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Performance evaluation of a cell in belt type metering device for planting of gladiolus corms

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■ **ABSTRACT :** Planting of gladiolus is traditionally performed by manual labour which is very arduous. Till date no planter has been developed for mechanizing this permeation. With this aim, a prototype gladiolus planter was developed with cell in belt types metering unit, the performance of the metering unit was evaluated in –situ condition with three; levels of forward speed (1, 1.5 and 2 km/h) and three levels of nominal corm spacing (15, 20 and 25 cm). The test result indicated that the metering unit was able to deliver the some at sensors spacing but with an overall deviation of 15.08 per cent. The co-efficient of uniformity was found higher for 2km/h speed and 25 cm corm to deviation of 15.8 per cent. The co-efficient of uniformity was of und higher for 2km/h speed and 25 cm corm to corm spacing, the miss index was found less for wider spacing and higher speed of operation. Similarly, the quality feed index was found higher for wider nominal spacing and higher for wider nominal spacing and higher forward speed, however, the multiple index was found zero for all the treatment combinations. The overall performance was found better for 2 km/h forward speed.

■ **KEY WORDS :** Design parameter, Gladiolus planting, Physical properties, Performance evaluation, Planting mechanism

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Floriculture is a fast emerging major venture in the commercial world and is growing at the modest rate of 10-15 per cent in India. Globally, India occupies fourth place in terms of area for growing ornamental plants with and estimated production of 1.031 million loose and 690.27 million cut flowers (Anonymous, 2012). Floriculture is now commercially practiced in several states of the country with Tamil Nadu leading with 24 per cent, Karnataka (20%), Andra Pradesh (13%), and Maharashtra (8.8%) Punjab (8.04%), Haryana (5.8%). West Bengal (5.7%), Gujarat (4.8%), Chhattisgarh (2.6%), Jharkhand (2.2%), Uttar Pradesh (1.7%), other state (3.6%) contribution in loose flower production (Anonymous, 2012). *Gladiolus grandiflours* also known as "sword lily" is an ornamental bulbous plant and is grown for its cut flower which is in great demand. In India about 3500 ha area is under bulbous ornamental crop with maximum area being under gladiolus followed by tuberose in 800 ha (Deshraj, 2006). In Uttarakhand among the cultivated flowers, gladiolus rank first with an area of about 90 ha having a production of 121.89 MT with productivity of 1.34 tonnes per hectare (Arora, and Singh, 2002).

In manual seeding with conventional practice, the

higher and non-uniform plant population adversely affect grain yield of different crops (Kamaraj and Kathirvel, 2008). Traditionally gladiolus is planted manually which is very tedious and time consuming operation and often results in low work rate. Sometimes planting operation is jeopardized due to shortage of agricultural labourers leading to low yield. Productivity of this crop can be enhanced by introducing suitable planters for planting of gladiolus corms, however no such effort has been made till date (Seaudurad *et al.*, 2006). Developed and evaluated a two-row saffron corm planter for planting the same at 20 cm row spacing and 15 cm planting depths, cup type metering device was used for simulating the bulbs. Results indicated no damage of the corms. Corms with no diversion from the predetermined corm spacing and final means measured spacing were found 77 and 85 per cent, respectively. Filed capacity of planter was observed 0.12 ha/h at a forward speed of 3 km/h. when speed was increased form 3 to 4 km/h, the number of corms sown per meter length decreased for about 14.2 per cent (Kamaraj and Kathirvel, 2008). Developed and evaluated tractor operated cotton planter with belt type metering unit. It resulted in 73.33 per cent of two plants per hill, 6.67 per cent of missing hills and maintained the recommended plant population with desired with drum type metering unit for planting garlic (*Allium sativum* L.) clovers. Laboratory evaluation revealed satisfactory performance of the planter. The planter was capable of planting 220,000 cloves per ha at seeding depth and spacing of 12.3 and 22.7 cm, respectively. Miss index, multiple index and seed damage were measures as 12.23, 43. 2.43 And 1.41 per cent, respectively (Gaddi and Marey, 2011). Studied the effect of forward speed and tuber characteristics on tuber spacing uniformity of an auto feed cup- belt potato planter, three speeds (1.8, 2.25 and 3 km/h) and three tuber sizes (35-45, 45-55 and 55-65 mm) were selected for the study.

