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Productivity enhancement of sweet corn (*Zea mays*) through organic weed management practices

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ABSTRACT

Area under organic cultivation of crops is increasing not only in India but also in Rajasthan as well. Weeds are often recognized as the most serious threat to organic crop production and fear of ineffective weed control is often perceived by farmers as one of the major obstacles to conversion from conventional to organic farming. A two years field experiment was conducted to study the non-chemical methods of weed management in organically grown sweet corn (*Zea mays* L.) during 2018–19. Among the 12 organic weed management treatments, soil solarization + plastic mulch at sowing resulted in significantly lower weed density, weed dry matter, higher yield attributes and yield over other treatments but at par with stale seed bed preparation + plastic mulch at sowing during both the years. Stale seed bed preparation + plastic mulch at sowing gave highest net returns and benefit-cost ratio of ₹ 62746 and 105201 and 1.62 and 2.35, respectively followed by weedy check, which gave the net returns and benefit: cost ratio of ₹ 16093, 26858 and 0.96 and 2.18, respectively.

Keywords: Organic weed management, Plastic mulch, Productivity, Weed control efficiency

Organic farming in recent years is gaining impetus due to sustaining crop production and also maintaining dynamic soil nutrient status and a safe environment. In Rajasthan, area under organic certification is 2.17 lakh ha, which includes cultivable area, forest and wild area with production of 2.65 lakh tonnes organic products (Sharma *et al.* 2015). Sweet corn (*Zea mays* L.) is generally grown for fresh green cobs for human consumption and it is also used as raw and processed material for the food industry. It is an important source of dietary fiber, minerals and certain vitamins like A and C. Its taste and nutritional value have made it a valued crop all over world and the scope of sweet corn production is constantly increasing (Olabode and Sangodele 2015). Among the several factors, most critical for the low yield of sweet corn appears to be the weeds competing with the crop for nutrients, water, sunlight and space and deprive the crops from vital resources. The losses caused by weeds exceed the losses from any other category of agricultural pests (Sharma *et al.* 2010, Mali *et al.* 2019). Early emerging weeds and high weed densities usually cause the greatest yield reductions, than late-emerging weeds. Yield losses due to weeds in maize vary from 28-93% depending on the type of weed flora and intensity and duration of crop-weed competition.

Under organic farming, non-chemical methods of weed control is the only option, viz. stale seedbed, soil solarization, mulching, crop rotation, intercropping and physical methods of weed control and these methods provide effective and acceptable weed control measures for realizing high production. In these situations, integration of pre-sowing and post-sowing intercultural weed management practices are necessary to achieve satisfactory results is indispensable in organic farming (Ehsas *et al.* 2016). Keeping in view the potential of organic farming in India, the experiment was carried out to generate information and advice on better and most appropriate alternatives of integrated weed management approach in sweet corn under organic production system.

MATERIALS AND METHODS

A two years field experiment was conducted during *kharif* 2018–19 at the Instructional Farm, Department of Agronomy, Rajasthan College of Agriculture, MPUAT, Udaipur. The mean weekly meteorological parameters recorded at agromet observatory, Rajasthan College of Agriculture, Udaipur during 2018–19. The maximum and minimum temperature ranged between 24.1 to 40.4ºC and 5.2 to 25.3ºC during 2018–19, respectively. The maximum

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and minimum temperature ranged between 22.2 to 38.4ºC and 6.5 to 24.9ºC during 2019–20, respectively. The soil of the experimental site was clay loam texture having low organic carbon (0.55%) and nitrogen (220 kg/ha), medium available phosphorus (34.20 kg/ha), high potassium (235.50 kg/ha), low DTPA extractable iron (3.05 ppm) and zinc (0.45 ppm). The experiment was laid out in randomized block design (RBD) with 12 treatment combinations in three replications. Weeds were identified into species and then classified as annual broad-leaved and grassy weeds. The weeds have been air-dried followed by oven dried at 80 °C for 48 h in order to measure the dry weight of each weed type and total weight at 60 days after sowing. Weed control efficiency (WCE) was calculated at 60 DAS using the following formula.

$$\text{WCE (\%)} = \frac{\text{Dry weight of weeds in untreated plot - Dry weight of weeds in treated plot}}{\text{Dry weight of weeds in untreated plot}}$$

At harvest, samples of sweet corn plant were taken randomly from each plot to measure cob length, number of cobs per plant, weight of 1000 seed, and grain yield per ha were calculated based on per plot grain yield. For plastic mulch, polythene sheet of black colour with 25-micron size was used. In one ha, 11 kg polyethene sheet was used. The sweet corn was grown under organic management practices as per standards of National Programme on Organic Production (NPOP) (APEDA 2019). The crop was sown at a spacing of 60 cm × 25 cm distance. The 90 kg N/ha was applied to the crop through organic sources.

