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RESEARCH ARTICLE

Agro-Economic Assessment of Different Sesame Based Intercropping System

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ABSTRACT

A field experiment was conducted for agro-economic assessment of different sesame based intercropping systems at Agronomic Research Area, University of Agriculture, Faisalabad, Pakistan. The treatments were sesame alone; green gram alone; cowpea alone; single row of sesame+single row of green gram; two rows of sesame+single row of green gram; three rows of sesame+single row of green gram; single row of sesame+single row of cowpea; two rows of sesame+single row of cowpea and three rows of sesame+single row of cowpea. The results revealed that the different yield components of sesame were affected considerably by varying number of rows in intercropping. The maximum number of plants m^{-2} (35.33), plant height (139.03 cm), number of pods per plant (32.20), 1000-seed weight (3.57 g), biological yield (4531.00 kg ha^{-1}), seed yield (900.53 kg ha^{-1}) and oil yield (455.21 kg ha^{-1}) were recorded where three rows of sesame was intercropped with single row of green gram while the highest Land equivalent ratio (1.31), net income Rs.77523 and benefit cost ratio (2.39) was attained where single row of sesame was grown with single row of green gram. Data predicted that single row of sesame grown in association with single row of green gram utilized the resources more efficiently than grown alone.

INTRODUCTION

Sesame (*Sesamum indicum* L.) belongs to double-cotyledon Pedaliaceae family that is one of the key oil seed crops of Pakistan. It positions sixth in the world amongst vegetable oil. Its total production in the world is 3.66 million tons. Out of this total production, Asia contributes 0.95 million tons (Olowe, 2004). The seed of sesame contains 46.1% fat, 21.9% crude protein, 17.0% carbohydrate 4.70% crude fiber and 6.16% ash (Okudu et al., 2016) and about 50% oil of high quality. There is a severe scarcity of edible oil in Pakistan. Demand of edible oil in Pakistan is enhancing day by day with rise in population; however, supply of edible oil is decreasing each year (Zaman et al., 2009). During the year 2011-12, the indigenous production was 636 thousand tons encounters merely 34% of national need of edible oil; whereas, the remaining need of 1.467 million tons was fulfilled by import and total accessibility of edible oil was estimated as 3.079 million tons (GOP, 2011-12). Low production of sesame in Pakistan may be associated with the lack of the availability of good value seed, poor planting method, late sowing and more or less plant population (Nadeem et al., 2015).

In Pakistan, farmers are obtaining low crop production because of inadequate land resources. A promising method of enhancing the yield on small farms would be through intercropping, as it offers security against losses of sole cropping. Besides, there is a need for improved production of oilseeds and pulses because huge amount of foreign exchange is consumed annually on import of these commodities. An alternate to increase the production of oilseeds and pulses could be through intercropping. Land under agriculture is decreasing and it is essential to increase per acre yield by adopting intercropping system. Recommended Technologies and Production Practices at Farm give

good yield of crops (Ather et al., 2006). Previous studies showed that crops which were sown earlier produced high yields (Anjum et al., 2004). Khan and Khaliq (2003) studied the fertility condition of some cotton based intercropping systems and reported that organic matter was enhanced in all treatments and highest was noted in cowpea intercropping system. Therefore, this study was conducted to investigate the impact of green gram and cowpea intercropping in sesame at different number of rows on the yield and quality of sesame and to compare the economic feasibility of sesame alone and when intercropped with green gram and cowpea.

MATERIALS AND METHODS

To evaluate the effect of different sesame based intercropping system on yield and quality of newly evolved sesame variety TH-6, an experiment was carried out at Agronomic Research Area, University of Agriculture, Faisalabad, Pakistan. The experiment was conducted under randomized complete block design with net plot area of 4×2.4 m^2 with three replications. Seed was treated with fungicide before sowing. Sesame was sown using seed rate of 3.75 kg. ha^{-1} during Kharif season-2012, with single row hand drill. The intercrops including green gram and cowpea were sown in between the rows on the same day as per treatment using seed rate of 25 $kg.ha^{-1}$ and 10 $kg.ha^{-1}$, respectively. All of the phosphorous was used at the time of sowing in the form of DAP and Urea as a source of nitrogen was applied into two splits 1st and 2nd irrigation by using manual approach. The sesame and other intercrops were thinned out to achieve a uniform plant population in each plot. Four irrigations were applied during the entire growth period of the component crops. Both the sesame and intercrops were harvested at their physiological maturity. Observations on parameters were noted by employing standard procedures. Benefit cost ratio (BCR) and Land equivalent ratio (LER) were also calculated. The collected data on yield and quality parameters of sesame was analyzed statistically by using Fisher's analysis of variation method. Differences among treatments' means were compared by employing least significant difference (LSD) test at 5% probability level (Steel et al., 1997).

