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Non-chemical weed management to improve fruit yield and net income in ladies-finger

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ABSTRACT

A field experiment was conducted at Coconut Research Station, Balaramapuram, Thiruvananthapuram, India during winter (*Rabi*) season of 2020-21 to study the effect of stale seedbed and different non-chemical weed management practices on weed control in ladies-finger. The experiment was conducted in randomized block design with treatment combination of two methods of seedbed preparation and six methods of weed management. . Stale and non-stale seedbed were two seedbed preparation methods. Six non-chemical weed management treatments were tested. The uncontrolled weed growth caused 59.20% reduction in fruit yield in ladies-finger, locally called okra. Compared to non-stale seedbed, stale seedbed registered significantly lower weed density (35.67 no./m^2) and biomass (7.81 g/m^2) and significantly higher weed control efficiency (WCE) (81.13%), fruits per plant (36.5) and fruit yield (3.29 t/ha), higher net return (₹ 54520/ha) and B:C ratio (1.69). Among different non-chemical weed management practices, the mechanical weeding with wheel hoe weeder (MWHW) at 15, 30 and 45 DAS recorded the lowest total weed density (26.67 no./m^2) and biomass (2.54 g/m^2); and the highest WCE (93.86%), number of fruits/plant (38.8), fruit weight (6.98/g), fruit yield (4.41 t/ha), higher net return (₹ 97804/ha) and B:C ratio (2.25). Interaction between seedbed preparation and weed management practice was found to be significant only for absolute density of broad-leaved weeds (BLW), weed biomass and WCE. Among seedbed preparation, stale seedbed can be recommended for reducing the weed density and biomass in ladies-finger. The mechanical weeding with wheel hoe thrice at 15, 30 and 45 DAS can be recommended as a cost-effective weed management to attain higher weed control efficiency, ladies-finger yield and net returns in ladies-finger.

Ladies-finger locally called okra (*Abelmoschus esculentus* (L.) Moench) is regarded as one of the most important warm season vegetable crops all over the world. India is the world's leading producer of ladies-finger accounting for roughly 74% of global output. From a total area of 5.85 million hectares, India produced 6.34 million tonnes (AGRICOOP 2021). The major ladies-finger growing states in India are West Bengal, Uttar Pradesh, Bihar, and Orissa. Ladies-finger is a rich source of proteins, carbohydrates, vitamins and minerals. Other than being an essential component in human diet, it is effective in curing ulcers, genitourinary disorders, and useful as a plasma replacement or blood volume expander. The dry seed has an edible oil content of 13 to 22% and a protein content of 20 to 24%. Weed infestation is a major problem in ladies-finger cultivation, due to wider spacing and slow initial growth. Crop weed competition in ladies-finger is at its peak during the early stages of growth, owing to the crop's slow initial growth rate and resulting poor competitive ability (Narayan *et al*. 2020). Season long weed competition causes significant reduction in fruit yield of ladies-finger upto 43.84 to 45.90% (Sah *et al*. 2018). Hand weeding is the commonly adopted method. Non-availability of labour for weeding at right time, high wage rate, high cost of production *etc*. are some of the problems faced by farmers for adopting manual method of weed control. Mulching is considered to be an effective non-chemical method

of weed control in crops as it effectively controls both annual and perennial weeds (Chacko *et al*. 2021). Mulching aids in weed control by inhibiting the weed seed germination, smothering weeds and encouraging crop growth by retaining soil moisture and maintaining soil temperature. The application of grass mulch (5 t/ha) one week after germination (Baraiya *et al*. 2017) was very effective in reducing the weed infestation in ladies-finger.

Stale seedbed (SSB) technique is a cultural weed management practice in which weed seeds present on the top layer of soil (2-5 cm) were allowed to germinate and killed prior to seeding. The SSB with glyphosate *fb* mulching with black polyethene cover was the best method for the management of purple nutsedge in ladies-finger (Ameena *et al*. 2013). Herbicides were proven to be effective method of weed control, but due to environmental impacts and health concerns, non-chemical weed management practices have gained importance. Hence, the present study was conducted to find out a cost-effective non-chemical weed management method to manage weeds and increase productivity of ladies-finger.

