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EFFECT OF TRAVEL SPEED OF TRACTOR ON RATE OF APPLICATION IN LIQUID FERTILIZER APPLICATION SYSTEM

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Abstract

The study entitled "Development of liquid fertilizer application system for planting mechanism" was conducted in laboratory as well as on field at ASPEE Agricultural Research foundation, Tansa, Tal- Wada, Dist.- Palghar. Fertilizer is any organic or inorganic material that is added to soil to supply one or more plant nutrients essential to the growth of plants. Conservative estimates report 30 to 50% of crop yields are attributed to fertilizer. Fertilizer is a key player to enhance crop production by upgrading soil fertility. Liquid fertilizer application has many advantages over solid fertilizer application. Hence, For greatest fertilizer nutrient use efficiency it is important to select the right source, the right timing, the right rate and the right method of application, it can be achieved by developing a mechanism which will place the seed in soil and also precisely apply fertilizer in liquid form at root zone of crop at required rate and discharge. The various components of liquid fertilizer application mechanism such as furrow openers, frame, power transmission system for seed drill, ball valve, liquid tank etc. were designed and developed. The prototype was then tested and evaluated in laboratory by calibrating the ball valve for the required discharge at particular given tractor speed (3.5 km/h, 4.0 km/h and 4.5 km/h), pump pressure (1 kg/cm^2, 2kg/cm^2 and 3 kg/cm^2) and knob position (1, 2 and 3) of ball valve. The optimum requirement of liquid to be applied per meter length was 61-65 ml, hence the maximum value in the optimum range was observed at speed 3 (4.5 km/h), pressure 1 (1 Kg / cm^2) and knob position 3 as 64.4 ml.

Key words : Liquid fertilizer, machinery, planter, nutrients

Introduction

The level of agricultural productivity goes hand in hand with mechanization of different farm operations, which aims at achieving timeliness of operations, efficient use of inputs, improvement in quality of produce, safety and comfort of farmers, reduction in loss of produce and drudgery of farmers.

Cotton sustains the country's cotton textile industry, which is perhaps the largest segment of organized industries in the country. Textile industry contributes about 5 per cent to the GDP and 30 per cent to export earnings. India earns foreign exchange to the tune of $10-12 billion from exports of cotton yarn, thread, fabrics, apparel and made-ups. Cotton provides gainful employment to millions of people in the country who are engaged in its cultivation, trading, processing, manufacturing, fabricating and marketing. Cotton accounts for more than 75 per cent of the total fiber that is converted into yarn by spinning mills in India and 58 per cent of the total textile fabric material produced in the country. In the recent past, cotton crop has witnessed many hurdles which includes changed climatic conditions, unscientific methods of irrigation, large area under rain fed condition, non-availability of quality seeds, poor agronomic practices, lack of technical knowledge among the farmers, serious pest outbreak, high cost of cultivation and poor fibre quality. There are many instances of marginal farmers committing suicide because of failure of crop and financial loss incurred due to high investment and less returns. Many farmers decided that cotton crop is no more a profitable crop compared to other commercial crops and shifted to other crops *viz.*, soybean, paddy, chilly, sunflower etc., under irrigated ecosystem.

Fertilizer is any organic or inorganic material that is added to soil to supply one or more plant nutrients essential to the growth of plants. Conservative estimates report 30 to 50% of crop yields are attributed to fertilizer. Fertilizer is a key player to enhance crop production by upgrading soil fertility. It also serves as a key for securing the food requirements of a country. None of the country has been able to boost agricultural productivity without making expansion in the use of chemical industry. It is important to Select the right source, the right timing, the right rate and the right method of application, it can be achieved by developing a mechanism which will place the seed in soil and also precisely apply fertilizer in liquid form at root zone of crop at required rate and discharge.

Review of Literature

David Calcino (2013) stated that, peoples can use one-third less fertilizer when using liquids, as placement is better we don't need to use as much.

