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Field Evaluation of Different Weeders in Cauliflower Cultivation of Muzaffarpur District in Northern Bihar, India

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Abstract: Field experiment was conducted to evaluate the performance of different weeders namely Khurpi, improved Grabar, push type twin wheel hoe weeder and power weeder in the cauliflower field of seven farmers during the year 2021-22 and 2022-23. Various parameters such as weeding efficiency, field capacity, plant damage, performance index and economics of weeding operation were observed to assess the performance of different weeders. The power requirement was maximum for power weeder (3 hp) which was also associated with highest effective field capacity (0.05 ha/hr) and plant damage (2.24%). Maximum and minimum weeding efficiency pertained to *khurpi* (98%) and power weeder (81%) respectively. Highest performance index in improved *grabar* (1781.46) followed by push type two-wheel weeder (1546.74). The weeding operational cost was reduced by 50, 40 and 86.25% respectively for improved *grabar*, push type two-wheel weeder and power weeder as compared with *khurpi*. The economic analysis showed that despite of the low yield in power weeder as compare to other treatments, the maximum gain in net return due to lowest cost of cultivation showed that power weeder economically more feasible, viable and acceptable to the farmers.

Keywords: Field capacity, Performance index, Weeder, Weeding efficiency

Bihar is the third largest producer of cauliflower in the country and shares nearly 10.86% of the total production. An area of 65.71 thousand hectares is under cauliflower cultivation in Bihar and produces about 935.56 thousand tonnes of cauliflower annually with an average productivity of about 15.28 tonnes per hectare. Cauliflower is a very sensitive crop to various stresses including weeds which needs more care to grow successfully than most of other vegetables. Weeding is a time consuming and labour-intensive intercultural practice in the agriculture which accounts for about 25 % (900-1200 man-hours/hectare) of the total labour requirement (Yadav and Pund 2007). In India due to weed infestation an annual loss projected about 82 million tons in food grains, 14 million tons in pulse, 12 million tons in oil seeds and about 52 million tons in commercial crops (Singh 2013). Presently various types of weeders are developed in India are helpful for weeding in agriculture. The most common methods of weed control are mechanical, chemical, biological and traditional methods. Among them, mechanical weeding either by hand tools or weeders are most effective (Manjunatha et al 2014). Manually operated weeders have found wide acceptability due to their low cost (Behera and Swain 2005). Weed control and weeding work is mainly done by majority of farm women in India by using small hand tools like *khurpi*. Weeding through *khurpi* is most efficient way to reduce weeds but is labour intensive and very costly. Therefore, it is necessary to evaluate the performance of various types of manual as well as mechanical weeder. The present study is focussed to access the field performance of different weeders in term of economics, drudgery and farmers friendly to save farmers from drudgery, stress and minimising the cost of cultivationin cauliflower.

MATERIAL AND METHODS

The present study was carried out in seven farmers field located at Sakra and Muraul block of Muzaffarpur district during the year 2021-22 and 2022-23. The experimental site geographically lies between latitude 25°51'10" to 26°01'30"N and longitude 85°23'10" to 85°39'00"E (Table 1). All the seven location of experimental site falls under Northern West Agro-climatic Zone I location predominant in sandy loam soil with the total average annual rainfall of 1250 mm. The average temperature at all locations during the entire cropping season for the year 2021-22 and 2022-23 was 19.5^{0}C and 20^{0}C respectively whereas, average rainfall was recorded as 80.2 mm (2021-22) and 12.86 mm (2022-23). Monthly average temperature and rainfall of both the year are presented in Figure 1.

The cauliflower seedlings 20 days old with 15 cm height were transplanted manually at 45x30 cm spacing at seven different locations in two consecutive year 2021-22 and 2022-23.Cauliflower crop is ready to harvest in 90-120 days after transplanting (DAT). Weeding practices were carried out three times at 30, 45 and 60 DAT. Major weed infestation comprises of *Chenopodium album* a broad leaf weed locally called Bathua and *Phalaris minor* a narrow leaf weed was observed at all the locations. Across the location the weed population at 30, 45 and 60 DAT respectively was observed as 90.3, 124.7 and 190.6 per square metre. Data observation on draft, speed of operation, power requirement, effective field capacity, field efficiency, plant damage, weeding efficiency and performance index were recorded from the randomly selected area of $1m^2$ in each field to access the weeding impact of different weeders. Weeding cost (Rs.), crop yield (q/ha) and total cost of cultivation (Rs.) were also accessed to calculate the economics and B:C ratio of the crop produced.

