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Performance of Power Operated Sweep Hoe on Moisture Conservation, Weed Suppression and Yield of Finger Millet (*Eleusina indica*)

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ABSTRACT

A field experiment was conducted in the Department of Agricultural Engineering, College of Agriculture, University of Agricultural Sciences, Gandhi Krishi Vignana Kendra, Bangalore to quantify the soil moisture status and its effect on crop yield under varied rainfall situation in the region. The loss of soil moisture during critical period of crop growth (tillering, flowering and grain filling stages) result in the drastic reduction of yield. It could be prevented by adopting newly designed improved sweep bent tyne hoe through effective weed control and efficient intercultural operation. The present study clearly indicated that the power operated improved sweep type inter-cultural hoe confirms the superiority in conservation of soil moisture condition (13.87 to 15.07, 10.37 to 12.14 and 8.10 to 9.29 % during tillering, flowering and grain filling stage respectively) followed by bullock drawn bent tyne hoe (7.22 to 14.09 %) and blade harrow (7.70 to 13.55 %) irrespective of the critical stages of the crop growth period. The study revealed that the fresh weed biomass using improved sweep hoe was more (3.14t/ha) as compared to bullock drawn bent tyne hoe (1.88t/ha) and blade harrow (1.56t/ha). It was also observed that the weed efficiency of newly developed sweep hoe was high (78.99 to 86.38 %) compared to bent tyne hoe (76.68 to 79.99 %) and blade harrow (75.15 to 77.11 %).

Key Words: Bent tyne hoe, Blade harrow, Field capacity, Maximum water holding capacity, Sweep hoe, Weed efficiency.

INTRODUCTION

Finger millet (Ragi) is an important field crops predominantly grown in southern parts of Karnataka state on red soil areas. In India, it is being cultivated on 2.4 million ha with annual production of 2.6 million tons. The crop grows well even in medium to low fertile soils and also resist drought. Karnataka state dominates both in area (0.78 mha) and production (1.5mt) of finger millet in the country.

Among different field operations, the weeding and inter-cultural operations play an important role for enhancing the yield. The crop weed competition is very acute during first 35-40d of crop growth period and delayed weeding during this period reduces the crop yield up to 35-61 per cent (Chowdegowda and Dhananjaya, 2000). Considering the non-availability of labour for timely weeding, farm mechanization offers a probable solution. The development and adoption of farm tools offers the benefit of reducing drudgery, timely operation and conservation of natural resources *viz.*, moisture under dry land ecosystem. Although, bullock drawn intercultural implements are available, reduced draft power, necessitate the design and development of power operated weeding and intercultural hoe. Sweep hoes offer potential in improving the productivity and conserving moisture under finger millet production system. Hence, the study was undertaken to examine the suitability and performance of sweep hoe on soil moisture, weed infestation, growth and yield of finger millet.

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Table 1. Soil hydrological characteristics of the experimental area.

Sr. No.	Soil depth (m)	Bulk density (g/cm3)	Maximum water holding capacity (%)	Field capacity (F C) (%)	Wilting point (W P) (%)
1.	Up to 0.12	1.56	26.8	14.7	7.8
2.	0.12 to 0.24	1.48	31.6	16.0	9.7
3.	0.24 to 0.42	1.44	29.8	17.3	11.4
4.	0.42 to 0.70	1.40	33.2	18.0	13.1
5.	0.70 to 1.08	1.32	35.0	18.8	13.3

MATERIALS AND METHODS

To suit the location specific inter cultural operation in finger millet performed by the power operated machines, the improved sweep hoe was designed. This machine run with diesel engine of 2 hp, mounted on front side of the square frame with self propelled air cooled petrol start/ diesel run engine. The power transmitted from gear box through v-belt and pulley intern connects to the wheels. There were two sweeps hoe fitted to a main frame and each having 18 cm cutting width and 40□ curvature angle at a distance of 30 cm from shaft centre of the sweep hoe. The depth was controlled manually by clutch.

