



PERFORMANCE OF WEED CONTROL PRACTICES IN MAIZE UNDER RAINFED ORGANIC FARMING SYSTEM

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Abstract

Field experiment was conducted under organic farming for during 2016-17 to 2017-18 to study the effect of different non-chemical weed management practices on productivity and weed infestation in maize in mid altitude (950 m MSL) of Meghalaya, India. Total eight treatment in three replication were evaluated on maize. Grain weight/cob of maize was maximum under mulching with fresh *Eupatorium* sp. biomass after earthing up at 30 days after sowing (DAS). The highest maize yield was recorded under mulching with fresh *Eupatorium* 10 t/ha, but it was statistically at par with two hand weeding (HW) at 20 and 40 DAS, weed free check and soybean green manure incorporation in situ + one HW. Two Hand Weeding, soybean green manure incorporation + one Hand Weeding and mechanical weeding (20 DAS) + one HW (after earthing up) were found to be effective in weed reduction in maize. Weed control efficiency was recorded maximum under two Hand Weeding which was at par with mechanical weeding (20 DAS) + one Hand Weeding. Available N, P, K and soil organic carbon concentration after 3-cropping cycles were maximum under mulching with fresh *Eupatorium* 10 t/ha treatment followed by soybean green manuring + one Hand Weeding (45 DAS) than those under other weed management practices. Thus, mulching with fresh *Eupatorium* (after earthing up) and soybean green manuring + one Hand Weeding were the recommendable options for sustainable organic maize production under high rainfall hill ecosystem of North-East India.

Key words: Ecosystem, Mulch materials, Maize, Organic farming, Rainfed, Weeds control efficiency, Weed Density.

Introduction

Maize (*Zea mays* L.) is the second most important crop after rice in North East region (NER) of India and maize is predominant crop in the upland ecosystem of the region (Das *et al.*, 2010). Maize is among the high yielding crops and has great economic importance to the hill and mountain ecosystem as food, feed and fodder. Maize is cultivated as rainfed crop in subtropical mid hills ecosystem. Although yield potential of maize varieties is high but it has so far could not been realized upto its potential due to several constraints.

Weed infestation is a major factor in pulling down the yield of crop. Rainy season maize suffers from severe weed competition. Weed infestation causes yield losses varying from 28-100% depending upon the intensity, nature and duration. The losses caused by weeds exceed the losses from any other category of agricultural pests (Sharma *et al.*, 2010). Weeds compete with the crop

plants for sunlight, moisture and nutrients (Kumar *et al.*, 2013 and Saeed *et al.*, 2013) and deprive the crops from vital resources (Lehoczy and Reisinger, 2003). As a wide spaced crop, maize suffers from heavy weed infestation during *Kharif* season. The climate (high rainfall, congenial temperature and humidity) of the NER is favourable for luxuriant weed growth especially during rainy season. Maize is sensitive to weeds especially in early stages of development and thus, weed infestation during germination to 45 days after sowing (DAS) causes maximum reduction in yield. Weeds not only decrease crop yield but also harbour insect-pest and diseases and in some cases, they serve as an alternate host for these pest. In organic farming, the weed problems are further high mainly due to application of organic manure, mulches, biomass which exacerbates the weed multiplication and growth (Gupta, 2004).

Thus, it was necessary to devise organic system of weed control comprising of cultural, mechanical, biological and physical practices to manage weeds without synthetic

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herbicides and chemicals which promote weed suppression, rather than weed elimination. Hand Weeding (HW) is the most popular method of removing weeds in NER of India. However, HW is tedious, time consuming and labour demanding. Mulching is an effective method of weed control without using chemicals. The use of biomass from facultative weed such as *Eupatorium* as mulch has been reported a good source of organic matter and weed suppressor for several upland crops in Himachal Pradesh (Acharya *et al.*, 1998). Application of *Eupatorium* mulch along with HW gave significantly higher yield of upland rice compared to control in Nepal (Gaire *et al.*, 2013). A promising way to use allelopathy in weed control is using extracts of allelopathic plants as natural herbicides (Ankita and Mittal, 2012 and Pandya *et al.*, 2005). Keeping in view the importance of weed management in organic crop production, the present investigation was carried out to study the effect of various non-chemical weed management practices on weed population, dry weight, yield of maize and soil at experimental farm Annamalai University, Annamalai Nagar.

