production. In the present work an attempt has been made to compare five species of Carthamus on basis of their production (seeds per plant).

MATERIALS AND METHODS

For the present work five species of Carthamus were studied (table 1). The seeds of various species were sown at research field of 'Cytogenetics Laboratory' Botany department C.C.S. University, Meerut (Fig. 1). The sowing of the seeds, in lines was carried out between second and third week of October. The distance between two lines was about 50 cm and plant to plant distance was about 20 cm. The length of a line was about 3 m. The morphological studies were carried out using parameters related to vegetative characteristics. In Meerut the crop matures in about 9 to 10 months. Therefore, the morphological analyses were carried out after 8 months of the sowing in mature plants. The reproductive and yield related parameters used for analyses are as follows:

(a) Number of heads per plant
(b) Diameter of a head
(c) Number of fertile, sterile and total florets per head and
(d) Seeds set per plant

OBSERVATIONS

The adult plants of Carthamus accessions exhibited significant variability in all the reproductive and yield related parameters. Data are related to reproductive and yield related parameters in different species of Carthamus are tabulated in table 2. The mean number of heads per plant in C. glaucus, C. lanatus, C. oxycantha, C. palaestinus and C. tinctorius were found to be 15, 27, 20, 17 and 20 respectively. The mean diameter of the head was found to be 2, 3, 3, 3 and 2.2 respectively .The mean number of fertile florets per head was found to be 57, 52, 38, 55 and 43 respectively. The sterile florets per head were found to be 7, 8, 8, 9 and 10. The mean number of seed set per plant in C. glaucus, C. lanatus, C. oxycantha, C. palaestinus and C. tinctorius was found to be 857, 1412, 762, 928 and 920 respectively.

The mean number of heads per plant was found to be maximum in C. lanatus and minimum in C. glaucus. The mean diameter of the head was found to be largest in nearly all species except C. glaucus and C. tinctorius. The mean number of fertile florets and sterile florets were found to be maximum in C. glaucus and C. tinctorius. The mean number of seed set was found to be maximum in C. lanatus and minimum in C. oxycantha.

RESULTS AND DISCUSSIONS

Several workers have also analysed various reproductive and yield related parameters in mainly cultivated species. Most of the work in the world is concentrated on the improvement of Carthamus varieties for oil production (Grain research and Development Corporation, 2020 (a), (b) and (c)). Knowles (1955) worked on the production, processing and utilization of safflower. Khidir (1974) noticed that the plant height was the only character which has direct positive contribution to seed production. Chauhan and Singh (1975) and Chauhan (1976) have also worked on change in plant morphology by giving some chemical and radiation treatments.

In 2005 Pahlavani gave some technological and morphological characteristics of safflower. In 2008 Mailer discussed about the quality evaluation of safflower. Anjani (2010) did hybridization experiments between C. tinctorius and C. oxycantha and gave results by comparing the parents and F1 hybrids on morphological basis. Bergmen and Kandel (2019) discussed about safflower production.

The number of heads per plant was highly variable. This was not fluctuated only within different species but also varied even between different plants of the same species. Since Carthamus species are autogamous, the difference in the number of heads per plant of an accession could be because of difference in the surrounding microclimate rather than differential genotypes. Williams (1926) determined that the close spacing between plants decreased the number of heads on a plant. Beech and Norman (1963) found that in Australia the flower heads varied in their mean number 5-50 per plant. The minimum number of heads per plant was found to be three by Leninger (1963). Francois and Bernstein (1964) determined the adverse effect of salinity on the number of flowering heads. The mean number of flowering heads in different species of Carthamus in the present study was found to be in the range 15-27.

Ashri and Knowles (1960) and Hanelt (1961) noted that the head sizes in C. glaucus, C. lanatus, C. palaestinus and C. tinctorius ranging between 0.9-2.7cm, 1.2-1.7cm, 1.5cm and 1.4-3.3cm respectively. GRIN (2001b) and http://www.ars-grin.gov/npgs/descriptors.safflower (2001) reported that the mean diameter of the head could be as low as 5mm and as high as 45mm. Beech and Norman (1963) found that in Australia the flower heads varied in diameter from 1.25-4.00cm. Leninger (1963) observed that the heads present on the primary branches were higher in their diameter than those present on the secondary branches. Such an analyses were not undertaken during this study. In the present study the head sizes in C. glaucus, C. lanatus, C. palaestinus and C. tinctorius ranged between 1.9-3.1 cm, 2.2-2.9cm, 2.2-3.0cm and 2.0-2.5cm respectively. The mean number of sterile and fertile florets per head, worked out for the first time during this investigation, varied with the species. Some reports about the effect of phytohormones and the environmental factors on these parameters are available. Yermanos and Knowles (1960) observed the gibberellins treatment to the buds lead to the development of a ring of abnormal florets after 24 hours. All these florets were sterile and rotted before maturity. Hayashi and Handa (1985) found that the frequency of florets decreased by soil water deficit. The number of fertile and sterile florets in the present study was calculated in all the species of Carthamus. The mean number of fertile florets ranged from 38-57.

