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RESEARCH NOTE

Weed management in organic kodo millet in Eastern dry zone of Karnataka

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ABSTRACT

A field experiment was conducted at Research Institute of Organic Farming field unit, University of Agricultural Sciences, Gandhi Krishi Vignan Kendra, Bengaluru during *Kharif* (rainy season) of 2021 to evaluate different organic weed management methods in kodo millet (*Paspalum scrobiculatum* L.). The experiment was laid out in randomized complete block design with 12 treatments, replicated thrice. Hand weeding at 20 and 40 DAS was significantly superior in reducing the weed density (34.7 and 22 no./m^2) and dry weight (4.8 and 5.3 g/m^2) at 30 DAS and at harvest, respectively. Hand weeding at 20 and 40 DAS, stale seed bed technique *fb* inter cultivation twice at 25 and 45 DAS, inter cultivation at 25 DAS *fb* one hand weeding at 45 DAS, two mechanicals (cycle weeder) weeding at 20 and 40 DAS and kodo millet + fodder cowpea as intercrop with in-situ mulching on 35 DAS *fb* one intercultivation at 40 DAS registered 0.93, 0.76, 0.73, 0.68 and 0.67 t/ha grain yield, respectively as against the grain yield of 0.22 t/ha in weedy check. Among the weed control treatments, highest net returns of ₹ 34452/ha was recorded under weed free treatment while the highest B: C ratio (2.34) was recorded with both hand weeding at 20 and 40 DAS and stale seed bed technique *fb* inter cultivation twice at 25 and 45 DAS followed by two mechanicals (cycle weeder) weeding at 20 and 40 DAS (2.13).

Keywords: Economics, Kodo millet, Organic cultivation, Weed management

In the tribal regions of India, kodo (*Paspalum scrobiculatum* L.) is one of the main food crops. It can be found across the tropics and subtropics of the world in moist regions. It was cultivated in southern Rajasthan and Maharashtra for 3000 years (Kajale 1977, De Wet *et al*. 1983). Today it is cultivated from Uttar Pradesh state of India to Bangladesh in North and North-east region and Kerala to Tamil Nadu in the South. Varagu, kodo, haraka and arakalu are the other names for this millet. It is the primary component of the diet's nutritional requirements for farmers in several regions of India who work on marginal or dry land. Millet kodo has approximately 11% protein which protein's nutritional value has been found marginally superior to that of foxtail millet. Kodo millet is cultivated in a variety of soil types and climates and in regions with vastly different temperatures and photoperiods. Nowadays, kodo millet is recommended as a substitute for rice next to finger millet to the patients who are all suffering due to diabetes (Vanithasri *et al*. 2012). Further, the burgeoning population of India may stabilize in an around 1.40 and 1.60 billion by 2025 and 2050, with the need of 380 and 450 million tonnes of food grains, respectively (Siddiq 2000). Hence, there is an urgent need to enhance the production and productivity of kodo millet to meet future demand for food requirements. This crop's tenacity is beneficial for adopting themselves to various ecological niches. The low output of kodo millet (*Paspalum scrobiculatum* L.) is gradually hampered by the slow initial growth of the plant, favourable conditions for weed growth and a large variety of heterogeneous weed flora. Numerous biotic and abiotic factors affect crops. Weed competition with crops for water, light, nutrients and space is one of the main biotic limitations that limits productivity. Weeds compete with crops more fiercely in their early phases of development than in later stages, which hurt crop growth and ultimately reduces the grain yield. Depending on the type and amount of weeds present, crop yields are severely reduced by weeds in the field. In general, yield losses vary from 15 to 20%, but in extreme cases, yield losses may might exceed 50%.

A field investigation was carried out during rainy season (*Kharif*) 2021 at Research Institute of Organic Farming field unit, University of Agricultural Sciences, Gandhi Krishi Vignan Kendra, Bengaluru coming under Eastern dry zone of Karnataka. The soil of the experimental site was sandy loam in texture,

