Indian Journal of Weed Science **51**(1): 92–94, 2019

Print ISSN 0253-8040 Online ISSN 0974-8164

Performance evaluation of some selected weeding tools in faba bean

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Article information

DOI: 10.5958/0974-8164.2019.00021.2

Type of article: Research note

Received : 29 November 2018
Revised : 28 February 2019
Accepted : 2 March 2019

Key words
Grubber, Khurpi, Performance, Power weeder, Wheel hoe

ABSTRACT

The field performance of different weeding tools/implements *viz. khurpi* (hand hoe), grubber, wheel hoe, and power weeder were carried out at the Institute Research Farm, ICAR-Research Complex for Eastern Region, Patna, Bihar. Results revealed that actual field capacity of 0.0046±0.002, 0.0086±0.0002, 0.0189±0.0003, 0.0696±0.003 ha/h had associated with *khurpi*, grubber, wheel hoe and power weeder, respectively. *Khurpi* had recorded the maximum weeding efficiency (98.9%) and lowest in case grubber **(**74%). Similarly, power weeder contributed to higher plant damage (1.94%). Operational of *khurpi* had recorded maximum (Rs.6793/ha). A reasonable amount of savings of weeding operation were observed using grubber, wheel hoe, and power weeder as compared to *khurpi*.

Faba bean (*Vicia faba* L.) is a potential crop for nutritional security. However, it is still treated as an underutilized crop in India. Its seeds are very low in saturated fat, cholesterol, and sodium and having good source of dietary fibre, protein (20-41%), P, Cu and Mn (Singh *et al.* 2014). Currently 58 countries produce this bean on large scale, and in India it is cultivated in 25000 ha (Singh *et al.* 2013). Faba bean is poor competitor with weeds at initial stages of crop growth, thus, this makes an integrated weed management (IWM) essential for successful production. Research finding reveals that weeding at 30 and 45 days after sowing (DAS) proven effective for weed management (Ram *et al*. 2012). Hand weeding is a most followed practice to manage weeds in faba bean. However, it is labour intensive and account for~25% of total labour requirement that is 90–1200 man-hr/ha (Yadav and Pund 2007, Yadav *et al.* 2019). Delayed in weeding reduces crop yield by 40-60% and sometimes complete crop failure (Singh 1988). Hence, timely weeding is an important aspect for achieving the optimum yield (Singh *et al.* 2019). Use of improved weeders is a viable option to reduce time and drudgery (Sarkar *et al*. 2016). Managing weeds with use of improved weeding tools / implements not only uproots weed between crop rows but also keeping surface soil loose, ensuring better soil aeration and water intake capacity. There are many types of weeders available in India for weeding but all these designs are the region specific to meet the requirement of soil type, crops and availability of the local resources (Goel *et al*. 2008). Hence, in the present study different weeders (*khurpi* (hand hoe), grubber, wheel hoe, power weeder) were evaluated in faba bean for comparing the weeding efficiency under the irrigated ecosystem of Indo-Gangetic plains of Eastern India.

Comparative performance of different weeding tools in faba bean was evaluated in triplicate during the winter season of 2017 at the Institute farm, ICAR Research Complex for Eastern Region, Patna (25° 35.485 N latitude and 85° 04.951 E longitude). Soil of the experimental plot was clay loam (sand: 23.36%, silt: 39.64% and clay: 37%). Soil moisture content was 11.4% at 0-15 cm and 13.7% at 15-30 cm soil depth, respectively. Monthly mean maximum and minimum temperature during the cropping period ranged from 22.2-32.7˚C and 8.7-18.3˚C, respectively**.** Crop geometry was maintained by keeping of row and plant spacing of 40 × 20 cm, respectively. Data on weeds were recorded per plot at 45 DAS using a quadrate of 0.5 m^2 from randomly selected 4-5 places and averaged them. Data on weed density were subjected to the square root transformation ($\sqrt{x+0.5}$) before statistical analysis to normalize their distribution. Field observations like operational speed, operation width, labours required for weeding operation, soil moisture content were recorded. Data collected during the field evaluation

trails were analyzed to determine the actual field capacity, field efficiency, weeding efficiency and plant damage.

Field capacity: Effective actual field capacity was calculated using eqn. (Mehta *et al.* 2005)

$$\text{Effective field capacity} = \frac{A}{T_p + T_{np}}$$

Where, A= Area, ha, T_p= productive time, hr, T_{np}=non productive time, hr

Weeding efficiency

The weeder used during the study were measured for weeding efficiency by using following formula as suggested by Rangasamy *et al. (*1993).

$$\text{Weeding efficiency (\%)} = \frac{W_1 - W_2}{W_1} \times 100$$

Where, W_1 = No. of weeds before weeding, W_2= No. of weeds after weeding

Data were analyzed statistically as per standard method (Panse and Sukhatme 1978). Test of the significance of treatment differences were done on basis of t-test. Significant difference between treatments mean were compared with critical differences at 5% levels of probability.