The number of heads per plant and fertile florets per head directly affected the number of seeds set per plant. During the present investigation the mean seeds per plant were 762-1412. Subbia and Sivaram (1965) found that nipping out the central shoot before flowering increased the total seed yields.

Kheradnam and Bassiri (1978) observed that in wild safflower the number of seeds varied between heads of the same plant. Mathur et al. (1976) and Ramachandram and Goud (1982) noted direct correlation between the diameter of the heads and number of seeds per head. Similarly, Karve et al. (1981) observed that number of heads was positively correlated with seeds set per plant in safflower. The present sets of observations were in confirmations with these findings. Hayashi and Handa (1985) reported decrease in the number of seeds per plant under water deficit condition in safflower.

In the present study the variations observed may be due to environmental and genotypic differences in GRIN's and our experimental place and materials. In 2015 again Knowles performed hybridization experiments. Hassani et al. (2020) using latest marker technology like SRAP and SSR described morphology, genetic diversity and population structure of safflower.

Table 1. List of Carthamus species

S.No.	Name of the species	EC/IC	Courtesy
1.	C. glaucus	386043	USDA
2.	C. lanatus	156787	AICRPO
3.	C. oxycantha	154778	AICRPO
4.	C. palaestinus	303293-A	NBPGR
5.	C. tinctorius	386054	USDA

USDA = United States Department of Agriculture
AICRPO = All India Coordinated Research Project on Oilseeds
NBPGR = National Bureau of Plant Genetic Resources
DOR = Directorate of Oil Research

Table 2. Mean data of various productivity related parameters studied

SPECIES	CODE	MEAN	±	SE	RANGE		
C. glaucus	HP	14.8	±	1.1	11	-	21
	FFH	56.65	±	0.93	51.5	-	61.5
	SFH	6.6	±	0.66	4.5	-	9.5
	TFH	63.25	±	1.05	58	-	68.5
	SP	857.4	±	70.32	573.5	-	12.33
	HD	2.49	±	0.115	1.9	-	3.1
C. lanatus	HP	27.42	±	2.12	18.3	-	38.07
	FFH	52.25	±	1.48	44	-	58.19
	SFH	7.87	±	0.73	4.57	-	41.88
	TFH	60.12	±	1.55	51.07	-	66.23

	SP	1412.13	±	126.53	872.19	-	2092.65
	HD	2.51	±	0.077	2.18	-	2.89
C. oxycantha	HP	20.2	±	1.08	16	-	26
	FFH	37.9	±	1.31	32	-	44
	SFH	7.6	±	0.83	3	-	10
	TFH	45.5	±	1.85	37	-	54
	SP	762.1	±	44.22	612	-	1092
	HD	2.54	±	0.05	2.3	-	2.7
C. palaestinus	HP	16.53	±	1.78	8.85	-	26.28
	FFH	54.88	±	2.52	36.57	-	63.42
	SFH	8.65	±	1.06	5	-	14.57
	TFH	63.54	±	2.43	49.71	-	72.28
	SP	927.65	±	113.18	439.85	-	1541.71
	HD	2.57	±	1.21	2.21	-	3
C. tinctorius	HP	20.15	±	1.22	14.69	-	25.68
	FFH	43.12	±	1.36	36.23	-	40.04
	SFH	9.72	±	0.75	6.34	-	13.28
	TFH	53.002	±	1.48	45.29	-	59.69
	SP	919.94	±	60.55	598.73	-	1228.02
	HD	2.23	±	0.05	1.98	-	2.51