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neutral in reaction (pH 6.58), low electrical conductivity (0.24 dS/m) with medium in organic carbon (0.59 %), available nitrogen (307 kg?ha), available phosphorus (38.7 kg/ha) and available potassium (197.2 kg/ha). The field experiment was laid out in randomized complete block design replicated thrice with 12 treatment combinations (**Table 1**). Before sowing of kodo millet, farm yard manure was applied for all the experimental plots based on N equivalent of recommended dose of fertilizer for the kodo millet. The gross plot size was 5.4 × 4.8 m and net plot size was 4.8 × 4.6 m. On August 3, 2021, seeds of the kodo variety "*RK 390-25*" were sown at a spacing of 30×10 cm. Total rainfall (881.2 mm) received during cropping period in 2021 was higher than 2020 (541.9 mm). Before sowing, stale seed-bed technique was practiced by irrigating the respective plots and then harrowing to remove two flushes of weeds in an interval of 7-8 days. Weed density and weed dry weight were recorded 30 days after sowing and at the time of harvest from pre-marked quadrants of 1 square m area. Weed control efficiency and weed index were worked out at various stages of crop growth to assess the efficiency of different organic weed management methods. The crop was harvested on 25th November, 2021. And at the time of harvest, yield parameters were recorded from representative samples and yield were recorded and economics were worked out based on the cost of inputs, labour charges and prices of outputs during the course of investigation. All the data presented in this paper was of single season and discussed at a probability level of five per cent. Since the weed data is larger, the original values subjected to square root transformation *i.e.*, $(\sqrt{x+1})$ transformation.

Effect on weeds

Major weed species observed in the experimental site were sedges like *Cyperus rotundus*; grassy weeds like *Cynodon dactylon*, *Eleusine indica*, *Echinocloa crusgalli*, *Dactyloctenium aegyptium*, *Digitaria marginata*; and broadleaved weeds like *Ageratum conyzoides*, *Alternanthera sessilis*, *Commelina benghalensis* and *Borroria hispida*. All the weed management practices followed, reduced both weed density and weed dry weight compared to unweeded treatment. Among them hand weeding at 20 and 40 DAS recorded lower weed density both at 30 DAS and at harvest (34.7 and 22.0/m^2, respectively). Other than control, it was found to be lower in stale seedbed technique + inter cultivation twice at 25 and 45 DAS (51.3 and 30.0/m^2, respectively) (**Table 1**). Boyd *et al*. (2006) reported that effective stale seedbed should minimize the soil disturbance and the movement of the seeds from deeper soil profile to the germination zone. Weed dry weight was found to be minimum in stale seedbed technique *fb* intercultivation twice at 25 and 45 DAS at 30 DAS and at harvest (7.07 and 7.49 g/m^2, respectively) than the weed free treatment. Higher weed biomass was reported in unweeded check (15.9 and 14.9 g/m^2). It was due to the initial weed seeds deposition in the soil from previous season which influenced increase in weed seed bank in the soil which were not disturbed or destroyed by any management practice after sowing. All these factors have influenced for higher weed density in the

Table 1. Weed density, weed dry weight, weed control efficiency and weed index as influenced by different organic weed management practices

Treatment	Weed density (no./m^2)		Weed dry weight (g/m^2)		Weed control efficiency (%)	Weed index (%)
	30 DAS	At harvest	30 DAS	At harvest		
Inter cultivation at 25 DAS + 1 hand weeding at 45 DAS	7.88(61.3)	6.10(36.7)	3.05(8.39)	3.19(9.23)	38.0	20.9
Stale seed bed technique + inter cultivation twice at 25 and 45 DAS	7.21(51.3)	5.55(30.0)	2.82(7.07)	2.91(7.49)	49.6	17.6
Straw mulching 5 t/ha at 10-15 DAS	8.50(72.0)	5.79(32.7)	3.34(10.4)	3.04(8.27)	44.4	40.3
Kodo millet + fodder cowpea as intercrop + one inter cultivation at 30 DAS	9.21(84.0)	5.87(34.7)	3.52(11.4)	3.02(8.42)	43.4	67.5
Kodo millet + fodder cowpea as smothering crop in between rows of kodo millet	8.37(70.0)	5.06(25.3)	3.13(8.93)	2.64(6.15)	58.6	68.6
Kodo millet + fodder cowpea as intercrop with in-situ mulching on 35 DAS + one intercultivation at 40 DAS	8.82(78.0)	5.66(32.7)	3.36(10.4)	2.84(7.48)	49.7	28.1
Mechanical (cycle weeder) weeding at 35 DAS	10.33(106.7)	5.90(34.7)	3.73(13.0)	3.07(8.79)	40.9	36.5
Two mechanicals (cycle weeder) weeding at 20 and 40 DAS	9.07(82.0)	6.39(40.7)	3.25(9.59)	3.29(10.1)	31.9	26.6
Cucumber leaf extract spray 100 ml/l, one at 2-4 leaf stage and another spray depending on the weed density	9.75(95.3)	6.59(42.7)	3.61(12.2)	3.37(10.5)	29.3	49.3
Ageratum conyzoides leaf extract spray 100 ml/l, one at 2-4 leaf stage and another spray depending on the weed density	10.1(102.0)	6.65(43.3)	3.75(13.1)	3.43(10.8)	27.4	55.5
Weed free check (hand weeding at 20 and 40 DAS)	5.96(34.7)	4.77(22.0)	2.41(4.80)	2.50(5.30)	64.4	-
Unweeded check (weedy check)	11.58(133.3)	7.54(58.7)	4.11(15.9)	3.91(14.9)	-	76.5
LSD (p=0.05)	1.53	-	0.58	-	-	

