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Original Research Article

Effect of Sesame-based Intercropping and Weed Management Practices on Growth Parameters of Maize

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A B S T R A C T

A field experiment was conducted during at SIF, C.S. Azad University of Agriculture & Technology, Kanpur208002 (UP) during two *Kharif* seasons of 2015 and 2016. The experiment consisted 12 treatments having four intercropping viz, sesame + maize (4:1), sesame + maize (8:2), sesame + urd (4:1) and sesame + urd (8:2) and three weed management practices viz, Hand weeding, Pre-emergence of *Pendimethalin* 30% EC@3.0 L/ha and Early post-emergence of *Alachlor* 50% EC@ 0.75 kg/ha replicated four times. The experiment was laid out in Factorial Randomized Block Design. The main crop as Sesame of Shekhar variety and sub crops as Maize of P-3441 variety and urd of Shekhar-2 variety were used in the study year. Effect of sesame-based intercropping and weed management on growth parameters like plant population, dry matter accumulation and plant height of maize was evaluated. The data revealed that plant height of maize grown either with sesame (8:2) (41.54 cm and 50.29cm) recorded significantly higher compared to maize grown with sesame (4:1) in row ratio (40.38 cm and 43.06cm) at harvest stage during 2015 and 2016. At harvest, maize grown with sesame (8:2) recorded significantly higher fresh weight as compared to sesame with maize at (4:1) row ratio during the two years of experimentation. At harvest, maize grown with sesame (8:2) recorded significantly higher dry weight as compared to sesame with maize at (4:1) row ratio during both the years of experimentation. The lowest dry weight of maize at 60 DAS was recorded when it was grown with sesame.

Keywords

Plant population, Dry weight, Fresh weight, Maize

Introduction

Maize (*Zea mays* L.) is produced throughout the country under diverse environments. Successful maize production depends on the correct application of production inputs that will sustain the environment as well as agricultural production. Products from food animals provide over 33 % of protein consumed in human diets globally and 16 % of food energy. These inputs are, *inter alia*, adapted cultivars, plant population, soil tillage, fertilization, weed, insect and disease control, harvesting, marketing and financial

resources. In developing countries, maize is consumed directly and serves as staple diet for some 200 million people. Most people regard maize as a breakfast cereal. However, in a processed form it is also found as fuel (ethanol) and starch. Starch in turn involves enzymatic conversion into products such as sorbitol, dextrin, sorbic and lactic acid, and appears in household items such as beer, ice cream, syrup, shoe polish, glue, fireworks, ink, batteries, mustard, cosmetics, aspirin and paint. (Trivedi *et al.*, 2017)

Materials and Methods

A field experiment was conducted during at SIF, C.S. Azad University of Agriculture & Technology, Kanpur 208002 (UP) during two *Kharif* seasons of 2015 and 2016. The experimental soil was sandy loam in texture (48.20% sand, 24.51% silt and 26.79% clay), poor in fertility in respect of available nitrogen (228.2 kg/ha) and organic carbon (0.42%) and medium in respect of available phosphorus (13.07 kg/ha) and available potassium (173.76 kg/ha). Soil was slightly alkaline in reaction (pH 7.70) (Table 1 and 2).

The experiment was laid out in a split plot design with three replications. Four intercropping systems, viz. sesame + maize (4:1), sesame + maize (8:2), sesame + urd (4:1), and sesame + urd (8:2) intercropping system were allotted to main plot. Three treatments of weed management practices *viz.*, hand weeding, *pendimethalin* and *alachlor* were allotted to subplot. Thus, all total twelve (4 main plot x 3 subplot) number of treatment combinations were replicated thrice. The sources of fertilizers were Urea, DAP and MOP. As per treatment, full dose of nitrogen, phosphorus and potassium were applied as basal (just before sowing of the crop). The other crop management practices were performed as per standard recommendation of the region.

Observation recorded

Initial/final plant population

Initial plant population/plot was recorded after thinning and final plant population/plot was counted before harvest or maturity stage. Finally plat population was computed in numbers/hectares.

