International Journal of Agriculture Sciences
ISSN: 0975-3710&E-ISSN: 0975-9107, Volume 8, Issue 53, 2016, pp.-2725-2728.
Available online at http://www.bioinfopublication.org/jouarchive.php?opt=&jouid=BPJ0000217

Research Article

EFFECT OF RESOURCE CONSERVATION MACHINERIES ON TRACTIVE, FUEL AND POWER DELIVERY EFFICIENCIES, UNDER RAINFED CONDITION OF NORTH-GUJARAT REGION FOR GREENGRAM- *Vigna radiata* L.

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Received: April 22, 2016; Revised: October 05, 2016; Accepted: October 6, 2016; Published: November 01, 2016

Abstract- Field experiment was conducted to compare tractive, root profile and crop parameters among resource conservation machineries and conventional practice under leveled and unleveled plots for three consecutive years from kharif-2012 to kharif-2014, comprising of two main treatments i.e. No Leveling (L_0) and Leveling with laser land leveler(L_1) and five sub treatments *viz.*, zero till drill (M_1), roto till drill (M_2), strip till drill (M_3), raise bed planter (M_4) and conventional practices (M_5). The five sub-treatments i.e., M_1, M_2, M_3, M_4 and M_5 were performed uniformly under L0 and L1. The experiment was carried out for green gram crop in the research farm of Centre for Watershed Management and Participatory Research and Rural Engineering, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat State. The result revealed that the treatment L1 offered 5.79 per cent higher effective field capacity (EFC), 0.77 per cent more tractive efficiency, 3.40 per cent higher power delivery efficiency, 7.62 per cent less volume of soil disturbance, 6.50 per cent more fuel efficiency, 6.33 per cent less energy and 8.00 per cent reduction in surface soil disruption than the treatment L_0. Among resource conservation machineries M_1 recorded higher effective field capacity and tractive efficiency of 0.504 ha/hr and 71.87 per cent, which was correspondingly 51.78 and 2.05 per cent more than M_5. M_2 presented maximum value of power delivery efficiency equivalent to 18.73 per cent, which was 19.59 per cent higher than M_5. M_1 recorded lowest soil volume disturbance (359.68 m^3/hr) among sub-treatments, which was 38.65 per cent lower than M_5. Fuel consumption and energy requirement presented by M_1 was lowest with corresponding value of 7.60 l/ha and 77.96 kWh/ha, which were 47.94 and 47.76 per cent lesser than M_5. The treatments M_3 and M_2 stood second and third reporting fuel consumption equivalent to 8.51 and 8.91 l/ha, respectively. M_1 presented minimum surface soil disruption of 92.05 cm^2, which was lower by 50.99 per cent compared to M_5.

Keywords- Resource Conservation Machinery, Parameters, Tractive Efficiency, Power Delivery Efficiency, Fuel Efficiency, Energy Requirement, Root Profile, Crop Parameter.

Citation: Modi V.M., et al., (2016) Effect of Resource Conservation Machineries on Tractive, Fuel and Power Delivery Efficiencies, Under Rainfed Condition of North-Gujarat Region for Green gram- *Vigna radiata* L. International Journal of Agriculture Sciences, ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 8, Issue 53, pp.-2725-2728.

Academic Editor / Reviewer: Niketha L.

Introduction

Agriculture is the most important sector in India. In India still most of the farmers are practicing conventional method of agriculture. It involves lot exhaustive agricultural practices, which are responsible for degradation of natural resources. There is a need to promote Resource Conservation Technologies (RCT) in agricultural practices. The new challenges demand that efficient resource use and conservation receive high priority to make sure earlier gains can be sustained and further enhanced to meet the emerging needs [1]. RCT refer to those practices that improve resources or input-use efficiency. Zero tillage and minimum tillage practices that reduce fuel consumption and enhance plot-level water productivity may also considered as RCTs. Conservation tillage practices minimize the cost of operation, fuel consumption and time for operation of various crops [2]. RCT provides the possibility of conserving natural resources and optimizing crop productivity through controlled soil erosion, reduced soil compaction, increased water use efficiencies and reduced energy costs [3].