Values are subjected to $(\sqrt{x+1})$ transformation; original values are in parentheses; DAS- Days after sowing weedy check. These findings were in accordance with Pradhan and Sonboir (2009).

Hand weeding at 20 and 40 DAS recorded higher weed control efficiency (64.4%) and it was followed by stale seed bed technique + intercultivation twice at 25 and 45 DAS (49.6%). It was the result of the early control of weeds and disruption to the photosynthetic parts. The results of this study were similar with earlier findings of Ashok *et al.* (2003) and Ramamoorthy *et al.* (2009). Among various treatments, stale seedbed technique *fb* intercultivation twice at 25 and 45 DAS recorded lower weed index (17.6%) followed by intercultivation at 25 DAS *fb* one hand weeding at 45 DAS (20.9%) (**Table 1**). Weed free treatment recorded lowest weed index (0%) indicating that there was no reduction in grain and fodder yields due to weed infestation. The highest weed index (76.5%) was reported in unweeded check (control) as a result of uncontrolled weed growth which leads to higher competition with the crop. Similar results were obtained by Sharma and Jain (2003).

Effect on crops

Grain and straw yield of kodo millet were influenced by different organic weed management practices and the data pertaining to it is presented in **Table 2**. In comparison to all other treatments, weed free check (hand weeding at 20 and 40 DAS) recorded higher grain yield (0.93 t/ha) and straw yield (5.1 t/ha) and found to be statistically significant. This might be due to better control of weeds at critical crop-weed competition period and at tillering stage which resulted in production of a greater number of productive tillers, yield components and yield of the crop. This efficiency may be due to effective weed control at critical crop growth stage which lead to increase in availability of moisture, nutrients, light and space for the crop. Similar results were reported by Jawahar *et al.* (2019), who concluded that hand weeding at 20-25 and 30-45 DAS recorded higher grain yield compared to chemical weed management treatments in transplanted kodo millet. The lowest grain yield was obtained in unweeded control (0.22 t/ha). This reduced yield might be due to highest competition throughout the crop growth period. Similar findings were obtained by Patil *et al.* (2013) in finger millet. The straw yield of kodo millet was also extensively influenced by the various treatments. Higher straw yield was recorded under hand weeding at 20 and 40 DAS (5.1 t/ha) and more plant population owing to better weed control which might have contributed to maximum dry matter production and leaf area index and ultimately enhanced straw yield. Similar results were earlier reported by Chanu *et al.* (2018).

Economics

Hand weeding at 20 and 40 DAS recorded highest net returns (₹ 34452/ha), which was followed by stale seed bed technique *fb* inter cultivation twice at 25 and 45 DAS (₹ 28373/ha) and inter cultivation at 25 DAS *fb* 1 hand weeding at 45 DAS (₹ 24881/ha). The higher seed yield recorded with this treatment might be responsible for higher net returns. But in case of B:C ratio, both weed free check (hand

Table 2. Yield and economics of kodo millet as influenced by different organic weed management practices