A field experiment was carried out at Coconut Research Station, Balaramapuram, Thiruvananthapuram, Kerala during winter season (*Rabi*) of 2020-21 to identify a cost-effective seedbed preparation method and non-chemical weed management treatment. The experiment was conducted in randomized block design with treatment combination of two methods of seedbed preparation and six methods of weed management. Two methods of seedbed preparation comprised of stale seedbed (SSB) and non-stale seedbed (NSSB). The six non-chemical weed management treatments tested include: mulching with dried banana leaf (MBL)10 t/ha; MBL10 t/ha followed by (*fb*) mechanical weeding with wheel hoe weeder (MWHW) at 30 and 45 days after seeding (DAS) (MBL *fb* WHW); MBL 10 t/ha *fb* hand weeding (HW) at 30 and 45 DAS (MBL *fb* HW); MWHW at 15, 30 and 45 DAS; HW thrice at 15, 30 and 45 DAS (THW) and weedy check (WC). The soil texture was sandy loam acidic in reaction (4.71), normal in EC (0.1dS/m), low in available N (163.1 kg/ha), high in available P (33.5 kg/ha) and medium in available K (134.4 kg/ha). The variety used for the study was *Anjitha*, a high yielding yellow vein mosaic resistant variety of 120 days duration released from Kerala Agricultural University. The rainfall received during the experimental period was 248.4 mm. The site was previously under nendran banana (Chengazhikodan Nendran Banana, also known Chengazhikode Banana, is among the most popular traditional fruits cultivated in Thrissur district, Kerala, India. The mature fruits are pale yellow and on ripening, turn golden yellow with red patches.). Stale seedbed (SSB) was prepared by ploughing with a power tiller twice and 12 experimental plots each measuring 6.0 × 4.05 m were laid out. Small bunds were taken around each treatment plot. After ploughing irrigation was applied and the experimental plots were left alone for 14 days to allow the weeds to germinate. Weeds that emerged were uprooted by gentle raking with minimum soil disturbance. Field preparation of non-stale seedbed was started 10 days after the SSB. Twelve treatment plots with a gross plot size of 6.0 × 4.05 m were taken. Lime 250 kg/ha and farm yard manure (FYM) 20 t/ha were uniformly applied to all plots. Crop was fertilized with 120 kg/ha N, 35 kg/ha P and 70 kg/ha K. Half N, full P and half K were applied as basal dose and remaining N and K were applied in three equal splits at 30, 45 and 60 DAS. Two seeds were dibbled at a spacing of 60 × 45 cm. A light irrigation was given after sowing.

Total weeds density and biomass were recorded by randomly placing a quadrat of size 0.25 × 0.25 m in two different locations in each treatment plot at 60 DAS, outside the net plot area. Weeds present inside the quadrat were counted and reported as weed density (number/m^2). Weeds uprooted from the quadrat area were shade dried for two days and dried in a hot air oven at 65 ± 5° C till constant weight was obtained and weed dry weight (weed biomass) was expressed as g/m^2. Weed control efficiency (WCE) at 60 DAS and weed index were worked out using the standard formula. For calculating WCE, the treatment NSSB × WC was taken as the weedy check and to calculate the weed index (WI), SSB × MWHW was taken as the control treatment which recorded the minimum weed biomass and the highest fruit yield. Number of fruits per plant and fruit weight was recorded from the five tagged plants from each treatment and the mean value was recorded. Fruit yield per hectare was worked out from the fruits harvested from the net plot area. Economics was worked out based on the market price of the fruit and the cost of inputs. Data on absolute density of grasses, broad-leaved weeds (BLW), total weed density, weed biomass, WCE and weed index were subjected to square root transformation to normalize the distribution. Data were statistically analyzed using ANOVA and the treatments were compared at 5 per cent probability.

