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EFFECT OF DIFFERENT PLANTING DENSITY OF SUNFLOWER VARIETIES ON YIELD AND YIELD ATTRIBUTING CHARACTERS IN RICE-RICE-SUNFLOWER CROPPING PATTERN

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ABSTRACT

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The experiments were carried out at the Agronomy Experimental Field of Patuakhali Science and Technology University, Dumki, Patuakhali in order to evaluate the effect of sowing date and planting density on the yield and yield contributing characters of sunflower varieties. The experiment comprised of two varieties viz. BARI Sunflower2 and Hysun33 and six planting densities viz. 40cm×25cm, 40cm×35cm, 40cm×45cm, 50cm×25cm, 50cm×35cm, 50cm×45cm. The experiment was laid out in a split-plot design with three replications, where the variety was assigned in the main plot and planting density was assigned as sub-plot treatment. Planting density had a significant influence on all the characteristics of morphological growth, yield, and yield contributing character except plant height at 75 DAS and 90 DAS. In case of Hysun33 variety, the highest number of leaves (21.89), leaf area (3214.22 cm²), head diameter (19.27 cm), head weight (539.07 gm), number of seed head⁻¹ (973.33), seed weight head⁻¹ (65.89 gm), thousand seed weight (67.73 gm), total seed yield (3.27 tha⁻¹) and harvest index (34.30 %) was obtained from 50 cm × 45 cm planting density. On the other hand, in case of BARI Sunflower2 variety the highest number of leaves (18.44), leaf area (3342.90 cm²), head diameter (18.73 cm), head weight (457.80 gm), number of seed head⁻¹ (832.17), seed weight head⁻¹ (53.39 gm), thousand seed weight (64.07 gm) was obtained from 50 cm × 45 cm planting density and the highest stover yield (8.04 tha⁻¹) and biological yield (10.73 tha⁻¹) were obtained from 40 cm × 25 cm planting density. The highest total seed yield (2.94 tha⁻¹) was obtained from 50 cm × 25 cm (8 plants m⁻²) planting density.

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INTRODUCTION

In Bangladesh, the production of oil is still below the need and the country has to supplement the needs for oil to meet the annual requirements by importing. Sunflower (*Helianthus annus* L.) is a newly introduced oilseed crop in Bangladesh that belongs to the family Compositae. Sunflower originally belonged to subtropical and temperate zones crop and it is widely adaptable and more drought tolerant than most other oilseed crops. It is well adjusted to soil with high water-holding capacity but is easily adapted to various soil conditions. It is gaining popularity among farmers for its quality oil and easy extraction method. The sunflower is grown in the southern part of the country on a very limited scale. Due to its short growing season, it can be grown well under the low-fertility soils in the newly reclaimed areas. So, sunflower could be one of the main suggested oil crops in the southern part of Bangladesh to solve the edible vegetable oil shortage in the country. Besides the cropping pattern of the coastal belt is T-aman rice-fallow-fallow. We can increase cropping intensity by cultivating sunflowers after harvesting the T-aman rice.

Yield and yield attributing characters are affected by varietal characters (Ibrahim and El-Genbehy, 2009). Different varieties show different performances in controlling environmental conditions. There are several agro-techniques that can enhance the production of yield such as the use of proper land preparation, sowing date, and proper plant spacing. Plant spacing has an effect on sunflower yield and seed oil percentage. Increasing plant spacing increased the seed and oil yield. The optimum plant density plays a great role in increasing sunflower productivity (Emam, 1999). Under favorable growing conditions it is expected that the yield of seed per unit area increase with increasing plant density up to a level that defines the optimum plant population. Due to increasing interplant competition for light and other factors, the yield of seeds of individual plants is expected to decrease with increasing plant density (Diepenbrock et al., 2001). There is no research work on the interaction of varieties and spacing of sunflowers in the southern non-saline area where the major cropping pattern is T-aman rice-fallow-fallow. For the above circumstances, the research work was done in this area to observe the effect of varieties and spacing of sunflowers.

MATERIALS AND METHODS

Description of the experimental site

The experiment was conducted at the Agronomic research field of Patuakhali Science and Technology University (PSTU), Dumki, Patuakhali-8602 with a geographical location of 22°27'90"N latitude and 90°23'29"E longitude at an altitude of 1.5 meters above the sea level.

