Short communication

Effect of weed management practices on growth and yield of okra (*Abelmoschus esculentus* (L.) Moench.)

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Abstract

A field experiment was conducted during the summer season of 2016 to study the effect of different weed management practices on growth and yield of okra as well as economics of cultivation. Treatments included four different organic mulches (mango leaves, paddy straw, newspaper and coir fibre mat), mulching with black polythene sheet, hand weeding, weed management by herbicide and an unweeded control. Black polythene sheet mulching was the best treatment for weed control. Pre emergence application of pendimethalin resulted in lower weed population and dry matter production during initial period of the crop and thereafter population and dry matter increased. Among organic mulches, newspaper mulching resulted in greater weed control followed by paddy straw mulching. Higher weed control efficiency (more than 90%) was obtained with black polythene sheet throughout the crop period. Mulching with paddy straw and newspaper resulted in lower weed index than hand weeding and pre emergence application of pendimethalin. Black polythene mulching recorded higher fruit yield of 14.58 Mg ha^{-1}, followed by paddy straw mulching and newspaper mulching (11.16 and 11.01 Mg ha^{-1}). Highest B:C ratio was also obtained with black polythene mulching.

Keywords: B:C ratio, Coir fibre mat, Mango leaves, Newspaper mulch, Okra, Organic mulches, Paddy straw, Polythene mulch, Weed management

Introduction

Okra (*Abelmoschus esculentus* (L.) Moench.) is a warm season vegetable crop cultivated widely all over the world mainly for its immature fruits. Heavy infestation of weeds is a major constraint in cultivation of okra due to the wide spacing adopted and slow initial growth. A yield loss of about 54.1 to 90.6% has been reported in okra due to weed competition (Singh et al., 1982). Weeds are generally controlled by physical and cultural methods, and hand weeding is the most efficient method of weed control. However, these methods are tedious, time consuming and laborious. The easiest way to control weeds is through herbicides, which is quicker and cheaper as compared to other methods. However, considering the side effects of continued use of chemicals, relying only on herbicides alone for weed management is not ideal. Mulching is a proven alternative. It is a non chemical cultural method of covering the land surface with organic or inorganic materials, often for managing weeds. A study was carried out to determine the effect of different weed management practices on growth and yield of okra, and to identify the most efficient economic practice. A field experiment was conducted during the summer season (March to June, 2016) at Agronomy farm, Department of Agronomy, College of Horticulture, Vellanikkara. The experimental site is located at 13^0 32^I N latitude and 78^0 26^I E longitudes, at an altitude of about 40 m from mean sea level. The soil of the experimental site is sandy loam with low pH (5.08), and is medium in organic carbon (1.06%), low in available N (165.23 kg ha^{-1}),

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Table 1. Effect of weed management practices on plant height of okra

Treatments		Plant height (cm)		
		30 DAS	60 DAS	90 DAS
T_1	Mulching with mango leaves + Hand weeding at 45 DAS	40.13	101.73	107.37
T_2	Mulching with paddy straw + Hand weeding at 45 DAS	43.13	102.20	112.13
T_3	Mulching with newspaper + Hand weeding at 45 DAS	34.53	106.77	120.80
T_4	Mulching with coir fibre mat	38.00	99.070	102.03
T_5	Mulching with polythene sheet	47.07	110.23	123.87
T_6	Hand weeding at 20, 45 and 60 DAS	38.80	106.17	119.87
T_7	Pendimethalin 1.0 kg ha^{-1}+ Hand weeding at 45 DAS	33.27	105.10	115.70
T_8	Unweeded control	37.32	99.67	100.87
	CD(0.05)	5.21	6.09	5.45

medium in available P (12.58 kg ha^{-1}) and medium in available K (136.80 kg ha^{-1}). The experiment was laid out in RBD with eight treatments and three replications. The treatments comprised four organic mulches [mulching with fresh mango leaves @ 5 Mg ha^{-1} followed by hand weeding at 45 DAS, dry paddy straw @ 5 Mg ha^{-1} followed by hand weeding at 45 DAS, mulching with newspaper (spread out in two layers) followed by hand weeding at 45 DAS, mulching with coir fibre mat (1000 GSM, spread out)], mulching with black polythene sheet (30 microns), hand weeding thrice at 20, 45, and 60 DAS, pre emergence application of pendimethalin (1.0 kg ha^{-1}) followed by hand weeding at 45 DAS and an unweeded control. Okra variety "Arka Anamika" (@ 8.5 kg ha^{-1}) was used for the experiment with a plot size of 3.6 x 3.6 m^2 and spacing was 60 cm x 30 cm. Mulching was done at the time of sowing as per the treatments.

