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RESPONSE OF SAFFLOWER (*Carthamus tinctorius* L.) CULTIVARS TO SOWING WINDOWS IN VERTISOLS

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ABSTRACT

The field experiment was conducted during *rabi* season of 2017-2018 with safflower variety AKS-207, Bhima and PKV (Pink) AKS-311 on field No. 10 of Agronomy farm, College of Agriculture, Nagpur. The experiment was laid out in Split Plot Design with nine treatment combinations with four replications consisting three levels of sowing date *i.e.* 42nd MW, 43rd MW, 44th MW and three varieties *i.e.* AKS-207, Bhima, PKV (Pink) AKS-311. Various sowing dates significantly influenced the growth and yield of safflower varieties. Sowing of different varieties under different dates significantly influenced the plant height, dry matter accumulation plant^{-1}, number of branches plant^{-1} and days to maturity. The yield contributing characters such as number of capitula plant^{-1}, number of seeds capitula^{-1}, seed yield plant^{-1}, test weight, seed and straw yield (kg ha^{-1}) and harvest index. Among the three cultivars AKS-207 recorded the higher growth and yield attributing characters which resulted in significantly higher seed yield over the varieties Bhima and PKV (Pink) AKS-311. In case of weather parameters, temperature requirement is highest when crop sown on 42nd MW than rest of the sowing dates. Safflower varieties was not influence due to relative humidity .Agro-meteorological, sowing of safflower crop on 42nd MW was found suitable while variety AKS-207 performed better than Bhima and PKV (Pink) AKS-311.

(Key words: Safflower, sowing windows, cultivars)

INTRODUCTION

Safflower (*Carthamus tinctorius* L.) is an important *rabi* oilseed crop of Maharashtra apart from its superior adaptability to scanty moisture conditions, it produces oil rich in poly unsaturated fatty acids (linoleic acid 78%) which plays an important role in reducing the blood cholesterol level. The crop possesses deep and efficient root system and hence, it utilizes the soil moisture efficiently. The crop, being spiny, does not require protection from the stray cattle and birds. The oil content of whole seed ranges from 28 to 32%. The oil is also used for various industrial purposes. A number of products are developed from safflower such as carthamin pigments. This is used as a food additive for making herbal type of tea and extracting protein and amino acids.

India has the legitimate pride of being the largest producer of safflower in the world, grown on an area of 1.78 lakh ha with the production of 1.14 lakh tones. In India, Maharashtra contributes an area of 32.7 ha with the production of 15.7 tones and productivity of 481 kg ha^{-1} during the year 2017-2018, respectively. (Anonymous, 2018).

The optimum yield of safflower can be achieved through only two protective irrigations. It requires low input cost technology. There is a tremendous scope for expansion of area under safflower by replacing number of conventional dryland crops like wheat, chickpea, linseed and mustard in all potential areas of its cultivation in Jayakwadi and Purna commands in Marathwada and Vidarbha region. Despite three fold increases in the production of this crop in the last two decades, the present productivity of about 641 kg ha^{-1} in India (Anonymous, 2017) is still very low as compared to the yield of demonstrations conducted on the farmers fields with the improved methods of crop cultivation.

About 90% of the oilseed cultivation in India is under uncertain and abnormal weather conditions. Irregular rains and inadequate irrigation sources at maturity largely affect the final yield. Unlike food crops, oilseed crops are grown under low management situations. Full package of practices are not followed since the major category of oilseed growers are small and marginal farmers.

As safflower is a salt tolerant crop, hence suitable for command areas of Jayakwadi and Purna. It has wider range of elasticity both in rainfed as well as irrigated

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conditions due to its deep root system, xerophytic characters, thorniness and waxy coating of leaves, thus reducing the moisture use as compared to other *rabi* crops, the cost of cultivation of safflower crop is low with highest B:C ratio with minimum irrigations. This will result into increase in productivity of safflower there by sustaining the production in irrigated command areas.