RESULTS AND DISCUSSION

Weed dry matter: AT 60 DAS, all the three treatments of plastic mulch either with soil solarization, summer ploughing and stale seed bed techniques proved equally effective in reduction of weed dry matter. Plastic mulch in different combinations proved most effective and recorded 95-100% reduction in total weed dry matter at 60 DAS, in comparison to weedy check (Table 1). During 2019, stale seed bed techniques with plastic mulch observed the lowest weed dry matter with 98.83 % reduction over weedy check (71.41 g/m^2) at 60 DAS. Lowest weed density and dry matter at 30 and 60 DAS (0.27 and 1.50 g/m^2) was recorded by summer ploughing with plastic mulching at sowing. Weedy check plot exhibited the highest dry matter accumulation of weeds at all stages of observations due to uncontrolled situation and exerted competition with crop plants for production factors, viz. sunlight, space, soil moisture and nutrients as weed dominated crop plant. Use of black plastic sheet had reduced the transmission of sunlight, an essential component for photosynthesis might have resulted in lower dry matter accumulation of weeds under the treatments with use of plastic mulch. Our findings are corroborated with the previous results of Chakraborty *et al.* (2017), Baldaniya *et al.* (2018) and Senthil Kumar *et al.* (2019).

Weed control efficiency: Soil solarization + plastic mulch at sowing recorded maximum weed control efficiency (94.12%) during 2018, whereas maximum weed control efficiency at 60 DAS (98.80%) was observed with stale seed bed technique with plastic mulch (Table 1). Kareem *et al.* (2015) reported that plastic mulch provided almost 100% control of all types of weeds, bringing about the highest weed control efficiency over weedy check. Similar results were reported by Baldaniya *et al.* (2018) and Mahmood *et al.* (2018).

Yield attributes: Among various organic weed management treatments, maximum number of cobs per plant (1.47 and 1.45) and cob weight/plant (106.99 g and 192.58 g) were recorded with soil solarization with plastic mulch at sowing, results of all these attributes were found at par with summer ploughing + plastic mulch, stale seed bed preparation + plastic mulch (Fig 1 and 2). These