Fresh weight

The Fresh weight of sesame in all the three plants/plot were counted at 30, 60 DAS and at harvest stage, the average fresh weight (g) were workout, mean values were expressed on plant basis.

Dry matter

The periodical changes in dry mater accumulation per plant were recorded at 30 DAS, 60 DAS, and at harvest time.

Sesame plants were randomly taken out from second row of plot from both the sides to measure dry matter accumulation, the selected plants were chopped into small pieces and dried in over at 70^0C till a constant weight was achieved. Finally, these samples were weighed and dry matter accumulation was expressed in gram/plant.

Plant height

The height of sesame plants was measured at 30, 60 DAS and maturity stage in centimetre from ground level up to transverse mark of top portion of the plant. The average was used for statistical analysis.

Statistical analysis

Data recorded in respect of yield and yield attributes, were analyzed by the method as given by Gomez and Gomez *et al.*, (1984).

Results and Discussion

Plant stand

It was recorded twice, once after the thinning as initial plant population and again at the time of physiological maturity for final plant population. The data pertaining to plant population of maize under main effects of treatments recorded at initial and physiological maturity stages during 2015 and 2016 are tabulated in table 3.

It is evident from the results obtained during the two years of study revealed that the plant population recorded at initial and physiological maturity stages did not affected significantly due to intercropping systems. Sesame-based intercropping system treatments did not affect the plant population at both the stages at the level of significance during the two years. At initial stage, the plant population was maintained by thinning of extra plants.

The data for plant population at final stage indicate that after initial stage, some plants died. Hence, mortality of plants in different treatments was worked out, which was maximum of 2.41 % in treatment where sesame planted with maize (8:2) in association. Lesser mortality (1.47 %) was recorded under sesame + maize (4:1) intercropping association during the two year of study.

Initial and final plant population of maize did not influence significantly due to different weed management practices during both the years. The maximum plant population was noticed under hand weeding as compared to all other weed management practices. The minimum plant stand (19.34 and 19.44)10^3/ha was observed from pendimethalin during 2015 and 2016. Interaction effect of intercropping systems and weed management practices for plant stands of maize was not found significant in the two years and on mean basis.

Plant height

It was recorded at different crop growth stage. The data pertaining to plant height of maize under main effects of treatments recorded at 30, 60 and at harvest during 2015 and 2016 are summarized in Table 4. The results have indicated that the plant height of maize was influenced significantly due to intercropping systems and weed management at 60 DAS during both stage and at harvest during 2016 but did not influenced significantly at 30 DAS. The data revealed that plant height of maize grown either with sesame (8:2) (41.54 and 50.29 cm) recorded significantly higher compared to maize grown with sesame (4:1) in row ratio (40.38 and 43.06 cm) at harvest stage during 2015 and 2016, respectively. Different weed management practices affected significantly to plant height. The plant height was observed significantly highest from hand weeding followed by *alachlor*.

The minimum plant height of maize was recorded under *pendimethalin* treatment (37.54 and 42.39 cm) at harvest stage during 2015 and 2016. Interaction effect of intercropping systems and weed management practices did not influence significantly in respect of plant height in the two years except at harvest during 2016.The results showed in table 5 the interaction effect of intercropping system and weed management practices on plant height of maize was observed with sesame + maize (8:2) with hand weeding as compared to both the combination of sesame + maize (4:1) with *pendimethalin* as well as with *alachlor* during 2016.

Plant height, fresh weight/plant and dry weight/plant which is the vital parameter of

plant growth was appreciably increased in intercropping with sesame with 8:2 row ratios which was decreased 4:1 row ratio during the two years of study. It might be owing to synergetic effect of maize on sesame in association. In other words, the beneficial effect of maize on sesame was probably due to fact that there may be synergetic association between secretions of allele-chemicals by root exudates of maize, urd and sesame plants. Additional advantage of synergetic association and extra nutrients to sesame, maize and urd crops might results in overall development of crops in terms of fresh weight/plant and dry weight/plant. These results in conformity with the Tomar *et al.,* (2020); Rajiv and Singh (2018), Reddy *et al.,* (2002), Jalalian *et al.,* (2008) and Pinto *et al.,* (2011).

