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INTERCROPPING OF PEA AND KHESHARI AS VEGETABLES AND FODDER CROP WITH DWARF TYPE SUNFLOWER VARIETY

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Abstract

To find out the optimum row arrangement of pea and khesari as intercrop with sunflower for higher productivity and return, a field experiment of intercropping pea and khesari with sunflower was conducted in Oilseed Research Centre, BARI, Gazipur during rabi season of 2020-21 and 2021-22. Six treatments were T_1= Sole sunflower, T_2 = One row of gardenpea in between two normal rows of sunflower (50 cm x 25 cm), T_3 = Two rows of gardenpea in between two normal rows of sunflower, T_4 = One row of kheshari in between two normal rows of sunflower (50cm x 25cm), T_5 = Two rows of kheshari in between two normal rows of sunflower & T_6= Broadcast kheshari in between two normal rows of sunflower. Although intercropping reduced sunflower yield but total productivity was increased due to addition of pea and khesari yield. Total productivity in terms of sunflower equivalent yield (SEY) (7.02 t ha^{-1} and 6.64 t ha^{-1} during 2020-21 and 2021-22 respectively) was found to be highest from T_3 (two rows of pea in between two normal rows of sunflower treatment while the lowest (1.80 t ha^{-1} and 1.72 t ha^{-1}) in T_1 (sole sunflower) for both the years. Highest benefit cost ratio (BCR) (4.0 and 3.80 in 1st and 2nd year respectively) was recorded in T_2 treatment (one row of gardenpea in between two normal rows of sunflower) with highest gross margin (Tk. 263905 ha^{-1} and Tk. 244012 ha^{-1}).

Introduction

Intensive sunflower production is mainly focused on increasing seed yield, but less importance is given to soil properties, potential ecosystem services and resource conservation. This practice can cause the reduction in organic matter content in the soil, loss of soil fertility, increased erosion, as well as pollution of ground waters. Hence, it is necessary to introduce alternative practices such as intercropping that has raised much attention because it could improve agriculture production for many crops. Previous research has show that it is best to combine two crops, including one from the Fabaceae family. Plants from this family have the ability to create a large amount of above-ground mass, strong root systems with high absorption power, ability to adapt to shady conditions, suppressive effect on weeds and the ability to fix atmospheric nitrogen and provide nitrogen for other plant species that are intercropped with (de la Fuente *et al.*, 2014). Commonly intercropped with legumes are crops from a Poaceae family, whereas the combination of sunflower with legumes is relatively rare. The reason for this may be that in an earlier period there were no hybrids tolerant to different diseases and pests. However, today there are justifiable reasons for studying combinations of sunflower and the most important legumes. The goal of this research is to analyze and recommend sustainable technology of

sunflower cultivation in intercropping systems and select the legumes most suitable for intercropping with sunflower, aiming to increase productivity per unit area.

Materials and Methods

The field experiment was conducted at the research field of Oilseed Research Centre, Bangladesh Agricultural Research Institute, Gazipur during rabi season of 2020-21 and 2021-2022. There were six treatments viz. T_1 = Sole sunflower, T_2 = One row of gardenpea in between two normal rows of sunflower (50 cm x 25 cm), T_3 = Two rows of gardenpea in between two normal rows of sunflower, T_4 = One row of kheshari in between two normal rows of sunflower (50 cm x 25 cm), T_5 = Two rows of kheshari in between two normal rows of sunflower & T_6=Broadcast kheshari in between two normal rows of sunflower. The experiment was laid out in Randomized Complete Block Design with three replications. The unit plot size was 4m x 5m. Both the seeds of sunflower (BARI Surjomukhi-3), khesari (BARI Khesari-4) and gardenpea (BARI Motorshuti-3) were sown on 18 November and 21 November during 2020 and 2021 respectively. Fertilizers at the rate of $N_{88}P_{34}K_{80}S_{28}Zn_3B_2$ kg ha^{-1} in the form of urea, TSP, MoP, gypsum, zinc oxide and boric acid, respectively. Full amount of triple super phosphate, muriate of potash, gypsum, zinc oxide, boric acid and half of urea were broadcasted in the experimental plot at the time of final land preparation. The rest half of urea was applied in equal amounts at 30 and 55 days after sowing (DAS). At harvest, the yield data was recorded plot wise. Collected data were analyzed statistically and means were adjusted by LSD test at 5% level of significance using SPSS. Yield of individual crops was converted to sunflower equivalent yield (SEY) considering prevailing market price of the crops according to Bandyopadhyay (1984). Marginal benefit cost analysis was also done.

