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Development and performance evaluation of prototype single row gladiolus planter

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■ **ABSTRACT :** Gladiolus is also known as "queen of the flowers" is an important cash horticultural crop. Generally it is planted manually which is very tedious, time consuming and labor intensive operation. So far, there is no planter available for planting of gladiolus corms. With a view of mechanize the planting operation of this horticultural crop,atractor one of the popular bulbous ornamental plants. Traditionally the gladiolus corm are planted manually which is very high tedious, time consuming and labour intensive operation. A single row tractor operated prototype planter was developed to improve planting efficiency and reduce drudgery involved in manual planting method and its performance was evaluated in actual field condition. The three levels were selected for corm spacing *viz.*, 15, 20 and 25 cm and three for forward speed *viz.*, 1.0, 1.5 and 2.0 km/h were taken as performance parameter for the developed prototype planter. The indicator namely missing index, multiple index, mechanical damage, corm spacing per meter length and properties of gladiolus corms etc. determined during the test.

■ **KEY WORDS :** Co-efficient of uniformity, Corm spacing, Field capacity, Gladiolus planter

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Floriculture has been identified as the fast-emerging sector and is now branded as an industry in domestic as well as export market. The area under floriculture crop has risen to approximately 1.91 lack hectares, globally India occupies fourth place in total area for growing ornamental plants with an estimated production of 1.031 million loose and 690.27 million cut flowers (Anonymous, 2013 and Singh and Singh, 2017).

Looking the present situation of the gladiolus in India, it is noticed that the level of productivity is very low. The production of gladiolus can be enhanced by adopting different measure such as increasing area under cultivation, use of improved high yielding and short duration verities, supplementing with nutrient requirement, adopting appropriate plant protection measure and efficient machinery for its cultivation. The current and future demands are for horticulture and floriculture machinery as more and more farmers are moving towards it to achieve profit in farming.

Agricultural machines increases productivity of land and labour both by the management of timeliness of farm operation and increased work out put per unit time. Sowing / planting of gladiolus is considered as one of the most important operation which involve factor like correct seed rate, appropriate depth of placement and require spacing and orientation which determines the crop production. The time and method adopted for sowing decisively affect the germination and hence, production. The traditionally method of planting gladiolus as adopted by farmers, is to make shallow furrow dig with the spade and put the corm (bulb) in the ground and cover it with the soil which is very tedious and time consuming. Sowing equipment plays an important role, especially in labour scarcity area. The use of seed- cum-fertilizer drills not only conserves energy but also saves about 20 per cent of the seed and increase the yield by 15 per cent through better placement of seed and more effective utilization of fertilizer (Bansal *et al.*, 1989). Mechanization of planting of gladiolus is one such area where there is a greater scope to increase its production and productivity and make it a profitable business venture for farmers.In this paper the development and performance evaluation of prototype single row gladiolus planter is discussed. Author found out that a simply designed planter, constructed from readily available materials.

■ METHODOLOGY

A single row gladiolus planter was developed for planting of gladiolus corms. It main component of planter are frame, hopper, ridger tines, metering unit, depth control wheel, drive wheel, and hitch system. Fig. A shows the details of the developed gladiolus planter.

Hitch system:

The hitch system of the gladiolus planter was fabricated using mild steel flat section of 50 x16 mm size. The mast height of the hitch system was kept 610 mm and the lower hitch point span was kept as 685 mm. The dimensions of the hitch system were kept in accordance with the Indian Standards (IS: 4468 (Part-I)-1997) for category-II hitches suitable for tractors in the power range of 40-100 hp.

Frame:

The frame has been constructed in two parts one with hitching system and another for metering system with power transmission units. The frame with hitching system is made in rectangular shape of 800 × 400 mm size using angle iron of size 50 × 50 × 5 mm. The frame for metering unit has been fabricated in triangular shape using three angle irons of length 115, 80 and 65 cm, respectively. The size of angle iron used for this frame is 35 × 35 × 5 mm. Another piece of frame with similar size and shape was also fabricated. Both the triangular frame was welded face to face with m.s. flat pieces of length 18 cm and thickness of 5 mm to provide stability to the frame.

Hopper:

A hopper, with 20 kg capacity, has been fabricated from 20 mm GI sheet with the help of gas welding. The side slope of the walls has been kept 45º which is greater than the angle of repose of gladiolus bulb *i.e.,* 31º. The bottom of the hopper is provided with rectangular shape opening of size 150 × 120 mm.