Treatment of the experiment

The experiment consists of two sets of treatments; the first set comprises two different varieties and the second set comprises six planting distances.

1. Factor A: Varieties (a) Variety1 -BARI sunflower2 (b) Variety2- Hysun33

2. Factor B: Plant spacing (a) 40cm×25cm (b) 40cm×35cm (c) 40cm×45cm (d) 50cm×25cm (e) 50cm×35cm (f) 50cm×45cm

The experiment was laid out following a split-plot design with three replications. The sunflower varieties were assigned in the main plot and plant spacing was assigned in the subplot treatment. So, the number of plots was 36 (2 varieties × 6 Plant spacing×3 replication).The area of the subplot was 10m² (2.5m×4m). The row-to-row distance was 40cm and 50 cm. Plant-to-plant distances were 25cm, 35cm, and 45 cm.

Land preparation and application of manures and fertilizers

The experimental plot was harrowed, ploughed, and cross-ploughed three times followed by laddering to obtain good tilth. Weeds and stubbles were removed and finally obtained the desired tilth of soil. Finally, the land was prepared and the same amount of fertilizers such as urea (180 kg ha⁻¹), TSP (160 kg ha⁻¹), MOP (150 kg ha⁻¹), gypsum (150 kg ha⁻¹), zinc sulfate (8 kg ha⁻¹), boric acid (10 kg ha⁻¹), and cow dung (10 t ha⁻¹), were applied according to the BARI fertilizer recommended guide in each plot (Azad et al., 2020).

Seeds sowing and intercultural operations

The seeds of sunflower (HUSAN33 and BARI sunflower2) were sown manually. Three seeds were placed on every hill. All the intercultural operations like thinning, gap filling, irrigation, weeding, insect and pest management, etc. were done according to BARI (Azad et al., 2020).

Sampling, harvesting, and processing

Five plants from each plot were randomly selected and marked with a sample card. Plant height and leaf area index were recorded from selected plants at an interval of 15 days starting from 45 days after sowing to 90 days after sowing and at harvest. Harvesting was done depending on the full maturity of the head. The harvested crop of each plot was separately bundled, properly tagged, and then dried in the sun. The straw was also sun-dried properly.

Data collection

The following data were recorded:

1. Plant height, 2. Number of leaves per plant, 3. Leaf area index, 4. Diameter of head (cm), 5. Weight of head (g), 6. Number of filled seeds per head, 7. Total seed weight per head (g) 8. Thousand seed weight (g), 9. Seed yield (ton/ha), 10. Stover yield, 11. Biological yield, 12. Biomass (t/ha), 13. Harvest index (%)

Statistical analysis

The mean values of all the characters were calculated and analysis of variance was performed by using the 'Analysis of variance technique' with the help of the SPSS computer program the mean differences were compared by Duncan's Multiple Range Test at a 5% level of significance (Gomez and Gomez, 1984).

RESULT AND DISCUSSION

Interaction effect of density and variety on plant height

The interaction effect of spacing and variety on plant height of sunflower showed significant variation (Table 1) with respect to plant height at different growth stages of sunflower. At 45 DAS and 60 DAS the highest plant height was observed from BARI Sunflower2 at 50 cm x 45 cm (4.44 plants m⁻²) spacing. But at 60 and 90 DAS the highest plant height from Hysun33 at 50 cm x 45 cm (4.44 plants m⁻²) spacing.

Table 1. Interaction effect of planting density and variety on plant height of sunflower