Effect on weeds

Grasses and BLW were the predominant weed flora of the experiment field. However, more diversity

was observed in broad-leaved weeds (BLW). *Setaria barbata* (Lam.) Kunth and *Digitaria sanguinalis* (L.) Scop. were the two grasses present in the experimental field. *Synedrella nodiflora* (L.) Gaertn, *Phyllanthus niruri* L., *Boerhavia diffusa* L., *Mimosa pudica* L. and *Tridax procumbens* L. were the BLW present in the experimental field.

The stale seedbed recorded lower absolute density of grasses (33.11 no./m^2) and BLW (2.55 no./m^2) than normal seedbed (**Table 1)**. At 60 DAS, stale seedbed (SSB) significantly reduced the total weeds density and biomass and consequent higher WCE compared to normal seedbed method (NSSB) as demonstrated by Ameena *et al.* (2013).

Weed management treatments significantly influenced the absolute density of grasses and BLW and total weed density and weed biomass at 60 DAS. Mechanical weeding with wheel hoe weeder (MWHW) at 15, 30 and 45 DAS recorded significantly lower absolute density of grasses (21.33 no./m^2) which was statistically at par with MBL *fb* WHW and THW. MWHW recorded the lowest weed biomass (2.54 g/m^2). The WCE was higher (81.13%) with stale seedbed method than non-stale seedbed (WCE of 68.51%). Among the weed management treatments, MWHW recorded the highest WCE (93.86 %) which was statistically at par with MBL *fb* WHW, MBL *fb* HW and THW.

Mechanical weeding with wheel hoe weeder (MWHW) at 15, 30 and 45 DAS very effectively destroyed the weeds and created a condition congenial for the crops to grow vigorous and smother the weeds that resulted in significantly lower weed density and biomass and higher WCE (**Table 1**). The efficacy of mechanical weeding in reducing the weed density and biomass was also reported in other crops (Mynavathi *et al.* (2008). Mulching with dried banana leaf mulch alone (MBL) or MBL *fb* WHW at 30 and 45 DAS also registered lower total weed density and biomass as reported by Baraiya *et al.* (2017), Shamla *et al.* (2017), Sinchana (2020). This was due to the fact that banana leaf mulch on the soil surface prevented the germination of weed seeds by obstructing the solar radiation from reaching the soil and smothering the weed seedling that emerged during the initial growth stages of crop growth and the effective removal of latter emerged weeds by wheel hoe weeder.

Interaction was found to be significant only for absolute density of BLW, total weed biomass and WCE (**Table 2**). The treatment combination SSB × WC registered the lowest density of BLW. The treatment combination SSB × MWHW recorded significantly lower total weed biomass (1.03 g/m^2) and the highest WCE (97.57%) due to the favourable effect of SSB in exhausting the weed seed bank before sowing of seeds and better killing of weeds at the latter growth stages of the crop growth by MWHW at 15, 30 and 45 DAS as observed by Reimens *et al.* (2006) in lettuce.

Effect on ladies-finger

The adoption of stale seedbed technique resulted in significantly higher number of fruits per plant (36.50) and fruit weight (6.49 g) and higher yield (3291 kg/ha) and lower weed index (27.68 %) compared to the non-stale seedbed as observed by Sinchana (2020).

Among the weed management treatments, MWHW at 15, 30 and 45 DAS recorded the highest number of fruits per plant (38.8/plant) and fruit

Table 1. Effect of seedbed preparation and weed management on absolute density and total weed density and biomass and weed control efficiency in ladies-finger at 60 DAS

