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IMPROVEMENT IN PRODUCTIVITY AND LAND EQUIVALENT RATIO WITH MAIZE SOYBEAN INTERCROPPING SYSTEM THROUGH CANOPY MANIPULATION

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Abstract

Stress on the agro-qualitative traits of soybean is oftenly observed in maize-soybean intercropping system due to the expected shadding effect of the companion crop. Canopy manipulation of maize would pave the role to improve the productivity and land equivalent ratio of maize-soybean intercropping system. Keeping in view the above mentioned facts, an experiment was carried out at Agronomic field area, University of Agriculture Faisalabad in autumn 2020 and repeated it in autumn 2021. In these experiments, treatments based upon canopy manipulation of maize (**T_1:** Sole soybean plantation, **T_2:** Sole maize plantation without leaf removal and detasseling, **T_3:** Sole maize plantation with removal of 2 top leaves, **T_4:** Sole maize plantation with detasseling, **T_5:** Sole maize plantation with removal of 2 top leaves and detasseling, **T_6:** Maize intercropping with soybean without leaf removal and detasseling of maize, **T_7:** Maize intercropping with soybean with removal of 2 top leaves of maize, **T_8:** Maize intercropping with soybean with detasseling of maize and **T_9:** Maize intercropping with soybean with removal of 2 top leaves and detasseling of maize) were studied. Randomized Complete Block Design was followed for this experimentation under three replications. Growth and the yield influencing variables were critically studied by following the standard procedures. Fisher's analysis of variance techniques was used to analyze the recorded data and treatments' means were compared by Least Significant Differences (LSD) test at 5% probability level. Results revealed that during both the years (autumn 2020-21 and autumn 2021-22), all treatments had a substantial effect on maize and soybean yield and growth-related metrics. In case of maize, throughout both years, maximum grain yield (7.90 t ha^{-1} and 7.89 t ha^{-1}), biological yield (25.64 t ha^{-1} and 24.55 t ha^{-1}), leaf area index (LAI) and crop growth rate (CGR) were found with treatment T_2 (Sole maize plantation without leaf removal and detessaling). However in case of soybean, maximum grain yield (1.99 t ha^{-1} and 1.97 t ha^{-1}), biological yield (5.70 t ha^{-1} and 5.68 t ha^{-1}), leaf area index (LAI), crop growth rate (CGR) were observed with treatment T_1 (Sole soybean plantation). While minimum values of all of these parameters of maize were reported with treatment T_9 (Maize intercropping with soybean with removal of 2 top leaves and detasseling of maize) and of soybean were reported with treatment T_6 (Maize intercropping with soybean without leaf removal and detasseling of maize). Overall, during both study years, maximum land equivalent ratio (LER) (1.34 and 1.23) were recorded in treatment T_9 (Maize intercropping with soybean with removal of 2 top leaves and detessling of maize). The present investigations conclude that with removal of 2 top leaves and detasseling of maize canopy manipulation technique would be a feasible and economical strategy for the attraction of the farming community of maize belt in Punjab, Pakistan.

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Keywords: Maize, Soybean, Intercropping, Canopy Manipulation, Defoliation, Productivity, Land Equivalent Ratio.

INTRODUCTION

In the world's agriculture economy, maize is considered one of the most important cereals for human beings (33.3%) and feed/fodder (66.6%) for animals [10]. There is a need to develop such a cropping system which can sustain the production and soil fertility [1]. Soybean (*Glycine max* L.) is considered a miracle crop because of its higher contents of protein (38-40%), edible oil (18-22%), essential amino acids, minerals and vitamins. It is also used to treat chronic illnesses including cancer and heart attack [23].

There is a pressing need to build such a type of patterning which permits intercropping [14]. Poly-Culture, especially inter-cropping, is a beneficial approach round the world. It is beneficial for the farmer as it provides sustainable yields [12]. In Pakistan the areas where irrigated agriculture is practiced and ample sunlight is available, polyculture can be an economically viable option for the small growers with respect to sustainability and productivity. Solar radiation has a vital role in crop production [5]. shadowing conditions are prevalent in agricultural fields because of the high planting density required for full light capturing, and almost all crop plants experience shadowing during their growth phase. [6]. Shadowing inhibits leaf area development [27] and decreases photosynthesis in the leaves [7], which ultimately reduces total biomass production which results in crop yield reduction [16],[11]. Light deficiency during grain filling affects the photosynthesis capability of maize leaves, because the top canopy reduces the transmission of light to lower leaves by 19%, depending on the variety. [4].

Leaf elimination has been found to alter nitrogen uptake in plants. For example, removing two leaves from the upper part of the maize canopy improved N accumulation as well as distribution in maize grains [21], and also enhanced the uptake of P and K at maturity stage under an intercropping system [17]. Previously, it has been demonstrated that middle stratum leaves of maize supply more carbs and nutrients to seeds as they are more adept at using sunlight than other leaves [28],[24]. In Pakistan, most of maize hybrids don't have erect type leaves, so shadding effect for soybean on later stages is very common. This study aims to look at the effects of maize canopy manipulation technique to enhance productivity and land equivalent ratio of maize soybean intercropping system.