The most important production factors in safflower are both soil and ambient temperature and soil moisture. Hence, sowing date assumes greater significance. Any delay in sowing resulted drastic reduction in seed yield and oil content. Sowing or planting the crop at right time is quite important. Early sowing with improved variety is one of most cost effective ways of increasing crop yield as reported by Daltalab *et al.* (2013) and Sahu and Thakur (2013) in safflower.

Cultivar selection is also a key management component in any cropping system even more critical in sowing date for crop production. All the varieties may not be suitable for timely as well as the late sowingin safflower (Soleymani *et al*., 2011 and Daltalab *et al.,* 2013).. The field and quality properties of safflower are largely determined by ecological factors and cultivation techniques.

Keeping above points in view, this study was conducted to investigate on the response of safflower cultivars to sowing windows in vertisols with the objectives,tostudy the effect of sowing dates on growth and yield of safflower cultivars, to find out optimum date of sowing for safflower cultivars and to work out economics.

MATERIALS AND METHODS

The experiment was conducted on Plot No.10 of the Agronomy farm, College of Agriculture, Nagpur, during *rabi* season 2017-18. The experiment was laid out in Split Plot Design with two factors *i.e*. sowing dates as main plot treatment and three varieties as sub plot treatment, thus making nine treatment combinations, replicated fourth.The distance between two replications was 1 m and 0.80 m between two plots. The gross and net plot size were 3.6 m × 4.0 m and 2.70 m × 3.20 m, respectively.Three varieties of Safflower namely V_1- AKS-207, V_2-Bhima and V_3-PKV (Pink) AKS-311 were sown in three different dates S_1-42nd MW (15th-21st October), S_2- 43rd MW (22nd-28th October) and S_3-44th MW (29th-04th November) to evaluate the optimum sowing date for *rabi* safflower. Sowing of safflower was done by manually, keeping 45 cm distance between the rows. All the agronomic package of practices were followed to maintain a healthy crop.

Observations were recorded on five randomly selected plants on plant height (cm) and number branches plant^{-1} at 30, 60, 90 DAS and at harvest, final plant stand, dry matter accumulation plant^{-1}, days to maturity, number of capitula plant^{-1}, number of seeds capitula^{-1}seed yield plant^{-1} (g),test weight (g), seed yield (kg ha^{-1}), straw yield (kg ha^{-1}) and harvest index (%) at harvest.

Thermal requirement observations were recorded with the help of line quantum sensor (LI-191 SA) at 12.00 hrs, once in a week. Thermal (temperature) requirement , also referred as thermal unit, for each calendar day during the crop period, for all the treatment were calculated from daily weather data on maximum and minimum temperature as under-

$$\text{Thermal requirement} = \frac{T_{max} + T_{min}}{2 - T_{base}}$$

Where

T_{max} - maximum temperature
T_{min} - minimum temperature
T_{base} - base temp as 10^0C

Base temperature is the temperature below which the physiological activities in plant practically cease and as a result plant does not show any growth. It is considered as 10^0C for safflower crop.Further total thermal unit requirement over crop period under each treatment was calculated by summation.In present study, the base temperature of safflower was taken as 10^0C.Relative humidity for each crop growth in respect of each treatment were added together so as to obtain relative humidity requirement in percentage during that crop period. Mean relative humidity over crop period under each treatment was calculated by summation.

Analysis of varience was used for statistical analysis. The critical difference was worked out at 5% level of significance and F value was used to differentiate significant or non significant effects. The treatment effects are presented by preparing tables of means with appropriates standard error of means (SE(m)±) and critical difference (CD) values, in respect of various aspects studied

RESULTS AND DISCUSSION

Data regarding effect of diferent sowing dates and varieties on diffèrent parameters in safflower are presented in table 1.

Plant stand plot^{-1}

Data regarding plant stand of safflower recorded at 12 DAS and at harvest are presented in table 1. The data revealed that emergence count and final plant stand at harvest of safflower as influenced by different sowing dates was statistically non-significant during the investigation. Interaction effect due to sowing dates and varieties on final plant stand at harvest was found to be non-significant during the study.