Spacing	Varieties	Plant Height (cm) at			
		45 DAS	60 DAS	75DAS	90DAS
40 cm x 25 cm	BARI Sunflower2	70.33 b	134.23 b	153.87	173.87
	Hysun33	51.17 c	110.53 d	155.37	176.77
40 cm x 35cm	BARI Sunflower2	74.90 ab	141.03 ab	157.53	178.60
	Hysun33	54.30 c	116.80 cd	159.53	181.03
40cmx45cm	BARI Sunflower2	78.40 ab	144.27 ab	160.27	183.43
	Hysun33	55.25 c	120.20 cd	164.67	186.53
50 cm x 25 cm	BARI Sunflower2	71.89 b	137.67 ab	155.37	176.57
	Hysun33	52.57 c	113.47 cd	157.67	178.13
50 cm x 35 cm	BARI Sunflower2	76.27 ab	143.37 ab	159.00	181.87
	Hysun33	54.56 c	119.83 cd	162.33	184.27
50 cm x 45 cm	BARI Sunflower2	81.27 a	146.23 a	164.13	187.43
	Hysun33	56.83 c	122.10 c	168.53	189.50
Level of significance		*	*	NS	NS
CV (%)		6.33	4.09	4.46	4.35

Figures in a column followed by different letters differ significantly, but with a common letter (s) do not differ significantly at a 5% level of probability by DMRT. * = Significant at 5% level. NS= Not significant.

Interaction effect of density and variety on the number of leaves, leaf area, head diameter, head weight, and number of seeds per head

The interaction effect of density and variety on the number of leaves, leaf area, head diameter, head weight, and number of seeds per head of sunflower showed significant variation (Table 2). The highest number of leaves (21.89) was recorded from the Hysun33 variety at 50 cm × 45 cm (4.44 plants m⁻²) spacing and the lowest number of leaves (15.04) was recorded from BARI Sunflower2 at 40 cm × 25 cm (10 plants m⁻²) spacing. The highest leaf area (3342.90 cm²) was recorded from the BARI Sunflower2 variety at 50 cm × 45 cm (4.44 plants m⁻²) spacing and the lowest number of leaves (2019.91 cm²) was recorded from the Hysun33 variety at 40 cm × 25 cm (10 plants m⁻²) spacing.

Table 2. Interaction effect of planting density and variety on the number of leaves, leaf area, head diameter, head weight and number of seed head⁻¹ of sunflower

Spacing	Varieties	Number of leaves	Leaf area (cm ²)	Head diameter (cm)	Head weight (g)	Number of seed head ⁻¹
40 cm × 25 cm	BARI Sunflower2	15.04 f	2133.33 cd	13.90 e	274.60 d	590.00 g
	Hysun33	16.44 def	2019.91 c	14.67 de	319.47 cd	535.40 h
40 cm × 35 cm	BARI Sunflower2	16.66 def	2806.57 abc	15.47 cde	327.47 cd	762.37 de
	Hysun33	18.55 bcd	2577.27 bc	16.73 bcd	365.40 bcd	726.67 ef
40 cm × 45 cm	BARI Sunflower2	17.44 cde	3083.40 ab	17.27 abc	371.80 bc	797.61 cd
	Hysun33	19.88 ab	2768.33 abc	17.83 ab	392.60 bc	866.67 b
50 cm × 25 cm	BARI Sunflower2	15.33 ef	2321.05 bcd	14.87 de	337.27 cd	690.00 f
	Hysun33	17.11 c-f	2115.83 cd	15.27 cde	365.80 bcd	593.33 g
50 cm × 35 cm	BARI Sunflower2	17.00 c-f	2926.88 abc	16.73 bcd	366.67 bcd	794.97 cd
	Hysun33	19.11 bc	2842.38 abc	17.17 abc	389.93 bc	846.67 bc
50 cm × 45 cm	BARI Sunflower2	18.44 bcd	3342.90 a	18.73 ab	457.80 ab	832.17 bc
	Hysun33	21.89 a	3214.22 a	19.27 a	539.07 a	973.33 a
Level of significance		*	*	*	*	**
CV (%)		6.84	13.31	6.99	13.96	4.05

Figures in a column followed by different letters differ significantly, but a common letter (s) does not differ significantly at a 5% level of probability by DMRT. * and ** = Significant at 5 and 1% level, respectively. NS= Not significant

The highest head diameter (19.27 cm) was recorded from the Hysun33 variety at 50 cm × 45 cm (4.44 plants m⁻²) spacing and the lowest head diameter (13.90 cm) was recorded from BARI Sunflower2 at 40 cm × 25 cm (10 plants m⁻²) spacing. The highest head weight (539.07 gm) was recorded from the Hysun33 variety at 50 cm × 45 cm (4.4 plants m⁻²) spacing and the lowest head weight (274.60 gm) was recorded from BARI Sunflower2 at 40 cm × 25 cm (10 plants m⁻²) spacing. The highest number of seeds per head (973.33) was recorded from the Hysun33 variety at 50 cm × 45 cm (4.44 plants m⁻²) spacing and the lowest number of seeds per head (535.40) was recorded from the Hysun33 variety at 40 cm × 25 cm (10 plants m⁻²) spacing.