MATERIALS AND METHODS

Research Location and Planting Material Details

This study was conducted in 2020-21 and 2021-22 at Agronomic Research Area, University of Agriculture, Faisalabad (31.25° N, 73.09° E, altitude 184 m). Semi-erect YH-5427 maize hybrid from maize and millet research institute Yousaf Wala, Sahiwal and the NARC-16 soybean variety were used in both years of experimentations.

Crop Husbandry

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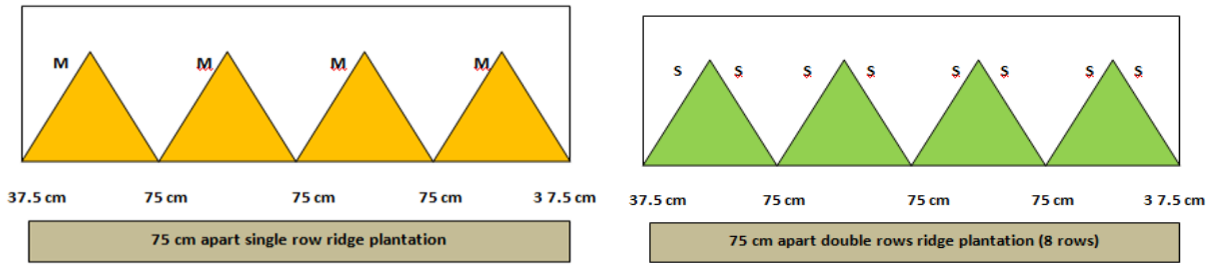
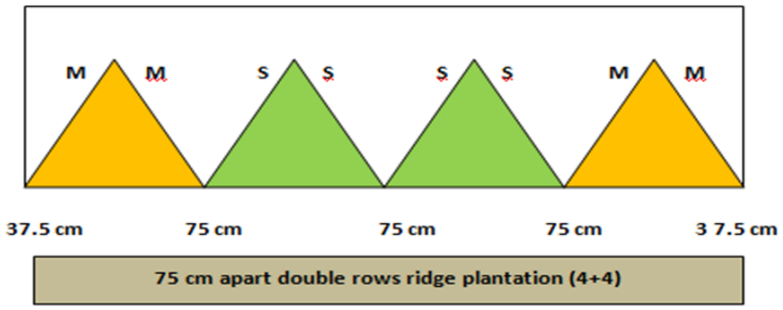
In the experiment, In case of sole maize plantation, 75 cm apart ridges were used and plant to plant distance of 17.5 cm was maintained.



In case of sole soybean, 75 cm apart ridges were used and plant to plant distance of 10 cm was maintained and both sides of four ridges were used for soybean plantation.

In case of maize-soybean intercropping (75 cm apart ridges were used), both sides of 1st and 4th ridges were used to grow maize plants (4 rows). However, both sides of 2nd and 3rd ridges were used to maintain four rows of soybean. Plant to plant distance for maize and soybean was 17.5 cm and 10 cm respectively. In case of soybean plantation only one seed of soybean was placed per hill. So, it was the combination of 4+4 (Four rows of maize and four rows of soybean in one plot).



The trial was included both broad and narrow leave crops therefore to control the weeds in it, pre-emergence weedicide, Stomp (Pendi-methalin) + Dual Gold (S-metolachlor) and post-emergence weedicide, Atrazine was used. Regarding nutrients management, 250 kg ha^{-1} nitrogen, 125 kg ha^{-1} phosphorus and 125 kg ha^{-1} potassium (recommended rates for main crop i.e. maize) was applied by using Urea, Single super phosphate (SSP) and Sulphate of potash (SOP). However, no extra fertilizer was applied for soybean. Total amount of Phosphorus and potassium was applied at sowing whereas nitrogen was added from Urea in three splits that were at sowing, at 4-6 leaf stage and at flowering. For sowing, manual dibbling was carried out for both the crops in all the treatments.

Grain Yield (t ha^{-1})

After harvesting of maize and sun drying, the cobs were shelled with the help of mechanical sheller and yield was recorded on per plot basis. Later it was converted into

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tons per hectare. Similarly, for soybean when crop was at maturity, harvesting was done with sickles. After sun drying, seeds were collected from pods of each plot and seed yield was determined in kg per plot which then changed to tons per hectare (t ha^{-1}).

Biological Yield (t ha^{-1})

At maturity, maize was harvested; plants were tied up into small bundles and left in their respective plots for sun drying. Sun-dried bundles were weighed and biological yield of each experimental unit was recorded which was then converted into tons per hectare. Similarly At maturity soybean plants were harvested and left in their respective plots for sun drying. After few days, sun-dried bundles were weighed and biological yield of each experimental unit was recorded which is then then converted into tons per hectare.