The field evaluation was taken up in the Department of Agricultural Engineering, College of Agriculture, University of Agricultural Sciences, G.K.V.K Bangalore located at 77□ 39′ 22″ east longitude, 120 58' N latitude and 929 m above mean sea level during 2011-12 and 2012-13. The soil of the experiment area represents typical lateritic area (Anon, 2014). These soils are very deep, well drained red sandy loam to sandy clay loam having slightly acidic in reaction. The field capacity of the soils varies from 15 to 22 per cent with maximum water holding capacity of about 30 per cent and infiltration rate varies from 4-6 cm/hr (Table 1).

Table 2. Monthly rainfall distribution, normal rainfall and per cent deviation from the normal rainfall during experimental period.

Month	2011-12		Normal rainfall (mm)	% deviation from normal rainfall	2012-13		Normal rainfall (mm)	% deviation from normal rainfall
	Monthly rainfall (mm)	No. of rainy days			Monthly rainfall (mm)	No. of rainy days		
January	0.0	0	1.4	-100	0.0	0	1.3	-100
February	16.6	1	10.1	64.3	0.0	0	9.8	-100
March	0.0	0	14.1	-100	0.4	0	16.9	-97.6
April	57.4	5	48.8	17.6	8.6	2	47.9	-82.0
May	121.7	8	99.8	21.94	84.4	4	100.4	-15.9
June	24.8	4	78.2	-68.3	26.6	3	78.9	-66.3
July	95.4	9	103.3	-7.74	97.2	7	103.7	-6.3
August	249.7	14	134.3	85.9	100.1	7	135.4	-26.1
September	59.6	7	200.5	-70.3	29.2	3	195.4	-85.1
October	126.4	7	166.9	-24.3	64.2	3	168.4	-61.9
November	35.4	4	52.5	-32.6	150.0	4	54.5	175.4
December	0.0	1	12.7	-100	11.2	1	12.6	-11.3
Total	804.5	60	922.6	-	571.9	34	925.2	-

Table 3. Soil moisture content at different depth and crop stage as influenced by different inter-cultural hoes (Average of 2 yr).

Sr. No.	Treatment	Soil moisture content (% dry weight basis)					
		Tillering stage		Flowering stage		Grain filling stage	
		0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
1.	T_1: Blade harrow	12.87	13.81	8.98	9.98	7.22	8.03
2.	T_2: Blade harrow + 1 HW	12.30	13.55	9.19	10.18	7.38	8.18
3.	T_3: Bent tyne hoe	13.17	14.09	9.71	10.73	7.70	8.52
4.	T_4: Bent tyne hoe + 1 HW	12.83	13.91	10.41	11.44	7.99	8.64
5.	T_5: Sweep hoe	14.05	15.07	10.37	11.41	8.10	8.98
6.	T_6: Sweep hoe + 1 HW	13.81	14.86	10.85	12.14	8.31	9.29
	S.Em.+	0.092	0.174	0.243	0.29	0.052	0.081
	CD @ 5%	0.277	0.525	0.732	0.87	0.156	0.243

During the year 2011, 804.5 mm of rainfall was received in 60 rainy days with comparatively uniform distribution. However, it was observed that there was a deficit in total amount of rainfall compare to average annual rainfall (922.6 mm). The rainfall during 2012 (571.9 mm in 34 rainy days) was deficit to an extent of 40 % (Table 2).

The experiment consisted of six treatments with three inter-culture implements *viz.*, bullock drawn blade harrow, bent tyne hoe and power operated improved sweep hoe in combination with and without hand weeding replicated four times in randomized complete block design (RCBD). The area of the experimental plot was 7.2 m2 (2.4 m wide and 3.0 m long) and the medium duration finger millet crop variety GPU-28 was sown with a row spacing of 30 cm and the inter-culture treatments were imposed 35 days after sowing.