Plant height

Data collected in respect of mean periodical plant height of safflower as influenced by different treatments are presented in table1. It was observed that the mean plant height increased with advancement in the age of the crop till harvest. The mean initial plant height was 26.11 cm at 30 days and increased up to 98.22 cm at harvest. The data also

revealed that the plant height influenced by sowing dates was found non-significant at 30 DAS, whereas the plant height recorded at 60, 90 DAS and at harvest was found to be significant.Safflower sown during 42nd MW had recorded maximum plant height was at par with 43rd MW at 60, 90 DAS and at harvest and both sowing dates were found significantly superior over 44th MW.This might be due to congenial climatic condition for better germination and further growth and development of *rabi* safflower crop. Similar to this results Soleymani *et al.* (2011) reportedthat the first planting time (19th October) had the highest plant height (96.67 cm) than second (3rd November) and third (29th November) sowing respectively in safflower and Tayebi *et al*. (2012) reported highest plant height (86.01 cm) in the conventional planting date in comparison with the delayed planting date respectively in safflower.The data on plant height revealed that height of plant recorded at 60, 90 DAS and at harvest was significantly influenced by different varieties except at 30 DAS. The variety AKS-207 recorded significantly higher plant height *viz,*. 64.17 cm, 82.76 cm, and 99.83 cm at 60, 90 DAS and at harvest respectively, whereas it was at par with variety Bhima at 60, 90 DAS and at harvest. Significantly lowest plant height was recorded by variety PKV (Pink) AKS-311.This might be due to genetically characters of AKS-207. Similar to this findings Odivi *et al*. (2013) reported that significantly highest plant height (89.5 cm) was recorded in Isfahan land race genotype over other genotypes viz ; Zenderood (76.7 cm) and Goldasht (63.1 cm) respectively.Interaction due to sowing dates with varieties was found to be non-significant at all the stage of crop growth.

Dry matter accumulation plant^{-1}

Data regarding mean dry matter accumulation plant^{-1} at harvest are presented in table 1. Dry matter production of safflower was significantly influenced by different sowing times indicating that, sowing taken on 42nd MW recorded significantly higher dry matter accumulation (99.67 g) at harvest of safflower crop than 44th MW sowing date. However, it was at par with 43rd MW at harvest.During present investigation it was observed that there was a progressive decrease in dry matter accumulation as sowing delayed and lowest dry matter accumulation (84.25 g) was recorded in sowing taken on 44th MW. Similar results were reported by Soleymani *et al.* (2011) observed highest, leaf dry weight (121.0 g/cm^2) and total dry weight (968.6 g/cm^2) in the first planting time (19th October) than second (3rd November) and third (29th November) sowing respectively in safflower..The dry matter production at harvest was significantly influenced due to different varieties. Variety AKS-207 recorded maximum dry matter at harvest (93.92 g) but it was at par with variety Bhima. However, minimum dry matter accumulation recorded by variety PKV (Pink) AKS-311 (92.50 g) which was at par with Bhima. This was due to the meteorological conditions at that time and plant spread. Interaction effect between sowing dates and varieties was found to be non-significant for dry matter accumulation plant^{-1} at harvest.

Number of branches plant^{-1}

The data presented in (Table 1) revealed that effect of sowing dates on number of branches plant^{-1} was found significant at 60, 90 DAS and at harvest and number of branches plant^{-1} at 30 DAS was found to be non-significant. Sowing of safflower on 42nd MW produced maximum number of branches (13.58) which was at par with sowing done on 43rd MW at 60, 90 DAS and at harvest. Similar to this result Talal (2015) reported that second and third date of sowing in late December resulted in a significant increase in vegetative growth number of branches in safflower. The data presented in table1 indicated that the effect of varieties on number of branches plant^{-1} was significant at 60, 90 DAS and at harvest except at 30 DAS. The significantly higher number of branches was produced with AKS-207 variety (12.42), but it was at par with variety Bhima at 60 DAS. Lowest number of branches were recorded by variety PKV (Pink) AKS-311 at all the growth stages of crop growth.This might be due to varietal performance to *rabi* growing period. These results are in accordance with those reported by Rahim (2008), who observed that highest values was recorded by F6 for number of branches (11.6 plant^{-1}). Interaction effect between sowing dates with varieties was found to be non-significant at all stages of crop growth.