Harvest Index (%)

Harvest index is the ratio of grain yield to biological yield expressed in terms of percentage. Harvest index was calculated by formula recommended by Beadle (1987).

Harvest Index (%) = (Grain yield/Biological yield) x 100

Leaf Area Index (LAI)

Ten randomly selected maize and soybean plants were taken from each experimental plot and their leaf area was measured by simply multiplying their length by width of respective leaf and then multiplying with crop-specific coefficient factor of 0.70 and 0.75 respectively (Gao *et. al*., 2013).

By using the following equation, the leaf area index of maize was calculated as

$$LAI = \frac{\text{Leaf area}}{\text{Land area}}$$

Crop Growth Rate (CGR) $gm^{-2}day^{-1}$

CGR values were estimated with 15 days interval for both crops as described by Hunt (1978). According to formula, crop growth rate (g m^{-2} day^{-1}) was calculated as:

$$CGR = \frac{W_2 - W_1}{T_2 - T_1}$$

Where W_1 and W_2 are total dry weights harvested at times T_1 and T_2, respectively.

Intercropping Parameters

Land equivalent ratio (LER)

The following equation was used to determine land equivalent ratio:

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$LER = LER_{Maize} + LER_{soybean}$

$LER_{Maize} = (Y_{yz} / Y_{yy})$

$LER_{soybean} = (Y_{zy} / Y_{zz})$

Y_{yz} = Yield of maize in intercropping

Y_{yy} = Yield of sole maize

Y_{zy} = Yield of soybean in intercropping

Y_{zz} = Yield of sole soybean

RESULTS

Yield Parameters of Maize

All treatments had significant impact on grain yield (t ha^{-1}) and biological yield (t ha^{-1}) during twice years (Autumn 2020-21 and Autumn 2021-22) at 5% probability level. Maximum grain yield (7.90 and 7.89 respectively) and biological yield (25.64 and 24.55 respectively) were reported in treatment T_2 **(**Sole maize plantation without leaf removal and detasseling) however, minimum grain yield (6.30 and 6.29 respectively) and biological yield (19.47 and 19.25 respectively) were recorded in T_9 (Maize intercropping with soybean with removal of 2 top leaves and detasseling of maize). There was a positive and high association between grain yield and biological yield for both research years and in pooling.

Physiological Traits of Maize

Canopy manipulation treatments had significant impact on harvest index of maize in maize soybean intercropping in both the years (Autumn 2020-21 and Autumn 2021-22) at 5% probability level. Maximum harvest index (33.04 and 34.24 respectively) were recorded with treatment T_5 sole maize plantation with removal of 2 top leaves and detasseling however, minimum harvest index (30.85 and 32.76 respectively) were recorded with T_2 **(**Sole maize plantation without leaf removal and detasseling).(Table.1)

Impact of canopy manipulation in maize-soybean intercropping system on LAI showed significant variation from 30 to 90 DAS in different canopy manipulation treatments during both years (Autumn 2020-21 and Autumn 2021-22). Highest values of LAI (0.39, 1.65, 3.65, 2.64, 0.91 and 0.39, 1.59, 3.69, 2.62, 0.89) after 30, 45, 60, 75 and 90 DAS respectively were recorded in treatment T_2 where sole maize plantation without leaf removal and detasseling. However, lowest values of LAI (0.33, 1.39, 3.45, 2.43 0.79 and 0.32, 1.39, 3.43, 2.39, 0.76) at 30, 45, 60, 75 and 90 DAS respectively was reported with treatment T_9 where maize intercropping with soybean with removal of 2 top leaves and detasseling of maize (Figure 1)

Crop growth rate showed significant variation from 45 to 90 days after sowing in different canopy manipulation treatments. Highest values during both the years (Autumn 2020-21 and 2021-22) of CGR (5.58, 10.22, 16.29, 11.55 and 5.55, 1.18, 16.26, 11.5) were

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reported at 45, 60, 75 and 90 DAS respectively in T_2 where Sole maize plantation without leaf removal and detasseling was followed. While, the lowest values of CGR (4.28, 10.04, 15.22, 10.12 and 4.26, 10.02, 15.17, 10.08) were recorded at 45-90 DAS respectively having 15 days interval with treatment T_9 where Maize intercropping with soybean with removal of 2 top leaves and detasseling of maize was followed.(Figure.2).

