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Development and laboratory optimization of Liquid fertilizer application system

Er. Y. G. Kasal*, S. K. Thakare, M. M. Deshmukh

INTRODUCTION

Background Information

Different crop cultivation practices are carried out to cultivate the crops wiz. land preparation, sowing, intercultural operations, harvesting. Dealing with the sowing, it can be done by different equipments such as seed drill, ridger planter, disc planters etc. As the seeds are placed in the soil they must need some nutrients to enhance their growth. So for the enhancement of the crop growth in the very initial stage and to increase the immunity of crop against the diseases we need fertilizer application one of the strategies to boost farm productivity is by means of agricultural intensification. However, the process of intensification in agriculture depends on the sufficient supply of plant nutrients to the crops for assuring high yield of the cotton crop.

Importance of Study

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. Balanced fertilization refers to application of essential nutrients of plant, chiefly the major nutrients-Nitrogen (N), Phosphorous (P) and Potassium (K) in optimal quantities through accurate method and application time in precise proportion. Balanced fertilization leads to enhance the yield of crops, quality of crops and farm income. Further it serves as a remedy to correct soil nutrient deficiencies and helps in maintaining the soil fertility.

Liquid fertilizer application has many advantages over solid fertilizer application such as,

1. Liquid fertilizers are homogeneous solutions while dry blends can vary in consistancy as batch to batch
2. Pure grade Solutions does not settle down or segregate in tank while dry blends can segregate during transportation or in fertilizer dry box
3. Liquid fertilizers are non-corrosive while most of the dry fertilizers are corrosive
4. Liquid fertilizers are unaffected by high humidity and rainy weather condition while high humidity and rainy conditions can cake the fertilizer in dry fertilizer boxes
5. For more precise placement of fertilizers, liquid fertilizers are used, dry fertilizers are fit best where precise placement isn't necessary.
6. Through liquid fertilizes there is no yield drag as higher amount of nutrients are taken up by crops from liquid starter, while there might be some yield drag as dry starter may not uniformly distributed to crop.

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.

LITERATURE CITED

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

* Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola

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 fertilizer address this issue of early season nutrient availability to plant by placing fertilizers in the soil near or with the seed.

Alley Mark, 2010, also stated that, Pop up or starter fertilizers are beneficial to increase the early season corn seedling growth with small amount of fertilizer.

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

James Wilkinson stated that, when water soluble 'N' fertilizer is used, liquid applications may give a slightly quicker response and dry material may give slightly longer residues.

James Wilkinson also stated that, during hot weather dry applications are also less likely to cause burn.

Agroculture liquid fertilizer company, 2007 carried out the study on planter fertilizer rate placement comparison for corn. In this experiment they have studied the effect of fertilizer on crop at different doses and at different places.

Agroculture liquid fertilizer company, 2007 also concluded that, for higher rate fertilizer application it is better to place it at 2X2 position and for low rate 0X0 position

Toler J. E., 2004 Studied the effect of starter fertilizer on cotton development. In this experiment he studied the effect of starter fertilizer placement at 5X5 on crop growth parameters at different time interval.

Forsynth, 2010 studied the apparatus and method to improve field application of anhydrous ammonia in cold temperature. In this it is stated that the air compressor injects compressed air into the tank to maintain head pressure within the tank at between 80-150 psi facilitate flow of liquid NH3 from the tank to applicator, when the level of liquid NH3 present in the tank declines.

MATERIAL AND METHOD

The system was developed with following design consideration;

1. It must be tractor mounted suitable for three furrow openers.
2. Fertilizer tank should be large enough to apply fertilizer for minimum a hectare of land.
3. It should have separate liquid cut off mechanism for all furrow openers.
4. It should have liquid pressure regulation system.

With above considerations the system/assembly of liquid fertilizer application and planting mechanism was developed in the workshop of ASPEE, Agricultural Research Foundation, Tansa, Tal- Wada Dist- Palghar.