The result revealed that increase in forward speed induced a significant increase in the mean tuber spacing and a significant reduction in the tuber spacing uniformity, tuber spacing uniformity than other tested tuber sizes. (Singh and Mane, 2011). Developed and carried out laboratory performance of an electronically controlled cup type metering mechanism for okra planter. The electronic circuit controlled the operation of a DC motor which in turn rotated the metering plate having cups on its periphery. Study on greased belt under laboratory condition was performed with different leaves of seed spacing and speed of seed spacing with higher quality feed index, the miss and multiples indexes were found zero. Seed placement was observed more accurate at lower speed to seed spacing (Nare *et al.*, 2012). Designed and developed a self propelled garlic clove planter with elliptical spoon type metering unit. Twelve elliptical spoon of size 30×12×10 cm was attached to 50 mm long and 40 mm round bar and fitted at an interval of 50 mm on a disc of 20 cm diameter. The results revealed that elliptical soon with 180^{o} is the best with 1.04 per cent is the best with 1.04 per cent miss index, 3.23 per cent multiple index and 1.67 per cent damage with overall losses of 5.79 per cent.

The review of past work shows that no work has been some till date to develop a gladiolus planter for mechanizing the planting operation, therefore, considering the importance of the crop and need of the planting device was evaluated in the field for planting gladiolus corm.

METHODOLOGY

Cup in belt type metering unit was fabricated using wooden blocks and canvas belt, wooden blocks of square shape having dimensions of 70 ×70×40 mm (length, width and thickness) were selected for making the groove, in the shape of a cup, was made in each wooden block. The diameter and depth of the groove was kept 60 and 30 mm, respectively. The dimension of the cups was decided based on the average geometrical dimension of the gladiolus corm. Furthers, two holes of 4 mm diameter was made in the bottom of each cup for fitting it on a canvas belt with help of nuts and bolts, a total of 34 such cups were fitted on a canvass belt with help of nuts and belts, a total of 34 such cups were fitted on a canvass belt continuously without any gap between them, the centre distance between the two cups was kept as 80mm. before the actual planting operation, the metering unit was fitted on a prototype gladiolus planter and its performance was evaluation in the field. Corn to corm spacing, co-efficient of uniformity, and number of corms dropped per mater length, percentage missing and mechanical damage was taken as performance indicators. The metering unit was evaluated for 3 levels of corms to corms spacing (15, 20 and 25cm) and 3 levels of forward speeds (1,1.5, 2.km/h) number of corms in a row and their spacing was determined in 5 mater long test run. Deficient of uniformity, miss index, multiple

index, quality feed index and mechanical damage was determined by using the following equation.

$$\text{Co - efficient of uniformity (C.U.)} = \left[1 - \frac{\Sigma |x|}{m \times n}\right] \times 100 \quad (1)$$

where,

Σx= Sum of absolute value, cm

m = Average of all observations, cm

n = Number of observation

$$\text{Mixx index, \%} = \frac{N_1}{N} \times 100 \quad (2)$$

where,

N_1= Number of spacing ≥ 1.5 times theoretical spacing

N= Total number of measured spacing

$$\text{Multiple index, \%} = \frac{N_2}{N} \times 100 \quad (3)$$

where,

N_2 = Number of spacing ≤ 0.5 times theoretical spacing

N = Total number of measured spacing.

$$\text{Quality of feed index} = -(\text{Miss index} + \text{multiple index}) \quad (4)$$

$$\text{Mechanical damage, \%} = \frac{\text{Damaged bulb in 5 meter distance}}{\text{Total bulb dropped in 5 meter distance}} \times 100 \quad (5)$$