Sunflower equivalent yield (SEY) (kg/ha) = Yis + (Yig*Pg) / Ps &Yis + (Yik*Pg) / Pk

Where,
Yis = Sunflower yield (kg/ha) in intercropping
Yig = gardenpea yield (kg/ha) in intercropping
Yik = khesari yield (kg/ha) in intercropping
Pg = Price of gardenpea
Pk = Price of khesari
Ps = Price of sunflower

Results and discussion

Light availability

Average data on light availability during the crop growth period of two consecutive years in this study is representing in Figure 1. Availability of light on sunflower and pea & khesari intercropping was not markedly affected with each other. Because pea & khesari were harvested at 70 to 100 DAS. At that time sunflower canopy could not produce much shade which might affect gardenpea & khesari. Irrespective of treatments availability of light on pea & khesari canopy was almost 100% at earlier growth stage, 30 DAS of gardenpea & khesari and it decreased with the increase of shade produced by sunflower canopy over the time up to 60 DAS or up to harvest of gardenpea & khesari. However, among the intercropping treatments, the higher light availability on intercrop system was observed inT_1 treatment followed by T_2 throughout the growing period. The lower light availability on sunflower was observed in T_5 treatment.

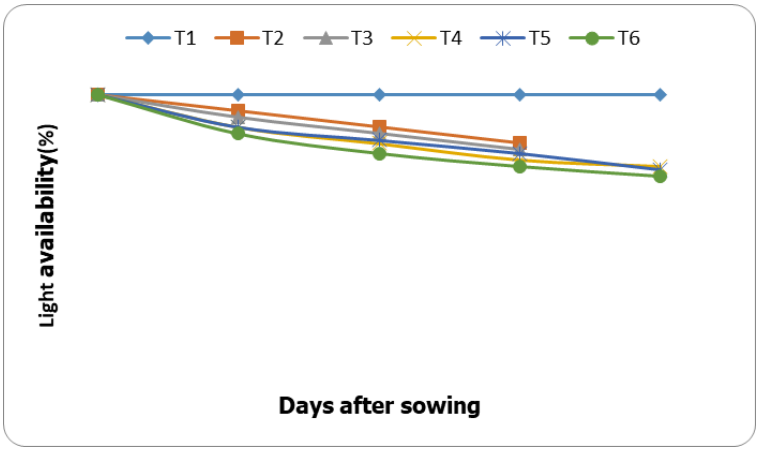

Fig 1. Average light availability on sunflower and pea & khesari intercropping during rabi season 2020-21 and 2021-22

Effect of sunflower

Seed yield and yield attributes of sunflower was significantly influenced by intercropping system where as total number of branches per plant and seeds per plant did not show any significant difference (Table 1). Two years average data (2020-21 and 2021-22) on different yield attributing characters are representing here in table 1. Total number of seeds per plant, mature seeds per plant, immature seed per plant, 100 seeds weight and yield of sunflower were significantly differed under different treatment combinations. Plant height showed higher in treatment T_1 and others are similar. Maximum number of seeds per plant (801), mature seed per plant (669) and highest seed yield (1.72 t ha^{-1}) were obtained from sole crop (T_1). Lowest yield (1.33 t ha^{-1}) was obtained from T_6 treatment which might be due to lowest number of mature seed per plant (455) and lower 1000 seed weight (61.02 g).

Table 1. Yield and yield components (in average) of sunflower under sunflower + pea and sunflower + khesari intercropping system during rabi season 2020-21 and 2021-22

Treat-ments	Days to 1st flow.	Days to maturity	Plant height (cm)	Seeds head^{-1} (no.)	Mature seeds head^{-1} (no.)	Immature seeds head^{-1} (no.)	Head diameter (cm)	100-seed wt. (g)	Seed yield (t ha^{-1})	
									2020-21	2021-22
T_1	32	95	79.02	801	669	132	20.01	78.28	1.88	1.72
T_2	30	95	77.05	753	689	64	18.50	76.51	1.76	1.56
T_3	31	95	76.13	720	625	95	18.11	62.30	1.62	1.42
T_4	32	95	77.10	755	650	105	14.33	75.12	1.70	1.60
T_5	31	95	75.22	622	605	117	12.20	61.13	1.63	1.45
T_6	34	95	77.90	580	455	125	11.13	61.02	1.50	1.33
LSD (0.05)	NS	NS	4.9	5.5	2.2	1.8	NS	1.7	1.7	1.2
CV (%)	-	-	1.8	8.4	9.2	8.1	4.2	1.6	5.7	

T_1= Sole sunflower, T_2 = One row of gardenpea in between two normal rows of sunflower (50 cm x 25 cm), T_3 = Two rows of gardenpea in between two normal rows of sunflower, T_4 = One row of kheshari in between two normal rows of sunflower (50 cm x 25 cm), T_5 = Two rows of kheshari in between two normal rows of sunflower and T_6= Broadcast kheshari in between two normal rows of sunflower.

