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Yield, Profitability and Prospects of Sunflower Cultivation in Chapainawabganj District Bangladesh

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ABSTRACT

The present research was conducted to investigate the growth, yield, profitability and prospect of two sunflower varieties grown in Chapainawabganj District, Bangladesh. The study was carried out at the research field of EXIM Bank Agricultural University Bangladesh under the Barind tract during the Rabi season. Two varieties of sunflowers namely BARI Surjomukhi-3 (HYV) and DS 275 (Hybrid) were cultivated in the research field by making rows. All the growth and yield attributes were measured and compared between the sunflower varieties cultivated. The results of the experiment showed that the growth parameters such as plant height (198.73 cm), number of leaves plant^{-1} (32.67) and leaf length (37.08cm) were performed better in DS 275 (Hybrid) without stem diameter (2.58 cm), was better in BARI Surjomukhi-3 (HYV) than DS 275. The flowering duration (61 DAS) and maturity duration (103 DAS) were earlier in BARI Surjomukhi-3 (HYV). The head diameter (18.27 cm), 1000 seeds weight (61.92 g), number of unfilled grains (202.33 head^{-1}) responded better in BARI Surjomukhi-3 (HYV) but the number of filled grains (1711.33 head^{-1}) and yield (8.20 mound bigha^{-1}) were found to be better in DS 275 (Hybrid). Both the positive and negative correlation with grain yield and growth and yield parameters were obtained in the present study. The results on the BCR of BARI Surjomukhi-3 (HYV) and DS 275 (Hybrid) were 2.52 and 3.03, respectively. The present study will be helped the growers of Barind tract.

Keywords: Correlation, Profitability, Prospect, Sunflower cultivation, Yield

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1. INTRODUCTION

Sunflower (*Helianthus annuus* L.) belongs to the family Compositae. It is one of the major sources of oil in the world and assumed to be originated from southern United States where its progenitor or wild *H. annuus* was found (Heiser, 1978). Sunflower is a wide spread oilseed crop of the world and it is almost grown in all continents. Europe, America and Australia accounts for 80% of the total production of the world whereas Asia contributes to 18% and the rest 2% from Africa (Damodaran & Hege, 2010; Iqbal et al., 2009).

Acute shortage of edible oil has been prevailing in Bangladesh during the last several decades. This shortage inherited from the past has been met through imports, using a huge amount of foreign exchange every year. Bangladesh produces 0.358 million tons of edible oil against the annual

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demand of 1.6 million tons, while the remaining 1.242 million tons of the country's domestic requirements is met through imports (Khatun et al., 2016; Miah et al., 2013; Iqbal et al., 2009). Besides, the area under oilseeds cultivation is decreasing over the years due to various economic and technical reasons (Hossain, 2014). The total cultivated area of oil seeds was 1234969.71 acre and the production rate was 995543.71 Metric Tons in 2021 (BBS, 2021).

The per capita consumption of edible oil in Bangladesh increased by 20 per cent in the last five years to reach 18.4 kgs in 2020 but in 2016, the per capita consumption of edible oil stood at 15.3 kgs. The country's annual consumption of oils and fats currently stands at 30.3 lakh tonnes, 92 percent of which is met through imports. Bangladesh imported 27.73 lakh tonnes of edible oil, fats and oil seed worth $2.12 billion in the fiscal year 2019-2020 (Mirdha, 2022).