Metering unit:

The metering unit has been fabricated from wooden blocks of square shape having dimension 70mm x 70mm x 40 mm. In each wooden block semi-circular in the groove form of the cup has been made. The depth of the cup has been kept as 30 mm with diameter as 60 mm. The dimension of the cups has been decided based on the average size of the gladiolus bulbs. Further each cup has two holes in its bottom centre position of 4 mm diameter for fitting of the same on a canvas belt with

Front view | Side view | Isometric view

Fig. A: Developed single row gladiolus planter

help of nuts and bolts. The canvass belt having a length and width of 2310 mm and 70 mm, respectively has been used for fitting of the wooden cups.

Power transmission unit:

Power transmission unit was used for transmitting power from drive wheel (ground wheel) to main shaft of metering device through a set of chain sprocket arrangement. The main transmission system consisted of two mild steel sprockets having 13 teeth and 27 teeth, respectively the power from ground to metering unit has been provided through a power transmission wheel *i.e.* a wheel with lugs on it. Verma (1986) suggested the diameter of the power transmission wheel as 225 to 400 mm for bullock driven planter/seed drill and 400 to 600 mm for the tractor driven planter. Therefore, diameter of power transmission wheel was selected as 400 mm. The rim width of lug wheel was chosen as 45 mm as it ranges from 40 to 60 mm in case of bullock drawn planter. The thickness of rim, t, was calculate by following relationship (Panday and Shah, 1962).

$$t, \text{mm} = (D/200) + 3.175 \qquad \ldots (1)$$

$$t = (400/200) + 3.175$$

$$= 5.17 \text{ mm.}$$

where,

D = Diameter of lug wheel, mm

A mild steel flat of 45 mm width and 5 mm thickness was selected due to ease availability of the material.

Axle shaft:

The bulb metering mechanism as a whole consists of 4 shafts, 3 for belt pulley, and one for the transmission wheel and intermediary hinge.

Furrow opener:

Gladiolus is required to be planted on ridges for better emergence and crop yield. A suitable ridger-furrow opener was therefore, selected.The machine consists of a single row ridger furrow unit. The ridger bottom is provided with adjustable wings to adjust the width of the ridges as per the requirement. The ridger bottom is fitted with rectangular frame through shank has been made from 50 mm mild steel flat of size 500 × 500 × 50 mm and length of 200 mm. Reversible shovel is attached to the ridger by plough bolt. The wings are 320 mm long and 340 mm wide with sufficient curvature to avoid moist soil sticking (RNAM, 1991).

Performance parameters:

Co-efficient of uniformity:

The average value of observed corm spacing in each row was determined and the corresponding value of co-efficient of uniformity was calculated using the following equation (Kate *et al.*, 2012 and Singh and Gautam, 2015).

$$\text{Co-efficient of uniformity (C.U.)} = 1 - \left(\frac{\sum|X|}{m \times n}\right) \times 100 \qquad \ldots (2)$$

where,

ΣX = Sum of absolute value, cm

m = Average of all observations, cm

n = Number of observation.

Missing index:

Miss index is an indicator of how often a seed skips the desired spacing. andit is expressed as:

$$\text{Miss index, \%} = \frac{n_1}{N} \times 100 \qquad \ldots (3)$$

where,

N = Total number of observations and

n_1= Number of spacing's in the region >1.5 times of the theoretical spacing.

Multiple index :

Multiple index is an indicator of more than one seed dropped within a desired spacing. It is the percentage of spacings that are less than or equal to half of the theoretical spacing:

$$\text{Multiple index, \%} = \frac{n_2}{N} \times 100 \qquad \ldots (4)$$

where,

N = Total number of measured spacing.

n_2 = Number of spacing's ≤ 0.5 times of the theoretical spacing.

Quality of feed index:

The quality of feed index is mathematically expressed as follows:

$$\text{Quality of feed index, \%} = 100 - (\text{Miss index} + \text{Multiple index}) \qquad .(5)$$

The planter was evaluated in lab and field for its performance in terms of co-efficient of uniformity, number of corm per meter length, missing index, multiple index, quality of feed index, corm damage, fuel consumption, draft, actual field capacity, field efficiency.

■ RESULTS AND DISCUSSION

During the field evaluation the developed single row prototype planter was operated for planting of gladiolus corms. The following performance parameters were measured and calculated. The relevant results are presented below.