Smart gardening conference (2012) in the feeding plants understanding fertilizers session have revealed that, since plants can take up nutrients continuously, slow release fertilizers may be beneficial to provide them with a somewhat steady supply throughout their most active periods of growth. Slow-release fertilizers contain one or more essential nutrients. These elements are released or made available for plant use over an extended time period it is also stated that in the feeding plants understanding fertilizers session have revealed that, liquid fertilizers are water-soluble powders or liquid concentrates that mix with water to make a fertilizer solution. The liquid nutrients generally last 1 to 2 weeks, so you need to reapply often. They are quickly absorbed, so plants get their benefits soon after you apply them. They are great as a starter solution and for a quick boost during the growing season. When properly diluted you also negate the chances of fertilizer burn. Properly diluted liquid fertilizer is ideal for use of soft, sensitive and young plants.

Alley Mark, (2010) studied the effect of pop up or starter fertilizer for corn in this it is stated that, In early season planting of corn when planted in cool soils, early root growth is slow, hence nutrient uptake during early growth stage can be low due to the small root system and cold soil temperature which limits root exploration. Hence the starter fertilizers address this issue of early season nutrient availability to plant by placing fertilizers in the soil near or with the seed he also stated that, Pop up or starter fertilizers are beneficial to increase the early season corn seedling growth with small amount of fertilizer.

Khotte and Kulkarni (1996) reported that there was 50 % saving of fertilizer through fertigation in cotton.

Smith (1986) and Klocke (1989) reported that hoe openers perform well under dry and hard conditions while disc openers are more appropriate when seeding in soft and moist soils.

Choudhary *et al*. (1985); Baker and Afzal (1986). A desired vertical and lateral separation should be maintained between the seed and fertilizer. For most cereal crops, placement of fertilizers about 30 mm to the side and 20 mm below the seed is recommended.

Nielsen (1993) in the study of Planting Speed Effects on Stand Establishment and Grain Yield of Corn stated that, The average planting speed used for general planting operations as reported by the farmers was 5.5 mph and only ranged from 4.5 to 6.0 mph.

Afzal Tabassum and Abdul Shakoor Khan (1992) have developed a test rig for performance evaluation of seed metering devices. Regularity of seed spacing of wheat, paddy, millet, and rape/mustard were evaluated at speeds of 3.7, 4.5 and 5.4 Kmph. A speed of 4.5 Kmph with universal seed wheel metering unit was found suitable for all crops except millet. In the case of sponge feed metering unit, a speed of 3.7 Kmph was found suitable for wheat and paddy. Whereas, millet and rape/mustard distribution was found better at a speed of 4.5 Kmph.

Material and Methods

The liquid fertilizer application mechanism is the equipment that can be able to apply fertilizer in liquid form at the time of sowing in the form of starter solution. This mechanism was proposed to mount on planting mechanism and desired to apply liquid fertilizer in prerequisite amount. The liquid fertilizer was then proposed to consist of liquid controlling device that may be throttle valve or ball valve, tank of suitable capacity, pump to maintain the liquid pressure. Pump was operated by tractor PTO and can be able to deliver required amount of liquid fertilizer. The equipment was then tested and evaluated in laboratory by calibrating the ball valve for the required discharge at particular given tractor speed, pump pressure and knob position of ball valve. The optimum combination of above mentioned variables were then selected and the liquid fertilizer application mechanism was then evaluated in the field with cotton crop of AKH-081 variety.

The developed prototype was calibrated and tested in the workshop of ASPEE, Agricultural Research Foundation, Tansa, Tal- Wada, Dist.- Palghar.

All the three ball valves were calibrated in order to mark the three positions of knob rotation in terms of discharge of the required amount of water. Then calibrated ball valves those were designed and manufactured in the workshop of ASPEE, were tested one by one, by placing the semi circled PVC pipe on the plane surface and then tractor was allowed to passed over it. Four notches of 1m distance each were done in the semi circled PVC pipe, so that when tractor along with liquid fertilizer application system was moving over it, the liquid fertilizer application system will apply the liquid in the notches and dropped liquid was measured with the help of measuring cylinder.

Plate : Laboratory testing of liquid fertilizer application system

Speed for the experimentation purpose was selected in the range of 3.5 km/h to 4.5 km/h as the recommended speed of tractor for sowing is 3 km/h to 6 km/h (Nielsen, 1993) and its effect was seen on amount of liquid applied per meter length, ml. Hence, amount of liquid applied by liquid fertilizer application system was recorded at each of the combination speed.