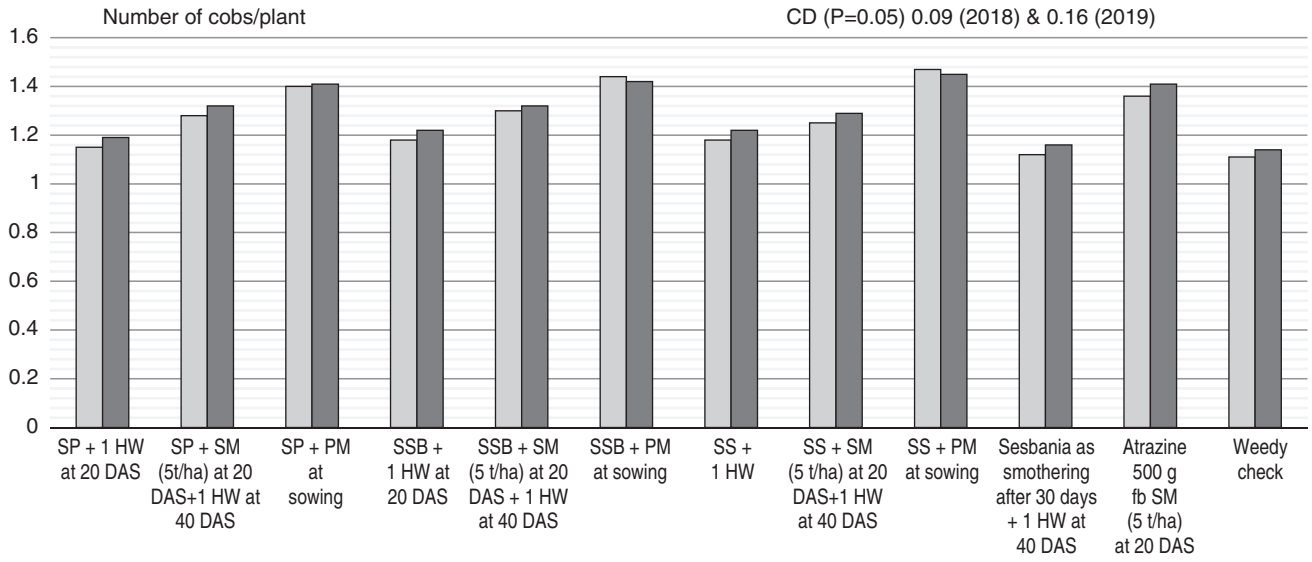

Fig 1 Effect of various weed control treatments on number of cobs per plant of sweet corn.

Table 1 Effect of various weed control treatments on weed dry matter and weed control efficiency (WCE) at 60 DAS

Treatment	Weed dry matter at 60 DAS						Weed control efficiency (WCE) at 60 DAS					
	2018			2019			2018			2019		
	Monocot	Dicot	Total	Monocot	Dicot	Total	Monocot	Dicot	Total	Monocot	Dicot	Total
Summer ploughing + one hand weeding at 20 DAS	8.55	7.48	16.03	9.83	7.09	16.92	65.44	81.40	76.30	79.15	70.71	76.31
Summer ploughing + straw mulch (5 t/ha) at 20 DAS+ one hand weeding at 40 DAS	5.00	2.49	7.49	5.74	2.55	8.29	88.48	89.13	88.92	87.81	89.46	88.37
Summer ploughing + plastic mulch at sowing	3.01	1.20	4.21	0.93	0.57	1.50	94.47	93.45	93.77	98.01	97.62	97.88
Stale seed bed preparation + one hand weeding at 20 DAS	13.95	6.92	20.87	13.89	6.92	20.82	68.00	69.63	69.11	70.43	71.30	70.75
Stale seed bed preparation + straw mulch (5 t/ha) at 20 DAS+ one hand weeding at 40 DAS	4.63	2.45	7.08	4.60	2.49	7.09	88.65	89.94	89.53	90.23	89.68	90.05
Stale seed bed preparation + plastic mulch at sowing	5.25	2.17	7.43	0.38	0.45	0.83	89.97	88.57	89.02	99.17	98.11	98.80
Soil solarization + one hand weeding	13.07	8.67	21.74	13.04	8.71	21.75	59.87	71.57	67.83	72.29	63.96	69.48
Soil solarization + straw mulch (5 t/ha) at 20 DAS+ one hand weeding at 40 DAS	10.32	3.99	14.31	6.40	4.12	10.52	81.54	77.54	78.82	86.33	82.94	85.20
Soil solarization + plastic mulch at sowing	2.52	1.44	3.96	0.52	0.62	1.14	93.31	94.51	94.12	98.91	97.41	98.38
Sesbania as smothering crop in between rows and used same Sesbania as mulch after 30 days + one HW at 40 DAS	16.27	12.46	28.73	16.36	12.51	28.87	42.44	64.61	57.52	65.25	48.24	59.49
Atrazine 500g *fb* straw mulching (5 t/ha) at 20 DAS	5.84	3.89	9.73	5.85	3.41	9.26	82.02	87.28	85.59	87.55	85.91	87.01
Weedy check	45.98	21.62	67.60	47.22	24.19	71.41	0.00	0.00	0.00	0.00	0.00	0.00
SEm ±	0.29	0.51	0.65	0.58	0.28	0.73						
LSD (P=0.05)	0.85	1.49	1.91	1.71	0.82	2.13						