Table 1: Impact of canopy manipulation of maize in maize-soybean intercropping on grain yield, biological yield and harvest index of maize and soybean during autumn 2020-21 and autumn 2021-22

Years	Treatments	Biological Yield ($t\ ha^{-1}$)		Grain Yield ($t\ ha^{-1}$)		Harvest Index (%)	
		Maize	Soybean	Maize	Soybean	Maize	Soybean
2020-2021	T_1	-	5.70 a	-	1.99 a	-	34.93
	T_2	25.64 a	-	7.90 a	-	30.85 b	-
	T_3	22.89 bc	-	7.49 b	-	32.76 a	-
	T_4	23.79 b	-	7.52 b	-	31.64 ab	-
	T_5	21.98 cd	-	7.26 c	-	33.04 a	-
	T_6	21.37 de	2.62 c	6.69 d	0.71 c	31.35 ab	27.33
	T_7	20.62 ef	2.90 bc	6.50 e	0.86 bc	31.58 ab	29.58
	T_8	20.76 de	2.99 bc	6.41 ef	0.95 b	30.91 ab	32.29
	T_9	19.47 f	3.26 bc	6.30 f	0.99 b	32.43 ab	30.57
LSD		1.2396	0.4463	0.1204	0.1947	1.7013	-
2021-2022	T_1	-	5.68 a	-	1.97 a	-	34.92 a
	T_2	24.55 a	-	7.89 a	-	32.18 b	-
	T_3	22.87 b	-	7.48 b	-	32.76 ab	-
	T_4	23.07 b	-	7.49 b	-	32.49 ab	-
	T_5	21.51c	-	7.35 b	-	34.24 a	-
	T_6	20.94 cd	2.61 c	6.69 c	0.70 c	31.97 b	27.66 b
	T_7	20.29 de	2.85 bc	6.49 cd	0.85 bc	32.03 b	30.12 ab
	T_8	20.01 d	2.90 bc	6.38 de	0.93 b	31.90 b	32.37 ab
	T_9	19.25 e	3.22 b	6.29 e	0.98 b	32.70 ab	30.66 ab
LSD		1.08	0.5654	0.1939	0.1563	1.8377	6.3839

Discussion for Maize

Leaves are thought to be the principal source of assimilates for grain filling and, ultimately, grain production. This may be attributed to genetic potential and transfer of more assimilates when no leaf was removed. On the other hand where leaves were removed

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less grain weight was recorded because due to removal of leaves less assimilates was transferred to grain. [15]

Supporting these findings who concluded that the leaf removal procedures had a considerable impact on maize grain production. The top leaves in maize have an important function in photosynthesis which provides energy needed for grain filling when the top leaves are removed; the plants ability to produce and transport carbohydrates to the developing cob or seeds are compromised. As a result, there can be a reduction in grain filling, leading to smaller cobs, fewer seeds, and potentially lower maize yield.

Different canopy manipulation of maize had a substantial impact on cob length [18]. Differences in maize ear characteristics are influenced by genotype and environmental factors [19]. Biological yield is the consequence of morphological and physiological processes taking place within the plant. Leaves have a significant role in plant biomass production. Leaves act as a food factory for plants. This was due to transfer of more assimilates in source sink relationship. On the other hand where defoliation was followed less assimilates was translocated to the plant body that resulted into lower biomass production.

The results are same with [16] who concluded that biomass production and nutrient uptake are affected by defoliation of maize plants. Harvest index depicts the splitting and transference of assimilates into economic yield. It determines how much dry matter was transformed into economical yield. The difference in harvest values in different canopy manipulation techniques was may be due to shading effect of maize on soybean. There are two simple and important measures for evaluating cereal performance: aboveground dry matter production and harvest index [3].

Leaf area index was recorded maximum where no leaf removal was followed because more number of leaves resulted into more total leaf area. These findings are further confirmed by [17] who demonstrated that maize leaf removal affected the LAI of both crops in maize soybean intercropping. Crop growth rate is an expression of the increase in dry matter generation of the crop per unit land area per unit time.

More vegetative growth can be ascribed to improved crop growth rate. When no leaves were removed more total dry matter was recorded that resulted in higher CGR. On the other hand where leaves were removed less crop growth rate was recorded because of less dry matter production. The same results are produced by [16] who stated that maize leaves removal affected the CGR of both crops in maize soybean intercropping.