Fresh weight/plant (g)

Fresh weight per plant was recorded at 30 DAS, 60 DAS and at harvest. The data pertaining to fresh weight of maize at different successive growth stages under main effects of treatments recorded during 2015 and 2016 are given in table 6. Fresh weight in maize plant gradually increased when crop age attained maximum at maturity in all the intercropping system and weed management practices during the two years that differed significantly at all the successive growth stages. Maximum fresh of maize was noticed when the crop was intercropped with sesame (8:2) at all the successive growth stages during 2015 and 2016. At 60 DAS, maize grown with sesame (8:2) recorded significantly higher fresh weight as compared to sesame with maize at (4:1) row ratio during both the years of experimentation. The lowest fresh weight of maize at 60 DAS was recorded when it was grown with sesame. The similar trend was observed during at harvest during the two years. Weed management practices influenced significantly the fresh weight of maize during both the years of study. Similar to intercropping systems, fresh weight in maize plant also gradually increased with crop age attained maximum at harvest in all the weed management practices. Application of hand weeding recorded significantly higher fresh weight at 30 DAS, 60 DAS and at harvest during both the years. The minimum fresh weight of maize plant was obtained with the plots received pendimethalin during the two years. Interaction effect of intercropping system × weed management practices did not very significantly in respect of fresh weight of maize at all the significantly growth stages during the two years.

Dry weight/plant (g)

Dry weight in maize plant gradually increased with crop age attained maximum at maturity in all the intercropping system and weed management practices during the two years that differed significantly at all the successive growth stages. Maximum fresh of maize was noticed when the crop was intercropped with sesame.(8:2) at all the successive growth stages during 2015 and 2016. At 60 DAS, maize grown with sesame (8:2) recorded significantly higher dry weight as compared to sesame with maize at (4:1) row ratio during both the years of experimentation. The lowest dry weight of maize at 60 DAS was recorded when it was grown with sesame. The similar trend was observed during at harvest during the two years. Weed management practices influenced significantly the dry weight of maize during both the years of study. Similar to intercropping systems, dry weight in maize plant also gradually increased with crop age, and attained maximum at harvest in all the weed management practices. Application of hand weeding recorded significantly higher dry weight at 30 DAS, 60 DAS and at harvest during the two years.