According to Food and Agricultural Organization (FAO), sunflower ranges second subsequent to soybean as an oil crop in the world. Sunflower is a good substitute when it's difficult to cultivate other crops due to climate hazards. There is high demand for sunflower because its oil is good for health as it contains low cholesterol (Gupta, 2014). The oil from sunflower, however, is a premium due to its light color, bland flavor, high smoke point and good nutritional quality (Alagawany, 2015; Bashir et al., 2015; Fowler, 2006). Moreover, sunflower has a wide adaptability, photoperiod insensitivity, high yield and easy for cultivation (Kaleem et al., 2011). One kg of sunflower seeds yields 500 to 600 grams of oil, which is more than that of any other oilseeds (Bashir et al., 2015). Rathore (2001) reported that oil derived from sunflower is called premium oil since it has a high level of unsaturated fatty acid, containing up to 60% of polyunsaturated fatty acid. Such an attribute makes sunflower oil the most preferred vegetable oil used in diets since it helps reduce cholesterol levels in the blood (Kefale & Sisay, 2017). Sunflower oil contributes about 13% of the world edible oil production with high value Yield (Zamaradi et al., 2020). Due to its larger adaptation capability and higher oil quality, sunflower can be grown almost in all the regions of the world with high seed yield and oil content (Skoric et al., 2012; Seiler & Jan, 2010). Since 1975, small-scale farmers in Bangladesh have begun growing sunflowers (Miah et al., 2014). In Bangladesh's coastal region, farmers are growing sunflowers as a method of coping with climate change. Two crop production cycles are also popular as nutrition requirement of crops is supplemented by each other cultivation like sunflower, chickpea and Khesari after the cultivation of transplanted Aman in coastal regions (Rashid et al., 2014; Jahangir et al., 2006).

For increasing the sunflower production across the country, it is needed to increase the area by utilizing the fallow land. To meet the demand of edible oil, increasing production, marketing facilities, and processing of sunflower seed is needed. Therefore, this study will figure out the profitability of sunflower, farmers' perception on the problems, challenges and prospects of sunflower cultivation in Chapainawabganj district Bangladesh.

2. MATERIALS AND METHODS

The experimental field at main campus of EXIM Bank Agricultural University located in Jhilim 3, Amnura, Chapainawabganj, Bangladesh was chosen for this study. The study area's geographic location was between latitudes 24'22 and 24'57 and longitudes 87'23 and 88'23, was in the northwest of Bangladesh, where subtropical conditions predominated.

Generally, Chapainawabganj is dominated by tropical wet and dry climate. The monsoon high temperature with high humidity and moderate rainfall are the predominant feature of the climate of Chapainawabganj. The study area where conducted this research was a medium highland under the agricultural zone AEZ 26. The drainage condition of the studied soil was pretty well which contains silty clay loam soil. The soil consists of 48% porosity with 6.68 soil pH. Topography, flood level, soil color, infiltration rate of studied field was fairly leveled, above flood level, dark grey and 3 cm/hr (moderate), respectively.

The experimental was designed as Randomized Complete Block Design (RCBD) with three replications and 2 varieties, BARI Surjomukhi 3 (HYV) and DS 275 (Hybrid). BARI Surjomukhi 3 (HYV) seeds were collected from Kurigram district and DS 275 (Hybrid) seeds were collected from Naogaon district in Bangladesh.

Different intercultural operations such as irrigation, weeding, mulching, pest management and fertilizer management were practiced in the experiment for successful plant growth and development and suitable fertilizer doses were applied by the following Fertilizer Recommendation Guide (BARC, 2012) as AEZ 26. Proper Integrated Weed Management (IWM) was done to control the weed infestation in the experimental field. Harvesting was done at full maturity when 80% of the head turned yellowish in color.

As growth parameters, plant height (cm), number of leaves, leaf length (cm) and stem diameter (cm) were collected from two varieties. As yield parameter, duration of flowering and maturation of plant, head diameter (cm), number of filled grain, number of unfilled grain, 1000 seeds weight (g), yield (mound/bigha) were calculated. Duration of flowering was determined within the cultivated varieties studied by different times of flowering stages of plants were collected and calculated flowering time. The maturation time of plant also calculated from different the times of flowering stages. The data were analyzed with SPSS 2010.

The analysis of profitability performed considering only the variable production costs. These costs involved day labors, use of equipment's, the input cost (seed, fertilizer, pesticide, and irrigation). Net Returns (NR) were calculated by deducting the overall total variable cost (TVC) of cultivation from gross returns (GR). The benefit-cost ratio (BCR) was calculated finally for measuring profitability.