Growth and yield parameters observed were plant height and number of branches (at 30, 60 and 90 DAS), days to first flowering, days to first harvest, number of fruits per plant and fruit yield. Weed density and weed dry matter production were measured at 20, 45 and 90 DAS. Weed density was measured using a quadrat (0.25 m^2) placed at random in the plots, and the weed species within the quadrat were identified and counted. Weed control efficiency and weed index was worked out as per the formulae suggested by Mani et al. (1973) and Gill and Vijaykumar (1969) respectively. The data were subjected to analysis of variance for randomized block design.

Plant height of okra ranged from 33.27 cm to 47.07 cm, 99.67 cm to 110.23 cm and 100.87 cm to 123.87 cm at 30, 60 and 90 DAS respectively (Table 1) and the number of branches increased from 30 DAS to 90 DAS (Table 2). Mulching with black polythene sheet resulted in significantly greater plant height and number of branches throughout the crop period and was on par with T_2 at 30 DAS; with T_3, T_6, T_7 at 60 DAS and with T_3 and T_6 at 90 DAS. Muhammed

Table 2. Effect of weed management practices on number of branches of okra

Treatments		Number of branches		
		30 DAS	60 DAS	90 DAS
T_1	Mulching with mango leaves + Hand weeding at 45 DAS	1.33	2.00	2.33
T_2	Mulching with paddy straw + Hand weeding at 45 DAS	2.00	2.66	3.00
T_3	Mulching with newspaper + Hand weeding at 45 DAS	2.00	3.00	3.66
T_4	Mulching with coir fibre mat	1.33	1.66	1.66
T_5	Mulching with polythene sheet	3.00	4.00	4.33
T_6	Hand weeding at 20, 45 and 60 DAS	1.33	2.00	2.33
T_7	Pendimethalin 1.0 kg ha^{-1}+ Hand weeding at 45 DAS	2.00	2.66	2.66
T_8	Unweeded control	1.00	1.00	1.00
	CD(0.05)	0.81	1.12	1.12

(2015) reported improvement in height and number of branches of okra plants grown under polythene mulches. Among organic mulches, paddy straw recorded greater plant height at 30 and 60 DAS. At 60 DAS it was on par with newspaper mulching. At 90 DAS, coir fibre mat mulching and unweeded control treatments recorded the lowest heights. Number of branches in hand weeded and mango leaf mulched plots were more or less the same. Unweeded control plot recorded the least height and number of branches throughout the crop period, may be due to severe infestation of weeds in this treatment. As suggested by Usman et al. (2005), reduction in plant height may occur due to severe crop weed competition.

In all the treatments except unweeded control and mulching with coir fibre mat, flowering started by 36th day after sowing (Table 3). Plants in unweeded control treatment took more number of days for first flowering (43 DAS) and harvesting (48 DAS). The plants mulched with coir fibre mat took 38.33 days for first flowering and 43 days for first harvest. Higher weed count and dry matter production in these treatments throughout the crop growth period might have influenced the flowering and fruiting characteristics (Table 4). Similar findings were reported earlier by Olabode et al. (2007). According to them, plants in weedy check took more number of days for flowering because of higher competition from weeds. Black polythene mulching, hand weeding and pre emergence spraying of pendimethalin were the best treatments, with regard to number of days to harvest.

Number of fruits produced per plant (Table 3) was significantly higher in black polythene sheet (12 nos.). Mulching with newspaper and paddy straw, and hand weeding were the next best treatments with regard to number of fruits per plant. Unweeded control plots recorded the lowest number of fruits (5 nos.). Similarly, plants mulched with black polythene sheet and plants with heavy weed infestation (unweeded control), gave highest and lowest number of harvests (Table 3). Except for mulching with coir fibre mat, all other treatments with mulching were uniform with respect to number of harvests. Arin and Ankara (2001) reported that polyethylene mulching was useful for encouraging crop development during initial stages of plant growth, resulting in early harvest and high total yield.