Table.1 Weekly meteorological data recorded during crop period *Khraif* 2015

Std. weeks	Periods 2015	Rain fall (mm)	Temperature (^{0}C)		Relative humidity (%)		Wind fall (mm)	E.T.R. (mm/ day)
			Max.	Min.	Max.	Min.		
28	05 July - 11 July	35	33.83	23.99	87.43	67.86	8.26	6.37
29	12 July - 18 July	28.9	34.09	24.00	84.57	67.29	8.23	5.66
30	19 July - 25 July	11.4	33.80	24.36	86.00	67.86	8.87	6.29
31	26 July - 01 Aug.	2.0	34.1	23.4	77.0	59.6	10.0	6.6
32	02 Aug.- 08 Aug.	9.8	34.60	23.67	83.29	64.29	6.86	6.74
33	09 Aug. - 15 Aug.	90.0	34.09	20.54	88.43	68.86	5.06	6.49
34	16 Aug. - 22 Aug.	10	33.51	23.01	87.57	70.86	8.06	6.14
35	23 Aug. - 29 Aug.	12	34.39	23.20	86.43	65.86	6.46	6.17
36	30 Aug. - 05 Sept.	36.1	23.7	77.0	50.1	7.7	6.3	36.1
37	06 Sept. - 12 Sept.	-	36.6	22.3	72.6	52.3	6.6	6.3
38	13 Sept. - 19 Sept.	52.5	34.9	22.7	88.7	67.0	5.6	5.9
39	20 Sept. - 26 Sept.	46.5	34.1	21.4	82.9	61.9	6.0	4.9
40	27 Sept. - 03 Oct.	-	35.6	19.0	87.1	51.3	2.5	4.6
41	04 Oct. - 10 Oct.	-	35.7	17.6	85.6	47.4	2.8	4.1
42	11 Oct. - 17 Oct.	0.6	34.6	18.5	79.7	56.0	4.4	3.7
43	18 Oct. - 24 Oct.	-	34.6	15.9	87.4	50.7	2.6	3.4
44	25 Oct. - 31 Oct.	18.7	27.6	14.4	87.0	59.4	3.4	2.7
45	01 Nov. - 07 Nov.	-	31.3	13.3	90.7	50.6	2.0	2.3
46	08 Nov. - 14 Nov.	-	30.8	12.5	88.0	51.7	2.8	2.0
47	15 Nov. - 21 Nov.	-	30.1	9.9	91.3	45.4	1.7	2.0
48	22 Nov. - 28 Nov.	-	28.3	9.9	87.3	47.7	2.4	1.8
49	29 Nov. - 05 Dec.	26.0	26.9	13.0	92.0	63.6	3.5	1.3
50	06 Dec. - 12 Dec.	-	25.0	8.9	97.3	54.6	2.5	1.3
51	13 Dec. - 19 Dec.	-	21.7	3.3	89.6	41.4	3.5	1.5
52	20 Dec. - 26 Dec.	-	21.5	3.5	87.1	32.7	2.6	1.4
	Total	**379.5**	**-**	**-**	**-**	**-**	**-**	**-**
	Average	**-**	**31.4**	**19.6**	**85.0**	**55.0**	**4.9**	**5.4**

Table.2 Weekly meteorological data recorded during crop period *Khraif* 2016

Std. weeks	Periods 2015-16	Rain fall (mm)	Temperature (^{0}C)		Relative humidity (%)		Wind fall (mm)	E.T.R. (mm/ day)
			Max.	Min.	Max.	Min.		
28	03 July - 09 July	108	32.4	24.9	91.9	78.6	4.5	4.9
29	10 July - 16 July	84.9	32.2	26.1	89.4	86.1	6.2	4.5
30	17 July - 23 July	16.4	32.1	26.3	87.9	77.4	7.5	3.4
31	24 July - 30 July	75.4	32.3	25.4	90.7	77.3	5.4	3.7
32	31 July - 06 Aug.	25.2	32.5	26.2	88.4	72.3	6.5	3.3
33	07 Aug. - 13 Aug.	67.9	32.2	26.0	89.9	74.6	6.1	3.5
34	14 Aug. - 20 Aug.	33.1	31.5	25.3	90.1	77.1	6.1	3.3
35	21 Aug. - 27 Aug.	5.6	33.0	25.3	86.9	69.4	5.5	3.7
36	28 Aug. - 03 Sept.	-	34.3	26.6	87.3	67.6	4.4	4.2
37	04 Sept. - 10 Sept.	-	34.0	25.9	80.6	63.3	5.7	4.5
38	11 Sept. - 17 Sept.	13.0	32.5	24.9	88.0	72.6	1.3	4.3
39	18 Sept. - 24 Sept.	-	32.4	25.2	90.3	75.0	4.2	4.3
40	25 Sept. - 01 Oct.	-	33.1	24.4	91.0	64.4	4.7	4.1
41	02 Oct. - 08 Oct.	20.0	34.5	24.8	85.4	61.4	4.1	4.1
42	09 Oct. - 15 Oct.	14.0	33.9	20.2	83.0	44.1	3.2	4.0
43	16 Oct. - 22 Oct.	-	33.6	16.7	80.7	38.0	2.6	3.9
44	23 Oct. - 29 Oct.	-	33.2	16.2	80.4	35.6	3.3	3.7
45	30 Oct. - 05 Nov.	-	31.2	13.9	89.4	39.1	1.8	3.4
46	06 Nov. - 12 Nov.	-	30.1	13.0	83.7	45.1	3.1	3.1
47	13 Nov. - 19 Nov.	-	29.0	11.8	84.7	41.7	2.5	2.7
48	20 Nov. - 26 Nov.	-	28.5	12.4	78.3	43.4	4.9	2.4
49	27 Nov. - 03 Dec.	-	24.5	13.0	92.4	67.7	3.4	2.4
50	04 Dec. - 10 Dec.	-	19.7	10.2	99.7	71.9	3.2	1.8
51	11 Dec. - 17 Dec.	-	26.0	8.9	94.4	44.6	2.7	1.4
52	18 Dec. - 24 Dec.	-	24.3	8.1	91.0	50.4	4.0	1.5
53	25 Dec. - 31 Dec.	-	20.9	9.5	95.4	64.1	3.6	1.2
	Total	**463.5**	**-**	**-**	**-**	**-**	**-**	**-**
	Average	**-**	**30.5**	**19.7**	**88.1**	**61.6**	**4.3**	**3.4**