Treatment	Absolute density of grasses (no./m^2)	Absolute density of BLW (no./m^2)	Total weed density (no./m^2)	Total weed biomass (g/m^2)	Weed control efficiency (%)
Seedbed preparation method					
Stale seedbed	5.37^a (33.11)	1.80^a (2.55)	5.65^a (35.67)	2.67^a (7.81)	8.97^a (81.33)
Non-stale seedbed	6.98^b (54.11)	3.13^b (9.11)	7.73^b (63.22)	3.40^b (13.05)	7.53^b (68.51)
LSD (p=0.05)	0.269	0.211	0.282	0.114	0.640
Weed management					
Mulching with dried banana leaf (MBL) 10 t/ha	6.22^b (39.33)	2.36^b (4.67)	6.60^d (44.00)	3.99^c (15.13)	8.11^b (63.34)
Mulching with dried banana leaf 10 t/ha *fb* mechanical weeding with wheel hoe weeder at 30 and 45 DAS	4.80^a (22.67)	2.63^b (7.00)	5.42^{ab} (29.67)	2.12^b (3.59)	9.56^a (91.36)
MBL 10 t/ha *fb* HW twice at 30 and 45 DAS	5.21^a (26.67)	3.09^c (9.33)	5.99^c (36.00)	2.23^b (4.07)	9.49^a (90.18)
Mechanical weeding with wheel hoe weeder at 15, 30 and 45 DAS	4.64^a (21.33)	2.35^b (5.33)	5.13^a (26.67)	1.83^a (2.54)	9.69^a (93.86)
Hand weeding thrice at 15, 30 and 45 DAS	5.11^a (26.67)	2.45^b (5.33)	5.66^{bc} (32.00)	2.23^b (3.99)	9.50^a (90.37)
Weedy check	11.19^c (125.0)	1.88^a (3.33)	11.33^e (128.33)	5.80^d (33.23)	3.14^c (19.81)
LSD (p=0.05)	0.467	0.366	0.488	0.196	0.903

Values in parentheses are original values, data are subjected to square root transformation, absolute total weed density and weed dry weight ($\sqrt{x+1}$) and weed control efficiency and weed index $\sqrt{x}$; DAS: Days after seeding; HW: Hand weeding

Table 2. Interaction effect between seedbed preparation and weed management methods on absolute broad-leaved weeds (BLW) density, total weed biomass and weed control efficiency at 60 DAS in ladies-finger

Treatment	Absolute BLW density (no./m^2)	Total weed biomass (g/m^2)	Weed control efficiency (%)
Stale seedbed × mulching with dried banana leaf	2.49^{de} (5.33)	3.62^{d} (12.13)	8.73^{b} (70.56)
Stale seedbed × mulching with dried banana leaf *fb* mechanical weeding with wheel hoe weeder	1.66^{bc} (2.00)	1.80^{b} (2.25)	9.72^{a} (94.54)
Stale seedbed × mulching with dried banana leaf *fb* HW twice at 30 and 45 DAS	2.24^{cd} (4.00)	1.96^{bc} (2.86)	9.64^{a} (93.09)
Stale seedbed × mechanical weeding with wheel hoe weeder at 15, 30 and 45 DAS	1.40^{ab} (1.33)	1.41^{a} (1.03)	9.88^{a} (97.57)
Stale seedbed × hand weeding thrice at 15, 30 and 45 DAS	1.90^{bc} (2.67)	2.14^{cd} (3.57)	9.55^{ab} (91.38)
Stale seedbed × weedy check	1.00^{a} (0.00)	5.09^{h} (24.99)	6.28^{d} (39.61)
Non-stale seedbed × mulching with dried banana leaf	2.24^{cd} (4.00)	4.37^{g} (18.12)	7.48^{c} (56.13)
Non-stale seedbed × mulching with dried banana leaf *fb* mechanical weeding with wheel hoe weeder	3.60^{gh} (12.00)	2.43^{e} (4.93)	9.39^{ab} (88.18)
Non-stale seedbed × mulching with dried banana leaf *fb* HW twice at 30 and 45 DAS	3.95^{h} (14.67)	2.51^{e} (5.29)	9.34^{ab} (87.28)
Non-stale seedbed × mechanical weeding with wheel hoe weeder at 15, 30 and 45 DAS	3.20^{fg} (9.33)	2.25^{de} (4.07)	9.49^{ab} (90.14)
Non-stale seedbed × hand weeding thrice at 15, 30 and 45 DAS	3.00^{ef} (8.00)	2.33^{de} (4.41)	9.45^{ab} (89.36)
Non-stale seedbed × weedy check	2.77^{ef} (6.67)	6.51^{i} (41.46)	0.00^{e} (0.00)
LSD (p=0.05)	0.518	0.278	0.905