Table 1 Growth parameters of the studied two varieties of sunflower

Varieties	Plant height (cm) ($\bar{x}$±SD)	Leaf number ($\bar{x}$±SD)	Leaf length (cm) ($\bar{x}$±SD)	Stem diameter (cm) ($\bar{x}$±SD)
BARI Surjomukhi-3, HYV	105.72±1.30b	24.33±0.88b	33.51±0.32b	2.58±0.11a
DS 275, Hybrid	198.73±2.02a	32.67±0.33a	37.08±0.42a	2.20±0.15a
Significance level	***	***	**	NS

$\bar{x}$: Mean value; SD: Standard deviation; in a column, means followed by a similar letter(s) were not significantly different whereas, means followed by dissimilar letter(s) were significantly different. *, 5% level of significance; **, 1% level of significance; ***, 0.1% level of significance; NS, non-significant.

Table 2 Yield parameters of the studied sunflower varieties

Cultivars	Duration of flowering (days)	Duration of maturity (days)	Head diameter (cm)/plant	No. of filled grain / head	No. of unfilled grain/head	1000 seeds weight (g)	Yield (mound/ bigha)
BARI Surjomukhi-3, HYV	61.00±1.45 b	103.00±1.53b	18.27±0.65a	561.00±8.08b	202.33±3.93a	61.92±0.90a	6.83±0.12b
DS 275, Hybrid	78.00±1.45 a	112.00±1.45a	17.10±0.21a	1711.3±12.99 a	188.33±7.13a	34.02±0.17b	8.20±0.16a
Significance level	**	*	NS	***	NS	***	**

$\bar{x}$: Mean value; SD: Standard deviation; in a column, means followed by a similar letter(s) were not significantly different whereas, means followed by dissimilar letter(s) were significantly different. *, 5% level of significance; **, 1% level of significance; ***, 0.1% level of significance; NS, non-significant.

The method (BCR = GR/TVC) of Khatun et al. (2016) and Miah et al. (2013) used for calculating the BCR.

3. RESULTS AND DISCUSSION

3.1. Growth Parameters

Table 1 showed a significant difference at 0.1% in the plant height of two varieties of sunflower. The recorded plant height was found in DS 275 (Hybrid) was higher than BARI Surjomukhi-3 (HYV). The plant height of DS 275 (Hybrid) was shown 198.73 cm. It was 105.72 cm in BARI Surjomukhi-3 (HYV). Growth parameters were different in 10 different genotypes of sunflower (Gul & Coban, 2020). the reactions of the same genotypes to varying ecologies are different and yield and yield characteristics may vary depending on this (Schneiter & Miller, 1981). We observed changes in plant height due to the genetic differences between the genotypes and environmental conditions at different locations (Alem et al., 2016; Adugna & Labuschagne, 2003; Mostafa & Ashmawy, 1998;). Response of nitrogen and phosphorus fertilizer and plant spacing on growth and yield contributing character of sunflower (Jahangir et al., 2006).

The number of leaves was measured 32.67 in DS 275 (Hybrid) that was higher than 24.33 observed in BARI Surjomukhi-3 (HYV). The significant differences were observed at 0.1% level among the number of leaves between two sunflower varieties (Table 1).

The higher leaf length (37.08 cm) was recorded in the variety of DS 275 (Hybrid). The lower leaf length (33.51 cm) was noted in BARI Surjomukhi-3 (HYV). The differences of leaf length were significant at level of 1% (Table 1). Variation in leaf number and leaf length of sunflower plants among the varieties and enhanced number up to 18 days was recorded (Chbani et al., 2013).