The greengram [*Vigna radiata L.],* also known as mungbean is one of the important legume crops grown for their seed under rain fed condition. *Kharif* green gram was sown at the onset of monsoon with seed rate of 17.5 to 20 kg/ha with 45 cm distance between two rows. Land is prepared to a medium tilth before planting and early enough so that planting can start immediately after the rain starts. Drilling (Dropping of seed in the furrow through seed tubes) method is usually adopted in traditional sowing in which bamboo fennel cum tube or metallic funnel cum tubes attached to country plough is used for dropping the seed and manual metering method is known as 'PORA' method of seeding. Keeping all these in view the present study was undertaken with the following objective to study the effect of selected resource conservation machineries on tractive, fuel and power delivery efficiencies and energy requirement.

Materials and Methods

The experiment was conducted in the research farm of Centre for Watershed Management Participatory Research and Rural Engineering, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar in three successive years of 2012, 2013 and 2014 during *kharif* season (July to October).

On the basis of review, four resource conservation machines *i.e.,* Zero Till Drill (ZTD), Roto Till Drill (RTD), Strip Till Drill (STD), Raise Bed Planter (RBP) were selected under study. Laser beam guided Land Leveler (LLL) was chosen to identify the effect of land leveling on tractive, root profile and crop parameters. To compare the performance of resource conservation machineries, cultivator and manually metered seed cum fertilizer drill, which are largely used in the region were selected as a Conventional Practice (CP).

A 50 HP, 4 cylinder agricultural tractor was selected as a test tractor in the study (Appendix-A1). The parameters like speed of operation, slip, drawbar pull, fuel

consumption and soil disruption were measured to study the tractor performance in terms of tractive, power delivery and fuel efficiencies, energy requirement and soil volume disturbance for selected resource conservation machineries and conventional practices.

[Table-1] provides detail of the plan of work, the experiment was conducted in six replications and each replication plot was termed as main plot. Each main plot was divided into two treatments L_0 and L_1. L_0 stands for normal unleveled plot and L_1 was the plot subjected to leveling operation by means of laser land leveler. Five sub-treatments *i.e.*, M_1, M_2, M_3, M_4 and M_5 were performed uniformly under L_0 and L_1. Split plot design was selected to carry out statistical analysis of the experimental data recorded during three years. All agronomical parameters and agricultural operations were followed uniformly as per best recommendations laid down in the region for green gram crop.

Table-1 *Experiment details*

Sr. No.	Code	Main plot treatments	Machinery / Equipment
1.	L_0	No leveling	-
2.	L_1	Leveling	Laser beam guided land leveler
		Sub plot treatment	
1.	M_1	Zero till drilling	Zero till drill
2.	M_2	Roto till drilling	Roto till drill
3.	M_3	Strip till drilling	Strip till drill
4.	M_4	Raise bed planting	One pass of cultivator + Raise bed planter
5.	M_5	Conventional	Two pass of cultivator + Manually metered

		practice	seed cum fertilizer drill
		Treatment combination	
		L_0M_1	L_1M_1
		L_0M_2	L_1M_2
		L_0M_3	L_1M_3
		L_0M_4	L_1M_4
		L_0M_5	L_1M_5

Field survey was conducted to undertake leveling operation in October-2011 before commencing the experiment. [Table-2] shows, the total area of experimental plot and area under precision land leveling.

Table-2 *Particulars of the selected fields*

Parameters	Size of experimental plot	Area under precision laser land leveler
Length of the field, m	100	16.5 x 35 x 6 replication = 3465 m^2
Width of the field, m	70	
Area of the field, m^2	7000	

After completion of the field survey using auto level, tractor operated laser land leveler was engaged for precision land leveling of the plot under treatment L_1.