Table.3 Mean table for initial plant stands (10^3/ha) and final plant stands (10^3/ha.) of Maize crop during the two years

Treatments	Mean Table			
	Initial plant stands (10^3/ha)		Final plant stands (10^3/ha)	
	2015	2016	2015	2016
Intercropping				
Sesame + Maize (4:1)	19.74	19.92	19.66	19.82
Sesame + Maize (8:2)	20.26	20.38	20.00	20.07
SE(d)±	**0.813**	**0.762**	**0.746**	**0.793**
CD at 5%	**N.S.**	**N.S.**	**N.S.**	**N.S.**
Weed Management				
Hand Weeding	20.83	20.97	20.70	20.89
Pendimethalin 30% EC @3.0L/ha.	19.34	19.44	19.06	19.01
Alachlor 50% EC @0.750kg/ha.	19.83	20.05	19.73	19.93
SE(d)±	**0.996**	**0.934**	**0.914**	**0.972**
CD at 5 %	**N.S.**	**N.S.**	**N.S.**	**N.S.**

Table.4 Mean table for plant height (cm) at 30, 60 DAS and at harvest stage of maize crop during the two years

Treatments	Mean Table					
	Plant Height (cm) at 30 DAS		Plant Height (cm) at 60 DAS		Plant Height (cm) at Harvest	
	2015	2016	2015	2016	2015	2016
Intercropping						
Sesame + Maize (4:1)	16.76	20.05	30.89	42.48	40.38	43.06
Sesame + Maize (8:2)	17.53	20.95	33.58	45.47	41.54	50.29
SE(d)	**0.511**	**0.786**	**1.003**	**1.060**	**1.513**	**1.719**
CD at 5%	**N.S.**	**N.S.**	**2.137**	**2.260**	**N.S.**	**3.664**
Weed Management						
Hand Weeding	18.02	21.92	35.31	48.01	46.49	55.09
Pendimethalin 30% EC @ 3.0L/ha.	16.44	19.01	30.30	39.33	37.54	42.39
Alachlor 50% EC @0.750kg/ha.	16.98	20.58	31.11	44.58	38.85	42.54
SE(d)±	**0.626**	**0.963**	**1.228**	**1.298**	**1.853**	**2.105**
CD at 5 %	**N.S.**	**2.053**	**2.617**	**2.768**	**3.950**	**4.488**

Table.5 Interaction effect of cropping system and weed management practices on plant height (cm) of maize at harvesting during year (2016)

	Hand Weeding	Pendimethalin	Alachlor	Mean
Sesame + Maize (4:1)	48.48	37.81	42.88	**43.058**
Sesame + Maize (8:2)	61.70	46.97	42.19	**50.287**
Mean	**55.090**	**42.391**	**42.535**	
SE(d)±	**2.977**			
CD at 5 %	**6.346**			

Table.6 Mean table for fresh weight/Plant (g) at 30, 60 DAS and at harvest of Maize crop during the two years