Corm to corm in row spacing :

Actual spacing between individual corms dropped in rows was measured during field test for all the three levels of nominal corm spacing and four levels of forward speed. The data were measured from each planted row. The result of the same is presented in Table 2. The relationship between corm to corm spacing and percentage of frequency occurrence for developed planter at various forward speeds and different required spacing has been plotted and shown in Fig. 1 and Table 1 and 2. It is clear from the data that three forward speed the majority of the corm dropped between 16 cm to 19 cm range at forward speeds of 1.0 km/h and 2.0 km/h. The peak value was obtained between 18 to 19 cm corm to corm spacing at a forward speed of 1.5 km/h. It is clear from the Fig. 1 that the average observed corm to corm spacing was quite closer to the theoretical corm to corm spacing of 15 cm. At 25 cm it was observed that at 20 cm nominal spacing that at 1 km/h forward speed about 39 per cent of occurrence was observed between corm to corm spacing of 21 cm to 24 cm with a peak value between 23- 24 cm. At 1.5 and 2.0 km/h forward speed the per cent frequency occurrence was observed between 41 to 43 per cent for corm to corm spacing of 21 cm to 24 cm showing peak value at corm to corm spacing of 23-24 cm and 21-22 cm, respectively. At 25 cm. Similarly the planter was tested at 25 cm corm to corm spacing, for three levels of forward speeds the observed value of corm spacing for the required corm to corm spacing of 25 cm ranged from 22.5 cm to 34.9 cm with an average of 29.08 cm at a forward speed of 1 km/h. For the same required spacing, when the forward speed was increased to 1.5 km/h, the observed corm spacing varied from 20.3 cm to 38.3 cm with an average of 28.41 cm. When the speed was increased further to 2 km/h *i.e.* maximum achievable speed for 25 cm corm to corm spacing, the observed corm to corm spacing was found to vary from a minimum of 22.6 cm to a maximum of 35.8 cm with an average value of 28.52 cm. It is clear from the data that the average observed corm to

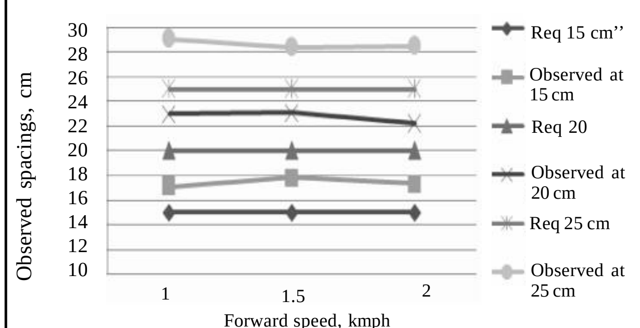

Fig. 1 : Variation in observed corm to corm and required spacing

Table 1 : Missing percentage of bulbs during field test

Replications	Bulb to bulb spacing of 15 cm			Bulb to bulb spacing of 20 cm			Bulb to bulb spacing of 25 cm		
	Forward speed, km/h			Forward speed, km/h			Forward speed, km/h		
	1	1.5	2	1	1.5	2	1	1.5	2
Average	2	4	6	4	6.6	1.3	1.6	3.3	5
Grand avg.		4			3.9			3.3	

Table 2 : Observed mean spacing of corms during field test

Forward speed	Nominal spacing 15 cm			Nominal spacing 20 cm			Nominal spacing 25 cm		
	observed spacing	SD	CV	observed spacing	SD	CV	observed spacing	SD	CV
1 km/h	17.08	3.45	20.18	23.01	3.75	16.27	29.08	3.93	13.52
1.5 km/h	17.84	3.21	18.01	23.11	4.06	17.97	28.41	4.04	14.23
2km/h	17.32	3.28	18.97	22.19	3.77	17	28.52	3.94	13.8
overall mean	17.41	3.31	19.05	22.77	3.86	17.08	28.67	3.97	13.85

corm spacing was quite closer to the theoretical corm to corm spacing of 25 cm.

Co-efficient of uniformity:

The relationship between forward speed and co-efficient of uniformity has been illustrated in Fig. 2 which show higher co-efficient of uniformity for a required bulb to bulb space setting of 25 cm compared to other required spacing. The co-efficient of uniformity was observed lower for 20 cm required bulb to bulb space setting. The co-efficient of uniformity was also observed highest for 2 km/h forward speed for all the settings of required bulb to bulb spacing. This may be due to the fact that the planter movement was more uniform at higher speed of operation in the field compared to lower speeds.