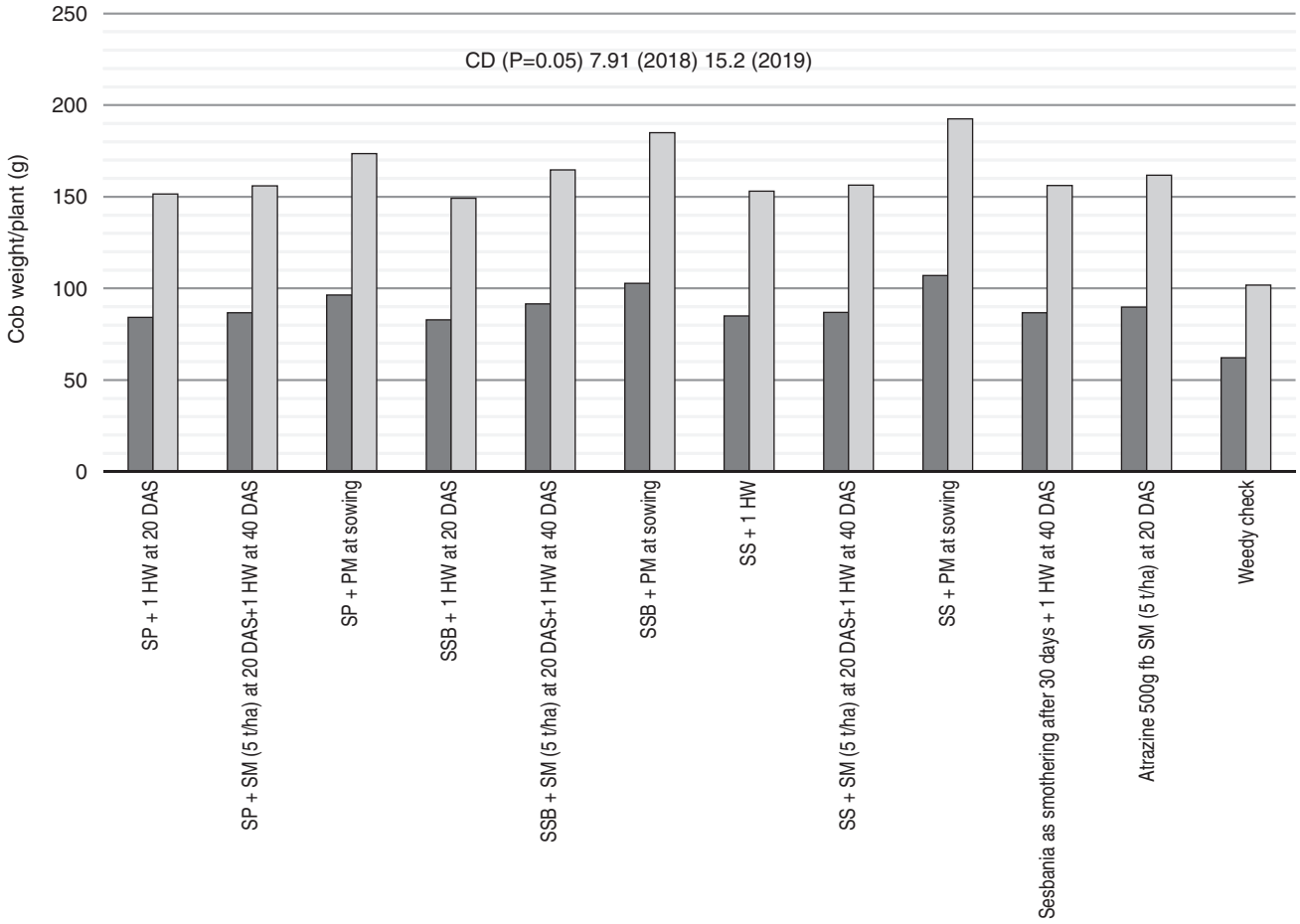

Fig 2 Effect of various weed control treatments on cob weight per plant of sweet corn.

three treatments of plastic mulch at sowing with different agronomic practices were found significantly superior over other treatments. It was emphasized that weed management practices markedly improved the overall growth of crop in terms of dry matter production, leaf area index, CGR and NAR due to better weed control at critical stages of crop growth thus ensuring favorable environment for better growth. This suggests greater availability of nutrients, metabolites and photosynthates in the sink and their translocation and accumulation ultimately led to appreciable enhancement of yield attributes of sweet corn. This increase of yield attributes in these treatments could be ascribed due to its profound influence on vegetative and reproductive growth of the crop (Sanbagavalli *et al.* 2016 and Yadav *et al.* 2020). The plastic mulching had resulted in higher yield attributes parameters of maize but was at par with summer ploughing + plastic mulch, stale seed bed preparation + plastic mulch (Sharma *et al.* 2008). These results are in line with those of previous studies by Saikia and Pathak (1993), Awasthy *et al.* (2015), Kumar *et al.* (2016) and Deewan *et al.* (2017).