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Physical properties of gladiolus corms :

Table 1 presents the physical properties of the gladiolus corm. The average value of the length, width and thickness was found as 45.36, 37.93 and 23.69 mm, respectively with average geometric mean as 34.2 mm. based on the sphericity, which was found as 0.76, the shape of gladiolus corm was found to be oblong. The average weight of a dingle corm was found as 24.7 g. the mean bulk density was found as 0.58 g/ cc at average moisture content of 45.20 per cent. These parameters were used to design the metering unit and hopper capacity of the planter.

Performance at various nominal spacing of corms:

The observation regarding corm spacing for various levels of nominal spacing's and forward speeds was recorded and the same has been presented through Fig. 1 to 3. Also the mean spacing and their variation is presented in Table 2. The result for 15 cm nominal spacing revels that the observed corm to corm spacing ranged from minimum, 12.1 cm to a maximum of 24.3 cm with an average value of 17.08 cm at belt speed corresponding to 1 km/h, the observed corm spacing varied between 10.9 cm to 25.5 cm with an average of 17.84 cm. further when speed was spacing varied between 10.9 cm to 25.5 cm with an average of 17.84 cm. future when forward speed was increased to 2 km/ h then observed value of 17.32cm the result reveals that the average observed corm to corm spacing was found speed was increased to 1.5km/h, the observed corm to corm spacing was found quite close to the required corm spacing was found to vary from a minimum of 10.3 cm to a maximum of 23.5 cm with an average value of 17.32 cm. the result reveals that the average observed corm to corm spacing was found spacing was found quite close to the required corm to corm spacing of 15 cm. on an average, the variation in observed and required corm spacing was observed as 16.7 per cent which may be due to forward rolling of gladiolus corms after touching the ground. Standard deviation was also determined which was observed as 3.45, 3.21 and 3.28 cm for 1, 1.5

Table 1 : Physical properties of the gladiolus corm (variety- Punjab Morning)

Parameters	Range	Mean	SD	CV
Physical dimensions (Data of 300 gladiolus corm)				
Length, mm	33.2- 53.5	45.36	4.99	8.86
Width, mm	20 - 48.2	37.54	5.36	15
Thickness, mm	15 - 47	23.93	4.37	17.2
Geometric mean dimensions, mm	25.2 – 44.51	34.20	3.14	9.19
Sphericity	0.59 – 0.99	0.75	0.07	9.16
Unit mass, g	17.5 – 45.5	24.7	-	-
Moisture content, %	40.90 – 47.53	45.20	-	-
Bulk density, g/cc	0.56 – 0.62	0.58	-	-

and 2 km/h forward speeds. This indicates that determined which was observed corm spacing is affected by forward speed and is less for higher forward speeds. Co-efficient of variation was also found to decrease with increase in forward speed, the lower value of standard deviation and coefficient of variation may be due smooth working of the planter at 2km/h compared to 1km/h.

Result for 20 cm nominal corm to corm spacing is also presented in Table 2 which shows that at 1 km/h forward speed, the average observed corm to corm spacing ranged between 16.4 and 30.9 cm with an average spacing of 23.01 cm. when speed was increased