Mechanical damage :

External damage caused by metering unit to the bulbs was determined during the field test at different forward speed and the results have been presented in

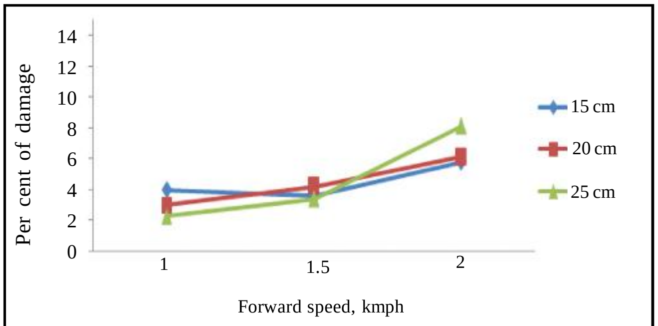

Fig. 2 : Variation between forward speed and damage

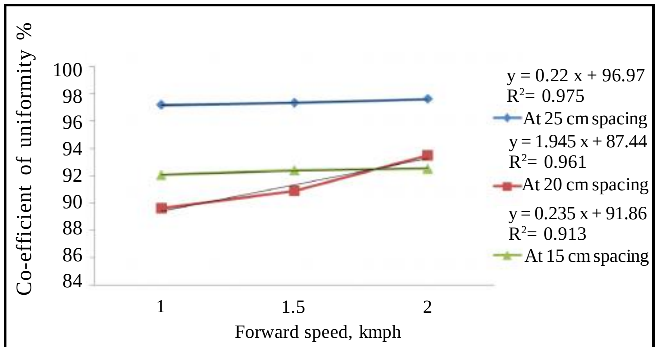

Fig. 3 : Variation between speed and co-efficient of uniformity

Table 3 : Uniformity in planting of gladiolus corms during field test

Forward speed, km/h	Nominal spacing	Mean spacing	Miss, %	Multi, %	Quality feed index, %	Ratio of mean/ Nominal spacing
1.0	15	17.08	2	0	98.0	1.139
	20	23.01	4	0	96.0	1.151
	25	29.08	1.6	0	98.4	1.163
1.5	15	17.84	4	0	96.0	1.189
	20	23.11	6.6	0	93.4	1.156
	25	28.41	3.3	0	96.7	1.136
2.0	15	17.32	6	0	94.0	1.155
	20	22.19	1.3	0	98.7	1.110
	25	28.52	5	0	95.0	1.141

Table 4 : Observed machine performance parameter

Draft, kgf	85
Speed of operation, km/h	1.4
Power consumption, hp	0.45
Fuel consumption, l/ha	3.2
Turning time loss, sec.	25
Theoretical field capacity, ha/h	0.091
Actual field capacity, ha/h	0.126
Field efficiency, %	72.93

Fig 3. The average visual damage for 15 cm bulb to bulb spacing, observed as 4.0, 3.6 and 5.8 whereas the same for 20 and 25 cm bulb to bulb spacing was observed 3.0, 3.1 and 6.1 and 2.3, 3.4 and 6.1 per cent, respectively at 1, 1.5, 2 km/h forward speed.

Missing percentage and multiple index:

It is evident from the data (Table 3) that missing percentage maximum was 9 per cent for 15 cm bulb spacing and 16 per cent for 20 cm bulb spacing at 1.5 km/h forward speed, respectively. For 25 cm bulb spacing, the maximum missing percentage was found 10 per cent at forward speed 2 km/h. The overall percentage of missing bulbs was observed lower for higher bulb spacing which may be due to the reason that more time was available for self filling of the bulbs in the cups of metering unit as compared to lower bulb to bulb spacing.

Quality of feed index:

The quality of feed index for 15 cm bulb spacing at forward speed of 1, 1.5 and 2 km/h was found as average value of 96 per cent. For 20 and 25 cm bulb to bulb spacing at forward speed of 1, 1.5 and 2 km/h the average value of quality of feed index was found as 96.1 and 96.7 per cent, respectively. All over of the quality of feed index was found as minimum value of 84 per cent and maximum value of 100 per cent feed index.

Field capacity, draft and fuel consumption:

The actual average speed of operation of the planter in the field was kept 1.4 km/h. From the result, the field capacity was found 0.126 ha/h with an observed field efficiency of 72.93 per cent. Draft requirement was found to be 85 kgf and fuel consumption 3.2 l/ha.

Conclusion:

Based on the field test of developed single row gladiolus planter it could be concluded that the planter should be operated in 1.5 to 2 km/h for satisfactory performance. The co-efficient of uniformity was found 97 per cent and field efficiency was found 72.93 per cent. Draft and actual field capacity of planter was found 85 and 0.126 per cent, respectively.

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