RESULTS AND DISCUSSION

The data revealed that the number of plants of sesame varies because of number of rows per unit area. Significantly higher ($P<0.05$) number of plants (36.67) was found in sole sesame but in case of intercropping more number of plants (35.33) was recorded where three sesame rows were sown with single row of green gram. Significantly higher number of plants (23.00) was found where two sesame rows were sown with single cowpea row. The less number of plants was because of less number of rows per unit area of sesame. In intercropping system non-uniform plant population of sesame than sole crop was because of higher number of rows in sole cropping. Significantly enhanced plant height (139.03 cm) was recorded where three rows of sesame were sown with single row of green gram. While minimum plant height (94.94 cm) was recorded where three rows of sesame were intercropped with single row of cowpea. The results indicated that more plant height of sesame when intercropped with green gram than sole sesame was due to small canopy and less competition of green gram for light and nutrients while the minimum plant height of sesame was recorded when intercropped with cowpea that may be due to more competition for nutrients, light and climbing effect of cowpea. These findings are in agreement with results of Bhatti et al. (2005) who stated increased plant height of sesame in relationship with cowpea.

Data (Table1) depicted that number of pods per plant (15.13) was statistically significantly reduced when sesame was intercropped with cowpea than the sole crop of sesame with (29.80) pods per plant. Nevertheless, significantly maximum pods per plant (32.20) were recorded where three rows of sesame were sown with single row of green gram which were same to the sole crop of sesame. Maximum number of pods per plant of sesame when intercropped with cowpea may be due to more competition for nutrients, light and climbing effect of cowpea. Bhatti et al. (2005) described that less pods per plant was found in sesame when intercropped with cowpea. Considerably more seeds per pod (68.40) were noted where single row of sesame was intercropped with single row of green gram which was at par with sole crop of sesame. The minimum number of seeds per pods (60.30) was observed where three sesame rows intercropped with one row of cowpea. The results indicated that maximum seeds per pod were counted while sesame was intercropped with green gram and minimum in association with cowpea. Climbing behavior of cowpea resulted in decreased number of seeds per pod of sesame. The mono cropped sesame produced significantly heavier seeds as compared to that grown as intercrop sesame. In intercropping, significantly heavier 1000-seed weight (3.57 g) was found where three rows of sesame were sown with single row of green gram. While, the lighter 1000-seed weight (2.73 g) was noted in treatment where one row of sesame was intercropped with one row of cowpea. The lowest 1000-seed weight of sesame may be because of more antagonism and climbing effect of cowpea. Similar results have been shown by Bhatti et al. (2005) who

stated that the least 1000-seed weight was found once sesame was intercropped with cowpea.

The significantly highest biological yield (4616.30 kg ha^{-1}) was recorded where sesame was sown alone which was at par with treatment where three rows of sesame were intercropped with single row of green gram. On the other hand, minimum biological yield (91783.70 kg ha^{-1}) was found where single row of sesame was intercropped with single row of cowpea. It might be due to more competition for light and space and climbing effect of cowpea as reported previously (Khan et al., 2005). Data regarding seed yield as influenced by intercropping system are presented in Table 1 which shows that in case intercropping system significantly higher seed yield (900.53 kg ha^{-1}) was observed where three rows of sesame were sown with single row of green gram which was similar with sole crop of sesame. The lowest seed yield (257.20 kg ha^{-1}) was found where single row of sesame was sown with single row of cowpea. The minimum yield in case of cowpea may be due to more competition for nutrients, light, space and climbing effect of cowpea. Decline in seed yield of sesame because of cowpea intercropping has been described previously by Bhatti et al. (2005).

Data regarding harvest index as influenced by intercropping system are presented in Table 1. Results revealed that significantly higher ($P<0.05$) harvest index (20%) was observed in treatment group where single row of sesame was sown with single row of green gram which was at par with sole crop of sesame. The lowest harvest index (12.53%) was found where three rows of sesame were sown with single row of cowpea. Similarly, Bhatti et al. (2005) found the lowest harvest index for sesame intercropped with cowpea.

Significantly higher oil yield (460.85 kg ha^{-1}) was recorded where sesame was sown alone which was statistically similar ($P>0.05$) with treatment where three sesame rows were intercropped with single green gram row and minimum oil yield was recorded where sesame was sown with cowpea. The lower percentage of seed oil content in case of sesame intercropped with cowpea might be because of more competition for nutrients and light and climbing effect of cowpea. The results are a like with those of with influence on oil of sunflower in intercropping system.