Days to maturity

The days to maturity was significantly influenced due to varieties and sowing dates.The data presented in table1 revealed that the mean days to maturity was 134.58.The data regarding to days to maturity as influenced by different dates of sowing are presented in table1. It was significantly influenced by different sowing dates. Sowing during 42nd MW recorded minimum maturity duration (132.92) which was at par with 43rd MW. The maximum maturity days i.e.136.67 days was recorded by 44th MW.The data regarding to days to maturity as influenced by different varieties are presented in table1. The different varieties were significantly influenced. Variety AKS-207 (V_1) recorded minimum days of maturity(133.33) whereas, it was at par with variety Bhima (V_2) and maximum days to maturity was recorded by variety PKV (Pink) AKS-311 (V_3) (135.58). This was due to the meteorological condition at that time and genetic factor of those varieties.The interaction between sowing dates and varieties was found non-significant in respect of days to maturity.

Number of capitula plant^{-1}

The number of capitula plant^{-1} at harvest was significantly influenced due to varieties and sowing times. The data presented in table1 revealed that the mean number of capitula plant^{-1} at harvest was 27.39.Sowing taken during 42nd MW had recorded significantly higher number of capitula (29.75) than other sowing dates. Late sowing recorded significantly lower number of capitula. Subsequent late in sowing resulted significant reduction in total number of capitula plant^{-1}. In accordance to this result Emami *et al.* (2011) also reported highest heads plant^{-1} (20.9) with first planting date (5 November: 1877 kg ha^{-1}) in safflower. Sahu

and Thakur (2013) also observed that maximum capitula plant^{-1} (26.21), were recorded with 1st November sown crop, which was significantly superior over 15th and 30th November on medium black soils at Indore. The data pertaining to number of capitula plant^{-1} at harvest was significantly influenced by different varieties. A variety AKS-207 recorded maximum number of capitula plant^{-1} (28.33) which was at par with variety Bhima and significantly lowest number of capitula plant^{-1} was recorded by variety PKV (Pink) AKS-311 (26.17) which was at par with Bhima variety. This has indicated that, the significant difference in number of capitula plant^{-1} due to different safflower varieties might be due to genetic makeup of cultivar. Similar to this finding Sahu and Thakur (2013) reported that highest number of capitula plant^{-1} (27.21) were found in A-1 than NARI-6 and NARI-57 respectively. The interaction effect between sowing times and varieties was found to be non-significant in respect of number of capitula plant^{-1} at harvest.

Number of seeds capitula^{-1}

The data pertaining to number of seeds capitula^{-1} as influenced by different treatments are presented in table1. The number of seeds capitula^{-1} was significantly influenced due to sowing dates and varieties. The data presented that the mean number of seeds capitula^{-1} at harvest was 27.22.The data pertaining to number of seeds capitula^{-1} hadsignificantly influenced by different sowing dates. Sowing during 42nd MW recorded significantly more number of seeds capitula^{-1} (29.33) than 43rd MW and 44th MW. In accordance to this result Sahu and Thakur (2013) observed maximum number of seeds capitula^{-1} (22.21) with 1st November sown crop, which was significantly superior over 15th and 30th November on medium black soils at Indore. The data presented in table1 revealed that variety AKS-207 recorded significantly maximum number of seeds capitula^{-1} (28.00) than Bhima and PKV (Pink) AKS-311.The interaction effect between sowing dates and varieties was not evident for number of seeds capitula^{-1} at harvest.