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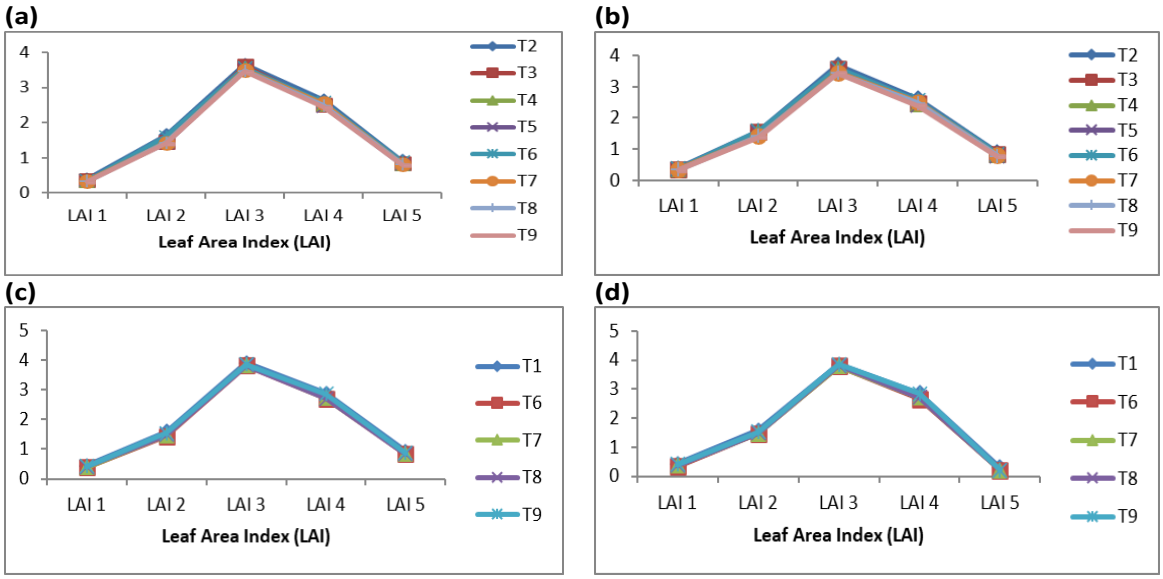

Figure 1: Impact of canopy manipulation of maize in maize soybean intercropping on leaf area index of maize (a,b) and soybean (c,d)mn 2020-21 and 2021-22 respectively

Yield Parameters of Soybean

Impact of canopy manipulation of maize on seed yield (t ha^{-1}) and biological yield (t ha^{-1}) of soybean intercropped with maize demonstrated that all treatments had significant impact on soybean seed yield during both of the study years (Autumn 2020-21 and 2021-22) at 5% probability level. During both the autumn seasons of 2020-21 and 2021-22, maximum seed yield (1.99 and 1.97 respectively) and biological yield (5.70 and 5.68 respectively) were recorded with sole soybean (T_1) while minimum seed yield (0.71 and 0.70 respectively) and biological yield (2.62 and 2.61 respectively) were recorded where maize was intercropped with soybean without leaf removal and detasseling (T_6).(Table.1)

Physiological Parameters of Soybean

Data about the impact of canopy manipulation of maize on harvest index (%) of soybean in maize soybean intercropping demonstrated that all treatments had non-significant impact on understudied parameter during first year (Autumn 2020-21) of experimentation and significant effect during the second year (Autumn 2021-22) at 5% probability level.(Table.1)

Leaf area index during both years (Autumn 2020-21 and Autumn 2021-22) showed significant variation from 30 to 90 DAS in different planting methodologies. Highest values of LAI (0.43, 1.58, 3.90, 2.87, 0.91 and 0.43, 1.58, 3.89, 2.89, 0.30) after 30, 45, 60, 75 and 90 DAS respectively were recorded in treatment T_1 where sole soybean plantation was followed. However, lowest values of LAI (0.39, 1.43, 3.81, 2.70, 0.83 and 0.34, 1.46,

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3.79, 2.66, 0.22) at 30, 45, 60, 75 and 90 DAS respectively were reported with treatment T_6 where maize intercropping with soybean with no leaf removal and no detessaling was followed (Fig. 1). The correlation analysis revealed a favorable relation between grain yield and the LAI (Fig.3) during individual years and in pooled value.

Crop growth rate during both the years (Autumn 2020-21 and Autumn 2021-22) showed significant variation from 45 to 90 days after sowing due to canopy manipulation treatments. Highest CGR (0.32, 0.48, 0.96, 0.66 and 0.3, 0.47, 0.94, 0.65) at 45, 60, 75 and 90 DAS respectively) in T_1 where sole soybean plantation was followed while, the lowest CGR (0.21, 0.4, 0.85, 0.43 and 0.19, 0.37, 0.82, 0.4) at 45, 60, 75 and 90 DAS respectively) in treatment T_6 where maize intercropping with soybean without leaf removal and detasseling of maize was followed (Fig. 2). The correlation analysis demonstrated a positive association among grain yield and crop growth rate (Fig. 3) during both years and in pooled value.

Discussion for Soybean

In canopy manipulation treatments in maize soybean intercropping, the maximum seed yield was produced in T_9 where maize intercropping with soybean with removal of 2 top leaves and detasseling of maize was followed. This might be due to increased lighter environment to soybean after removing the top 2 leaves and detasseling of maize. Soybean plants were highly sensitive to shading conditions [24],[8]. Wide-row spacing resulted in higher intercrop yields than narrow-row spacing, owing to increased light interception (Wang et al*.,* 2015). These results are also in quiet agreement with those reported by [13] who studied that there is increase in soybean seed yield with increasing the intensity of light.