Maximum land equivalent ratio (LER) value of 1.31 was recorded in treatment where single row of sesame intercropped with single row of green gram. It is

Table 1: Yield and yield contributing parameters of sesame affected by different sesame based intercropping system

Treatments	No. of Plants (m^{-2})	Plant Height (cm)	No. of pods $Plant^{-1}$	No. of seeds Pod^{-1}	1000 Seeds Weight (g)	Seed Yield ($kgha^{-1}$)	B. Yield ($kgha^{-1}$)	Oil Yield ($kgha^{-1}$)	HI (%)	LER
T_1	36.67a	123.40b	29.80ab	63.40abc	3.60a	914.70a	4616.30a	460.85a	19.83a	1.00
T_2	---	---	---	---	---	---	---	---	---	1.00
T_3	---	---	---	---	---	---	---	---	---	1.00
T_4	24.33cd	133.43a	29.30b	68.40a	3.40b	747.47b	3737.70b	376.37b	20.00a	1.31
T_5	26.33c	132.73a	31.87ab	68.27a	3.50ab	765.30b	3869.10b	384.71b	19.83a	1.09
T_6	35.33a	139.03a	32.20a	65.67ab	3.57a	900.53a	4531.00a	455.21a	19.87a	1.23
T_7	24.00d	98.87c	17.47c	60.57bc	2.73d	257.20d	1783.70d	126.48d	14.43b	0.81
T_8	23.00d	95.00c	15.33c	62.87bc	2.90c	275.43d	1854.30d	134.01d	14.83b	0.55
T_9	32.67b	94.93c	15.13c	60.30c	2.93c	336.27c	2710.30c	163.51c	12.53c	0.62
LSD	2.08	6.39	2.69	5.25	0.15	20.23	182.28	10.55	0.70	

LSD: Least significant difference test, HI: Harvest Index, T_1: sesame alone, T_2: green gram alone, T_3: cowpea alone, T_4: single row of sesame + single row of green gram, T_5: two rows of sesame + single row of green gram, T_6: three rows of sesame + single row of green gram, T_7: single row of sesame + single row of cowpea, T_8: two rows of sesame + single row of cowpea, T_9: three rows of sesame + single row of cowpea; LER: land equivalent ratio

Table 2: Economic analysis of sesame affected by different sesame based intercropping system

Treatments	Sesame kg ha^{-1}	Value Rs.	Green Gram kg ha^{-1}	Value Rs.	Cowpea kg ha^{-1}	Value Rs.	Gross income Rs.	Variable costs for Green Gram & Cowpea Rs.	Total cost Rs. ha^{-1}	Net return Rs. ha^{-1}	BCR
T_1	914.70	91470	---	---	---	---	91470	---	51627	39842	1.77
T_2	---	---	1148.80	114880	---	---	114880	---	55635	59245	2.06
T_3	---	---	---	---	1431.50	71575	71575	---	30550	41025	2.34
T_4	747.47	74747	584.03	58403	---	---	133150	4000	55627	77523	2.39
T_5	765.30	76530	285.37	28537	---	---	105067	3000	54627	50640	1.92
T_6	900.53	90053	287.10	28710	---	---	118763	3000	54745	64018	2.16
T_7	257.20	25720	---	---	752.83	37641	63361	2000	53655	9706	1.18
T_8	275.43	27543	---	---	360.73	18036	45579	1500	52700	-7121	0.86
T_9	336.27	33627	---	---	358.57	17928	51555	1500	52325	-770	0.98

BCR: Benefit cost ratio, Sesame: Rs.4000/40kg, Green gram: Rs.4000/40kg, Cowpea: Rs.2000/40kg.

concluded that single row of sesame at 30 cm intercropped single row of green gram would be the most efficient profitable intercropping system while in case of sesame intercropped with cowpea showed lower land equivalent ratio than sole sesame that means intercropping of sesame with cowpea is not profitable. Bhatti et al. (2005) also described the higher value of Land equivalent ratio (LER) for intercropping of sesame with mungbean as compare to alone alone cropping of sesame. Both the productivity and viability of an intercropping system is reproduced to final economic profit. Data regarding the details of economic analysis along with all relevant calculations (Table-2) revealed that intercropping system under study significantly gave higher income per hectare where sesame was intercropped with green gram than sole sesame. The highest net income of Rs.77523 ha^{-1} and benefit cost ratio (2.39) was got where single row of sesame was intercropped with single row of green gram. These results are supported by findings of Ali et al. (2007) in a similar study.

Conclusions

Data predicted that single row of sesame grown in association with single row of green gram utilized the resources more efficiently than cowpea. Intercropping system decreased the seed yield of sesame to a substantial level. However, addition production from intercrops gained from sesame + green gram recom-pensed more than the losses in sesame production.

Authors' Contributions

All the authors contributed equally in this manuscript.

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