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Inter and Intra Row Spacing Effect on the Growth, Seed Yield and Oil Content of Safflower *Carthamus tinctorius* L.

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Abstract: The experiment was laid-down to determine the inter and intra row spacing effect on the growth, seed and oil production of safflower crop. Three row spacing (25, 35, and 45cm) and three plant spacing (15, 22 and 30 cm) where applied to Thori-78 safflower variety. It was observed that crop maturity, plant height, number of branches, number of capitula, seed and oil content varied significantly between inter and intra row spacing as well as their interactions. Safflower planted at the distance of 45 x 30cm row to row and plant to plant recorded significantly maximum seed yield, plant height, oil production, branches and capitula number of the crop. However, closer space between row and plant (25 x 15cm) prolonged maturity days. Thus, it was concluded that safflower crop should be planted at 45 x 30 cm row and plant distance for maximum seed and oil production.

Key words: Safflower, inter and intra row spacing-seed, oil production

Introduction

Safflower is an important crop in the traditional farming of the semi arid areas of India, Iran, Egypt, Pakistan and other Mediterranean countries where the flowers were formerly used mainly as a source of dye. At present safflower is grown exclusively as an oil crop. Safflower, *Carthamus tinctorius L.* was one of the first crops to be grown in many countries in Asia, Europe and America. It belongs to the family composite. In the Mediterranean region about twenty five species of wild safflower are found, number of which are very similar to the cultivated species (Knowles, 1958) of these, *C. oxvantha* and *C. palaestinus* appear to be the most likely ancestors of the cultivated species. Although plant closely resembles some thorny/thistles that grow wild in the Mediterranean region, there is little or no danger of the safflower becoming a troublesome weed after introduction into new regions.

In parts of California, as well as in Pakistan safflower is grown frequently after the rice crop when the soil does not dry out sufficiently to permit early winter sowing of cereals. Safflower can produce a good crop on such soil to a considerable depth is actually an advantage under these circumstances, as the drying has beneficial effects (Chaudhary *et al.*, 1988). In Pakistan, safflower is being grown in the province of Sindh in a limited scale. It is also grown in rice harvested land in upper Sindh and as irrigated crop in lower Sindh. The area under safflower is about 49 thousand hectares with an annual production of 64 metric tones, which is very less (Anonymous, 2001). It might be due to no proper policy like support price or lack of exploitation about the importance of its oil, as well as lack of decimation of improved technology in the region. Safflower can be sown on land that was prepared and fertilized for a cereal crop. Shallow sowing (maximum 5cm) is very important for good emergence (Classen and Kiesselbach, 1945). The seed should, however, be placed in moist soil and press wheels should be used. Seeding at 18 to 25cm row interval is the common practice for safflower sowing in dry land areas (Anonymous, 1961). It was also observed that among various package of improved production technology proper plant population with appropriate adjustment row and plant distances play pivotal role in enhancing the safflower production. In Pakistan, Qayyum *et al.* (1996) found that safflower seed yield varied significantly between row spacing. The rows spaced at 50cm gave maximum seed yield of safflower crop. Looking the above facts an experiment was carried-out to assess the inter and intra row spacing for the safflower crop as farmer guideline for achieving maximum yield and oil production.

Materials and Methods

The experiment was carried out at Sindh Agriculture University Tandojam, Pakistan having three row spacing (25, 35, and 45cm) and three plant spacing (15, 22 and 30 cm). The treatments were laid-down in Randomized Complete Block Design, data analysis was performed following the procedures of Gomez and Gomez (1984).

The land was prepared with two dry plowing each followed by clod crushing and leveling to eradicate the weeds and uniform distribution of irrigation water. Homogenous seeds of standard safflower variety Thori-78 was drilled following the rows and plant spacing by single coulter hand drill. The plant spacing was maintained just before first irrigation application. The fertilizer was incorporated at the rate of 134-67 NP Kg ha^{-1}. The full dose of phosphorus with half dose of nitrogen was applied at the time of sowing, while the remaining nitrogen was split and added at the time of flowering and grain filling stages. All the plots were kept free from insects and weeds. The chemicals were applied when ever necessary.

Results and Discussion

Days to maturity: The results of the experiment showed that wider row spacing (45cm) recorded early days to crop maturity (152.78 days). Plant spaced at 15cm apart resulted prolonged maturity followed by optimum (22cm) and wider (30cm) which exhibited 161.95, 158.17 and 153.32 maturity days respectively. The interaction between closer distance between rows and within plants (25 x 15 cm) recorded maximum (166.75) days to maturity, followed by 25 x 22cm (162.95 days) and 35 x 15cm (161.85 days) respectively. However, the wider row and plant spacing (45 x 30cm) displayed early maturity (147.80 days). The findings are supported by Mundel *et al.* (1994) who reported that closer row spacing increased maturity days.