Interaction effect of density and variety on thousand seed weight, total seed yield, stover yield, biological yield, harvest index

The interaction effect of density and variety on thousand seed weight, total seed yield, stover yield, biological yield, and harvest index of sunflowers showed significant variation (Table 3).

Table 3. Interaction effects of density and variety on the weight of seed head⁻¹, 1000 seed weight, yield stover yield, biological yield and harvest index of sunflower

Spacing	Variety	Weight of seed head ⁻¹ (g)	1000 seed weight (g)	Seed yield (t ha ⁻¹)	Stover yield (t ha ⁻¹)	Biological yield (t ha ⁻¹)	Harvest index (%)
40 cm x 25 cm	BARI Sunflower2	29.64 f	50.33 e	2.70 cde	8.04 ab	10.73 ab	25.14 cd
	Hysun33	28.00 f	52.27 de	2.55 e	8.61 a	11.16 a	22.80 d
40 cm x35cm	BARI Sunflower2	43.73 d	57.23 b-e	2.75 b-e	7.03 cde	9.78 d	28.12 bc
	Hysun33	43.08 d	59.13 bcd	2.76 b-e	7.27 cd	10.03 cd	27.68 bc
40cmx45cm	BARI Sunflower2	47.49 cd	59.50 bcd	2.59 e	6.52 efg	9.11 ef	28.47 bc
	Hysun33	54.55 b	62.97 abc	3.07 ab	6.80 def	9.87 d	31.13 ab
50 cm x 25 cm	BARI Sunflower2	36.80 e	53.33 e	2.94 a-d	7.53 bc	10.48 bc	28.16 bc
	Hysun33	32.94 ef	55.67 cde	2.63 de	8.03 ab	10.66 ab	24.82 cd
50 cm x 35 cm	BARI Sunflower2	46.93 cd	59.07 bcd	2.54 e	6.59 efg	9.13 ef	27.82 bc
	Hysun33	52.53 bc	62.03 abc	3.01 abc	6.87 ef	9.88 d	30.52 b
50 cm x 45 cm	BARI Sunflower2	53.39 bc	64.07 ab	2.56 e	6.14 g	8.70 f	29.42 b
	Hysun33	65.89 a	67.73 a	3.27 a	6.27 fg	9.54 de	34.30 a
Level of significance		*	*	*	*	*	*
CV (%)		7.57	7.12	6.48	4.74	3.16	6.85

Figures in a column followed by different letters differ significantly, but with a common letter (s) do not differ significantly at a 5% level of probability by DMRT. *, ** and *** = Significant at 5, 1 and 0.1%, respectively. NS= Not significant

The highest thousand seed weight (67.73 gm) was recorded from the Hysun33 variety at 50 cm x 45 cm (4.44 plants m⁻²) spacing and the lowest thousand seed weight (50.33 gm) was recorded from BARI Sunflower2 at 40 cm x 25 cm (10 plants m⁻²) spacing. The highest total seed yield (3.27 t ha⁻¹) was noted from the variety of Hysun33 at 50 cm x45 cm (4.44 plants m⁻²) spacing and the lowest total seed yield (2.54 t ha⁻¹) was recorded from BARI Sunflower2 at 50 cm x 35 cm (5.71 plants m⁻²) spacing. Hysun33 variety produced the highest (3.27 t ha⁻¹) total seed yield at 50 cm x 45 cm (4.44 plants m⁻²) spacing on the other hand BARI Sunflower2 produced the highest (2.94 t ha⁻¹) total seed yield at 50 cm x 25 cm (8 plants m⁻²) spacing. The highest stover yield (8.61t ha⁻¹) was recorded from the Hysun33 variety at 40 cm x 25 cm (10 plants m⁻²) spacing and the lowest stover yield (6.14 t ha⁻¹) was recorded from BARI Sunflower2 at 50 cm x 45 cm (4.44 plants m⁻²) spacing. The highest biological yield (11.16t ha⁻¹) was noted from the variety of Hysun33 at 40 cm x 25 cm (10 plants m⁻²) spacing and the lowest biological yield (8.70t ha⁻¹) was recorded from BARI Sunflower2 at 50 cm x 45 cm (4.44 plants m⁻²) spacing. The highest harvest index (34.30 %) was recorded from the Hysun33 variety at 50 cm x 45 cm (4.44 plants m⁻²) spacing and the lowest harvest index (22.80 %) was also recorded from the Hysun33 variety at 40 cm x 25 cm (10 plants m⁻²) spacing. As low-density plants produced low biological yield, here Hysun33 variety showed the highest harvest index percent and the high-density Hysun33 variety showed a low harvest index percent.