Fig. 1. Field of Carthamus

Fig.2. Plant of C. glaucus

Fig. 3. Plant of C. oxycantha

Fig. 4. Plant of C. palaetinus

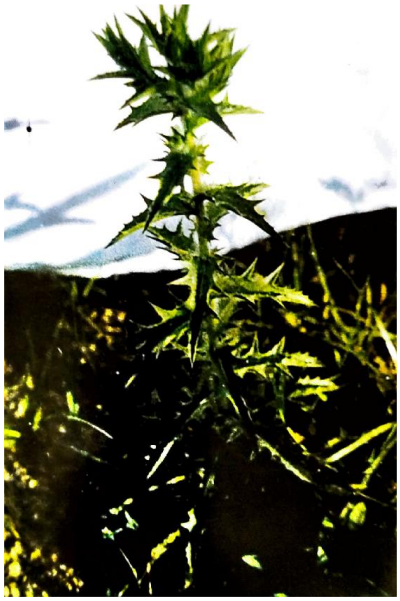

Fig. 4. Plant of C. lanatus

Fig. 6 & 7. Plant of C. tinctorius

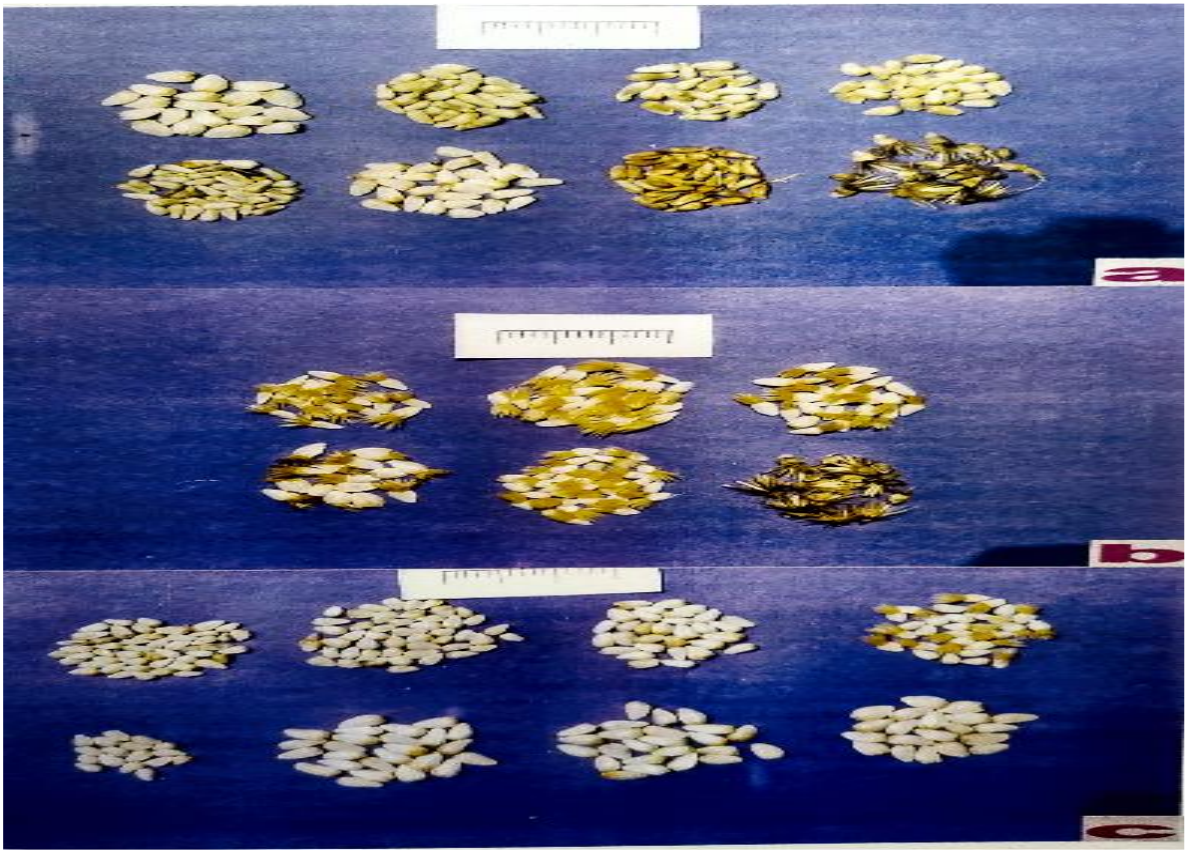

Fig. 8. Seeds of different species of Carthamus.

REFERENCES

Anjani, K. 2010. Morphological description of Carthamus tinctorius x C. oxyacantha hybrid. Electronic Journal of Plant Breeding 1(5).

Argikar, G.P., Morbadir and V.V. Thobbi (1957). The range of variation and correlation of some quantitative characters in Carthamus tinctorius L. Ind. Oilseeds J. 1(4): 228-234.

Ashri A. and P.F. Knowles 1959. Further notes on Carthamus in California. Leaflets western bot. 9(1): 5-8.

Banerji, I. (1940). A contribution to the morphology and cytology of Carthamus tinctorius L. Proc. Nat. inst. Sci. India 6: 73-86.

Beech D.F. and M.J. T. Norman1963. The effect of time of planting on yield attributes of varieties of safflower. Aus. J. Expt. Agric. Husbd. 3(9): 140-148.

Bergmen J. and H. Kandel (2019). Safflower Production. NDSU extension. www.ag.ndsu.edu.

Chauhan, Y.S. and R.P. Singh 1975. Morphological studies in safflower (Carthamus tinctorius Linn.) with special reference to the effect of 2, 4- D and gamma rays-I. Vegetative shoot apex. Radiation botany 15(1). 69-70.

