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GS Bhagat
MGCGVV, Chitrakoot, Satna, Madhya Pradesh, India

HS Kushwah
MGCGVV, Chitrakoot, Satna, Madhya Pradesh, India

P Panwar
MGCGVV, Chitrakoot, Satna, Madhya Pradesh, India

R Mehra
MGCGVV, Chitrakoot, Satna, Madhya Pradesh, India

M Nagar
MGCGVV, Chitrakoot, Satna, Madhya Pradesh, India

RK Sanodiya
MGCGVV, Chitrakoot, Satna, Madhya Pradesh, India

J Pandey
MGCGVV, Chitrakoot, Satna, Madhya Pradesh, India

GK Rana
MGCGVV, Chitrakoot, Satna, Madhya Pradesh, India

Corresponding Author:
GS Bhagat
MGCGVV, Chitrakoot, Satna, Madhya Pradesh, India

Effect of row arrangement on growth and yield intercropped maize with sesame and cowpea

GS Bhagat, HS Kushwah, P Panwar, R Mehra, M Nagar, RK Sanodiya, J Pandey and GK Rana

Abstract
Intercropping appears to be the only solution to boost productivity and land use intensity with the rapid growth in population and limited opportunity of putting new land under cultivation. The experiment was conducted in kharif season during the year 2020 on a well levelled field at Agriculture farm of the Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya, Chitrakoot Satna (MP) India. The farm is situated under the agro-climatic zone Bundelkhand Region of Northern Madhya Pradesh. Six treatments with one control were tried in a factorial randomized block design with three replications in maize crop. Factor A like a Row arrangement regular (1:1) and Paired (2:2) and the factor B like an Intercropping system with maize crop Maize + Mungbean, Maize + Cowpea and Maize + Sesame. The result revaluated that the maximum plant height at Intercropping (Maize + Sesame) and Row arrangement was significant at regular (1:1) 20, 40, 60 and harvest stage. Yield attributes like Cob and grain yield was significant at Intercropping (Maize + Sesame) and Row arrangement regular (1:1).

Keywords: Intercropping advantage, maize and row arrangement

Introduction
Maize (*Zea mays* L.) is the most important cereal crop in the world agricultural economy both as food for man and feed for animals including poultry next to wheat and rice in India. It is the most widely consumed grain due to its large yield, simplicity of processing, and digestibility. It's also a versatile crop that may be grown in a variety of agro-ecological zones. In India it is grown over an area of 9.72 million hectares with annual production of 28.64 million tonnes with productivity of 2945 kg/ha, during 2019-20 (Anonymous, 2020) [1]. It is mostly concentrated in Uttar Pradesh, Rajasthan, Madhya Pradesh, Bihar, Gujarat, Karnataka and Himachal Pradesh and also grown in small area in almost all the states. In Madhya Pradesh it is cultivated on 1.34 million ha area, with the production of 3.91 million tonnes and average productivity 2921 kg/ ha, during 2019-20 (Anonymous, 2020) [1]. Maize is versatile crop grown in more than 160 countries is tropical, subtropical and temperate regions from sea level to more than 300 meter. In India 35% of the maize produced in which 60% is used for human consumption, 25% each in poultry and cattle feed, 15% in food processing like corn flakes, popcorn etc and in other industries mainly starch, dextrose, corn syrup, corn oil.
The grains of special variety called the “pop corn” are characterized by a hard corneous interior structure covered in the “popped” from which is the favourite food for children in urban areas, several food dishes including “Chapatti’s” are prepared out of maize flours and grains. It is also good food for poultry, piggery and other animals. The demand of maize will touch 42 million tonnes by 2025 of which 20-21% will be used for human consumption, more than 60% as poultry and live stock feed, remaining 12-13% for industrial raw material. Then it is essential to increase the maize productivity as per need of increasing population in India.
Sesame (*Sesamum indicum* L.) commonly known as till, is one of the important edible oil seed crop. India is a major producer of this crop in the world. It is usually rich in oil (50%) and protein (18-20%), nearly 73% of the oil is used for edible purposes, 8-13% for hydrogenization, and 4.2% for industrial purpose in the manufacture points, pharmaceuticals and insecticides. It can also used as cattle feed especially for milch animals. It can be used as manure. It cake contains 6.0-6.2% N, 2.0-2.2% P_2O_5 and, 1.0-1.2% of potash. This crop is also suitable for mixed or intercropping with maize, jowar and pigeon pea crop during rainy season. Intercropping condition necessitates the development of a system for cultivating field crops in conjunction with legumes that avoids excessive intercrop interference and competition. In intercropping systems, changing the planting configurations of the main and component crops

is an essential agronomic method, although it has not been fully researched. Intercropping of maize (*Zea maize* L.) and sesame (*Sesamum indicum* L.) was found to maintain maize yield while producing an important cash crop to supplement small holder income. Maize and sesame are partially complementary in resource use and are hence good companion crops. Kolawhole *et al.*, (2015) have tested intercropping of maize and sesame and reported that intercropping maize and sesame superior to sole cropping and advantage was in the range of 16 to 25%.