Biological yield determines the growth and development during the life span of the crop. It contributes directly to crop yield through the production and allocation of photosynthates. Crops having maximum biomass convert maximum assimilates for seed yield. Soybean is very sensitive plant in the sense of light as results of research showed less biological yield in intercropping treatments because soybean had to face so much competition due to dominance of maize plants. [9] Concluded similar results that planting methodologies had significant impact on the biomass accumulation of both crops in intercropping.

Leaf area index (LAI) is a main factor regulating the interception of radiation, canopy photosynthesis and yield. The increase in LAI reflects the general crop trends that rising plant density raises the leaf area index because greater area is occupied by the green canopy of plants per unit area. T_1 treatment (No leaf removal and no detasseling) shows higher LAI than the other canopy manipulations treatments which is might be due to that in T_1 There is no removal of top leaves and detasseling occurs. The large change in soybean LAI owing to canopy alterations may be related to limited solar radiation the soybean received due to shadow from the maize plant. These findings were further supported by [16] who stated that different planting geometries affect the LAI of soybean in M-S intercropping. Crop growth rate indicates efficiency of a crop for using input

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resources and producing assimilates for production of economic yield of plant. More vegetative growth can be ascribed to improved CGR as in treatment T_1.The same results were also reported by [22] who determined that throughout the early period, particularly after 30 DAG, the CGR rises dramatically until 75 DAS, when it gradually declines.

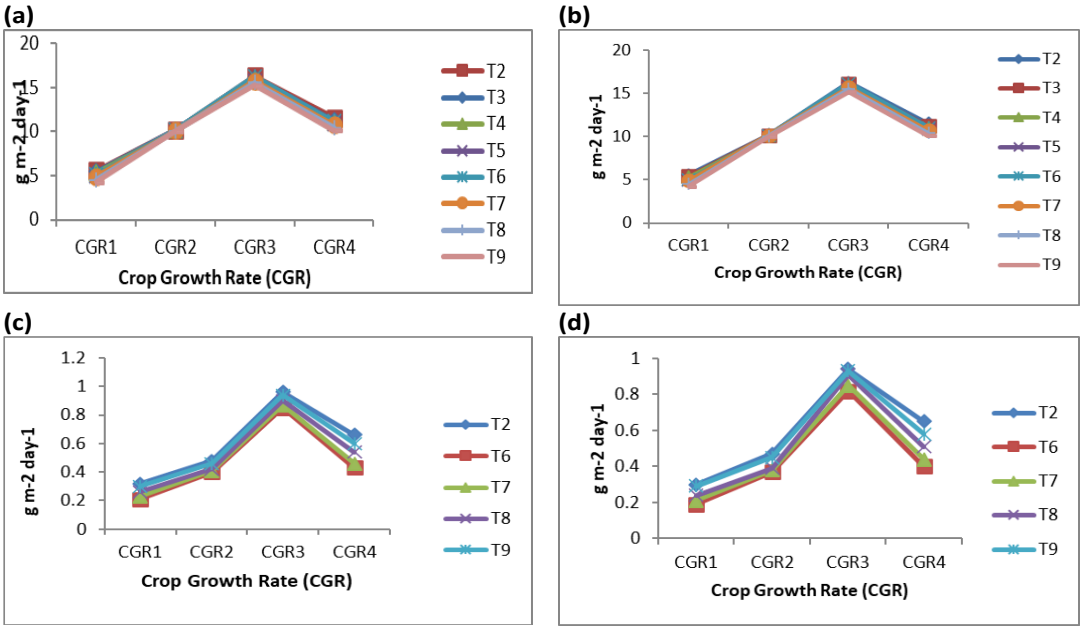

Figure 2: Impact of canopy manipulation of maize in maize soybean intercropping on crop growth rate of maize (a,b) and soybean (c,d)during 2020-21 and 2021-22 respectively