Materials and Methods

Field experiments were carried at experimental farm Annamalai University, Annamalai Nagar during 2016-17 to 2017-18. The soil of the experimental site was sandy clay loam in texture, acidic in reaction (pH 4.9) with 1.80% soil organic carbon (SOC). The soil was low in available N (180.0 kg N/ha) and P (9.5 kg P/ha) and medium in available K (175.1 kg K/ha).

Field experiment was laid out in randomized block design with eight treatment in three replications. Treatments were, mechanical weeding at 20 DAS + one Hand Weeding at 45 DAS, mulching with fresh biomass of *Eupatorium adhenophorum* 10 t/ha after earthing up at 30 DAS, aqueous leaf extract (10%) spray of *Lantana* and pine (*Pinus kesiya*), two Hand Weeding - 1st before earthing up (20 DAS) and 2nd after earthing up (45 DAS), aqueous leaf extract spray of *Lantana* and pine + one Hand Weeding after earthing-up (35 DAS), soybean green manure incorporation in situ during earthing up + one Hand Weeding (45 DAS), weed free check (HW at 10, 25, 40, 55 and 70 DAS) and weedy check.

Mechanical weeding was performed with the help of wheel hoe and leaf extract was sprayed directly in the inter row spaces of maize. One row of soybean was grown simultaneously in between two rows of maize as green manure crop and incorporated into the soil at 30 days after germination during earthing up. FYM was applied on N equivalent basis and P requirement was compensated through rock phosphate. Neem cake was

applied 150 kg/ha as general dose in all the treatments to control soil borne pathogens. A uniform dose of organic manure to supply recommended dose of N and P in maize (60:26.2 kg/ha) was used. Data on weeds (density, dry weight) were recorded at 30 and 60 DAS from two randomly selected quadrants (0.5 × 0.5 m) from each treatment during maize growing period. Weeds were uprooted gently, roots washed and their counts were recorded. Weeds were oven dried at 70°C for 48 hours after sun drying for recording dry weight. Weed control efficiency (WCE) was calculated by using following formulae given by Mani *et al.*, (1973). Yield attributes and yield of maize were recorded from each treatment at harvesting stage.

The initial and post-harvest soil samples (after 3 years) were collected (500 g composite sample, one sample from each plot) from 0-15 cm depth for analyzing the available N, P, K status, SOC and soil microbial biomass carbon (SMBC). The soil samples were air dried, processed and passed through 2 mm sieve and used for analyzing soil fertility parameters such as available N by the alkaline permanganate method (Subbiah and Asija, 1956), available P by NaHCO₃ extraction method (Olsen and Sommers, 1982) and available K by neutral normal NH₄OAC extraction method (Knudsen *et al.*, 1982). SMBC was estimated by soil fumigation technique (Anderson and Ingram, 1993). Bulk density (nb) was determined by the core method (Blake and Hartge, 1986) using cores of 5.8 cm height and 5.4 cm diameter at 0-15 cm depth and oven dried at 105°C (one sample per plot).

Experimental data pertaining to each parameter were subjected to statistical analysis by using technique of analysis of variance and their significance was tested by “F” test (Gomez and Gomez, 1984). Standard error of means (SEm+) and least significant difference (LSD) at 5% probability (P=0.05) were worked out for each parameter studied to evaluate differences between treatment means.