Material and Methods

The trials were conducted in kharif season during the year 2020 on a well levelled field at Agriculture farm of the MGCGV, Chitrakoot Satna (MP). The farm is situated under the agro-climatic zone Bundelkhand Region of Northern Madhya Pradesh. Chitrakoot is situated between 250 10' North latitude and 800 52' East longitudes and about 190-210 meter above mean sea level.

The fertility status of experiment field: A number of soil samples were taken randomly from experimental plot before the sowing of crop (July 13, 2020) to a depth of 0-15 cm. These samples were mixed together and a composite soil sample was drawn for chemical analysis. The results of the analysis of soil sample are given in table1. The result showed that the soil of the experimental plot was sandy loam in texture with neutral soil ph (7.0). The electrical conductivity was normal, organic carbon and available nitrogen low, available phosphorus high and available potassium medium in experimental plot.

Treatments and experimental design: Inclusion of Sesame by constant maize population was used in the study. The treatments consisted of sole maize, Sesame, 1:1 and 1:2 row ratios of maize- Sesame intercropping. The experiment was arranged in Factorial randomized complete block design with three replications. Each experimental plot area consisted of 5.0 m x 6.0 m length (30 m^2) and 16.8 m^2 was used as a net plot area. Plants from the internal rows of net plot area were used for data collection.

Data collection: Growth parameter like Plant population, plant height and number of leaves. Yield attributes Cob and Grain yield (kg ha^{-1}): Grain yield of the component crops were measured from the net plot area and expressed as kg ha^{-1}.

Results and Discussion

Plant population: - Plant populations of maize were recorded at 25 DAS and at harvest stage of crop in per running meter. Later on it was converted into plants/ha.

It is clear from table 4 that plant population of maize were affected significantly due to row ratio and intercropping system as well as sole maize and treatment mean of intercropped maize neither at initial stage (25 DAS) nor at harvest of crop. Treatment A2 had maximum plant population of 80814 at initial and 69573 plants /ha at harvest stage. Among intercropping systems, maize + cowpea system had highest plant of 80527 of 25 DAS and 68860 plants / ha at harvest stage. In control v/s treatment the highest plant population of maize were recorded in intercropped mean of 79296 and 68675 plants 25 DAS and at harvest respectively.

Table 1: Effect of treatment on number of plants of maize.

Treatment	Plant population of maize (plants/ha) at	
	25 DAS	At harvest
A. Row arrangement		
A1: Regular (1:1)	77777	67777
A2: Paired (2:2)	80814	69573
S.Em±	1492.4	2147.0
CD (P=0.05)	NS	NS
B. Intercropping		
I1: Maize + Mungbean	77805	68388
I2: Maize + Cowpea	80527	68860
I3: Maize + Sesame	79555	68777
S.Em±	1827.8	2129.5
CD (P=0.05)	NS	NS
C. Control V/S treatment		
Control (Sole maize)	77666	68221
Treatment mean	79296	68675
S.Em±	2792.0	4016.6
CD (P=0.05)	NS	NS

Plant height: Effect of row arrangement: It is apparent from table 2 that both the row arrangement system had produced statistically similar plant height during all the observations (20, 40, 60 DAS and at harvest). Plant height increased in every successive stages of crop (from 20 DAS to at harvest).

Effect of intercropping system: Plant height of maize was not influenced due to intercropping system at 20 and 60 DAS and at harvest stage but significant only at 40 DAS. At 40 DAS, the maize + sesame had tallest plant (119.60 cm) which was significantly higher than maize + mungbean system (107.90 cm). Saudy (2015), Latin *et al*., 2016 and Kithan and Kumar (2017) [7, 5, 4].

Control V/S Treatment: Sole maize provided significantly more taller plant than intercropping maize at 20 DAS while at 40, 60 DAS and at harvest sole and intercropping maize had similar plant height. Sole maize produced taller plant by 8.87 cm, 11.05 cm, 7.05 cm and 4.5 cm at 20, 40 and 60 DAS and at harvest over intercropped maize, respectively.

Interaction effect: Height of maize was recorded (48.07 cm) in maize + sesame in row arrangement of regular (1:1) while maize + cowpea had height plant height of 47.87 cm under paired (2:2) row arrangement.

Table 2: Effect of treatments on plant height of maize (cm) at different successive stages.