The evaluation of inter-cultivators was taken up in the field and the different parameters such as time of operation, effect on plant population, weed count, weeding efficiency and actual field capacity was calculated using the standard procedures described by the Singhal (2001) and Tajuddin *et al* (1991). The soil samples were collected with the help of screw auger at 15 and 30 cm depth from each plot at tillering (40 DAS), flowering stage and grain filling stage. The soil moisture content was determined by gravimetric method (Piper, 1966). The weeding efficiency was calculated considering the weed population before and after the intercultural operation using the formulae

$$\text{Weeding Efficiency (\%)} = \frac{Wb - Wa}{Wb} \times 100$$

Where, Wa = Number of weeds after the intercultural operation

Wb= Number of weeds before the intercultural operation

The per cent plant damage (PD) was calculated as a ratio of plant population before and after inter-cultivation using the formulae

$$\text{Plant Damage (\%)} = \frac{N_2}{N_1} \times 100$$

Where, N_1 = Number of plants before intercultural operation

N_1 = Number of plants after intercultural operation

The working Field capacity (FC) is calculated by considering area covered (A) by inter-cultivator in a given time (T) using the formulae

Field Capacity (cm/hr) = A / T

Table 4. Performance evaluation of power operated improved sweep hoe as compared to bent tyne and blade harrow (Average of 2 years)

Sr. No	Treatment	Weed biomass removed (t/ha)	Weed efficiency (%)	Plant damage (%)	Actual field capacity (ha/hr)
1.	T_1: Blade harrow	1.56	77.11	7.00	0.173
2.	T_2: Blade harrow + 1 HW	2.41	75.15	7.13	-
3.	T_3: Bent tyne hoe	1.88	76.68	6.93	0.168
4.	T_4: Bent tyne hoe + 1 HW	2.65	79.42	6.40	-
5.	T_5: Sweep hoe	3.14	78.99	5.40	0.200
6.	T_6: Sweep hoe + 1 HW	3.37	86.38	5.87	-
	S.Em.+	-	0.83	0.90	-
	CD @ 5%	-	2.49	2.71	-

RESULTS AND DISCUSSION

Soil moisture

The soil moisture content at different depths and crop stage varied significantly among different treatments (Table 3). The soil moisture was significantly higher with inter-cultivation with sweep hoe at tillering (T5: 14.05 and 15.07%), flowering (10.37 and 11.41%) and grain filling stage (8.31 and 9.29%) at 0-15 and 15-30 cm soil depth, respectively. This was at par with sweep hoe with one hand weeding. Significantly lower soil moisture was noticed with inter cultivation using blade harrow. The increased soil moisture with sweep hoe was associated with the higher depth of tilling compared to blade hoe and bent tyne hoe. Ranjan *et al* (2011) attributed higher soil moisture content with deeper tillage owing to better soil inversion resulting in higher infiltration. Further, the pulverized soil form dust mulching effect and reduce the evaporation losses from the soil. Increased infiltration and reduced evaporation were responsible for increased soil moisture content in the soil with sweep hoe inter-cultivation.

Impact on weed and plant stand

The inter cultivation with different tillage influenced the weed efficiency and plant damage considerably (Table 4). The weed biomass removed with inter cultivation was significantly higher with sweep hoe (3.14t/ha) compared to bent tyne hoe (1.88 t/ha) and blade harrow (1.56t/ha). The better removal of weeds with sweep hoe was associated with greater depth of penetration and earthing up, which uprooted weeds largely compared to the shallow tillage with blade harrow. Further, one hand weeding helped to remove the weeds ranged between 0.23 to 0.85t/ha. The weeds removed with hand weeding was higher with sweep hoe inter-cultivated treatment (0.23t/ha) compared to bent tyne hoes (0.77t/ha) and blade harrow (0.85t/ha). The lower weed removal by hand weeding with sweep hoe compared to other implements was associated with lower weed population left during the inter-cultivation. Chowdegowda and Dhananjaya (2000) also reported reduced weed population with deeper inter cultivation.

The weeding efficiency was higher with inter cultivation with sweep hoe + one hand weeding (86.38%) followed by bent tyne hoe + one hand weeding (79.42%) and sweep hoe (78.99%). The higher weeding efficiency in these treatments are associated with lower weed population.

