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RESEARCH NOTE

Weed dynamics, growth and yield of maize as influenced by organic weed management practices

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ABSTRACT

Field experiment was conducted during winter of 2021-22 at Wetland farm of S.V. Agricultural College, Tirupati, Andhra Pradesh, India in a randomized block design with ten organic weed management practices and with three replications. Among all the organic weed management practices, lower weed density and dry weight with higher weed control efficiency was recorded with corn gluten meal 3.5 t/ha as pre-emergence (PE) *fb* hand weeding (HW) at 30 days after sowing (DAS), however, it was statistically comparable with HW twice at 15 and 30 DAS. Significantly higher growth parameters, yield attributes and kernel yield of maiz were recorded with corn gluten meal 3.5 t/ha as PE *fb* HW at 30 DAS over rest of the treatments. Mango leaves mulch 5 t/ha recorded significantly higher net returns; however, it was at par with HW twice at 15 and 30 DAS and groundnut shells mulch 12.5 t/ha. Higher benefit-cost ratio was realized with mango leaves mulch 5 t/ ha, which was significantly superior over rest of the treatments. Significantly lower net returns and benefit-cost ratio was registered with corn gluten meal 3.5 t/ha as PE *fb* HW at 30 DAS, when compared to rest of the treatments. It was concluded that mango leaves mulch 5 t/ha is the most effective, sustainable and economical organic weed management practice in maize.

Keywords: Corn gluten meal, Maize, Mulch, Organic weed management

Maize (*Zea mays* L.) is considered as queen of the cereals and is the most important crop next to rice and wheat in global agriculture. Maize is grown on 194 million hactares area in more than 170 countries across the globe with 1148 million metric tons of production. In India, it is grown in 9.89 million hactares area with 31.65 million tons of production and with a productivity of 3199 kg/ha (www.indiastat.com, 2021). Corn being widely spaced gets infested with number of weeds and subjected to heavy weed competition, which often causes huge losses in yield ranging from 28 to 100% (Patel *et al*. 2006). Modern agriculture is productivity oriented and depends mainly on synthetic inputs namely herbicides to manage the weeds. Continuous non-judicious use of herbicides for weed management leads to loss of bio-diversity, environmental pollution and also developing of herbicide resistance in weeds. Weed persistence is more in organic farming due to the extensive usage of organic manures, which act as weed seed reservoirs. Mulching is an effective method of weed control without using chemicals. Mulch covers the soil surface and can prevent weed seed germination by blocking sunlight transmission. Mulch also acts as a physical barrier to impede weeds emergence (Choudhary and Kumar 2014). Live mulch involves growing a smother crop between the rows of the main crop. It is very important to kill and till in, or manage live mulch so that it does not compete with the actual crop. Allelopathy is an eco-friendly and organic weed management approach, which may be used as a tool in controlling weeds by using extracts of allelopathic plants as natural herbicides (Ankita and Chabbi 2012). However, in the current scenario of agriculture, evolving an eco-friendly, sustainable and economical approach of organic weed management is more advisable so as to protect our environmental resources such as soil flora and fauna including human being and animals in a holistic manner. Hence, the present study was undertaken to assess the performance of different organic weed management practices for broad-spectrum weed control and for higher productivity in maize.

A field experiment was conducted during winter season of 2021-22 at Wetland farm, S.V. Agricultural College, Tirupati, located at 13.5°N latitude and

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79.5°E longitude with an altitude of 182.9 m above mean sea level in the Southern Agro-Climatic Zone of Andhra Pradesh, India. The soil was sandy clay loam in texture, neutral in soil reaction, low in organic carbon (0.26) and available nitrogen (249 kg/ha), and medium in available phosphorus (37 kg/ha) and potassium (285 kg/ha). The total rainfall received during the crop growth period was 801.0 mm in 34 rainy days. The experiment was laid out in randomized block design with ten organic weed management practices with three replications. Treatments include hand weeding (HW) twice at 15 and 30 days after sowing (DAS), groundnut shells mulch 12.5 t/ha, saw dust mulch 5 t/ha, mango leaves mulch 5 t/ha, live mulching with 2 rows of cowpea, live mulching with 2 rows of sunhemp, eucalyptus leaf extract spray 15 L/ha at 15 and 30 DAS, sunflower extract spray 18 L/ha at 15 and 30 DAS, corn gluten meal 3.5 t/ha as pre- emergence (PE) *fb* HW at 30 DAS, and weedy check. Maize hybrid '*DHM-117'* was raised with recommended package of practices except for the weed management. The crop was fertilized with 240 kg N, 80 kg P and 80 kg K/ha. Nitrogen was applied in the form of urea in three equal splits, *viz.* 1/3 as basal, 1/3 at knee high stage and the remaining 1/3 at tasselling stage and entire dose of phosphorus as single super phosphate and potassium as muriate of potash was applied basally at the time of sowing. Weed management practices were imposed as per the treatments. Different organic mulches were applied on the day of sowing in between the rows of maize. Live mulches were grown up to 40 DAS and uprooted and spread on the soil surface. The required quantities of filtered concentrated plant water extracts were sprayed at 15 and 30 DAS. Weed population was counted with the help of 0.25 m^2 quadrat thrown randomly at two places in each plot and expressed as density (No./m^2). Different weed species collected for assessing the density of weeds were dried separately in a hot air oven at 65ºC till constant dry weight was reached and expressed as weed biomass (g/m^2). Due to large variation in values of weed density and biomass, the corresponding data was subjected to square root transformation $\left(\sqrt{x+0.5}\right)$ and the corresponding transformed values were used for statistical analysis as suggested by Gomez and Gomez (1984).