Treatment	Plant height (cm) of maize at			
	20 DAS	40 DAS	60 DAS	Harvest
A. Row arrangement				
A1: Regular (1:1)	43.56	115.56	185.84	187.22
A2: Paired (2:2)	43.18	115.56	183.33	187.11
S.Em ±	1.82	2.83	4.51	3.70
CD (P=0.05)	NS	NS	NS	NS
B. Intercropping				
I1: Maize + Mungbean	40.30	107.90		184.20
I2: Maize + Cowpea	44.67	118.97		185.63
I3: Maize + Sesame	45.13	119.80	178.80	191.67
S.Em±	2.23	3.47	184.77	4.53
CD (P=0.05)	NS	10.68	190.20	NS
C. Control V/S Treatment				
Control (Sole maize)	52.33	125.60	191.63	192.72
Treatment mean	43.36	115.55	184.58	188.16
S.Em±	3.41	5.29	8.43	6.92
CD (P=0.05)	7.43	NS	NS	NS

Number of leaves: The numbers of leaves/plant were increased with duration of crop (20 DAS to 60 DAS). Leaves number were not significantly influenced due to row arrangement in any observation. Statistically equal numbers of leaves were formed in both the row arrangement during all the observations.

Numbers of leaves/plant of maize were statistically equal in all the intercropping system. It was at par in all the observation of maize recorded at 20, 40 and 60 DAS. It was increased with age of crop.

Table 3: Effect of treatment on number of leaves plant of maize at different stages of crop.

Treatment	Number of leaves per plant		
	20 DAS	40 DAS	60 DAS
A. Row arrangement			
A1: Regular (1:1)	7.27	11.33	11.27
A2: Paired (2:2)	7.42	11.38	11.71
S.Em±	0.23	0.14	0.18
CD (P=0.05)	NS	NS	NS
B. Intercropping			
I1: Maize + Mungbean	7.10	11.13	11.40
I2: Maize + Cowpea	7.47	11.33	11.53
I3: Maize + Sesame	7.47	11.60	11.53
S.Em±	0.28	0.17	0.22
CD (P=0.05)	NS	NS	NS
C. Control V/S treatment			
Control (Sole maize)	7.57	11.63	11.80
Treatment mean	7.34	11.35	11.48
S.Em±	0.43	0.26	0.34
CD (P=0.05)	NS	NS	NS

Cob and Grain yield (kg ha-1): Effect of row arrangement: Regular (1:1) and paired (2:2) maize had given statistically equal cob yield. It was maximum of 3914.38 kg/ha under regular (1:1) which was higher by a margin of 98.25 kg/ha or 2.57% over paired (2:2).

Effect of intercropping: It is apparent from table 4 that intercropped maize with sesame produced statistical maximum cob yield (4696.75 kg/ha) than maize + cowpea and equal to maize + mungbean, maize + sesame increased cob yield by 581.65 kg/ha and 1912.83 kg/ha over maize + mungbean and maize + cowpea, respectively.

Effect of row arrangement: It is evident from table 4 that grain yield maize was not significantly affected by row arrangement. Both row arrangements had produced statistically equal grain yield of maize. Paired planting (2:2) row ratio had increased maize yield by 159 kg/ha or 6.76% over regular (1:1).

Effect of intercropping: Result showed (table 4) that sesame intercropped maize produced significantly higher grain yield than cowpea intercropped maize and equal to mungbean intercropped maize. Maize + sesame enhance grain yield of maize by 173.67 kg /ha 6.57% and 978.84 kg/ha (53.31%) over maize + mungbean and maize + cowpea, respectively. Bhatnagar *et al.* (2012) [2], Kolawale *et al.*, (2015) and Latin *et al.*, 2016 [5].

Table 4: Effect of treatment on cob yield and grain yield of maize.

Treatment	Cob Yield (kg/ha)	Grain Yield sundry (kg/ha)
A. Row arrangement		
A1: Regular (1:1)	3914	2151
A2: Paired (2:2)	3816	2510.00
S.Em±	231.7	166.72
CD (P=0.05)	NS	NS
B. Intercropping		
I1: Maize+Mungbean	4115	2641
I2: maize + Cowpea	2783	1835
I3: Maize + Sesame	4692	2814
S.Em±	283.8	204.1
CD (P=0.05)	874.38	629.06
C. Control V/S treatment		
Control (Sole maize)	4933	3040
Treatment	3565	2430
S.Em±	433.5	311.9
CD (P=0.05)	944.66	NS

Conclusion

Planting sesame alongside maize can be done without reducing maize production. To find a spot to grow sesame in existing corn fields without competing with kharif crops and incurring higher expenditures as a result of kharif crop competition (rice, maize and cotton). Planting maize and sesame at the same time is the best approach to do this. The maximum reduction of plant population was observed in maize when maize + sesame grown regular in 1:1 row arrangement. Among intercropping, the maximum grain yield of maize was obtained in maize + sesame (2815 kg/ha) while highest maize equivalent grain yield (3691 kg/ha) and net returns of ₹ 60335/ha was recorded under maize + mung bean. To boost oilseed crop output, land use efficiency, and total return, it is recommended to sow sesame alongside maize by sowing one row of sesame in the centre of the maize bed.

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