THEORETICAL SPECIFICATION OF SYSTEM

Working width of machine is 2 m. Frame of 2 m X 0.5 m is developed. Adjustable furrow openers are attached to the rear pipe of frame. At the rear side of frame projected angles are attached in order to place the liquid fertilizer tank of capacity 500 lit. Main line of fertilizer is attached at the lower portion of tank and the HTP pump. Bypass tube from the pump is then connected to the metal tube through which different openings are given. On these different opening ball valves are attached. A flexible rubber tube is then attached to ball valve goes directly to the side of furrow openers.

RESULT AND DISCUSSION

As 1.8 m is the working width of machine then its theoretical capacity at 3.5 km/hr, 4 km/hr and 4.5 km/hr would be 0.63 ha/ hr, 0.72 ha/hr and 0.81 ha/ hr respectively.

As the optimum requirement for fertilizer application is approximately 350 l/ha then we can calculate the rate of fertilizer application at 3.5 km/ hr, 4 km/hr and 4.5 km/hr as 220.5 l/hr, 252 l/hr and 287 l/hr respectively.

LABORATORY TESTING

Keeping all above points in mind calibration of liquid fertilizer application mechanism was done in laboratory.

For this purpose a 10 ft long semi circled PVC pipe was selected which is made close on both the side. On this semi circled pipe three notches were made on 1 m distance from each other in order to collect the liquid inside.

Liquid fertilizer application system on planting mechanism is then attached to the tractor and tank of the system is filled with 500 litre water. A semi circled pipe is then placed on ground surface and then tractor is run over it for checking the combine effect of knob position (application rate), speed of tractor and pump pressures (2 kg/cm^2, 3 kg/cm^2, 4kg/cm^2) on Discharge/ m length or amount of water collected per meter length.

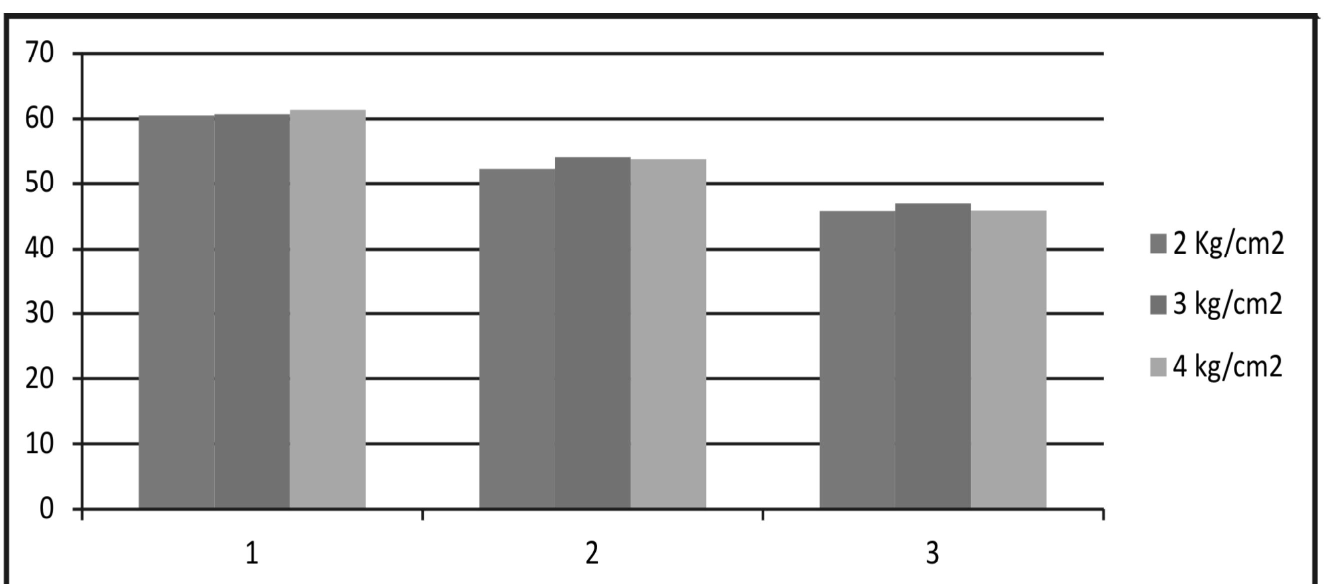
Plate: Liquid fertilizer application system on planting mechanism