Results and Discussion

Field survey was carried out using Auto Level, cut-fill volume was drawn to ascertain volume of soil to be shifted ensuring minimum disturbance of soil. Cut: fill ratio was also calculated as shown in [Table-3]

Table-3 *Cut: fill readings of laser land leveler on the volume bases*

Sr. No	Area No.	Area (m^2)	Av. elevation Difference (m)	Volume of cut (m^3)	Area (m^2)	Average elevation Difference (m)	Volume of fill (m^3)	Cut : fill ratio
1.	A_1	750	0.09	**67.5**	580	0.11	63.80	**1.05**
2.	A_2	680	0.05	**34.00**	680	0.05	34.00	**1.00**
3.	A_3	700	0.11	**77.00**	580	0.13	75.40	**1.02**

The operating speed of laser land leveler, recorded for ten different observations and its average was taken as the travelling speed, which was found as 2.85 km h^{-1}. The average value of TFC, EFC and FE were calculated as 0.58 ha/hr, 0.21 ha/hr and 36.35 per cent, respectively. Average value of fuel consumption calculated for laser land leveler operation was found to be equivalent to 4.15 liter per hour. The standard deviation calculated for the plots before and after leveling were found as 20.25 and 1.25 cm and reduction in standard deviation with respect to unleveled plot as 93.82 per cent.

Effect of Resource conservation machineries on tractor performance

Tractor performance parameters *viz.*, Slip (S), Effective Field Capacity (EFC), Tractive Efficiency (TE), Power Delivery Efficiency (PE), Soil Volume Disturbed (SVD), Fuel Efficiency (FE), Energy requirement (E) and Surface Soil Disruption (SD) were measured for individual resource conservation machineries.

Wheel slip (%)

The study revealed that, treatment under main plot *i.e.*, L_0 and L_1 showed significant effect on wheel slip. [Fig-1] shows that pooled result reported overall 5.71 per cent reduction in slip for leveled field as compared to the plot left unleveled.

Result presented in [Fig-2] revealed that treatments, comprising of Resource Conservation Machines (RCM) and Conventional Practices (CP) presented significant effect on slip. Pooled result showed that Zero Till Drill (ZTD) recorded minimum slip of 10.36 per cent which was 15.15 per cent lesser than conventional practices.

Effective field capacity (ha/hr)

The result revealed that effective field capacity was found significant and reasonably higher for the leveled experimental plot during all three year (*i.e.*, 2012, 2013 and 2014) and in pooled result. [Fig-3] shows that, leveled plot witnessed upper value of effective field capacity in all three years with a pooled value of 0.397 ha/hr. The pooled result revealed that, leveled field presented 5.79 per cent higher EFC than no leveling treatment which was 0.374 ha/hr.

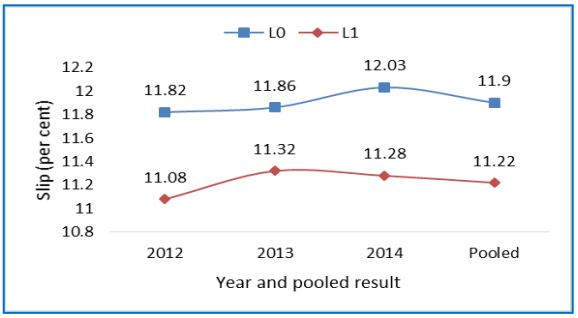

Fig-1 Effect of treatments under main plot on slip (%)

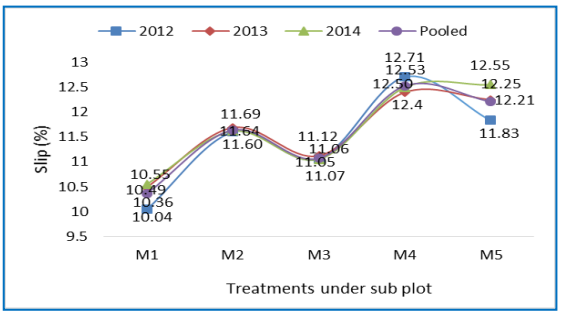

Fig-2 Effect of resource conservation machines and conventional method on slip (%)

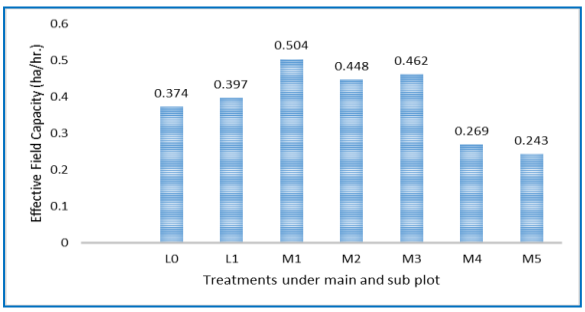

Fig-3 Pooled effect of treatments on effective field capacity (ha/hr)

Pooled result also showed that CP took 51.78, 47.40, 45.75 and 9.66 per cent extra time to finish operation as compared to treatment ZTD, STD, RTD and RBP.