Seed yield plant^{-1} (g)

The data pertaining to seed yield plant^{-1} as influenced by different treatments are presented in table1. The seed yield plant^{-1} was significantly influenced due to sowing dates and varieties.Sowing taken on 42nd MW had recorded significantly higher seed yield plant^{-1} (23.50 g) than other sowing dates. This was due to low flower drop and more fruit setting during this season. The similar results were reported by Mohan *et al*. (2005) and supported the favourable effect of sowing times on seed yield in safflower.. A variety AKS-207 recorded significantly higher seed yield (22.42 g) than variety Bhimaand variety PKV (Pink) AKS-311. This was due to more number of branches plant^{-1} that helped in production of more number of matured or reproductive capitula. Similar to this results Daltalab *et al.* (2013) observed highest seed yield in Mex 33 cultivar (1856 kg ha^{-1}) and lowest was in Goldasht cultivar (1432 kg ha^{-1}) respectively in safflower. Similarly Sahu and Thakur (2013) recorded highest seed yield (1700 kg ha^{-1}) in A-1 than NARI-6 and NARI-57 respectively. The interaction effect between sowing dates and varieties was found be non-significant for seed yield plant^{-1} (g) at harvest.

Test weight (g)

Test weight was influenced by sowing dates and varieties in safflower. The data presented in table1 revealed that the mean thousand seed weight was 40.86 g.Sowing of safflower during 42nd MW significantly influenced mean thousand seed weight. Sowing at 42nd MW (41.83 g) increased number of capitula thereby increased thousand seed weight, whereas it was at par with 43rd MW (41.00 g).Significantly lowest test weight (39.75 g) was recorded under 44th MW. Similar to this result Kaihan *et al.* (2010) reported that highest 1000 seed weight (28.6 g) was obtained under first sowing date (25 June; 762.5 kg ha^{-1}) which was the best time for sowing of safflower than second (5 July; 560 kg ha^{-1}) and third (15 July; 392.2 kg ha^{-1}) sowing date. The data pertaining to thousand seed weight at harvest as influenced by different varieties was significantly influenced by different varieties. Thousand seed weight was influenced significantly by different varieties of safflower. Highest thousand seed weight was recorded by AKS-207 which was at par with variety Bhima (40.83 g). Lowest test weight (40.00 g) was recorded under variety PKV (Pink) AKS-311. In accordance to this result Kumar and Yadav (2007) observed that among different cultivars of safflower, NDR 8501 recorded significantly number of seeds plant^{-1} and weight of seeds plant^{-1} over Varna. The interaction effect between sowing dates and varieties was found to be non-significant for test weight (g) at harvest.

Seed yield (kg ha^{-1})

The data presented in table1 indicated that mean seed yield was 1623.42 kg ha^{-1}. Seed yield was affected by different treatments.The data pertaining to seed yield of safflower at harvest as significantly influenced by different sowing dates. Sowing at 42nd MW had recorded significantly higher seed yield (1736.92 kg ha^{-1}) than other sowing dates. This is due to the higher number of capitula plant^{-1}, seed yield plant^{-1} and thousand seed weight. Similar to this results Soleymani *et al*. (2011) observed that the first planting time (19th October) had the highest seed yield (2248.9 kg ha^{-1}) than second (3rd Nov; 1978.4 kg ha^{-1}) and third (18th Nov; 1588.6 Kg ha^{-1}) planting time, respectively in safflower.Data presented in table1 revealed that variety AKS-207 had recorded significantly higher seed yield as compared to variety Bhima and PKV (Pink) AKS-311. This might be due to the higher number of capitula plant^{-1}, seed yield plant^{-1} and thousand seed weight of AKS-207 variety. Similar to this result Sahu and Thakur (2013) reported highest seed yield (1700 kg ha^{-1}) in A-1 than NARI-6 and NARI-57 respectively in safflower. The interaction effect between sowing dates and varieties was found to be non-significant for seed yield (kg ha^{-1}) at harvest.