Amount of liquid collected (ml) per meter

Knob Positions	*3.5 km/hr*			*4 km/hr*			*5 km/hr*		
	2 kg/cm²	*3 kg/cm²*	*4kg/cm²*	*2 kg/cm²*	*3 kg/cm²*	*4kg/cm²*	*2 kg/cm²*	*3 kg/cm²*	*4kg/cm²*
1	60.500	60.667	61.333	70.733	71.833	70.167	80.900	80.900	81.667
2	52.133	53.967	53.667	63.667	63.467	63.500	72.833	74.500	72.167
3	45.767	46.900	45.833	54.000	55.000	54.333	64.400	64.067	63.567

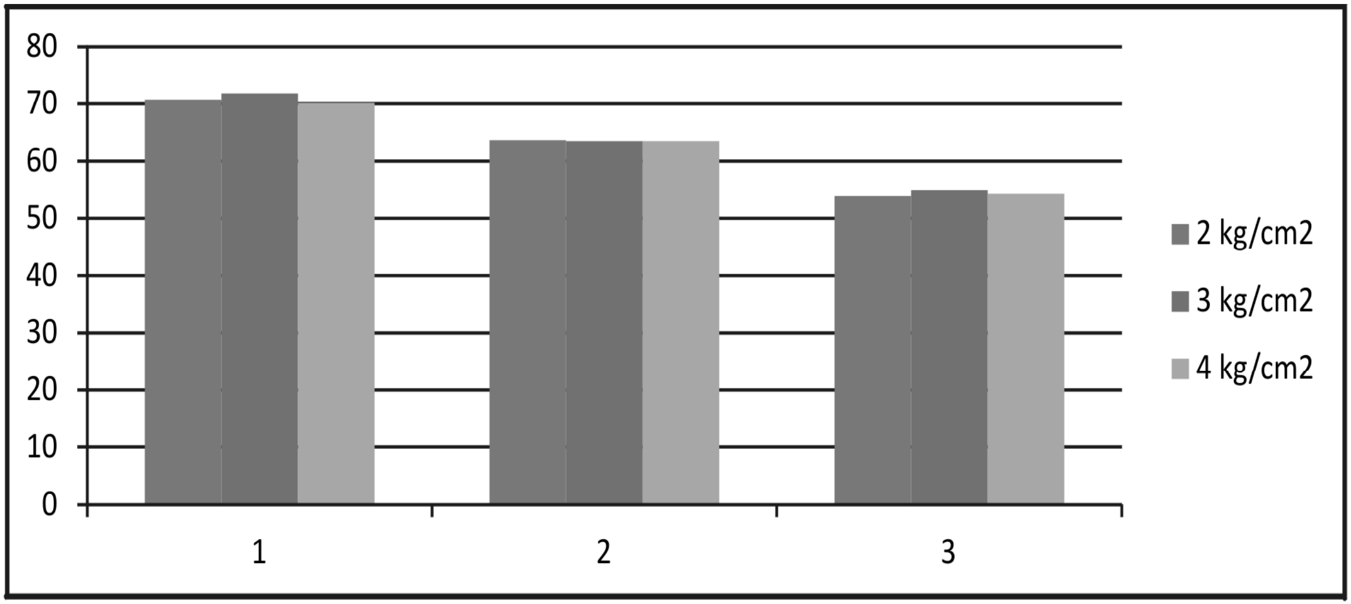
Combine effect of Knob Position and Pressure