Yield: Among different organic weed management treatments, maximum values of green cob and green fodder yield (4.11 and 5.99 t/ha) of sweet corn was recorded with stale seed bed and plastic mulch, which found at par with plastic mulch with soil solarization + plastic mulch and summer ploughing + plastic mulch during 2018. Application of plastic mulch with stale seed bed, summer ploughing, and soil solarization recorded 211.36, 205.30 and 200 %, increase in green cob yield over weedy check (1.32 t/ha), respectively. A similar trend of superiority of plastic mulch with different agronomic practices was observed in straw yield of sweet corn. During 2019, maximum values of green cob yield (8.79 t/ha) and green fodder yield (17.66 t/ha) of sweet corn were recorded where crop sown with soil solarization and plastic mulch, which proved at par with plastic mulch with stale seed bed technique and summer ploughing. All the organic weed management treatments proved statistically superior over weedy check (Table 4). The effect of plastic film mulching on soil temperature and water is generally regarded as the most important means by which the use of mulch affects crop yield of sweet corn and studies have confirmed that plastic film mulching decreases the amount of water loss caused by evaporation and improves crop yields (Ling *et al.* 2013).

Economics: The final validity of any new agro-technology in weed management system is validated by its relative economics over the conventional practices, both in terms of net profit and benefit cost ratio (B:C) ratio. Among organic weed management practices, highest net return

Table 2 Effect of various weed control treatments on yield and economics of sweet corn

Treatment	Green cob yield (t/ha)		Green fodder yield (t/ha)		Net return (₹/ha)		B:C ratio	
	2018	2019	2018	2019	2018	2019	2018	2019
Summer ploughing + one hand weeding at 20 DAS	2.08	5.22	3.08	10.30	27974	64250	1.19	2.17
Summer ploughing + straw mulch (5 t/ha) at 20 DAS+ one hand weeding at 40 DAS	3.01	6.67	4.69	13.43	45709	84835	1.56	2.40
Summer ploughing + plastic mulch at sowing	4.03	8.25	5.91	16.76	60885	104279	1.58	2.34
Stale seed bed preparation + one hand weeding at 20DAS	1.99	4.85	2.84	9.60	25490	57547	1.09	1.95
Stale seed bed preparation + straw mulch (5 t/ha) at 20 DAS+ one hand weeding at 40 DAS	2.94	6.23	4.52	12.36	44484	77225	1.55	2.22
Stale seed bed preparation + plastic mulch at sowing	4.11	8.30	5.99	16.91	62746	105201	1.62	2.35
Soil solarization + one hand weeding	2.47	6.24	3.83	12.43	32204	76898	1.10	2.17
Soil solarization + straw mulch (5 t/ha) at 20 DAS+ one hand weeding at 40 DAS	3.07	6.57	5.02	13.03	38455	73361	1.00	1.64
Soil solarization + plastic mulch at sowing	3.96	8.79	5.76	17.66	54097	108825	1.24	2.20
Sesbania as smothering crop in between rows and used same *Sesbania* as mulch after 30 days + one HW at 40 DAS	1.83	4.73	2.83	9.37	25134	58529	1.23	2.21
Atrazine 500g *fb* straw mulching (5 t/ha) at 20 DAS	2.93	6.89	4.34	13.82	44479	90094	1.59	2.65
Weedy check	1.32	2.75	2.08	5.56	16093	26858	0.96	1.18
SEm ±	0.07	0.51	0.14	1.01				
LSD (P=0.05%)	0.21	1.48	0.40	2.96				

(₹ 62746/ha) and BC ratio (1.62) were recorded with stale seed bed and plastic mulch, whereas in 2019 highest net return (₹ 108825/ha) was obtained with soil solarization and plastic mulch, whereas maximum B:C ratio (2.35) was recorded with stale seed bed technique and plastic mulch (Table 2). This opposite in B:C ratio was due to higher cost of plastic sheet used at the time of sowing and plastic mulching which increased the cost of cultivation in soil solarization + plastic mulch at sowing ultimately led to low BC ratio. On the basis of two-year field experimentation, it may be concluded that highest green cob yield, net return and BC ratio were recorded under stale seed bed and plastic mulch.

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