Table 1. Effect of different sowing dates and varieties on different parameters of safflower

Treatments	Final plant stand		Plant height (cm)				Dry matter at harvest (g)	Number of branches plant^{-1}				Days of Maturity
	Plot^{-1}	Ha^{-1}	30 DAS	60 DAS	90 DAS	At Harvest		30 DAS	60 DAS	90 DAS	At Harvest	
Sowing Dates												
S_1: 42nd MW	88.42	102338	26.67	64.50	83.82	100.58	99.67	3.08	7.50	10.50	13.58	132.92
S_2: 43rd MW	87.92	101759	26.33	63.67	83.10	99.33	95.50	2.83	7.25	9.08	11.75	134.17
S_3: 44th MW	87.17	100891	25.33	59.58	76.38	94.75	84.25	2.75	6.42	7.83	9.67	136.67
SE(m) ±	**1.49**	**-**	**0.87**	**0.31**	**0.26**	**0.40**	**0.40**	**0.24**	**0.13**	**0.31**	**0.17**	**0.51**
CD at 5%	**-**	**-**	**-**	**0.93**	**0.78**	**1.20**	**1.20**	**-**	**0.39**	**0.93**	**0.51**	**1.53**
Varieties												
V_1: AKS-207	89.83	103970	27.67	64.17	82.76	99.83	93.92	3.17	7.42	10.17	12.42	133.33
V_2: Bhima	87.67	101470	26.25	62.92	82.28	98.83	93.00	2.92	7.08	9.33	11.83	134.83
V_3: PKV (Pink) AKS- 311	86.00	99537	24.42	60.67	78.26	96.00	92.50	2.58	6.67	7.92	10.75	135.58
SE(m) ±	**1.04**	**-**	**0.88**	**0.44**	**0.17**	**0.45**	**0.35**	**0.17**	**0.18**	**0.18**	**0.16**	**0.48**
CD at 5%	**-**	**-**	**-**	**1.32**	**0.51**	**1.35**	**1.05**	**-**	**0.54**	**0.54**	**0.48**	**1.44**
Interaction												
SE(m) ±	**1.80**	**-**	**1.54**	**0.77**	**0.26**	**0.77**	**0.62**	**0.30**	**0.31**	**0.32**	**0.28**	**0.83**
CD at 5%	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
G.M.	87.83	101660	26.11	62.58	81.10	98.22	93.14	2.89	7.06	9.14	11.67	134.58

Table 1 continued

Treatment	Number of capitula	Number of seeds capitula^{-1}	Seek yield plant	Test weight (g)	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest Index (%)	Cost of cultivation (Rs ha^{-1})	Gross monetary return	Net monetary (Rs ha^{-1})	B:C ratio
Sowing dates											
S_1: 42nd MW	29.75	29.33	23.50	41.83	1736.92	4016.50	30.18	15725	55858	40133	3.55
S_2: 43rd MW	27.17	27.58	21.50	41.00	1682.42	4001.25	29.60	15725	54304	38579	3.45
S_3: 44th MW	25.25	24.75	20.00	39.75	1450.92	3724.50	28.03	15725	48534	32809	3.08
SE(m)±	**0.38**	**0.35**	**0.18**	**0.30**	**1.35**	**1.98**	**-**	**-**	**486**	**486**	**-**
CD at 5%	**1.14**	**1.05**	**0.54**	**0.90**	**4.05**	**5.94**	**-**	**-**	**1458**	**1458**	**-**
Varieties											
V_1: AKS-207	28.33	28.00	22.42	41.75	1678.25	3942.67	29.85	15725	56028	40303	3.56
V_2:Bhima	27.67	27.25	21.75	40.83	1672.33	3937.83	29.80	15725	55777	40052	3.54
V_3: PKV (Pink) AKS-311 2.98	26.17	26.42	20.83	40.00	1519.67	3861.75	28.23	15725	46890	31165	
SE(m)±	**0.35**	**0.23**	**0.16**	**0.34**	**1.84**	**1.93**	**-**	**-**	**428**	**428**	**-**
CD at 5%	**1.05**	**0.69**	**0.48**	**1.02**	**5.52**	**5.79**	**-**	**-**	**1284**	**1294**	**-**
Interaction											
SE(m)±	**0.61**	**0.41**	**0.29**	**0.59**	**3.18**	**3.35**	**-**	**-**	**741**	**166**	**-**
CD at 5%	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
G.M.	**27.39**	**27.22**	**21.67**	**40.86**	**1623.42**	**3914.08**	**29.28**	**15725**	**52898**	**37173**	**3.36**