Results

Effect of speed on amount of liquid applied

The mean observations on effect of speed on amount of liquid applied per meter length is tabulated in the table 1 and graphically represented in fig.1.

Table 1: Effect of speed.

Sr. No.	Speed, km/h	Liquid applied, ml/m
1	3.5	70.8
2	4.0	63.3
3	4.5	54.8
F test		Sig.
	SE(m)±	0.19
	CD at 5 %	0.55

The table 1 revealed that the effect of speed, 3.5 km/h, 4.0 km/h and 4.5 km/h on amount of liquid applied per meter length was found significant. The minimum value of amount of liquid applied was observed, 54.8 ml/m at speed of 4.5 km/h while the maximum value was observed, 70.8 ml/m at speed of 3.5 km/h. It can be interpreted from the table 1 that, as the tractor forward speed increases from 3.5 km/h to 4.5 km/h the amount of liquid applied per meter length decreases. It might be happened due to the reason that, as the tractor speed increases it covers the unit length in short period of time. fig. 1 shows the graphical representation of effect of speed on amount of liquid applied per meter length.

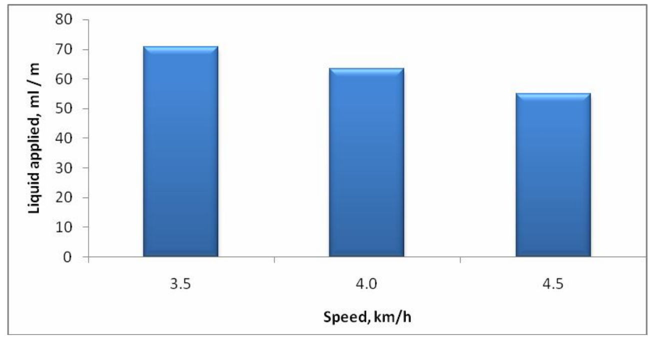

Fig. 1: Effect of speed on amount of liquid applied

The fig.1 shows that there was 10.58% decrease in the value of amount of liquid applied when speed was increased from 3.5 km/h to 4.0 km/h. It further decreased by 13.34% when speed was increased from 4.0 km/h to 4.5 km/h.

Draft

The draft of implement was measured by using hydraulic pull type dynamometer. The draft was measured at load condition and observed in the range of 875 to 887 kg (average 880.6 kg) and where as at no load condition, it was in the range of 654 to 662 kg (average 658.6 kg)

Effective field capacity

The effective field capacity was calculated by considering the productive as well as non-productive time required during the field operation of the implement. The effective field capacity of the tractor operated liquid fertilizer application system on planting mechanism was recorded as 0.65 ha/h at an average speed of 4.5 km/h.

Theoretical field capacity

Theoretical field capacity depends upon the speed of operation and theoretical width covered by the implement. The theoretical field capacity of the tractor operated liquid fertilizer application system on planting mechanism at an average speed of 4.5 km/h and theoretical width of 1.8 m was calculated to be 0.81 ha/h.

Field efficiency

Field efficiency was calculated from the values of theoretical field capacity and effective field capacity. The field efficiency for tractor operated liquid fertilizer application system on planting mechanism was found to be 81.40 %.

Tractor wheel slip

The no. of revolutions of tractor wheel with load and without load condition was counted for a 60 m length along a row. The average tractor wheel slip occurred during field operation was found to be in the range of 11.33 to 14.28% (average 12.76%) at 4.5 km/h speed of operation.

Conclusion

Liquid fertilizer application mechanism was developed to apply fertilizers in liquid form at prerequisite application rate and as per the design consideration all the working components were developed and fabricated to work in proper manner. The effect of speed of operation on amount of liquid applied per meter length was found significant. As the speed of travel increases the liquid applied or collected per meter length decreases. The maximum mean value of amount of liquid applied was recorded at the speed of 3.5 km/h as 70.8 ml/m. The average draft on load condition and no load condition was observed as 880 kgf and 659 kgf respectively. The average effective field capacity was observed 0.66 ha/h for liquid fertilizer application mechanism on planting mechanism while theoretical field capacity was calculated as 0.81 ha/h. The average field efficiency obtain for liquid fertilizer application mechanism on planting mechanism was around 81.40 %.

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