Table 3 Pearson correlation value of different growth and yield parameters of two sunflower varieties

Parameters		Pearson Correlation value (r)
Growth	Plant height	0.964**
	Leaf length	0.999**
	Leaf number	0.931**
	Stem diameter	-0.640 NS
Yield	Duration of flowering	0.871*
	Duration of maturity	0.851*
	Head diameter	-0.558 NS
	Number of filled grain per head	0.966**
	Number of unfilled grains per head	-0.831*
	1000 seeds Weight	-0.966**

*, 5% level of significance; **, 1% level of significance; NS, non-significant

There have been no significant differences the stem diameter between two sunflower varieties, showed in Table 3. BARI Surjomukhi-3 (HYV) had noticed 2.58 cm stem diameter. The stem diameter (2.20 cm) was observed in DS 275 (Hybrid). Iqbal et al. (2018) reported the diameter of the stem to be 1.28– 1.66 cm. This result is similar to our results. The change in stem diameter varies depending on genetic, climatic, 13 and environmental factors and cultivation

techniques (e.g., irrigation, hoeing) (Arıoglu, 2007; Habibullah et al., 2007).

3.2. Yield Parameters

It was found that BARI Surjomukhi-3 (HYV) had the early flowering at 61 days after sowing, while DS 275 (Hybrid) had the late flowering at 78 days after sowing.

There were significant differences at 1% level of significance in duration of flowering between the two sunflower varieties studied (Table 2). The duration of maturity at 103 days after sowing was observed in BARI Surjomukhi-3 (HYV). It was 112 days after sowing in DS 275 (Hybrid). Statistically it was significant difference between two sunflower varieties at 5% level (Table 2).

Table 4 Cost of sunflower cultivation in the study areas

Particulars	Quantity	Cost Bigha^{-1} (Tk.)	Total Cost ha^{-1} (Tk.)	%
Land preparation (Ploughing of land)	3 tillage	1200	8964	11.08
Labor	4	1600	11952	14.78
Seed	HYV – 150 tk/kg	210	1568.7	13.32
	Hybrid seed- 880 tk/kg	1232	9203.4	
Fertilizers (Urea, DAP, MoP, Gypsum, Magnesium Sulphate & Borax)		1450	10831	13.39
Pesticides, Vitamins & Hormone		1250	9337	11.54
Irrigation	3	480	3585	4.43
Miscellaneous		400	3000	3.71
A. Total variable cost		7822	58441.1	72.25
B. Total fixed cost (Tk)				
Land use		3000	22410	27.72
C. Total cost (Tk) (A+B)		10822	80851	100

Table 5 Profitability of sunflower cultivation (Tk ha^{-1})

Variety	Yield Kg/bigha	Price (Tk kg^{-1})	Gross Return (main product) (Tk)	Net Return (Tk)	BCR
BARI surjomukhi 3 (HYV)	273.33	100	27333	16511	2.52
DS 275 (Hybrid)	328	100	32800	21978	3.03

Head diameter was 18.27 cm in BARI Surjomukhi-3 (HYV), whilst it showed 17.10 cm in DS 275 (Hybrid). No significant differences were observed two sunflower varieties studied here. Previously reported average diameters of the genotypes of sunflower grown at different locations were 16.6–22.7 cm (Yılmaz & Emiroglu, 1995), 18.3–26.7 cm (Yılmaz & Bayraktar, 1996) and 13.64–16.29 cm (Iqbal et al., 2018).

Significant differences in the number of filled grains at 0.1% level noticed between two sunflower varieties (Table 2). It was found that DS 275 (Hybrid) had the higher number of filled grains (1711.03grains/head) than BARI Surjomukhi-3 (HYV) (561.00 grains head). The number of unfilled grains/heads was higher in BARI Surjomukhi-3 (HYV) than that of 33in DS 275 (Hybrid). The number of unfilled grains/heads (202.33) was found in BARI Surjomukhi-3 (HYV). It was 188.33in DS 275 (Hybrid). It showed that there were no significant differences between the numbers of unfilled grains of two sunflower varieties (Table 2). The similar study in rice was carried out previously (Rumanti et al., 2017).