Tractive efficiency

Tractive efficiency found consistently higher for precisely levelled experimental plot than unleveled plot for three consecutive year of field experiment. Pooled result showed that leveled plot observed 0.77 per cent more tractive efficiency as compared to its counterpart. The reason may be the lesser slip exhibited by all treatments under precision leveled field. [Fig-4] shows that highest tractive efficiency of 72.13 per cent was found for Zero Till Drill (ZTD) in the year 2012, while raise bed planter and conventional practices recorded lower value of tractive efficiency of 69.83 and 70.12 per cent in the year 2012 and 2014 respectively. All the treatments comprising RCM and CP have shown significant effect on tractive efficiency.

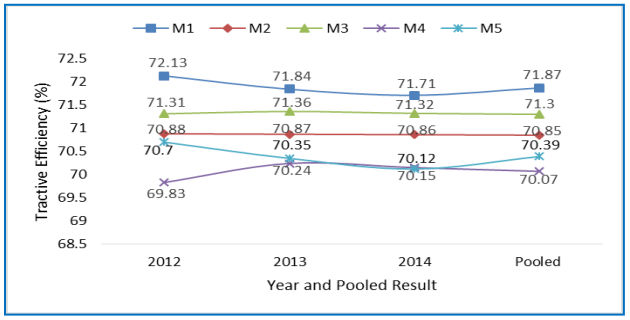

Fig-4 Effect of resource conservation machines and conventional Practices on tractive efficiency (%)

Power delivery efficiency Pooled result shown in [Fig-5] revealed that unleveled plot provided 3.40 per cent higher power delivery efficiency than leveled plot. Power delivery efficiency was significantly higher for unleveled plot than precisely leveled plot, which was attributed to more draft requirement for the tractor operated machines and implement to perform under unleveled experimental plot.

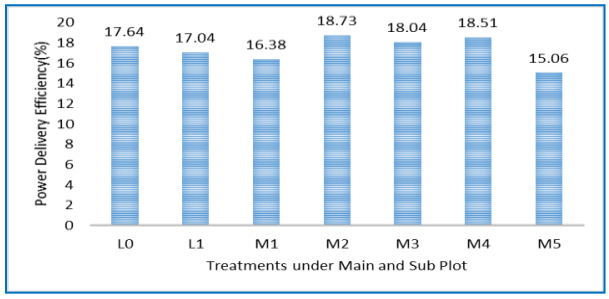

Fig-5 Pooled effect of all treatments on power delivery efficiency (%)

Result further showed that highest value of power delivery efficiency equivalent to 19.01 per cent was found for raise bed planter in the year 2013 while conventional method recorded minimum power delivery efficiency of 14.52 per cent in the year 2012. The result revealed that power delivery efficiency is a function of draft requirement and speed of operation.

Fuel efficiency

Pooled result of the trials showed significant effect on fuel consumption with a value of 10.92 l/ha and 10.21 l/ha found under unleveled and leveled experimental plot, respectively.

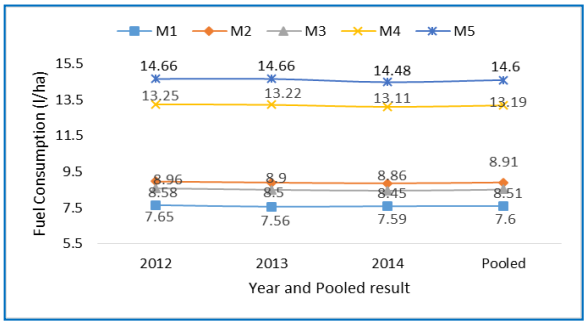

Fig-6 Effect of resource conservation machines and conventional practices on fuel efficiency (l/ha)

[Fig-6] presented that conventional practices recorded maximum fuel consumption of 14.66 l/ha which was attributed to longer duration of tractor work to accomplish farm operation (Two pass of cultivator followed by seed cum fertilizer drill). In terms of fuel consumption, resource conservation machines contributed greater role. Zero till drill recorded minimum fuel consumption of 7.60 l/ha, brought down 47.94 per cent of fuel consumption as compared to conventional practices.