Plant height: Statistical analysis for plant height showed significant differences among the rows and plant spacing. The plants spaced in rows 45cm apart produced taller plants (131.00 cm), followed by optimum (35cm) and closer (25cm) distance between row giving 126.20 and 121.88 cm, respectively. The closer plant spacing (15cm) produced also shorter plants (120.30 cm). The interaction of 45 x 30cm row and plant spacing showed greater plant height (136.00 cm) followed by 45 x 22cm row and plant spacing giving 132.80 cm. The recent results confirms the findings of Qayyum *et al.* (1986) who reported hat Trori-78 exhibited taller plants at an optimum plant and row spacing or plants should be planted at maximum distance for their growth and development.

Number of branches per plant: Data presented in the Table 1 shows that number of branches in safflower crop were higher when the crop was sown in rows of 45cm apart followed by 35 and 25cm respectively. It was also noted that safflower crop kept in the wider plant distance of 30cm produced more branches followed by 22cm plant distance. The interaction of 45 x 30cm row and plant distance was found to be best which produced 12.90 branches per plant, however, the closer row and

Table 1: Safflower plant characters under inter and intra row and plant spacing

Plant Spacing (cm)	Row spacing (cm) 45	35	25	Mean
Day to maturity				
30	147.80	153.45	158.70	153.32c
22	153.30	158.25	162.95	158.17b
15	157.25	161.85	166.75	161.95a
Mean	152.78c	157.85b	162.80a	
Plant height (cm)				
30	136.00	131.30	129.95	132.42a
22	132.80	126.20	121.30	126.77b
15	124.20	122.30	114.40	120.30c
Mean	131.00a	126.60b	121.88c	
Number of branches per plant				
30	12.90	9.15	6.10	9.38a
22	9.65	8.35	6.80	8.27b
15	8.20	7.30	6.55	7.35c
Mean	10.25a	8.27b	6.48c	
Number of capitula per plant				
30	59.00	51.95	33.70	48.23a
22	54.40	39.35	23.30	39.02b
15	40.10	30.55	18.15	29.73c
Mean	51.17a	40.62b	25.18c	
Seed yield (kg ha^{-1})				
30	1097.00	1012.00	898.75	1002.58a
22	1062.50	982.50	788.25	944.42b
15	991.00	905.00	695.00	863.67c
Mean	1050.17a	966.50b	794.00c	
Oil content (%)				
30	31.63	30.50	30.50	30.88a
22	30.75	30.50	29.88	30.38b
15	30.50	30.00	29.63	30.04c
Mean	30.96a	30.33b	30.00c	

Values followed by same letter are significantly different at $\propto = 0.05$

plant spacing 25 x 15 exhibited minimum number of branches (6.55). These results agree with the previous findings of Singh (1994) who concluded that growth parameters of safflower crop are significantly influenced by plant populations. Further, Blackshaw (1993) reported that plants sown at greater row and plant distance increased the biomass of the plant by producing healthy plant parts by receiving maximum sun light for the process of photosynthesis.

Number of capitula per plant: The results for capitula per plant showed significant differences among the tested row and plant spacing. The increasing row distance upto 45cm apart resulted maximum number of capitula per plant (51.17). The results also indicated that plant spaced at 30cm apart produced greater number of capitula per plant (48.23) and lower number of capitula appeared in the closer plant spacing (15cm). The interaction of row and plant spacing justified best at wider plant and row spacing. Similar results have been reported by Salera (1996) who observed that highest seed densities gave higher seed number but, reduced capitula per plant.

Seed and oil production: Seed yield significantly affected by row and plant densities. The wider spacing between row (45cm) proportionally enhanced seed yield, followed by optimum distance between rows i.e., 35cm. It was also found that increasing plant spacing from 15 to 30cm progressively increased seed yield. The interaction between wider row and plant distance of 45 x 30cm produced maximum seed yield, followed by 45x22cm^2 and 35 x 30cm, respectively. The results agree with the findings of Salera (1996) and El-Sharma *et al.* (1980). The increase in seed yield may be due to contribution of various yield and growth parameters which were higher at wider plant and row spacing. The safflower seed extracted from each treatment showed that increasing spacing upto 45cm correspondingly improved the oil content of the seed, followed by 35cm, while narrow row spacing resulted in low oil content of the seed. The increasing distance within plants significantly increased oil content of seed. Majid *et al.* (1978) also reported that row spacing at adequate to maximum distance displayed greater oil content percentage in safflower crop. However, Salera (1996) observed that higher planting densities produced greater oil content of seed.

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