Values in parentheses are original values, data are subjected to square root transformation, absolute total weed density and weed dry weight ($\sqrt{x+1}$) and weed control efficiency and weed index $\sqrt{x}$; DAS: Days after seeding; HW: Hand weeding

Table 3. Effect of seedbed preparation and weed management methods on yield attributes, fruit yield and weed index in ladies-finger

Treatment	No. of fruits per plant	Fruit weight (g/fruit)	Fruit yield (kg/ha)	Weed index (%)
Seedbed preparation				
Stale seedbed	36.5^{a}	6.49^{a}	3291^{a}	4.63^{a} (27.68)
Non-stale seedbed	31.9^{a}	6.16^{b}	2963^{b}	5.58^{b} (34.90)
LSD (p=0.05)	3.23	0.333	187.6	0.411
Weed management				
Mulching with dried banana leaf 10 t/ha	31.5^{cd}	6.15^{b}	2513^{d}	6.68^{d} (44.81)
Mulching with dried banana leaf 10 t/ha *fb* mechanical weeding with wheel hoe weeder at 30 and 45 DAS	37.8^{ab}	6.53^{a}	3936^{b}	3.61^{b} (13.52)
Mulching with dried banana leaf 10 t/ha *fb* HW twice at 30 and 45 DAS	36.5^{abc}	6.39^{ab}	3337^{c}	5.14^{c} (26.66)
Mechanical weeding with wheel hoe weeder at 15, 30 and 45 DAS	38.8^{a}	6.98^{a}	4412^{a}	1.22^{a} (3.08)
Hand weeding thrice at 15, 30 and 45 DAS	32.7^{bcd}	6.35^{ab}	2711^{d}	6.31^{d} (40.46)
Weedy check	28.0^{d}	5.54^{c}	1852^{e}	7.68^{e} (59.20)
LSD (p=0.05)	5.59	0.578	324.9	0.741

Values in parentheses are original values, data are subjected to square root transformation $\sqrt{x}$; DAS: Days after seeding; HW: Hand weeding

weight (6.98/g) and fruit yield (4.41 t/ha) (**Table 3**) due to lower crop weed competition during all stages of crop growth. Similar results were also reported by Daramola *et al*. (2020). The treatment, MWHW was followed by MBL *fb* WHW, MBL *fb* HW and THW. Mechanical weeding with wheel hoe not only reduced the crop weed competition but also improved the soil aeration, root development, nutrient availability and ultimately resulted in increased dry matter production with higher number of fruits per plant, fruit weight and higher fruit yield.

Among the treatment combinations, SSB × MWHW recorded the highest gross return, net return and B:C ratio (₹ 1, 82, 113/ha, ₹ 1, 02, 255/ha and 2.28, respectively) and it was followed by NSSB × MWHW which registered the gross return, net return and benefit cost ratio of ₹ 1, 70, 811/ha, ₹ 93, 353/ha and 2.21, respectively (**Table 4**). This was due to better weed control and reduced crop weed competition (**Table 1 and 2**). Higher fruit yield coupled with low cost of cultivation resulted in higher B:C ratio in SSB × MWHW and NSSB × MWHW. The reduced cost of cultivation by mechanical weeding was reported earlier (Remesan *et al*. 2007).

It may be concluded that the best cost-effective eco-friendly weed management in ladies-finger with higher ladies-finger productivity and net returns can be obtained by the combination of stale seedbed method with mechanical weeding with wheel hoe weeder at 15, 30 and 45 DAS.