The 1000 seeds weight (61.92 g) was found in BARI Surjomukhi-3 (HYV) that was higher than in DS 275 (Hybrid) (34.02 g). From statistical analysis, a significant difference in 1000 seeds weight was observed between two sunflower varieties at 0.1% level (Table 2). Mrdja et al. (2012) showed that sunflower production in terms of the 1000 seed weight differences between regions was 8.69%, and they stated that all the interactions of regional production areas are essential. Khan et al. (2008), according to the results of their adaptation study on sunflower thousand seed weight of genetic, environmental and climatic factors, have changed depending on the genetic. Ashok et al. (2000) also observed similarly high differences between sunflower genotypes at different locations. Our results have been slightly lower than the results of the researchers. Alem et al. (2016) 1000 seed weight of sunflower genotypes grown in different lotions between 47-68 g, Ozer et al. (2004) 61.87-61.98 g, Canavar et al. (2010) 53.40-69.77 g, Iqbal et al. (2018) found that it is between 56.66-68.66 g. These results are similar to our results.

A significant difference in the grain yield at 1% level between was observed between two different sunflower varieties (Table 2). According to the results of grain yield measurements, it was found that DS 275 (Hybrid) had higher grain yield (8.20 mound/bigha) than BARI Surjomukhi-3 (HYV) (6.83 mound/bigha). Ashok et al. (2000) also observed that there were similarly high differences between sunflower genotypes at different locations. When determining the effect of early sunflower genotypes on yield,