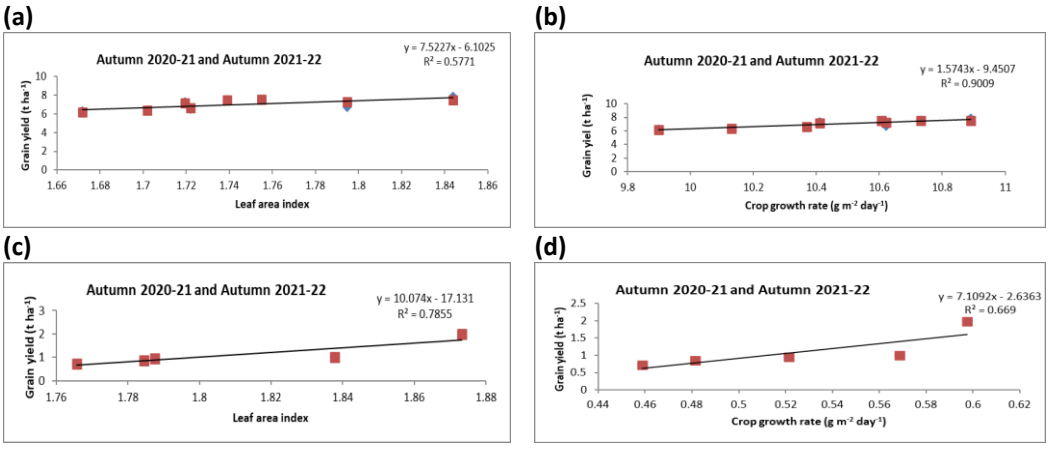

Figure 3: Relation among leaf area index and crop growth rate with grain yield in maize (a,b) and soybean (c,d) during 2020-21 and 2021-22

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Intercropping Parameter

Land Equivalent Ratio (LER)

All treatments in which intercropping was followed, significant improvement in LER value (more than 1) was observed in comparison with sole cropping. Maximum LER (1.34 and 1.23) was recorded in treatment T_9 (Maize intercropping with soybean with removal of 2 top leaves and detessling of maize) during both years (Autumn 2020-2021 and Autumn 2021-22 respectively). However, minimum LER (1.25) was recorded with treatment T_6 where maize intercropping with soybean without leaf removal and detesseling during (Autumn 2020-21) and LER (1.16) was recorded in treatment T_8 where maize intercropping with soybean with detessling of maize during (Autumn 2021-22) was followed (Table.2).

Table 2: Impact of canopy manipulation of maize in maize soybean intercropping on land equivalent ratio during autumn 2020-21 and 2021-22

Treatments	2020-21			2021-22		
	Maize	Soybean	Total	Maize	Soybean	Total
T_6: Maize intercropping with soybean without leaf removal and detesseling	0.84	0.41	1.25	0.88	0.32	1.2
T_7: Maize intercropping with soybean with removal of 2top leaves of maize	0.86	0.46	1.32	0.88	0.34	1.22
T_8: Maize intercropping with soybean with detessling of maize	0.86	0.41	1.27	0.86	0.3	1.16
T_9: Maize intercropping with soybean with removal of 2 top leaves and detessling of maize	0.83	0.51	1.34	0.88	0.35	1.23

CONCLUSION

It is concluded that with removal of 2 top leaves and detasseling of maize canopy manipulation technique would be a feasible and economical strategy in intercropping of maize soybean during autumn season for the attraction of the farming community of maize belt in Punjab, Pakistan.

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Conflict of Interest: The authors declare that there is no conflict of interest.

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References

1) C. Witt, J.M.C.A Pasquin JMCA, Maize in Asia and Global Demand 2nd Ed. Int. Fert. Corresp. 14: 5-6. 2007.

2) C.L. Beadle, Plant Growth Analysis. In techniques in Bioproductivity and photosynthesis. 2nd ed. J. Coombs, D.O. Hall, S.P. Long and J.M.O. Sacrlock (Eds.). Pregamon Press. Oxford New York. USA. 21-23.1987

3) C.M. Donald, J. Hamblin, The Biological Yield and Harvest index of Cereals as Agronomic and Plant breeding Criteria. Adv. Agron. PP: 28:361-405, 1976.

4) D. Karam, I.A. Pereira, Filho, P.C. Magalha˜es, M.C.D. Paes, J.A.A. Silva, J.D.C.M. Gama, Resposta de Plantas de Milho a`Simulac¸a˜o de Danos Mecaˆnicos. Revista Brasileira de Milho e Sorgo 9:201–211. 2010.

5) D.J. Connor, R.S. Loomis, K.G. Cassman, Crop ecology, productivity and management in agricultural systems. Cambridge University Press, Cambridge.2011

6) F. Valladares, U. Niinemets, Shade Tolerance, A Key Plant Feature of Complex Nature and Consequences. Annu Rev Ecol Evol Syst 39:237–257. 2008.

7) F. Yang, Effect of Aboveground and Belowground Interactions on the Intercrop Yields in Maize–Soybean Relay Intercropping Systems. Field Crops Res 203:16–23. https://doi.org/10.1016/j.fcr.2016.12.007. 2017.

8) F. Yang, S. Huang S, R.W. Wang, X. Wu, W. Yang, Growth of Soybean Seedlings in Relay Strip Intercropping Systems in Relation to Light Quantity and Red: Far-Red Ratio. Field Crops Res. 155:245-253. 2014.

9) J.M. Matusso, M.J.N Mujwve, M. Mucheru-Muna, Effect of Different Maize-Soybean Intercropping Patterns on Yields and Land Equivalent Ratio (LER). J. Cereal Oilseeds. 4:48-57. 2013.