Energy requirement

Energy requirement is an important consideration in selecting farm machine/implement. [Fig-7] shows that maximum and minimum values of energy requirement recorded under L_0 and L_1 were 112.38 kWh/ha and 103.87 kWh/ha, reported in the year 2013 and 2014, respectively. Pooled result revealed that leveled field registered 104.51 kWh/ha energy against its counterpart which claimed 111.58 kWh/ha of energy requirement. The leveled plot found to have 6.33 per cent lesser energy requirement than unleveled plot.

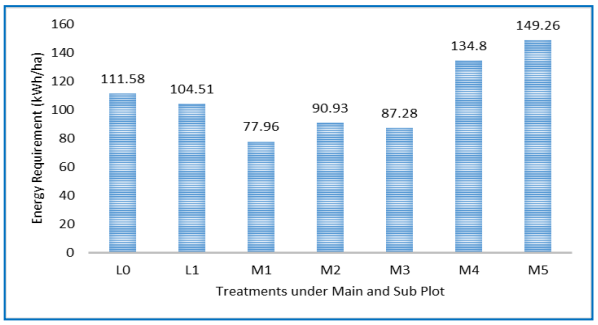

Fig-7 Pooled effect of all treatments on energy requirement (kWh/ha)

Pooled result showed that zero till drill found to be efficient with lower energy requirement of 77.96 kWh/ha which was 47.76 per cent less than energy consumed by conventional practices.

Surface soil disruption

Leveled experiment plot exhibited lesser surface soil disruption with pooled value of 158.67 cm^2 as compared to its counterpart treatment which recorded 172.47 cm^2 of surface soil disruption. Surface soil disruption had been found less for leveled plot in all three years with reduction of 8.00 per cent on pooled value than unleveled plot.

Zero till drill showed lower surface soil disruption to the tune of 50.99 per cent than conventional practices. The higher value of surface soil disruption displayed by raise bed planter and conventional practices was attributed to more soil mass inversion as compared to machines of no tillage and minimum tillage *i.e* ZTD, STD and RTD.

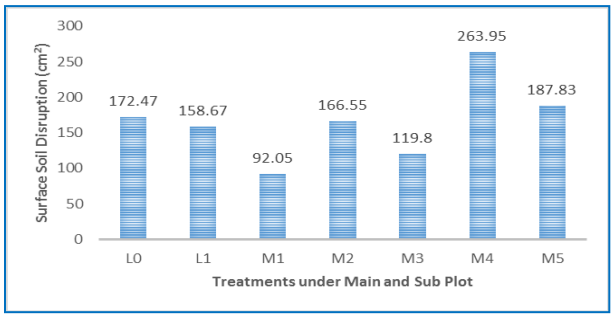

Fig-8 Pooled effect of all treatments on surface soil disruption (cm^2)

Conclusion

The plot under laser land leveler (L_1) offered 5.79 per cent higher effective field capacity (EFC), 0.77 per cent more tractive efficiency, 3.40 per cent higher power delivery efficiency, 7.62 per cent less volume of soil disturbance, 6.50 per cent more fuel efficiency, 6.33 per cent less energy and 8.00 per cent reduction in surface soil disruption than the treatment L_0. Among resource conservation machineries M_1 recorded higher effective field capacity and tractive efficiency of 0.504 ha/hr and 71.87 per cent, which was correspondingly 51.78 and 2.05 per cent more than M_5. M_2 presented maximum value of power delivery efficiency equivalent to 18.73 per cent, which was 19.59 per cent higher than M_5. Fuel consumption and energy requirement presented by M_1 was lowest with corresponding value of 7.60 l/ha and 77.96 kWh/ha, which were 47.94 and 47.76 per cent lesser than M_5. The treatments M_3 and M_2 stood second and third reporting fuel consumption equivalent to 8.51 and 8.91 l/ha, respectively. M_1 presented minimum surface soil disruption of 92.05 cm^2, which was lower by 50.99 per cent compared to M_5. In terms of fuel and energy requirement, the treatment L_1M_1 displayed best result for green gram crop.

Conflict of Interest: None declared

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