Performance Test

Draft force: Draft force important to push or draw the implement for weeding task. For physically operated soil working instruments the draft should be inside the physiological limit of the operator. The draft force of weeder can be determined by the following formula as per the Yadav and Pund (2007).

$$D = W \times d_w \times S_R$$

Where, D = Draft power of the weeder (N), d_w = depth of cut (cm), W = width of cut (cm), S_R = particular soil opposition (N cm^{-2}).

Speed of operation (km/h): Speed of operation of wheel operated sprayer cum weeder was measured the time required to cover 8m distance. Speed was calculated as follows (RNAM Procedure 1995).

$$\text{Speed (kmph)} = \frac{3.6 \times \text{distance travelled (m)}}{\text{time (s)}}$$

Table 1. GPS location of all the sites at Sakra and Muraul block of Muzaffarpur, Bihar

Name of village	Name of block	Latitude (N)	Longitude (E)
Machhahi	Sakra	25°57'32"	85°33'33"
Keshopur	Sakra	25°56'58"	85°34'28"
Muramohanpur	Sakra	25°58'28"	85°33'59"
Sujawalpur	Sakra	25°57'28"	85°33'48"
Dholi	Muraul	25°59'53"	85°35'14"
Lautan	Muraul	25°59'23"	85°35'33"
Itha	Muraul	25°58'44"	85°36'04"

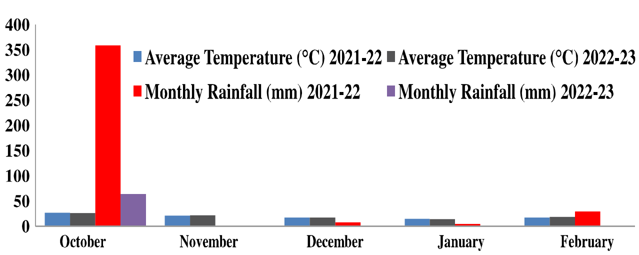

Fig. 1. Monthly Average temperature and rainfall for the year 2021-22 and 2022-23

Power requirement (hp): Calculation of power is needed to determine the efficient use of man power. A man can produce power equal to 0.05 to 0.1 hp operated for day long work. It was the power requirement to the implement by the man with average pushing force and speed (Michael and Ojha 1966).

$$\text{Power (hp)} = \frac{\text{Draft (kg)} \times \text{Speed (m/s)}}{75}$$

Effective field capacity (ha/h): This is the actual field capacity of weeder and was calculated as

$$\text{Effective field capacity (ha h}^{-1}) = \frac{A}{T_1 - T_2}$$

Where, A = actual area covered, ha T_1 = Total time require for operation in hours T_2 = non-productive time in hours.

Field efficiency (%): It was calculated by using the formula suggested by Dubey (2001).

$$\text{Field efficiency, n} = \frac{\text{Effective field capacity}}{\text{Theoretical field capacity}} \times 100$$

Plant damage (%): Plant damage percentage is measured using the following equation (Yadav and Pund 2007).

$$PD = [1 - qp] \times 100$$

Where PD = plant damage, q = number of plants in a 10 m row length after weeding, p = number of plants in a 10 m row length before weeding.

Weeding efficiency (%): The number of weeds present in one m^2 area before and after weeding operation was counted by the equation given below (Remesan et al 2007).

$$WE = \frac{N_1 - N_2}{N_1} \times 100$$

Where, WE= Weeding efficiency, (%) N_1 = Number of weeds/m^2 before weeding N_2 = Number of weeds/m^2 after weeding

Higher value of WE shows the weeder is more efficient to remove the weeds.