DISCUSSION

The differences between the tested sunflower genotypes may be due to the differences in their genetic constituents. Similar results were reported by Ali et al., (2014), Nasim et al., (2017), and Ibrahim (2012). Variations in varietal performance were reported by several researchers (Abou-kresha et al., 1996, Ibrahim and El-Genbehy, 2009). However, the yield and yield component might be influenced by different environmental and other factors like sowing time (Lipi and Maniruzzaman, 2023). The wider spacing between rows of sunflowers was shown to produce higher values in 1000-seed weight and seed yield as compared with narrow ones. This may be due to better environmental conditions in wide spacing and less competition between plants as well as increased light penetration within plant canopy which increased assimilation rate and oil formation. These results are in agreement with the findings of some researchers (Beg et al., 2007; Tenebe et al., 2008). The increase in seed yield with increasing plant spacing might be attributed to an increase in head diameter and 1000 seed weight (Al-Thabet, 2006; Kazemeini et al., 2009). These results are in parallel with those obtained by Ali et al., 2014; Al-Thabet, 2006; Awais et al., 2013; Basha, 2000; Ibrahim, 2012; Killi, 2004; Mojiri and Arzani, 2003; Zheljzkov et al., 2009) who found that plant spacing has a positive effect on yield and its components.

The head diameter, number of seeds per head, and 100–seed weight decreased with the increase in spacing while the yield increased (Narwal and Malik, 1985). The increased plant density resulted in a significant increase in seed yield (Sterjo, 1989; Kene et al., 1992; Killi and Özdemir, 2001). Less plant competition for water, nutrients, and light in low plant population plots increased vegetative growth (Iqbal et al., 2007). There is more competition for water, nutrients, light, and other environmental factors between plants at high plant populations (Ali et al., 2011), resulting in reduced seed production (Beg et al., 2007) and less head diameter (Tenebe et al., 2008). The head diameter, thousand seed weight, and number of seeds per head were increased with increasing spacing (Al-thabet, 2006).

CONCLUSION

Planting density had a significant influence on all the characteristics of morphological growth, yield, and yield contributing characters except plant height at 75 DAS and 90 DAS. In case of Hysun33 variety, the highest number of leaves (21.89), leaf area (3214.22 cm²), head diameter (19.27 cm), head weight (539.07 gm), number of seed head⁻¹ (973.33), seed weight head⁻¹ (65.89 gm), thousand seed weight (67.73 gm), total seed yield (3.27 tha⁻¹) and harvest index (34.30 %) was obtained from 50 cm × 45 cm planting density. On the other hand, in case of BARI Sunflower2 variety the highest number of leaves (18.44), leaf area (3342.90 cm²), head diameter (18.73 cm), head weight (457.80 gm), number of seed head⁻¹ (832.17), seed weight head⁻¹ (53.39 gm), thousand seed weight (64.07 gm) was obtained from 50 cm × 45 cm planting density and the highest stover yield (8.04 tha⁻¹) and biological yield (10.73 tha⁻¹) were obtained from 40 cm × 25 cm planting density. The highest total seed yield (2.94 tha⁻¹) was obtained from 50 cm × 25 cm (8 plants m⁻²) planting density.

CONFLICT OF INTEREST

There is no conflict of research interest

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