ABSTRACT

Power tillers are becoming popular in the North Eastern Hilly (NEH) region of India. Being a small machine, it can negotiate well in the narrow approach roads and can be handled more easily in the terraced lands than four wheel tractors. The draft developed by a power tiller is low and thus it is considered to be unsuitable for draft intensive operations like primary tillage. Multi-powered tools require less draft. An oscillatory tillage tool which meets part of its power requirement through rotary power can become an alternative to the passive tillage tools that demand high draft.

An oscillatory tillage tool operated through a crank and follower mechanism was investigated in the laboratory soil conditions. An instrumented soil bin was established in the Division of Agricultural Engineering of ICAR Research Complex for NEH region, situated at the place Barapani in the State of Meghalaya, where the tillage tool was tested. The requirement of testing tillage tool in general was kept in mind while developing the soil bin. Soil was collected from the cultivated lands and filled in the soil bin. During the experiment, the soil moisture content (11.56 to 12.07 gm/100 gm of dry soil), cone index (1108.58 to 1217.84 kPa) and soil bulk density (1.62 to 1.66 gm/cm$^3$), that was prevailing in the field, were maintained. Draft of laboratory model oscillatory tillage tool was measured at 10 levels of frequency: 6, 7, 8, 9, 10, 11, 12, 13, 14 and 15 Hz; 5 levels of amplitude: 7.9, 9.5, 11.0, 12.5 and 14.2 mm; and two levels of forward speed: 0.5 (low) and 1.0 m/s (high). It was compared with the draft of same tillage tool operating without oscillation. Relationships among frequency, amplitude, forward speed, draft ratio, draft power requirement, oscillatory power requirement and total power requirement were established. Draft of the tillage tool at 14 and 15 Hz frequency with 11 mm amplitude; 10, 11, 12 and 13 Hz frequency with 12.6 mm amplitude; and 15 Hz frequency with 14.2 mm amplitude at low forward speed was in the range of 0.49 to 0.47. However, the same draft ratio range at high forward speed was at 11, 12, 13, 14, and 15 Hz frequency with 12.6 mm amplitude; and 11, 12, and 13 Hz frequency with 14.2 mm amplitude.

The draft developed by an 8.1 kW capacity power tiller was tested in the rough and soft field condition for the development of the prototype oscillatory tillage tool. The power tiller was loaded by increasing the pay load filled in a trolley and the test was carried out at two different gears [2$^{nd}$ (Low) and 1$^{st}$ (High)]. From this experiment, the draft available from power tiller was found to be 1077 N at 20 per cent wheel slip. The draw bar power available in 2$^{nd}$ (Low) and 1$^{st}$ (High) gear of operation was 538 and 1273 W respectively.

A prototype oscillatory tillage tool similar to that tested in laboratory was developed for the use with the power tiller. It was designed based on the draft and power available from the power tiller and taking into account its constructional features. The prototype had tool width of 25 cm and was able to operate up to 15.3 cm average depth of operation in the dry land field conditions. Pulverization of tilled soil (MWD = 7.565 mm) and volume of soil handled per unit time ($V_s = 94.877$ m$^3$/h) were better with tillage tool operating in oscillatory mode than in non-oscillatory mode (MWD = 23.37 mm and $V_s = 41.569$ m$^3$/h). However, the fuel consumption increased to 2.699 l/h at 15.3 cm depth of operation from 1.977 l/h at 7.3 cm depth of operation. The overall performance index was high (2.986) while operation with the prototype oscillatory tillage tool.

Keywords: Multi-powered tillage tools, Oscillatory tillage, Draft, Power tiller.