Companion crop yield

In intercropping system, the highest yield (4.50 t ha^{-1} and 4.35 t ha^{-1} during 2020-21 and 2021-22) of pea was recorded when it was intercropped as two rows of pea in between two normal rows of sunflower (T_3). The lowest yield of pea was observed in T_2 (4.30 t ha^{-1} and 4.20 t ha^{-1} during 2020-21 and 2021-22) (Table 2 and 3). In case of khesari, yield was highest (4.83 t ha^{-1} and 4.62 t ha^{-1} during 2020-21 and 2021-22) in T_5 i.e. two rows of kheshari in between two normal rows of sunflower and lowest (2.88 t ha^{-1} and 2.44 t ha^{-1} during 2020-21 and 2021-22) in T_6 when it was broadcasted with sunflower which might be due to the lower plant population at harvest.

Intercrop efficiency

Table 2 and 3 show the cost return analysis of sunflower with pea and khesari intercropping system in the year 2020-21 and 2021-22 respectively. It was observed that all the intercrop combinations produced higher sunflower equivalent yield (SEY) over the sole sunflower.

Table 2. Sunflower equivalent yield and benefit cost analysis of sunflower + pea and sunflower + khesari intercropping system during rabi season 2020-21

Treatments	Companion crop yield (t ha^{-1})	Sunflower equivalent yield (t ha^{-1})	Gross return (Tk. ha^{-1})	Total cost (Tk. ha^{-1})	Gross margin (Tk. ha^{-1})	BCR
T_1	-	1.80	90000	62100	27900	1.44
T_2	4.38	7.01	350500	86595	263905	4.00
T_3	4.50	7.02	351000	87988	263012	3.98
T_4	3.91	2.48	124000	64550	56450	1.83
T_5	4.83	2.59	129500	68320	61180	1.89
T_6	2.88	2.07	103500	67110	36390	1.54

T_1= Sole sunflower, T_2 = One row of gardenpea in between two normal rows of sunflower (50 cm x 25 cm), T_3 = Two rows of gardenpea in between two normal rows of sunflower, T_4 = One row of kheshari in between two normal rows of sunflower (50 cm x 25 cm), T_5 = Two rows of kheshari in between two normal rows of sunflower and T_6=Broadcast kheshari in between two normal rows of sunflower.
Selling price: Sunflower seed = Tk.50 kg^{-1}, Pea = Tk.60 kg^{-1} (green vegetable), khesari= Tk.10 kg^{-1} (green vegetable)

Table 3. Sunflower equivalent yield and benefit cost analysis of sunflower + pea and sunflower + khesari intercropping system during rabi season 2021-22

Treatments	Companion crop yield (t ha^{-1})	Sunflower equivalent yield (t ha^{-1})	Gross return (Tk. ha^{-1})	Total cost (Tk. ha^{-1})	Gross margin (Tk. ha^{-1})	BCR
T_1	-	1.72	86000	62100	23900	1.37
T_2	4.20	6.60	330000	85595	244405	3.80
T_3	4.35	6.64	332000	87988	244012	3.77
T_4	3.50	2.30	115000	64550	50450	1.78
T_5	4.62	2.37	118500	68320	50180	1.73
T_6	2.44	1.81	90500	67110	23390	1.34

T_1= Sole sunflower, T_2 = One row of gardenpea in between two normal rows of sunflower (50 cm x 25 cm), T_3 = Two rows of gardenpea in between two normal rows of sunflower, T_4 = One row of kheshari in between two normal rows of sunflower (50 cm x 25 cm), T_5 = Two rows of kheshari in between two normal rows of sunflower and T_6=Broadcast kheshari in between two normal rows of sunflower.
Selling price: Sunflower seed = Tk. 50 kg^{-1}, Pea = Tk. 60 kg^{-1} (green vegetable), khesari= Tk.10 kg^{-1} (green vegetable)

The highest SEY (7.03 t ha^{-1} and 6.64 t ha^{-1}) was obtained from T_3 (two rows of pea in between two normal rows of sunflower) treatment while the lowest (1.80 t/ha and 1.72 t ha^{-1}) in sole sunflower for both the years. In both the year trials, maximum gross return (Tk. 351000 ha^{-1} and 332000 ha^{-1}) was recorded in T_3 (two rows of pea in between two normal rows of sunflower) with highest gross margin (Tk. 263905 ha^{-1} and 244405 ha^{-1}) was in T_2 (One row of gardenpea in between two normal rows of sunflower) treatment. However, the highest benefit cost ratio (BCR) (4.00 and 3.80 during 2020-21 and 2021-22) was obtained from T_2 (one row of pea in between two normal rows of sunflower) treatment which might be due to higher SEY and gross return. All the intercrop treatments showed much higher benefit over sole sunflower but highest in one row of pea in between two normal rows of sunflower.

Conclusion

Results revealed that among the intercropping treatments, the higher light availability on intercrop system was observed in sole crop followed by the intercrop of one row of gardenpea in between two normal rows of sunflower throughout the growing period. The lower light availability on sunflower was observed two rows of kheshari in between two normal rows of sunflower were intercropped. Seed yield was highest in sole crop than all the intercrop system. However by considering the gross margin, gross return and BCR, inercropping of one row of gardenpea in between two normal rows of sunflower would be agronomically feasible and economically profitable for the farmers in intercropping system.

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