The plant damage was lower with sweep hoe (5.40%) followed by sweep hoe + one hand weeding (5.87%) and bent tyne hoe + one hand weeding (6.40%). Significantly higher plant damage was noticed with blade harrow + one hand weeding (7.13%). This might be associated with earthing up

Table 5. Yield and economics of finger millet as influenced by the different intercultural Practices (Average of 2 years)

Sr. No.	Treatment	Finger millet yield (kg/ha)		Returns (Rs/ha)		B:C ratio
		Grain	Straw	Gross	Net	
1.	T_1 Blade harrow	1815	4052	29251	15710	2.16
2.	T_2: Blade harrow + 1 HW	1969	4254	31662	15428	1.95
3.	T_3: Bent tyne hoe	1892	4195	30478	17152	2.29
4.	T_4: Bent tyne hoe + 1 HW	1896	4309	30595	14576	1.91
5.	T_5: Sweep hoe	2073	5062	33626	20147	2.49
6.	T_6: Sweep hoe + 1 HW	2231	5188	36059	19887	2.23
	S.Em.+	81.35	194.62	-	-	-
	CD @ 5%	239.80	578.51	-	-	-

to support the plant during its operation in sweep hoe.

Finger millet yield and economics

The Finger millet grain and straw yield varied significantly among different treatments (Table 5). Inter cultivation with sweep hoe + one hand weeding recorded significantly higher grain (2231kg/ ha) and straw (5188kg/ha) followed by sweep hoe (2073 and 5062kg/ha). Significantly lower yield was noticed with blade harrow inter-cultivation (1815 and 4052kg/ha) followed by bent tyne hoe (1892kg and 4195kg/ha). The increased yield with sweep hoe was attributed to better soil moisture conservation and suppression of weeds. The soil moisture is the critical inputs under dry land situation. Increased soil moisture might have resulted in improvement of yield attributes and yield (Bhringuvanshi *et al,* 2014). The greater depth of operation and earthing up might have resulted in reduced soil erosion and contributed for higher yield. Further, reduced competition from the weeds with sweep hoe inter cultivation contributed additionally for the yield improvement. Nayara *et al* (2014) revealed higher crop yield with soil conservation practices.

The economic analysis proved the superiority of sweep hoe inter cultivation as shown by the net return (Rs. 20147/-ha), gross return (Rs. 33626/- and B:C ratio (2.49) followed by sweep hoe + one hand weeding (Rs. 19887/-, Rs 36059/-ha and 2.23). The lower income and B:C ratio was noticed with blade harrow and bent tyne hoe.

CONCLUSION

The results of the study clearly indicates that the inter cultivation with improved sweep hoe can potentially suppress the weeds, conserve soil & water and improve the productivity and economics of finger millet crop under dry land situation.

REFERENCES

Bhriguvanshi S R, Adak T, Kumar K, Singh A and Kumar V (2014). Impact of varying soil moisture regimes on growth and soil nutrient availability in mango. *Indian J Soil Cons* **42**(1): 68-73.

Chowdegowda M and Dhananjaya K (2000). Effect of inter cultivation on performance of finger millet under rain fed conditions. *Karnataka J Agric Sci* **13** (4):1040-1042.

Naraya D, Biswas H and Kumar P(2014). Conservation measures for resource conservation and enhancing yield of sorghum in red soils of Bundelkhand region in central India. *Indian J Soil Cons* **42**(1):62-67.

Singhal O P (2001). *Farm mechanization and farm machinery*. Text book Vol –I and II.

Tajuddin A, Karunanidhi R and Swaminathan K R (1991). Design development and testing of an engine operated blade harrow for weeding. *Indian J Agric Engg* **1**(2): 137-140.

Ranjan V, Nema A K, Singh A and Bisen Y(2011). Modelling of runoff sediment - yield kashinagar watershed. *Indian J Soil Cons* **39**(3):183-187.

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