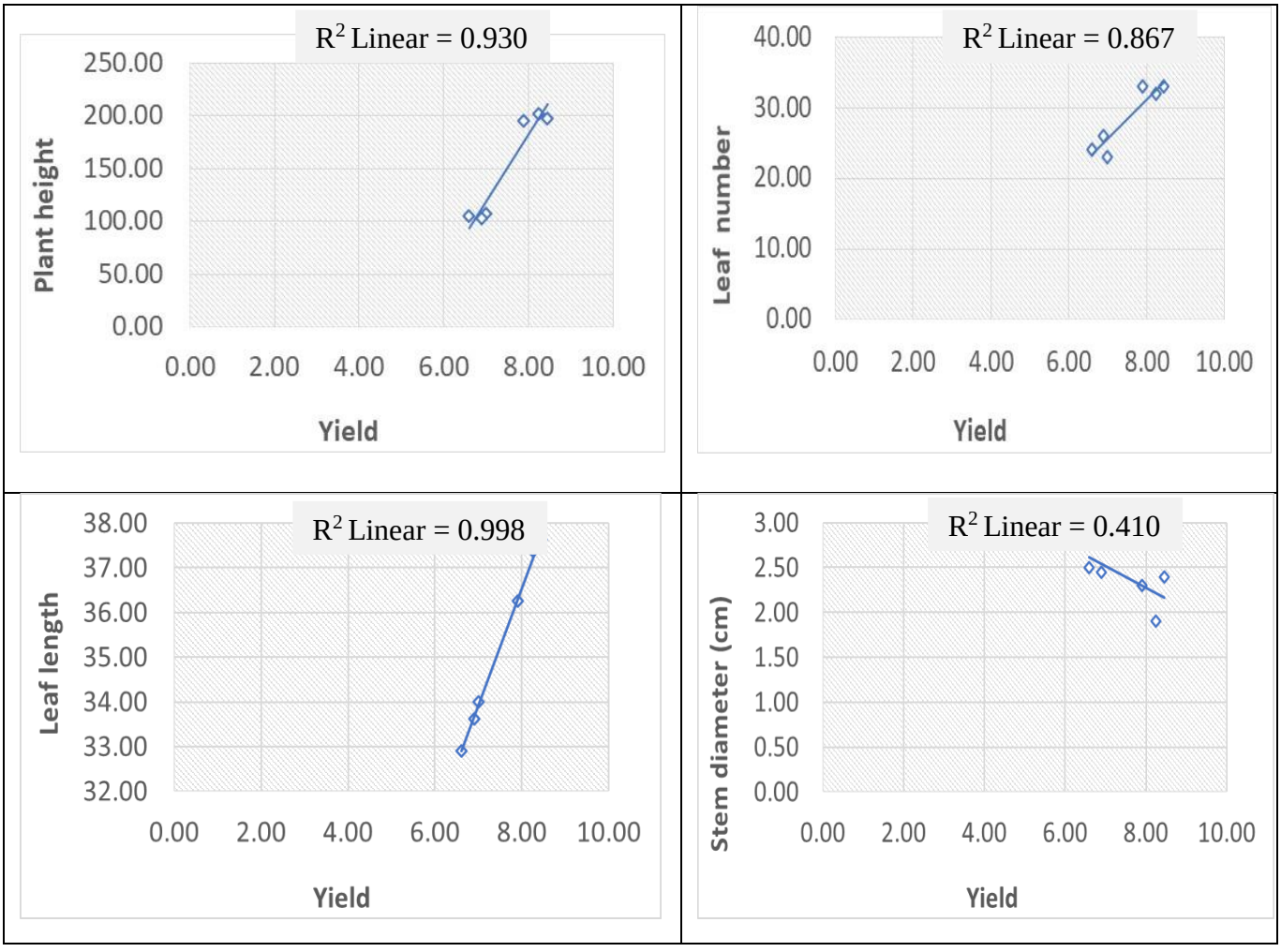

Fig. 1 Relationships of different growth parameters within grain yield of two sunflower varieties.

Cvejić et al. (2012) found that the highest yield (4028 kg ha^{-1}) was obtained from the Novi Sad-El region while the lowest yield (2222 kg ha^{-1}) was obtained from the Novo Miloševo-E3 region. They stated that the differences between locations might vary depending on environmental and climatic factors. Kang (2002) also reported that the change in yield parameters of certain genotypes depended on environmental factors. Marjanović-Jeromela et al. (2011) stated that some genotypes were adapted to specific seasons in terms of seed yield and were highly affected by environmental factors. Iqbal et al. (2018) showed that the seed yield of genotypes ranged from 922.6 to 2187 kg ha^{-1}. Taran et al. (2013), Pakistan, Balochistan in the highlands of sunflower genotypes grown in the study to determine the adaptability ability; seed yield of sunflower genotypes varied between 1724.9-2128 kg ha^{-1}. Likewise, Alem et al. (2016) have determined that the seed yield of sunflower genotypes grown in different locations ranged from 951 to 2926 kg ha-1. While these results were similar to our results, they stated that the sunflower genotypes were sensitive to environmental factors and, therefore, the genotypes varied depending on the differences among locations (Zavalía et al., 2011; Ayerza, 2010; Coates, 2009).

3.3. Correlations Within Grain Yield with Different Growth and Yield Parameters

The calculated value of 'r' for plant height, leaf length, leaf number and stem diameter, i.e. growth parameters were 0.964, 0.999, 0.931 and -0.640, respectively (Table 3). Negative and low correlation (-0.640) was observed in the stem diameter among the four parameters studied. High correlations were found in plant height, leaf length and leaf number with grain yield. Position and direction of the fit line also proved positive and strong correlation (Fig. 1).