Table 4. Effect of seedbed preparation and weed management on economics in ladies-finger

Treatment	Gross return (x10^3 `/ha)	Net return (x10^3 `/ha)	B:C ratio
Stale seedbed × mulching with dried banana leaf	106.59	38.43	1.56
Stale seedbed × mulching with dried banana leaf *fb* mechanical weeding with wheel hoe weeder	161.46	83.10	2.06
Stale seedbed × mulching with dried banana leaf *fb* HW twice at 30 and 45 DAS	140.02	56.26	1.67
Stale seedbed × mechanical weeding with wheel hoe weeder at 15, 30 and 45 DAS	182.11	102.25	2.28
Stale seedbed × hand weeding thrice at 15, 30 and 45 DAS	121.07	33.12	1.37
Stale seedbed × weedy check	78.51	13.95	1.22
Non-stale seedbed × mulching with dried banana leaf	94.44	28.68	1.44
Non-stale seedbed × mulching with dried banana leaf *fb* mechanical weeding with wheel hoe weeder	153.46	77.51	2.02
Non-stale seedbed × mulching with dried banana leaf *fb* HW twice at 30 and 45 DAS	126.95	45.59	1.56
Non-stale seedbed × mechanical weeding with wheel hoe weeder at 15, 30 and 45 DAS	170.81	93.35	2.21
Non-stale seedbed × hand weeding thrice at 15, 30 and 45 DAS	95.77	10.21	1.12
Non-stale seedbed × weedy check	69.64	7.48	1.12

REFERENCES

AGRICOOP. 2021. Area and production of horticultural crops in India [on line]. Available: https://www.google.cpm/search?g=okra +production+in+india+ [16 June 2021].

Ameena M, Kumari VLG and George S. 2013. Control of purple nutsedge in okra through integrated management. *Indian Journal of Weed Science* **45**(1): 51–54.

Baraiya M, Yadav KS, Kumar S, Lal N and Shiurkar G. 2017. Effect of integrated weed management in okra. *International Journal of Chemical Studies* **5**(4): 1103–1106.

Chacko SR, Raj SK and Krishnasree RK. 2021. Integrated weed management in vegetables. *Journal of Pharmacognosy and Phytochemistry* **10**(2): 2694–2700.

Daramola OS, Adigun JA and Adeyami OS. 2020. Efficacy and economics of integrated weed management in okra (*Abelmoschus esculentus* (L.) Moench). *Agricultura Tropica et Subtropica* **53**(4): 199–206.

Mynavathi VS, Prabhakaran NK and Chinnusamy C. 2008. Evaluation of mechanical weeders in irrigated maize. *Indian Journal of Weed Science* **4** (3&4): 210–213.

Narayan S, Malik AA, Magray M, Shameem SA, Hussain K, Mufti S and Khan FA. 2020. Effect of weed management practices on growth, yield and quality of okra ladies-finger (*Abelmoschus esculentus* (L.) Moench.) under temperate conditions of Kashmir valley. *International. Journal of Chemical Studies* **8**(5): 2485–2487.

Reimens MM, van der Weide RY, Bleeker PO and Lotz LAP. 2006. Effect of stale seedbed preparations and subsequent weed control in lettuce (cv. *Ice boll*) on weed densities. *Weed Research* **47**: 149–156.

Remesan R, Roopesh, M.S, Remya, N., and Preman, P.S. 2007. Wet land paddy weeding- a comprehensive comparative study from South India. *Agricultural Engineering International: CIGR Journal* **9**: 1–21

Sah D, Heisnam P and Pandey K. 2018. Weed management in ladies-finger under foot hill conditions of North Eastern Himalaya. *Journal of Crop and Weed* **14**(1): 201–204.

Shamla K, Sindhu PV and Menon MV. 2017. Effect of weed management practices on growth and yield of okra (*Abelmoschus esculentus* (L.) Moench.). *Journal of Tropical Agriculture* **55**(1): 57–62

Sinchana JK. 2020. *Integrated Weed Management in Bush Type Vegetable Cowpea (Vigna unguiculata subsp. unguiculata (L.) Verdcourt)*. M.Sc. (Ag). Thesis, Kerala Agricultural University, Thrissur, 226p.