Chauhan, Y.S Williams 1976. Morphological studies in safflower (Carthamus tinctorius Linn.) with special reference to the effet of 2, 4- D and gamma rays-II. Cellular responses. Environmental and experimental botany. 16(4). 235-240.

FAO 2022(a), Carthamus yellow; In: Compendium of Food Additive Specifications. (FAO Food and Nutrition Paper - 52 Add. 5)". FAO/WHO Expert Committee on Food Additives.

FAO 2022 (b). "World production of safflower seeds in 2020; World Regions/Crops/Production from pick lists". United Nations Food and Agriculture Organization, Statistics Division (FAOSTAT). 2022. Retrieved 16 May 2022.

Francois L.E. and L. Bernstein 1964. Salt tolerance of safflower. Agron. J. 56(1): 38-40.

Grain research and Development Corporation 2020 (a). "Safflower plant growth and physiology".

Grain research and Development Corporation 2020 (b). “Raising the Bar with Better Safflower Agronomy”.

Grains Research and Development Corporation 2020. “Corporation, Grains Research and Development".

GRIN 2001b. Germplasm resources information network (online database) USDA, ARS, National genetic resources program: http://www.ars-grin.gov/cgi-bin/npgs/html/dno_eval_acc.pl?108005+491299+201.

Gupta S. and A.K. Srivastava 2008. Meiotic investigation in different species of Carthamus. J. Cyto. Genet. Vol. 9(NS): 27-35.

Gupta, S.K. ed. 2012. Technological Innovations in Major World Oil Crops, Volume 1.

Hanelt P. 1963. Monographische unerasicht der gattung Carthamus L. (Comppsitae) Feddes repertorium 67: 41-180.

Hassani, S. M. R., R. Talebi**,** S. S. Pourdad, A. Mohammad and N. F. Fayaz 2020. Morphological description, genetic diversity and population structure of safflower (Carthamus tinctorius L.) mini core collection using SRAP and SSR markers. Biotechnology & Biotechnological Equipment. 34(1).

Hayashi H. and K. Handa 1985. Effect of soil water deficit on seed yield and yield components of safflower (Carthamus tinctorius l.) Japanese J. crop sci. 54(4): 346-352.

Karve A.D., A.K. Deshmukh and V.A. Deshmukh 1981. Seed setting in safflower. Indian J. genet. 41: 209-211.

Kheradnam M. and A. Bassiri 1978. Variations among heads, plants and ecotypes of wild safflower. J. agric. Sci. camb. 1: 223-228.

Khidir M.O. 1974. Genetic variability and inter-relationship of some quantitative characters in safflower. J. agric. Sci. camb. 83: 197-202.

Knowles, P. F. 1955. "Safflower — production, processing and utilization". Economic Botany. **9**(3): 273–299.

Knowles, P.F.1958. Safflower, adv. Agron. 10: 289-323.

Knowles, P. F. 2015. "Safflower". Hybridization of Crop Plants. Hybridization of crops. pp. 535–548.

Lee, T. 2020. "Safflower oil hailed by scientists as possible recyclable, biodegradable replacement for petroleum". ABC News. Landline. Australian Broadcasting Corporation. Retrieved 7 June 2020.

Leninger L.N. 1963. Evaluation of safflower lines with low iodine numbers. Crop sci. 3(2): 181.

Mailer, R., Potter, T., Redden, R., & Ayton, J. (2008). Quality evaluation of safflower (Carthamus tinctorius L.) cultivars. In Paper presented at the 7th international safflower conference (Wagga Wagga, NSW).

Mathur J.R., S.B.S. Tikka, R.K. Sharma, S.P. Singh and S.L. Dasora 1976. Genetic variability and path coefficient analysis of yield components in safflower. Indian J. Hered. 8: 1-10.

Mutwakil, A. 1968. Agronomist/plant breeder. Dept. of agric. Khartoum, Sudan-pers comm.

Pahlavani M. H. 2005. Some Technological and Morphological Characteristics of Safflower

(Carthamus tinctorius L.) from Iran. Asian Journal of Plant Sciences, 4: 234-237.

Pearman G. 2005. Prance, Ghillean; Nesbitt, Mark (eds.). The Cultural History of Plants. Routledge. pp.150.

Ramachandram M. and J.V. Goud 1982. Components of seed yield in safflower (Carthamus tinctorius L.) genet. Agr. 36: 211-222.

Subbia V. and M.R. Sivaram 1965. Increasing yield in safflower. Ind oilseeds J. 9(2): 155.

Williams J.H. 1926. The influence of plant spacing and flower position on oil content of safflower (Carthamus tinctorius). Crop Sci. 2(60): 475-477.

Yermanos D.M. and P.F. Knowles 1960. Effects of gibberellic acid treatment on safflower. Agron. J. 52(10): 596-598.