Treatment	Grain yield (t/ha)	Straw yield (t/ha)	Net returns (₹/ha)	B:C ratio
Inter cultivation at 25 DAS + one hand weeding at 45 DAS	0.73	3.97	24881	2.09
Stale seed bed technique + inter cultivation twice at 25 and 45 DAS	0.76	4.17	28373	2.34
Straw mulching 5 t/ha at 10-15 DAS	0.55	3.89	16554	1.85
Kodo millet + fodder cowpea as intercrop +one inter-cultivation at 30 DAS	0.30	3.61	297	1.02
Kodo millet + fodder cowpea as smothering crop in between rows of kodo millet	0.29	3.11	1159	1.07
Kodo millet + fodder cowpea as intercrop with in-situ mulching on 35DAS + one inter-cultivation at 40 DAS	0.67	3.91	22024	2.04
Mechanical (cycle weeder) weeding at 35 DAS	0.59	4.11	19471	2.04
Two mechanicals (cycle weeder) weeding at 20 and 40 DAS	0.68	4.14	23437	2.13
Cucumber leaf extract spray 100 ml/l, one at 2-4 leaf stage and another spray depending on the weed density	0.47	3.80	10797	1.55
Ageratum conyzoides leaf extract spray 100 ml/l, one at 2-4 leaf stage and another spray depending on the weed density	0.41	3.83	7029	1.36
Weed free check (hand weeding at 20 and 40 DAS)	0.93	5.10	34452	2.34
Unweeded check (weedy check)	0.22	2.99	-2620	0.84
LSD (p=0.05)	0.13	0.51	-	

DAS- Days after sowing

weeding at 20 and 40 DAS) and stale seed bed technique *fb* intercultivation twice at 25 and 45 DAS recorded same value of 2.34 followed by inter cultivation at 25 DAS *fb* one hand weeding at 45 DAS with 2.09. The lowest B: C ratio was recorded in unweeded check (weedy check) with 0.84 due to maximum yield reduction compared to other treatments (**Table 2**). These results were in accordance with Meghana (2019).

It was concluded that stale seedbed technique *fb* intercultivation twice at 25 and 45 DAS and intercultivation at 25 DAS *fb* one hand weeding at 45 DAS found to be the best weed management methods among the treatments.

REFERENCES

Ashok EG, Chandrappa M, Kadalli GG, Kirankumar, Mathad V and Krishnegowda KT. 2003. Integrated weed control in drill-sown finger millet (Eleusine coracana). *Indian Journal of Agronomy* **48**(4): 290-293.

Boyd NS, Brennan and Fennimore SA. 2006. Stale seedbed techniques for organic vegetable production. *Weed Technology* **20**: 1052-1057.

Chanu YB, Jawahar S, Nandini Devi K and Sanatombi Devi Y. 2018. Weed management practices in transplanted kodomillet (*Paspalum scrobiculatum* L.). *The Bioscan* **13**(1): 379-382.

Dewet JMJ, Prasadarao KE, Mengesha MH and BRINK DE. 1983. Diversity in kodo millet (*Paspalum scrobiculatum* L.). *Economic Botany* **37**(2): 159-163.

Jawahar S, Chanu YB, Suseendram K, Vinodkumar SR and Kalaiyarasan C. 2019. Effect of weed management practices on growth, yield and economics of transplanted kodo millet. *International Journal of Research and Analytical Reviews* **1**(6): 1121-1128.

Kajale MP. 1977. Ancient grains from excavations at Nevassa, Maharashtra. *Geophytology* **7**: 98-106.

Meghana GK. 2019. *Studies on efficacy of new herbicides in managing weeds of kodo millet* (*Paspalum scrobiculatum* L.). M. Sc. Thesis, University of Agricultural Science Bengaluru, India.

Patil B, Reddy VC, Ramachandraprasad TV, Shankaralingappa BC, Divendra R and Kalyanamurthy KN. 2013. Weed management in irrigated organic finger millet. *Indian Journal of Weed Science* **45**(2): 143- 145.

Pradhan A and Sonboir HL. 2009. Weed management in kodo millet under rainfed condition. *Indian Journal of Weed Science* **41**(3&4): 174-178.

Ramamoorthy K, Radhamani S and Subbain P. 2009. Productivity and profitability of rainfed finger millet (*Eleusine coracana* (L.) Gaertn) through organic farming. *Green Farming* **2**(5): 269-271.

Sharma OL, and Jain NK. 2003. Integrated weed management in pearl millet (*Pennisetum glaucum*). *Indian Journal of Weed Science* **35**(1&2): 34-35.

Siddiq EA. 2000. Yawning productivity gaps. pp. 39-44. In: The Hindu Survey of Indian Agriculture. The Hindu Publication, Chennai.

Vanithasri J, Kanchana S, Hemalatha G, Vanniarajan C and Sahulhameed M. 2012. Role of millets and its importance in new mellinium. *International Journal of Food Science and Technology* **2**(1): 35-47.