1. At 3.5 km/ hr



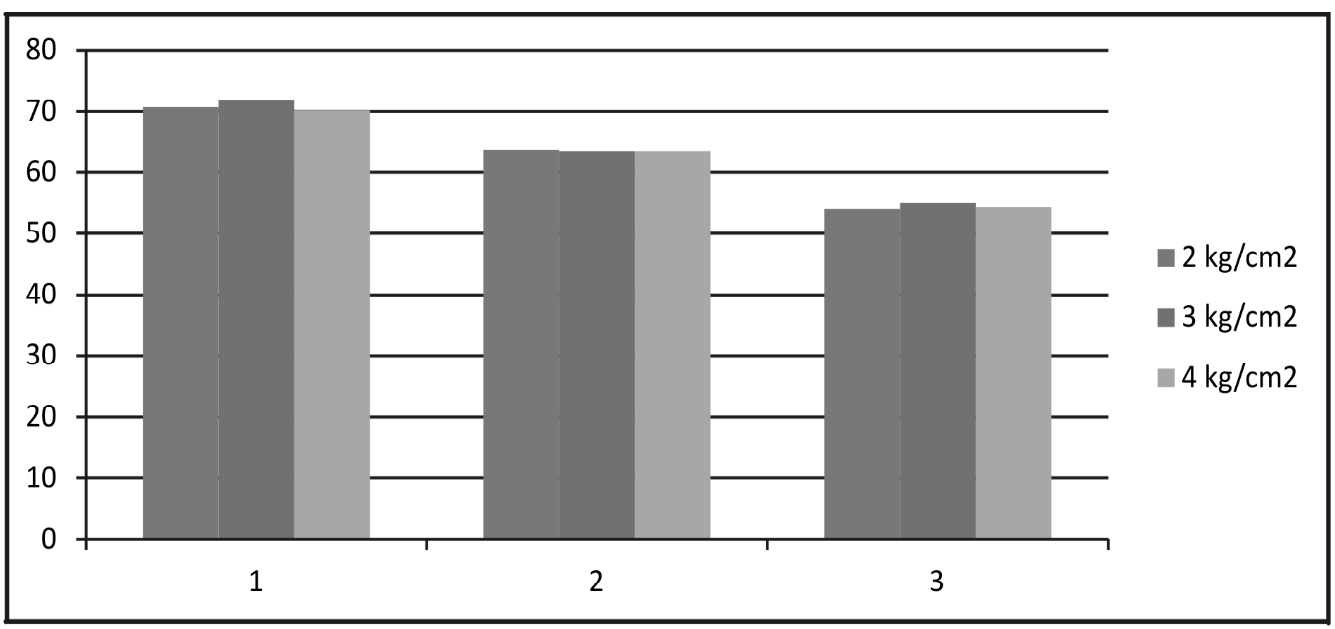
Above Fig. Shows the significant difference between the combine effect of knob position and pressure on amount of water collected per meter. It shows the decreasing trend. It interprets that at 3.5 km/hr speed when knob positions changes from 1 to 3 the amount of liquid collected decreases. The pressure shows non significant effect on amount of liquid collected per meter as it shows very negligible change. Amount of liquid collected was 60-63 ml/m, 50-52 ml/m and 46-48 ml/m on knob position 1, 2 and 3 respectively.

2. At 4 km/ hr



Above Fig. Shows the significant difference between the combine effect of knob position and pressure on amount of water collected per meter. It shows the decreasing trend. It interprets that at 4 km/hr speed when knob positions changes from 1 to 3 the amount of liquid collected decreases. The pressure shows non significant effect on amount of liquid collected per meter as it shows very negligible change. Amount of liquid collected was 70-71 ml/m, 61-62 ml/m and 51-52 ml/m on knob position 1, 2 and 3 respectively.

3. At 4.5 km/hr



Above Fig. Shows the significant difference between the combine effect of knob position and pressure on amount of water collected per meter. It shows the decreasing trend. It interprets that at 4.5 km/hr speed when knob positions changes from 1 to 3 the amount of liquid collected decreases. The pressure shows non significant effect on amount of liquid collected per meter as it shows very negligible change. Amount of liquid collected was 70-71 ml/m, 62-64 ml/m and 52-53 ml/m on knob position 1, 2 and 3 respectively.

In above all the graphs it shows the similar decreasing trend with respect to pressure and knob positions of ball valve. It may be because, as the knob of valve is opened gradually it increases the cross section area of the same, hence the resistance to flow decreases, as it gets more section area to liquid flow also as the section area increases it shows very less effect of pressure on liquid flow. Hence as the pressure and valve section area increases the amount of liquid collected per meter length decreases with respect to speed of tractor.

CONCLUSION

Keeping pressure effect economical a less pressure (2 kg/cm^2) was selected and considering the requirement of liquid application as 60-63 ml/m for cotton crop the second knob position was selected with 4 km/hr speed for field evaluation.

This combination will be tested in the field to evaluate the performance of liquid fertilizer application system on planting mechanism for cotton on different fertilizer placement positions.

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