In yield parameters, negative correlations were observed in head diameter, number of unfilled grains per head and 1000 seeds weight among six parameters (Table 3). The rest parameters such as duration of flowering, duration of maturity and number of filled grain per head were showed positive correlation. Number of filled grain per head showed strong positive and 1000 seeds weight showed strong negative correlation. Position and direction of the fit line was indicated the same result (Fig. 2). A study on correlation of

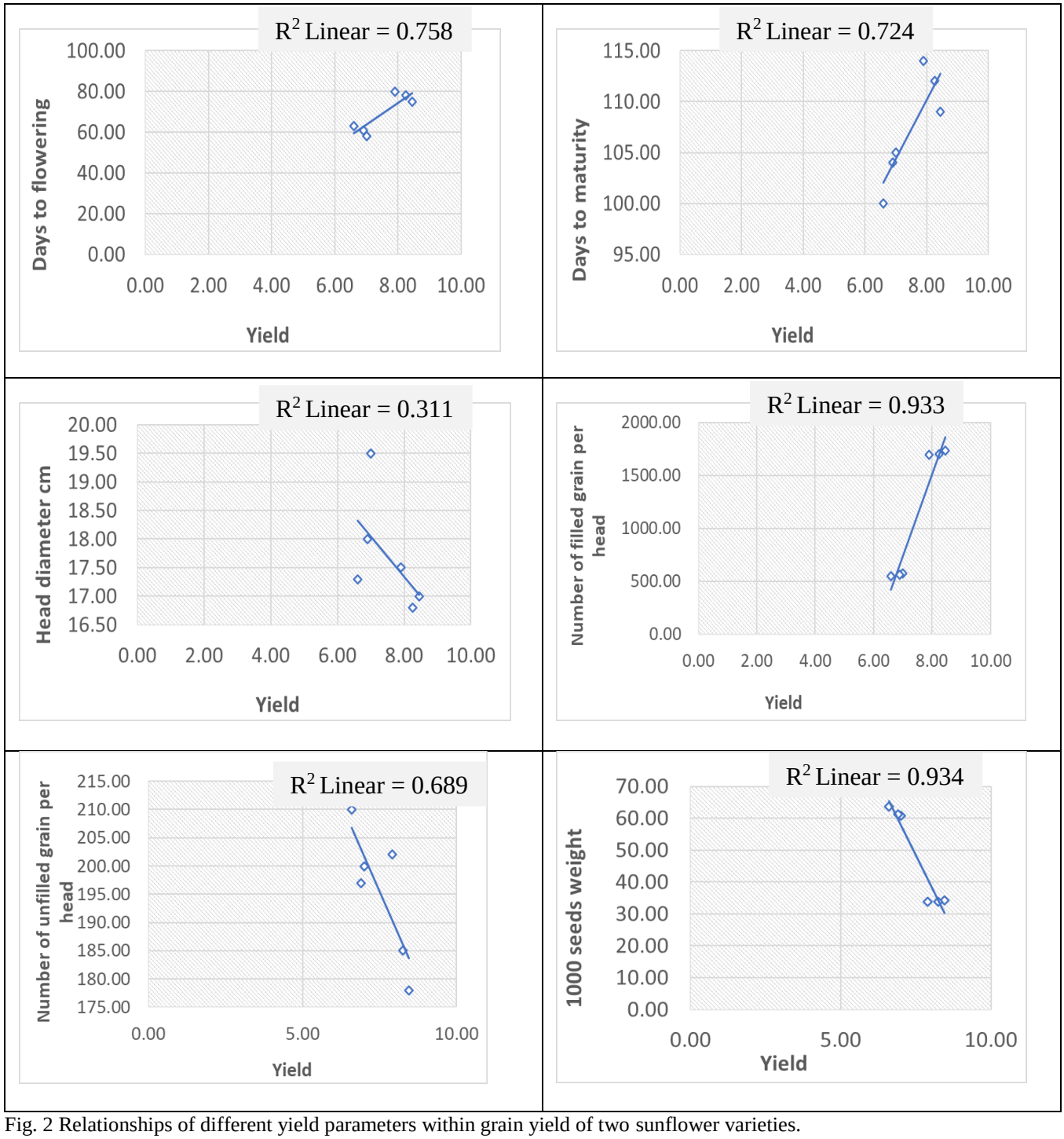

Fig. 2 Relationships of different yield parameters within grain yield of two sunflower varieties.

grain yield and plant parameters of wheat was conducted earlier (Jhilik et al. 2017).