Performance index: Weeder performance assessed through performance index was computed (Gupta 1981).

$$P.I = \frac{FCX\,(100 - PD) \times WE}{P}$$

Where, FC= Field capacity of the weeder, ha h^{-1}, PD = Plant damage (%), WE = Weeding efficiency (%) and P = Power input in hp

RESULTS AND DISCUSSION

There was substantial effect of weed management practices on all the growth parameters as well as yield. Although, the power requirement of power weeder was highest (3hp) but its incorporation in weeding can reduce

Table 2. Effect of technology option on power requirement, effective field capacity, field efficiency, plant damage, weeding efficiency and performance index

Parameters/ Treatment	Power requirement (hp)	Effective field capacity (ha/hr)	Field efficiency (%)	Plant damage (%)	Weeding efficiency (%)	Performance Index
T_1	0.05	0.002	91.0	0.24	98	391.06
T_2	0.08	0.016	83.0	1.02	90	1781.64
T_3	0.10	0.018	85.0	1.23	87	1546.74
T_4	3.00	0.05	71.5	2.24	81	131.98

Table 3. Economics of weeding option on yield, cost of cultivation, gross return and BC ratio of cauliflower

Parameters/ Treatment	Cost of weeding implements (Rs.)	Cost of weeding (Rs. /ha, 3 times per crop)	Yield (q/ha)	Cost of cultivation Rs./ha	Gross return Rs./ha	BC ratio
T_1	80	50880	210	100500	252000	2.51
T_2	400	25440	201	77060	241200	3.13
T_3	1200	30528	198	79972	237600	2.97
T_4	48000	6996	192	63956	230400	3.60

drudgery due to its higher field capacity (0.05 ha/h) among all hand tools. Weeding efficiency of T_1 was highest (98%) followed by T_3 and T_2. Shekhar et al (2010) and Kumar et al (2014) also observed the highest weeding efficiency with *khurpi* than the other weeders. The maximum weeding efficiency might be due to capability of this hand tools to work between plant to plant spaces in a row as well as weeding in periphery of root surface area is also possible by this method but other weeders may not be used around root periphery and between the two plants of closely/ densely planted. Highest field capacity (0.05 ha/h) was with power weeder followed by T_3 and T_2. However, the field efficiency was maximum in T_1 (91%) and among the mechanical weeders T_3 (85%) exhibited highest while was minimum in T_4 (71.5%) (Table 2). Shekhar et al (2010) in maize and Ragesh et al (2018) in paddy field observed the same trend. On contrary, highest field efficiency recorded in power weeder as compare to other mechanical weeders in paddy was reported earlier by Narwariya et al (2016). The variable field capacity of different tools/implements depends on the width of soil cutting parts and forward speed. The maximum operational speed and more weeding width of power weeder confer its higher field capacity as compare to other weeding methods. The plant damage recorded at 30, 45 and 60 DAT revealed that maximum damage was in power weeder (2.24%) while was minimum with *khurpi* (0.24%). Plant damage in T_2 and T_3 operations were at par however, was greater than T_1 but less than T_4. Higher rotating speed of blade as well as higher travel speed might be the reason of maximum damage of plant observed in power weeder as compared to other methods. Similar findings reported by Narwariya et al (2016) in paddy field.

Economics and BC ratio of cauliflower was calculated at all the locations and pooled data of both the year presented in Table 3. Cost of cultivation per hectare excluding weeding cost for all the treatments was same which includes nursery bed preparation, seed, pesticides and other chemicals, fertilizers and manure, harvesting cost. The small variation was observed due to miscellaneous cost. Despite of minimum field efficiency as well as weeding efficiency and maximum plant damage as compared to conventional method, mechanical method of weeding was most economical. Gross return was maximum in T_1 but cost of weeding was highest which reduced the net income and hence the least BC ratio (Table 3) but as compare to T_1 decrease of 86.25 % cost of weeding was estimated in T_4 which was due to labour deficit in areas . The T_2 and T_3 showed 50 and 40% reduction in cost of weeding. Conventional method of weeding difficult due to less availability of farm labours at peak season. T_2 and T_3 methods also revealed that without affecting yield significantly highest amount of return can be achieved as BC ratio was 3.13 and 2.97, respectively.

CONCLUSION

The power requirement was maximum for power weeder (3 hp) which was also associated with highest effective field capacity (0.05 ha/hr). The incorporation of power weeder in weeding operation reduced labour cost as well time of operation and there was a decrease in cost of weeding as compare to *khurpi* which was due to less labour requirement resulted in highest BC ratio. Maximum and minimum weeding efficiency was observed in khurpi and power weeder, respectively. Highest performance index recorded in *grabar* due to less plant damage in compare to two-wheel weeder and observed lowest in power weeder due to highest plant damage. Therefore, utilization of power weeder and other manually operated weeder as compare to hand weeding can increase net income of cauliflower growing farmer.

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