Results and Discussion

Effect on weeds

The predominant weed species observed in the experimental field during rainy season were *Ageratum conizoides*, *Alternanthera phytoliroides*, *Bidens pilosa*, *Borrevia hispida*, *Galinsoga parviflora* and *Spilanthus acemella* among broad-leaved weeds, *Cynodon dactylon*, *Digitaria marginata*, *Digitaria sanguinalis*, *Panicum repens* and *Eleusine indica* among grasses and *Cyperus rotundus* and *Fimbristylis miliacea* among sedges. Number of broad-leaved weeds were found maximum followed by grasses and sedges

Table 1: Population density, dry weight and weed control efficiency as influenced by various organic weed management practices.

Treatments	Population density (no./m ²)		Dry weight (g/m ²)		Weed control efficiency (%)	
	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS
Mechanical weeding at 20 DAS + one HW at 45 DAS	158	75	9.41	4.2	86.1	94.8
Mulching with fresh <i>Eupatorium</i> 10 t/ha after earthing up at 30 DAS	225	90	12.9	17.5	74.6	78.6
Aqueous leaf extract (10%) spray of <i>Lantana</i> and pine	359	235	26.0	44.6	48.6	34.2
Two HW -1 st before earthing up (20 DAS) and 2 nd after earthing up (45 DAS)	145	88	7.2	4.2	85.9	94.9
Aqueous leaf extract spray of <i>Lantana</i> and pine + one HW after earthing up (35 DAS)	185	91	11.7	6.7	76.9	91.7
Soybean green manure incorporation in situ + one HW (45 DAS)	156	84	10.5	4.9	79.2	94.0
Weed free check (HW at 10, 25, 40, 55 and 70 DAS)	4	2	0.8	0.2	98.4	99.8
Weedy check	493	392	50.7	81.6	-	-

HW: Hand weeding; DAS: Days after sowing.

irrespective of weed management practices. All the weed management practices were effective in suppressing total weed density and dry matter as compared to weedy check. Minimum weed population and dry weight at 30 and 60 DAS were recorded under weed free check (Table 1). Two Hand Weeding, soybean green manure incorporation + one Hand Weeding and mechanical weeding (20 DAS) + one Hand Weeding (after earthing up) was also found effective in reducing weed population to the extent of 72, 67 and 68% in 30 DAS and 77, 78 and 80% in 60 DAS as compared to weedy check, respectively. This result was in line with the findings of Syawal, (1998) who reported that Hand Weeding effectively controlled weeds.

In general, weed dry weight was found higher at 30 DAS compared to 60 DAS in all the treatments except weedy check and aqueous leaf extract spray of *Lantana* and pine which may be due to suppression of weed growth by maize canopy at later growth stages (Table 1). Lower

weed biomass during 60 DAS than 30 DAS indicated that increasing plant canopy covered the open niches which otherwise might have been utilized by weeds (Gul *et al.*, 2009). Pooled weed control efficiency (WCE) of different treatments ranged from 71.33-91.97 and 31.59-72.90% in 30 and 60 DAS, respectively. Among all the treatments, two Hand Weeding at 20 and 45 DAS and mechanical weeding at 20 DAS and one Hand Weeding at 45 DAS was recorded maximum WCE compared to other treatments. The finding confirms the results of Gul *et al.*, (2009).

Yield attributes and yield

Although the cob length in maize did not vary significantly across the treatments, highest cob length was recorded under mulching with fresh *Eupatorium* 10 t/ha and soybean green manuring + one Hand Weeding as compare to rest of treatment except weed-free check (Table 2). It might be due to addition of nutrients and

Table 2: Yield attribute and yield of maize as affected by organic weed management practices (pooled mean of 3 years).

Treatments	Maize		
	Cob length (cm)	No. of Seeds /cob	Grain weight /cob (g)
Mechanical weeding at 20 DAS + one HW at 45 DAS	14.5	262	127
Mulching with fresh <i>Eupatorium</i> 10 t/ha after earthing up at 30 DAS	15.1	281	137
Aqueous leaf extract (10%) spray of <i>Lantana</i> and pine	14.3	263	126
Two HW -1 st before earthing up (20 DAS) and 2 nd after earthing up (45 DAS)	14.5	281	119
Aqueous leaf extract spray of <i>Lantana</i> and pine + one HW after earthing up (35 DAS)	14.5	268	105
Soybean green manure incorporation in situ + one HW (45 DAS)	15.1	280	126
Weed free check (HW at 10, 25, 40, 55 and 70 DAS)	15.4	285	129
Weedy check	14.1	244	81
LSD (P=0.05)	NS	5.2	4.4

HW: Hand weeding; DAS: Days after sowing.