Five randomly selected plants were tagged in each treatment and from each replication in the net plot area and used for making observations on growth parameters and yield attributes at harvest of maize. Kernel and stover yield of maize were recorded based on the yield obtained from net plot. Net returns were calculated by subtracting the cost of cultivation from the gross returns. Benefit-cost ratio was calculated after dividing gross returns with cost of cultivation.

Weed dynamics in maize

The weed flora associated with maize belonged to thirteen different taxonomic families, of which the predominant weed species were *Dactyloctenium aegyptium* (L.) Willd (36%), *Cyperus rotundus* L. (22%), *Digitaria sanguinalis* (L.) Scop. (18%), *Boerhavia erecta* L. (11%), *Commelina benghalensis* L. (6%), *Euphorbia hirta* L. (3%) and others (4%). All the organic weed management practices significantly influenced weed density and biomass at harvest of maize (**Table 1**). Among the different organic weed management practices, lower density and biomass of grasses, sedges, broad-leaved weeds and total weeds and with higher weed control efficiency were recorded with corn gluten meal 3.5 t/ ha as PE *fb* HW at 30 DAS, which was comparable with hand weeding twice at 15 and 30 DAS. The lower weed density in corn gluten meal treatment might be due to the pre-emergence herbicidal activity that efficiently reduced the germination of weed seeds (Yang and Lu 2010). Hand weeding performed at 15 and 30 DAS might effectively reduce the density of all categories of weeds as well as total weeds compared to rest of the treatments. Similar results were also reported by Ram *et al.* (2017). Among the different organic mulches and live mulches, lower weed density and biomass of total weeds coupled with higher weed control efficiency was recorded with groundnut shells mulch 12.5 t/ha, which was statistically at par with mango leaves mulch 5 t/ha, live mulching with 2 rows of cowpea and live mulching with 2 rows of sunhemp. Significantly higher density and biomass of all categories of weeds including the total weeds at harvest of maize was noticed with weedy check due to heavy weed infestation at all the stages of the crop growth as also reported by Saimaheswari *et al.* (2022).

Growth and yield of maize

The results revealed that different organic weed control measures significantly improved the growth, yield attributes and yield of maize. Growth parameters of maize, *viz.* plant height and dry matter production and yield attributes, *viz,* cob length, cob girth, number of kernels/cob, kernel weight/cob, kernel and stover yield were significantly higher with corn gluten meal 3.5 t/ha as PE *fb* HW at 30 DAS over rest of the treatments (**Table 2**). This ought to be due to pre-emergence herbicidal activity of corn gluten meal, that have controlled weeds in the initial stages of the crop growth and late emerged weeds were effectively removed by hand weeding performed at 30 DAS might have accelerated the plant growth and dry matter production that in turn reflected in the form of higher yield attributes and yield. The next best treatment was HW twice at 15 and 30 DAS, however it was at par with groundnut shells mulch 12.5 t/ha and mango leaves mulch 5 t/ha. This might be due to lower crop weed competition for growth resources throughout the crop growing period enabling the crop for maximum utilization of nutrients, moisture, light and space, which enhanced the vegetative and reproductive potential of the crop as reported by Stanzen *et al.* (2017).

Economics of maize

Highest net returns of maize were reported with mango leaves mulch 5 t/ha, which was followed by HW twice at 15 and 30 DAS and groundnut shells mulch 12.5 t/ha. This might be due to increased yields and reduced cost of cultivation in the above treatments. These findings were in close conformity with Mahto *et al.* (2020). Live mulching with 2 rows of cowpea or with 2 rows of sunhemp were the next best treatments in obtaining higher net returns, while it was lowest with corn gluten meal 3.5 t/ha as PE *fb*

Table 1. Weed dynamics at harvest of maize as influenced by organic weed management practices