10) K. Kumar, M.D. Reddy, A. Sivasavkar, N.V. Reddy, Yield and Economics of Maize Soybean in Intercropping Under Different Row Proportion. Ind. J. Agric. Sci. 73:69-71. 2003.

11) L.Y. Feng, Narrow-wide Row Planting Pattern Improves the Light Environment and Seed Yields of Intercrop Species in Relay Intercropping System. PLos one 14:e0212885. 2019.

12) M. Farooq, N. Gogoi, S. Barthakur, B. Baroowa, N. Bharadwaj, S.S. Alghamdi, K.M.H. Siddique, Drought Stress in Grain Legumes during Reproduction and Grain filling. Journal of Agronomy and Crop Science, 203(2), PP: 81-102. 2017.

13) M. Muneer, M. Saeed, M. Imran, Crop Productivity and Net Returns in Wheat-Gram Intercropping. Pak. J. Agric. Res. 18: 20-24. 2004.

14) M.A. Khan, K. Ali, Z. Hussain, R.A. Afridi, Impact of Maize-Legume Intercropping on Weeds and Maize Crop. J. Weed. Sci. Res. 18:345-356.2012.

15) M.A. Raza, B. Asghar, C. Ahmad, H.I. Bin, Hussain, W. Li , L. Weiguo, Agro-Techniques for Lodging Stress Management in Maize-Soybean Intercropping System—A Review. Plants, 9(11), 1592. 2020.

16) M.A. Raza, L.Y. Feng, W.V.D. Werf, G.R. Cai, M.H.B. Khalid, N. Iqbal, W. Yang, Narrow-Wide-Row Planting Pattern Increases the Radiation Use Efficiency and Seed Yield of Intercrop Species in Relay-Intercropping System. Food Energy Secur. 8:170. 2019a.

17) M.A. Raza, M.H.B Khalid, X. Zhang, L.Y. Feng, I. Khan, M.J. Hassan, W. Yang, Effect of Planting Patterns on Yield, Nutrient Accumulation and Distribution in Maize and Soybean under Relay Intercropping Systems. Sci. Rep. 9:1-14. 2019b.

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18) M.S.I. Zamir, A.H. Ahmad, H.R.M. Javeed, T. Latif, Growth and yield behaviour of two maize hybrids (Zea mays L.) towards different plant spacing. Cercet. agron. Mold. 44; Iss. 2. 2010.

19) O. Konuskan, Effects of Plant Density on Yield and Yield-related Characters of Some Maize Hybrids Grown in Hatay Conditions as the Second Crop. M.Sc. Thesis, Science Institute. M.K.U., pp: 71. 2000.

20) R. Hunt, Plant Growth Analysis. Inst. Bioi. Stud. Bioi., 96. Camelot Press, Southampton, England. 1978.

21) T. Liu, R. Huang, T. Cai, Q. Han, S. Dong, Optimum Leaf Removal Increases Nitrogen Accumulation in Kernels of Maize Grown at High Density. Sci Rep 7:39601. 2017.

22) V. Limpinuntana, S. Sitthaphanit, B. Toomsan, S. Panchaban, R.W. Bell, Growth and Yield Responses in Maize to Split and Delayed Fertilizer Applications on Sandy Soils Under High Rainfall Regimes. Kasetsart J. Nat. Sci. 44:991-1003. 2010.

23) V. Popovic, J. Miladinovic , M. Vidic, M. Tatic, V. Sikora, J. Ikanovic, G. Dozet, Productive and quality characteristics of soybean in agroecological conditions of Sombor, Serbia. Ratarstvo i povrtarstvo, 50(2), 67-74. 2013.

24) W.G. Liu, J.L Zou , J. Zhang, F. Yang, Y. Wan, W.Y. Yang, Evaluation of Soybean (*Glycine max* L.) Stem Vining in Maize- Soybean Relay Strip Intercropping System. Plant Prod. Sci. 18:69-75. 2015.

25) X. Wang, X. Wu, G. Ding, F. Yang, T. Yong, X. Wang, W. Yang, Analysis of Grain Yield Differences among Soybean Cultivars under Maize–Soybean Intercropping. Agron. 10:110. 2020.

26) Y. Gao, A. Duan , X. Qiu, Z. Liu, J. Sun, J. Zhang, H. Wang. Distribution of Roots and Root Length Density in a Maize/ Soybean Strip Intercropping System. J. Agr. Water Manage. 98:199-212. 2010.

27) Y. Wu, W. Gong, W. Yang, Shade Inhibits Leaf Size by Controlling Cell Proliferation and Enlargement in Soybean. Sci Rep 7:9259. https://doi.org/10.1038/s41598-017-10026-5. 2017.

28) Z. Kefu, Effect of the Leaves of Different Positions in Maize on the Corn Yield and the Photosynthetic Properties of those Leaves after the Growing out of the Female Flowers. Acta Agrono Sin 4:005. 1981.