3.4. Benefit Cost Ratio (BCR)

In economic study, the two most crucial concepts are cost and return. A farm must assess profit in order to figure out whether a project will be profitable. Total cost (TC) is computed using total variable and fixed expenses; variable costs include labor costs for preparing the ground, purchasing seeds, fertilizer, insecticides, and managing water. One of the most important measures for measuring the viability and profitability of a project is BCR, or the average return on each taka spent on production. The undiscounted BCR was calculated as the ratio of total return to total cost per hectare (Khatun et al., 2016; Miah et al., 2013).

The variable cost of sunflower production was calculated Tk 58441.1 ha^{-1} (Table 4). The average cost of cultivation of sunflower was estimated to be Tk. 80851 ha^{-1}. This increased cost was for using the higher amount of labor, fertilizers, pesticides, and irrigation (Khatun et al., 2016).

Around 27.72 % cost was spent for fixed inputs of all sunflower variety, which includes land use and interest on operating capital for all the two sunflower varieties. The cost of land preparation, labor, fertilizers and vitamins were found highest in total variable cost. The total cost was found to be the highest for land use (27.72 %) followed by labor (14.78 %), fertilizers (13.39%) and seed (13.32%) among the cost items (Table 4). The highest yield was found 328 kg bigha^{-1} in DS 275 (Hybrid)and lowest was found in BARI surjomukhi 3 (HYV) (273.33 kg bigha^{-1}). The average net return of BARI surjomukhi 3 (HYV) was16511 Tk where DS 275 (Hybrid) (21978 Tk) was significantly higher (Table 5). This higher return was due to higher yield and high price of the produce. The benefit cost ratio (BCR) over total cost was higher than unity, implying that the productions of both BARI surjomukhi 3 (HYV) and DS 275 (Hybrid) were profitable at farm level. The BCR of BARI surjomukhi 3 (HYV) was 2.52 where DS 275 (Hybrid) (3.03) was higher compared to BARI surjomukhi 3 (HYV)(Table 5). According to Rahman (2012), the average sunflower production, gross return, and BCR per hectare in the coastal region were 3.12 tons, Tk. 114,841, and 2.87, respectively. According to Rashid et al. (2014), the timing of planting had an impact on the sunflower seed production, price, and return. They discovered that planting on January 14 yielded where the highest seed production and BCR were 3.06 and 2.32, respectively. The similar study on Oilseed production was reported by Miah et al. (2013). The benefit cost ratio of sunflower was calculated (Uzunoz et al., 2008) resulting in 0.51. According to a similar study made in the region, benefit-cost ratio was calculated as 0.88 (Bal, 2003).

4. CONCLUSION

The findings of this investigation showed that there was substantial variety in the vegetative, yield, and yield characteristics of the two sunflower types used in this experiment. According to the results of growth parameters measurements, it was found that all vegetative parameters were highly significant except stem diameter. DS 275 (Hybrid) had better efficacy than BARI surjomukhi 3 (HYV). In case of yield parameters measurement, DS 275 (Hybrid) had better response in grain yield and number of filled grain per head than BARI surjomukhi 3 (HYV). Whereas BARI surjomukhi 3 (HYV) had better 1000 seeds weight than DS 275 (Hybrid). According to the results of correlations within grain yield and different growth and yield parameters, such as plant height, number of leaves, leaf length, days to flowering, days to maturity, number of filled grain per head, number of unfilled grains per head, 1000 seeds weight showed significant effect to yield. And based on this finding the production of DS 275 (Hybrid) was profitable at the farm level, as indicated by the benefit cost ratio (BCR) over total cost being higher than unity. DS 275 (Hybrid) had a higher BCR (3.03) than BARI surjomukhi 3 (HYV). Considering the productivity, DS 275 (Hybrid) is suitable and would be recommended for cultivation in the Chapainawabganj district (Barind tract) of Bangladesh.

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