Weed flora

Major weed flora present in experimental block was *Solanum nigrum, Chenopodium album, Rumax retroflexus, Vicia sativa, Anagalis arvensis, Barbarea vulgaris* (**Table 1**). Total weed density was the lowest in *khurpi* (3.02/m^2) and the highest with wheel hoe (4.94/m^2) during the experimentation.

Field capacity

Field capacity of power weeder was found to be maximum 0.0696 ha/h higher than *khurpi* (0.0046 ha/h) and area coverage by grubber (0.0086 ha/h) and wheel hoe (0.0189 ha/h), which was more than *khurpi* (**Table 2**). Results revealed that power operated weeder was the most effective weeding tools as compared to hand weeding tools. Wide difference in field capacity of different tools/ implements might be due to width of soil cutting as well as forward speed. Shekhar *et al.* (2010) found that similar results of area coverage with power operated weeder (0.670 ha/h) followed by wheel hoe (0.009 ha/h), grubber (0.008 ha/hr) and *khurpi* (0.002 ha/h). Sarkar *et al.* (2016) also reported in winter maize that field capacity of wheel hoe was maximum (0.008 ha/hr), whereas spade had the minimum (0.0002 ha/hr|).

Weeding efficiency

The highest weeding efficiency was recorded with the *khurpi* (98.9%) followed by power weeder **(**83%), wheel hoe **(**80%) and grubber **(**74%), respectively (**Table 2**). A similar result was reported by Shekhar *et al.* (2016) in maize with *khurpi* (99.4%) and power weeder (89.7%). Rajak *et al.* (2018) also reported that weeding efficiency was maximum in grubber (93.1%) followed by *khurpi* (96.8%) and the lowest with herbicides (83.4%).

Plant damage

Higher percentage of plant damage was found in power weeder (1.94±0.038%) followed by wheel hoe (1.24±0.043%), grubber (1.21±0.041%) and *kurphi* (0.84±0.008%), respectively. Highest plant damage for power weeder may be attributed to higher speed of blades and operator skill (Singh *et al.* 2017).

Cost of operation

Khurpi had attributed the maximum cost of operation (` 6793/ha) followed by grubber (` 3906/ ha), power weeder (`1674/ha) and wheel hoe (` 1653/ ha). Operational cost of *khurpi* increased and resulted in minimum field capacity (**Table 2**). But operational cost of power weeder had minimum compared to other weeding tools. Cost of power weeder is much expensive and thus, the small and marginal land holding farmers cannot effort initial investment in spite of high field capacity. Results revealed that amongst four weeding tools, wheel hoe was the most economic and efficient weeding tools as compared to other weeding tools in row spaced crops.

Table 1. Weed density (no./m^2) as influenced by different treatments (mean value)

Wedding tools	*Solanum nigrum*	*Chenopodium album*	*Rumex retroflexus*	*Vicia sativa*	*Anagallis arvensis*	*Barbara vulgaris*	Others	Total weed density (no./m^2)
Khurpi	1.10(1.7)	0.60(0.9)	1.10(1.7)	0.50 (0.7)	0.60 (0.9)	0.40(0.7)	2.10(4.9)	3.02(9.6)
Grubber	4.16(17.8)	0.71(1.0)	0.71(1.0)	0.71(1.0)	0.71(1.0)	0.71(1.0)	3.29(11.3)	3.82(15.1)
Wheel hoe	3.60(13.5)	1.50(2.7)	1.80(3.7)	4.10(17.3)	2.30 (5.8)	2.30(5.8)	4.10(17.3)	4.94 (24.9)
Power weeder	3.20(10.7)	1.10(1.7)	1.50(2.7)	2.80(8.3)	1.60 (3.1)	1.80(3.7)	3.10(10.1)	4.39 (19.8)
LSD (P=0.05)	0.24	0.08	0.11	0.23	0.12	0.14	0.21	0.30

Weed density figures are transformed to $\sqrt{x+0.5}$ and actual figures are given in parentheses

Table 2. Operational parameters of different weeding tools in faba bean

Parameters	*Khurpi*	Grubber	Wheel hoe	Power weeder
Field capacity(ha/hr)	0.0046 ±0.002	0.0086 ±0.0002	0.0189 ±0.0003	0.0696 ±0.003
Weeding efficiency (%)	98.90 ±7.86	74.00 ±3.98	80.00 ±6.21	83.00 ±6.52
Cost of operation (`/ha)	6793/-	3906/-	1653/-	1674/-

ACKNOWLEDGMENT

Authors sincerely acknowledge to the Indian Council of Agricultural Research, New Delhi for financial support in conducting the present study under the project "CRP on Farm Mechanization and Precision Farming".

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