Table 3: Effect of soil properties as influenced by various weed management practices after three-cropping cycles.

Treatments	Bulk density (g/ cm ³)	SOC (g/ kg)	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)	SMBC (hg/g dry soil)
Mechanical weeding at 20 DAS + one HW at 45 DAS	1.25	22.9	256	24.1	275	232
Mulching with fresh <i>Eupatorium</i> 10 t/ha after earthing up at 30 DAS	1.19	23.6	278	30.8	280	272
Aqueous leaf extract (10%) spray of <i>Lantana</i> and pine	1.27	22.5	245	21.7	264	199
Two HW -1 st before earthing up (20 DAS) and 2 nd after earthing up (45 DAS)	1.24	23.0	260	23.9	263	250
Aqueous leaf extract spray of <i>Lantana</i> and pine + one HW after earthing up (35 DAS)	1.23	22.8	253	22.5	266	251
Soybean green manure incorporation in situ + one hand weeding (45 DAS)	1.21	23.9	280	29.0	274	258
Weed free Check (HW at 10, 25, 40, 55 and 70 DAS)	1.28	23.0	226	18.8	259	241
Weedy check	1.18	24.4	270	20.3	277	271
Initial value	-	19.6	219	12.5	245	-
LSD (P=0.05)	0.03	1.7	17	4.6	13	15

HW: Hand weeding; DAS: Days after sowing; SOC - Soil organic carbon.

moisture conservation through application of *Eupatorium* as mulch. The number of seeds/cob were the highest under weed free check, however it was statistically at par with mulching with weed biomass. The grain weight/cob was also highest under mulching with weed biomass. Three years average grain yield of maize was maximum (3.87 t/ha) under fresh *Eupatorium* mulching followed by two Hand Weeding at 20 and 40 DAS (3.64 t/ha) and soybean green manure incorporation in situ + one Hand Weeding (3.64 t/ha). Mulched biomass added large quantity of nutrients and the additional nutrients over that applied through manure might have contributed to the increased yield of maize (Sharma and Acharya, 2000 and Sharma *et al.*, 2010).

Soil fertility

At the end of three cropping cycles, mulching with fresh *Eupatorium* (after earthing up) 10 t/ha resulted in higher SOC (23.6 g/kg), available N (278.0 kg/ha), P (30.80 kg/ha) and K (280.1 kg/ha) in soil followed by soybean green manure incorporation in situ + one Hand Weeding than other treatments (Table 3). Percentage increase of SOC, available N, P and K were 20.4, 27.1, 76.0 and 14.3% respectively, under mulching with fresh *Eupatorium* (after earthing up) 10 t/ha relative to respective initial values (Table 3). Whereas, these enhancement in relation to two HW were 2.6, 6.8, 28.8 and 6.6%, respectively. Bulk density was recorded the lowest and soil SMBC was the highest under mulching with fresh *Eupatorium* (after earthing up) 10 t/ha treatments. Long term application of organic amendments were reported to improvement in SOC, available N, P and K in soil, thereby sustaining the soil health (Panwar

et al., 2010). The use of weed biomass (shrubs) such as *Eupatorium adhenophorum* as mulching material for soil and moisture conservation and fertility build up in crop production has been also reported by other researchers (Acharya *et al.*, 1998 and Gaire *et al.*, 2013), Jabro *et al.*, 2010; Rashidi and Keshvarzpour, 2007 and wasaya *et al.*, 2011.

It can be concluded that mulching with weed biomass such as fresh *Eupatorium* (after earthing up) and soybean green manuring in maize + one Hand Weeding are the recommendable options for organic maize production.

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