Weed management practices significantly influenced the yield of okra as is evident from the data presented in Table 3. Black polythene mulching resulted in the highest yield (14.58 Mg ha^{-1}). Among organic mulches, mulching with paddy straw (11.16 Mg ha^{-1}) and newspaper (11.01 Mg ha^{-1}) were best treatments for yield. Positive influence of paddy straw mulching and paper mulching on yield of okra was reported by many workers (Muhammed, 2015; Dutta et al., 2016). Yield with coir fibre mat mulching was very low compared to other weeded

Table 3. Effect of weed management practices on yield attributes and yield of okra

Treatments		Days to first flowering	Days to first harvest	No. of fruits per plant	No. of harvests	Yield (Mg ha^{-1})
T_1	Mulching with mango leaves + Hand weeding at 45 DAS	36.66	42.00	9.46	9.00	9.03
T_2	Mulching with paddy straw + Hand weeding at 45 DAS	36.66	42.00	10.20	9.00	11.16
T_3	Mulching with newspaper + Hand weeding at 45 DAS	36.33	41.66	10.60	9.00	11.01
T_4	Mulching with coir fibre mat	38.33	43.00	7.60	4.66	5.30
T_5	Mulching with polythene sheet	36.00	41.00	12.26	10.33	14.58
T_6	Hand weeding at 20, 45 and 60 DAS	36.33	41.33	10.46	9.00	10.69
T_7	Pendimethalin 1.0 kg ha^{-1}+ Hand weeding at 45 DAS	35.66	40.66	9.60	9.00	10.07
T_8	Unweeded control	43.66	48.00	5.26	4.33	1.12
CD (0.05)		1.00	1.65	0.76	0.60	0.89

Table 4. Effect of weed management practices in okra on weed count and dry weight at 20, 45 and 90 DAS

Treatments		Weed count (No. m^{-2})			Weed dry weight (g m^{-2})		
		20 DAS	45 DAS	90 DAS	20 DAS	45 DAS	90 DAS
T_1	Mulching with mango leaves + HW 45 DAS	12.99* (168.67)	12.71 (162.67)	10.15 (110.67)	3.87 (14.69)	13.85 (192.00)	10.70 (116.67)
T_2	Mulching with paddy straw + HW 45 DAS	11.25 (126.67)	9.68 (94.00)	9.74 (95.00)	3.63 (12.75)	8.70 (78.10)	8.44 (72.00)
T_3	Mulching with newspaper + HW 45 DAS	6.75 (45.33)	7.81 (66.67)	7.29 (53.33)	2.83 (7.64)	4.02 (16.87)	7.62 (58.55)
T_4	Mulching with coir fibre mat	16.05 (260.33)	17.05 (291.33)	13.81 (192.00)	5.26 (27.18)	19.07 (366.67)	21.25 (453.25)
T_5	Mulching with polythene sheet	1.39 (1.67)	1.61 (2.67)	3.43 (12.00)	1.74 (3.09)	3.01 (9.10)	5.40 (29.48)
T_6	Hand weeding at 20, 45 and 60 DAS	21.25 (452.00)	6.35 (41.00)	9.06 (82.67)	5.46 (29.65)	4.65 (22.43)	8.63 (74.93)
T_7	Pendimethalin 1.0 kg ha^{-1}+ HW 45 DAS	4.27 (18.33)	6.56 (44.00)	10.07 (102.67)	2.85 (8.00)	8.49 (72.47)	8.73 (77.66)
T_8	Unweeded control	23.01 (533.33)	18.74 (355.00)	16.64 (277.33)	5.59 (30.73)	21.93 (485.79)	23.02 (531.07)
	CD(0.05)	2.06	2.45	1.41	0.973	2.428	2.263

* x+0.5 transformed values, original values are given in parenthesis

treatments (5.30 Mg ha^{-1}). Higher weed growth noticed in coir fibre mat might have influenced crop growth adversely and finally, yield. The fruit yield from hand weeded plots and plots with pre emergence application of herbicide were statistically at par (10.70 and 10.07 Mg ha^{-1}). The unweeded control plot recorded the lowest fruit yield of 1.12 Mg ha^{-1} which was 13.46 tons less than the best yielding treatment. Compared to traditional hand weeding and pre emergence application of pendimethalin, weed management by polythene mulching gave 3.88 and 4.51 tons more yield per hectare respectively.

Weeds found in the experimental field were typical upland weeds. The main grass weeds observed in the field were *Digitaria ciliaris* and *Panicum maximum*. The broad leaf weeds were *Cleome burmanii, Euphorbia geniculata, Borreria hispida, Phyllanthus amara, Sida acuta,* and *Alternanthera bettzickiana.* No sedges were noticed during the crop period.