Treatment	Weed density (no./m^2)				Weed biomass (g/m^2)				WCE (%)
	Grasses	Sedges	BLW	Total	Grasses	Sedges	BLW	Total	
Hand weeding twice at 15 and 30 DAS	3.53 (12.00)	4.33 (18.33)	3.58 (12.33)	6.57 (42.66)	2.79 (7.27)	3.87 (14.53)	2.76 (7.13)	5.42 (28.93)	81.70
Groundnut shells mulch (12.5 t/ha)	4.56 (20.33)	5.58 (30.67)	4.33 (18.33)	8.35 (69.33)	3.56 (12.07)	4.88 (23.30)	3.46 (11.53)	6.88 (46.90)	74.36
Saw dust mulch (5 t/ha)	8.23 (67.33)	8.71 (75.33)	5.72 (32.33)	13.23 (174.99)	6.23 (38.35)	6.76 (45.27)	4.69 (21.50)	10.27 (105.12)	39.99
Mango leaves mulch (5 t/ha)	4.81 (22.67)	5.95 (35.00)	4.38 (18.69)	8.76 (76.36)	3.61 (12.57)	4.96 (24.20)	3.55 (12.15)	7.02 (48.92)	73.21
Live mulching with 2 rows of cowpea	5.13 (25.83)	6.31 (39.33)	4.22 (17.33)	9.10 (82.49)	3.85 (14.36)	5.00 (24.53)	3.37 (10.90)	7.09 (49.79)	72.93
Live mulching with 2 rows of sunhemp	5.17 (26.33)	6.57 (42.67)	4.26 (17.67)	9.33 (86.67)	3.93 (15.02)	5.11 (25.67)	3.42 (11.25)	7.24 (51.94)	71.69
Eucalyptus leaf extract spray 15 L/ha at 15 and 30 DAS	7.75 (59.67)	7.92 (62.33)	5.40 (28.67)	12.27 (150.67)	5.73 (32.37)	6.55 (42.53)	4.26 (17.70)	9.65 (92.60)	47.14
Sunflower extract spray 18 L/ha at 15 and 30 DAS	8.11 (65.33)	8.29 (68.33)	5.55 (30.33)	12.81 (163.99)	5.82 (33.33)	6.67 (44.06)	4.51 (19.90)	9.88 (97.29)	44.46
Corn gluten meal 3.5 t/ha as pre-emergence *fb* HW at 30 DAS	3.39 (11.00)	4.02 (15.67)	3.39 (11.00)	6.17 (37.67)	2.46 (5.60)	3.56 (12.20)	2.61 (6.33)	5.12 (25.57)	85.40
Weedy check (control)	9.95 (98.67)	10.22 (104.00)	6.47 (41.33)	15.63 (244.00)	7.55 (56.55)	9.43 (88.50)	5.51 (29.83)	13.25 (175.18)	-
LSD (p=0.05)	0.76	1.05	0.59	1.52	0.61	0.55	0.47	1.01	-

Data in parentheses are original values, which were transformed to $\sqrt{x+0.5}$ and analysed statistically. WCE: Weed control efficiency; DAS: Days after sowing

Table 2. Growth, yield attributes and yield of maize as influenced by different organic weed management practices

Treatment	Plant height (cm)	Dry matter production (t/ha)	Cob length (cm)	Cob girth (cm)	No. of kernels/ cob	Kernel weight/ cob (g)	Kernel yield (t/ha)	Stover yield (t/ha)	Net returns (₹/ha)	B:C ratio
Hand weeding 15 and 30 DAS	228	13.32	17.3	15.1	293	96.5	6.41	7.03	72616	2.66
Groundnut shells mulch (12.5 t/ha)	223	13.11	17.2	14.9	285	91.2	6.27	6.92	70952	2.69
Saw dust mulch (5 t/ha)	179	8.67	13.1	11.5	184	58.5	3.56	4.95	23344	1.56
Mango leaves mulch (5 t/ha)	222	13.01	16.9	14.8	278	88.3	6.22	6.85	73850	2.93
Live mulching with 2 rows of cowpea	204	11.32	15.4	13.6	248	76.1	4.92	6.21	50688	2.34
Live mulching with 2 rows of sunhemp	200	11.02	15.1	13.4	235	74.7	4.85	5.90	50346	2.36
Eucalyptus leaf extract spray 15 L/ha at 15 and 30 DAS	183	9.31	13.5	12.1	204	63.5	4.04	5.19	38254	2.11
Sunflower extract spray 18 L/ha at 15 and 30 DAS	180	9.04	13.4	11.8	195	61.8	3.95	5.10	36736	2.05
Corn gluten meal 3.5 t/ha as PE *fb* HW at 30 DAS	249	14.41	18.6	16.1	328	108.2	7.29	7.65	1408	1.01
Weedy check (control)	163	6.87	11.6	10.1	161	45.3	2.65	4.21	18206	1.55
LSD (p=0.05)	15	0.73	1.2	0.9	21	9.3	0.59	0.56	4634	0.21

HW at 30 DAS, this might be due to high cost of corn gluten meal. Significantly higher benefit-cost ratio was realized with mango leaves mulch 5 t/ha, which was statistically superior to rest of the treatments. This might be due to increased yields and reduced cost of cultivation. Groundnut shells mulch 12.5 t/ha was the next best, however it was comparable with hand weeding twice at 15 and 30 DAS. Corn gluten meal 3.5 t/ha as PE *fb* HW at 30 DAS recorded significantly lower net returns and benefit-cost ratio, when compared to rest of the treatments due to high cost of corn gluten meal.

The study revealed that mango leaves mulch 5 t/ ha or groundnut shells mulch 12.5 t/ha was most effective, sustainable, chemical free and economical organic weed management practice to increase the productivity and to maximize the net returns in maize under organic farming.

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