Treatments	Mean Table					
	Fresh Weight/Plant (g) at 30 DAS		Fresh Weight/Plant (g) at 60 DAS		Fresh Weight/Plant (g) at Harvest	
	2015	2016	2015	2016	2015	2016
Intercropping						
Sesame + Maize (4:1)	51.58	54.98	160.45	172.00	333.24	346.03
Sesame + Maize (8:2)	57.90	63.42	181.47	212.05	336.01	355.80
SE(d) ±	**2.511**	**3.017**	**8.618**	**13.831**	**13.184**	**16.607**
CD at 5%	**5.353**	**6.430**	**18.370**	**29.483**	**N.S.**	**N.S.**
Weed Management						
Hand Weeding	67.72	76.59	255.38	272.54	416.24	434.92
Pendimethalin	47.17	48.97	103.50	122.38	260.60	288.38
Alachlor	49.33	52.04	154.00	181.17	327.05	329.46
SE(d)±	**3.076**	**3.694**	**10.555**	**16.940**	**16.147**	**20.339**
CD at 5 %	**6.556**	**7.875**	**22.499**	**36.109**	**34.419**	**43.355**

Table.7 Mean table for Dry Weight/Plant (g) at 30, 60 DAS & at harvest of maize crop during the two years

Treatments	Mean Table					
	Dry Weight/Plant (g) at 30 DAS		Dry Weight/Plant (g) at 60 DAS		Dry Weight/Plant (g) at Harvest	
	2015	2016	2015	2016	2015	2016
Intercropping						
Sesame + Maize (4:1)	12.28	13.83	80.11	84.78	82.96	92.78
Sesame + Maize (8:2)	14.10	14.90	85.17	86.47	93.51	99.22
SE(d) ±	**0.780**	**0.807**	**2.525**	**3.534**	**2.543**	**3.005**
CD at 5%	**1.662**	**N.S.**	**N.S.**	**N.S.**	**5.421**	**6.406**
Weed Management						
Hand Weeding	15.47	16.56	101.25	104.77	103.03	112.17
Pendimethalin	11.28	13.17	63.00	65.76	70.42	78.57
Alachlor	12.83	13.37	83.67	86.35	91.26	97.26
SE(d)±	**0.955**	**0.988**	**3.093**	**4.328**	**3.115**	**3.681**
CD at 5 %	**2.036**	**2.107**	**6.593**	**9.226**	**6.639**	**7.846**

The minimum dry weight of maize plant was obtained with the plots received pendimethalin during the two years. Interaction effect of intercropping systems x weed management did not vary significantly in respect of dry weight of maize at all the successive growth stages during the two years.

The growth parameter of maize plant height, fresh and dry weight was significantly increasing with the application of hand weeding at different crop growth stage as compared to other weed management practices. The minimum growth parameter was identified with the pendimethalin application. They observed that parameters like plant height, fresh and dry weight were significantly affected by the various treatments of weed management on maize and urd. The hand weeding resulted in an increased plant height, fresh and dry weight per plant of maize and urd. Moreover, that weed free treatment produced significantly heavier plants, with more branches than the pendimethalin. Superiority of hand weeding was attributed not only to control weeds satisfactorily but also to provide better aeration to the crop. It was concluded that hand weeding was superior because of better branching and more cob and pod production, caused by satisfactory control of weeds in the early stages of crop growth. These views were also earlier confirmed by Gautam *et al.*, (2002), Vedharethinam *et al.,* (2004) and Grichar *et al.*, (2007).

The data revealed that plant height of maize grown either with sesame (8:2) (41.54 cm and 50.29cm) recorded significantly higher compared to maize grown with sesame (4:1) in row ratio (40.38 cm and 43.06cm) at harvest stage during 2015 and 2016. At harvest, maize grown with sesame (8:2) recorded significantly higher fresh weight as compared to sesame with maize at (4:1) row ratio during the two years of experimentation. At harvest, maize grown with sesame (8:2) recorded significantly higher dry weight as compared to sesame with maize at (4:1) row ratio during both the years of experimentation. The lowest dry weight of maize at 60 DAS was recorded when it was grown with sesame.

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