Lowest weed count and dry matter production were observed on mulching with black polythene sheet throughout the growth period (Table 4). The superiority of black polythene sheet in suppression of weed growth was also reported by Aniekwe (2013). Pre emergence application of pendimethalin @ 1.0 kg ha^{-1} was the next best treatment at 20 DAS and thereafter the count and dry weights increased, indicating reduced suppression of weeds. Similar finding was reported by Muhammed (2015). Among different organic mulches, newspaper mulching was superior in controlling weeds and recorded lower weed count and dry weight. As per Munn (1992), mulching with newspaper resulted in better control of weeds than straw mulch and bare soil. Mulching with coir fibre mat recorded a higher weed count and dry weight due to emergence of weeds through the holes of coir fibre mat. Since initial observations on weed count and dry matter production were taken before first hand weeding, the hand weeding treatment (T_6) recorded higher values for these parameters.

Black polythene mulching recorded high weed control efficiency (WCE) of more than 90% throughout the growth period (Table 5). Among organic mulches, newspaper mulching had higher

Table 5. Effect of weed management practices in okra on weed control efficiency and weed index

Treatments		Weed control efficiency (%)			Weed index (%)
		20 DAS	45 DAS	90 DAS	
T_1	Mulching with mango leaves +HW 45 DAS	25.49	54.75	55.31	37.98
T_2	Mulching with paddy straw + HW 45 DAS	34.90	40.84	66.63	23.42
T_3	Mulching with newspaper + HW 45 DAS	79.34	98.01	79.75	24.47
T_4	Mulching with coir fibre mat	13.60	10.68	13.11	63.61
T_5	Mulching with polythene sheet	95.67	98.06	93.14	0.00
T_6	Hand weeding at 20, 45 and 60 DAS	17.24	95.09	85.60	26.59
T_7	Pendimethalin 1.0 kg ha^{-1}+ HW 45 DAS	85.20	85.15	79.91	30.89
T_8	Unweeded control	0.00	0.00	0.00	92.35
	CD(0.05)	9.93	14.63	10.67	5.05

WCE during the entire growth period. At 20 DAS, WCE was higher in polythene mulched plots followed by pre emergence application of pendimethalin. At 45 and 90 DAS, polythene mulching, hand weeding, pendimethalin and newspaper mulching had higher WCE than other treatments. Sultana et al. (2008) had also reported a WCE of 87% with pre emergence application of pendimethalin followed by two hand weedings. Mulching with mango leaves and paddy straw gave comparatively better WCE during the duration of the crop.

Mulching with black polythene resulted in lowest weed index. Among organic mulches mulching with newspaper, paddy straw and mango leaves recorded lower values of weed index (Table 5). As reported by Muhammed et al. (2015), better weed management in okra could be achieved by organic mulching, thereby increasing crop yield. Hand weeding and pre emergence application of pendimethalin also recorded lower weed indices showing the effectiveness of the treatments in reducing crop weed competition and increasing yield.

The highest B:C ratio of 3.02 was obtained for black polythene sheet mulch (Table 6). Mulching with newspaper recorded a B:C ratio of 2.49 which was the next best treatment. The B:C ratio for herbicidal weed management was 2.46, whereas that for hand weeding was 2.26. Weed management by application of straw as mulch also gave better B:C ratio of 2.22.

Yield from plots with paddy straw and newspaper mulching followed by one hand weeding at 45 DAS was statistically at par with hand weeding three

Table 6. Effect of treatments on Benefit: Cost ratio

Treatments		Cost of cultivation (Rs/ha)	Income (Rs/ha)	B:C ratio
T_1	Mulching with mango leaves +HW 45 DAS	134659	270900	2.01
T_2	Mulching with paddy straw + HW 45 DAS	150951	334800	2.22
T_3	Mulching with newspaper + HW 45 DAS	132651	330300	2.49
T_4	Mulching with coir fibre mat	414299	159000	0.38
T_5	Mulching with polythene sheet	144799	437400	3.02
T_6	Hand weeding at 20, 45 and 60 DAS	141817	320700	2.26
T_7	Pendimethalin 1.0 kg ha^{-1}+ HW 45 DAS	122644	302100	2.46
T_8	Unweeded control	107224	33600	0.31

* Labour charges (Men – Rs. 449/day and Women- Rs. 349/ day)
* Cost of black polythene sheet – Rs. 6.10/ m^2 (100% coverage of field)
* Cost of coir fibre mat – Rs. 30/m^2
* Cost of pendimethalin – Rs.470/L
* Sale price of okra – Rs. 30/kg

times at 20, 45 and 60 DAS, indicating the possibility of reducing number of hand weedings from three to one on application of organic mulches. The results suggest the possibility of using mulches either organic (newspaper or paddy straw) or inorganic (polythene) as a better alternative to manual weeding and herbicidal application for weed management in okra and also for a higher B:C ratio.

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