Straw yield (kg ha^{-1})

Data in respect of straw yield (kg ha^{-1}) as influenced by different treatments are presented in table 1. Sowing taken on 42nd MW had recorded significantly higher straw yield (4016.50 kg ha^{-1}) than 43rd and 44th MW. Significantly lowest straw yield (3724.50 kg ha^{-1}) was recorded under 44th MW. This was due to the production of more number of capitula and branches plant^{-1}. Similar results were reported by Sahu and Thakur (2013), observed maximum straw yield (5683 kg ha^{-1}) in 1st November sown crop, which was significantly superior over 15th and 30th November on medium black soils at Indore. Data presented in table 1 revealed that variety AKS-207 produced significantly higher straw yield (3942.67 kg ha^{-1}) as compared to variety PKV (Pink) AKS-311, whereas it was at par with variety Bhima. This might be due to more plant height, number of branches, number of leaves and capitula contributed towards increase in straw yield. Similar to this results Sahu and Thakur (2013) recorded highest straw yield (5535 kg ha^{-1}) in A-1 than NARI-6 and NARI-57 respectively. The interaction effect between sowing dates and varieties was found to be non-significant for straw yield (kg ha^{-1}) at harvest.

Harvest index (%)

The mean harvest index was 29.28 per cent.The data in table1 revealed that sowing on 42nd MW recorded comparatively higher harvest index (30.18%) as compared to all other sowing dates. Similar results were found by Mostafa *et al*. (2007) and reported highest harvest index (38%), under 16th June sowing date than other sowing dates in safflower. The harvest index was comparatively higher in safflower variety AKS-207 (29.85%) than varieties Bhimaand PKV (Pink) AKS-311.

Gross monetary return and net monetary returns

Data on gross and net monetary returns as affected by different treatments are presented in table1. Mean gross and net monetary returns were Rs.52898 and Rs.37173 ha^{-1} respectively.Highest gross and net monetary returns of Rs.55858 ha^{-1} and Rs.40133 ha^{-1} respectively, were recorded when crop sown on 42nd MW which was at par with 43rd MW and significantly superior over 44th MW. Increase in net and gross monetary returns is due to significant increase in the seed yield of safflower.Highest gross monetary returns of Rs.56028 ha^{-1} and net monetary returns of Rs.40303 ha^{-1} were recorded with variety AKS-207 which was at par to variety Bhima and found significantly superior over PKV (Pink) AKS-311.The interaction of sowing dates and varieties was found to be non-significant.

B:C ratio

Mean B: C ratio of safflower crop obtained was 3.36. Highest B:C ratio of (3.55) was recorded with sowing on 42nd MW as compared to other sowing dates. Increase in B:C ratio is due to significant increase in gross monetary return.Comparatively higher B:C ratio (3.56) was recorded with variety AKS-207 over Bhima.

Thus, it is concluded from this study that sowing of safflower during 42nd MW significantly improved all the growth and yield components as compared to sowing of safflower during 43rd, and 44th MW resulted in significant increase in seed yield of safflower. Among the three different cultivars of safflower, AKS-207 recorded significantly higher growth and yield components resulting in increased seed yield as compared to Bhima and PKV (Pink) AKS-311.

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