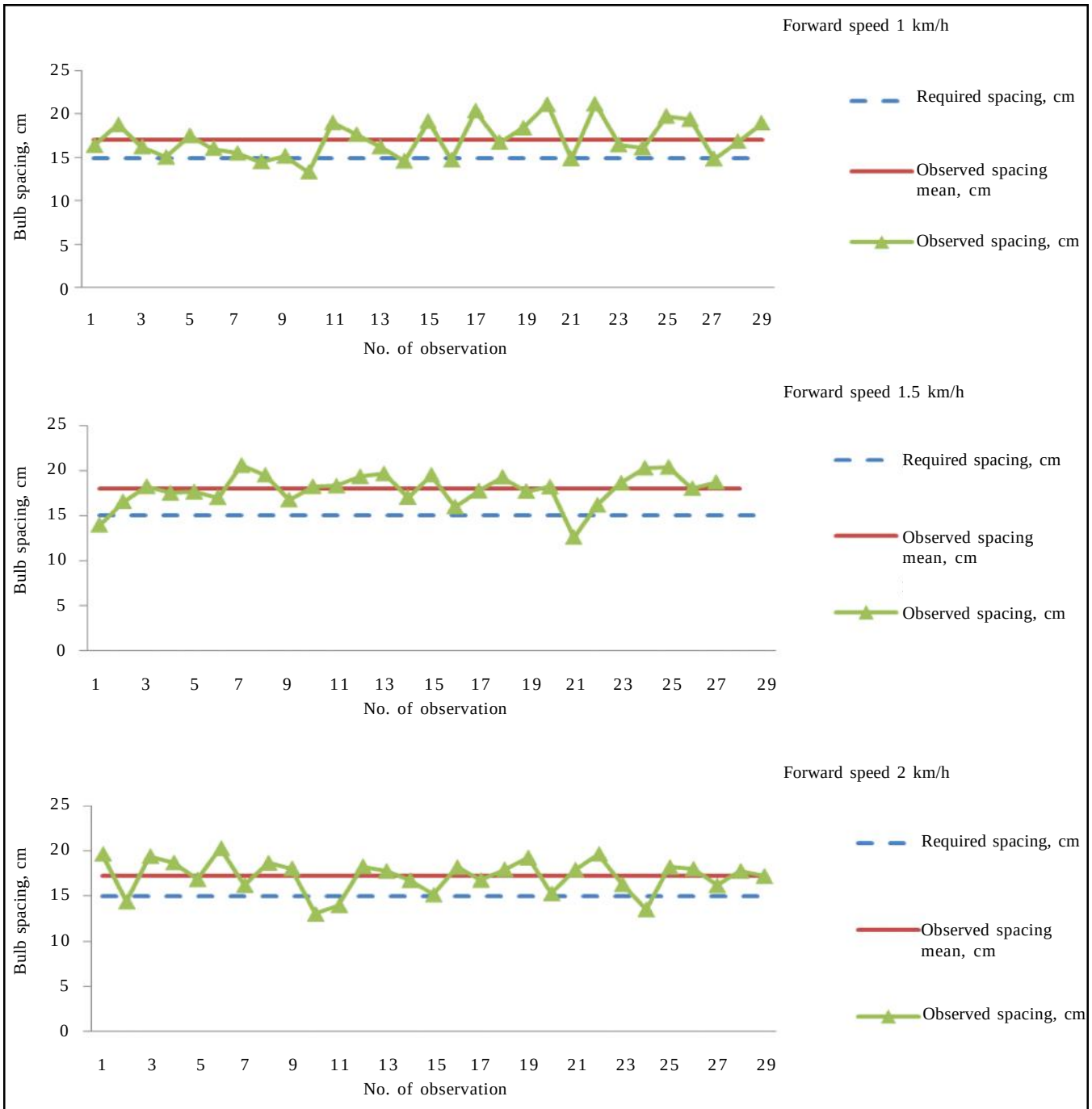

Fig. 1 : Variation in observed corm to corm spacing at different forward speed for nominal spacing of 15 cm

to 1.5 and 2.0km/h then the average observed spacing was found 23.11 and 22.19 cm, respectively. The standard deviation was found less for lower speed was found as 3.75, 4.06 and 3.77 cm, respectively. The co-efficient of variation was found less for lower speed than for higher speeds, the overall mean of observed corm spacing was found 13.85 per cent higher than the nominal corm spacing of 20cm. the variation in spacing between the gladiolus corms any be due to the reasons explained earlier.

The metering unit was also rested for 25 cm nominal corm to corm spacing at all the three levels of forward

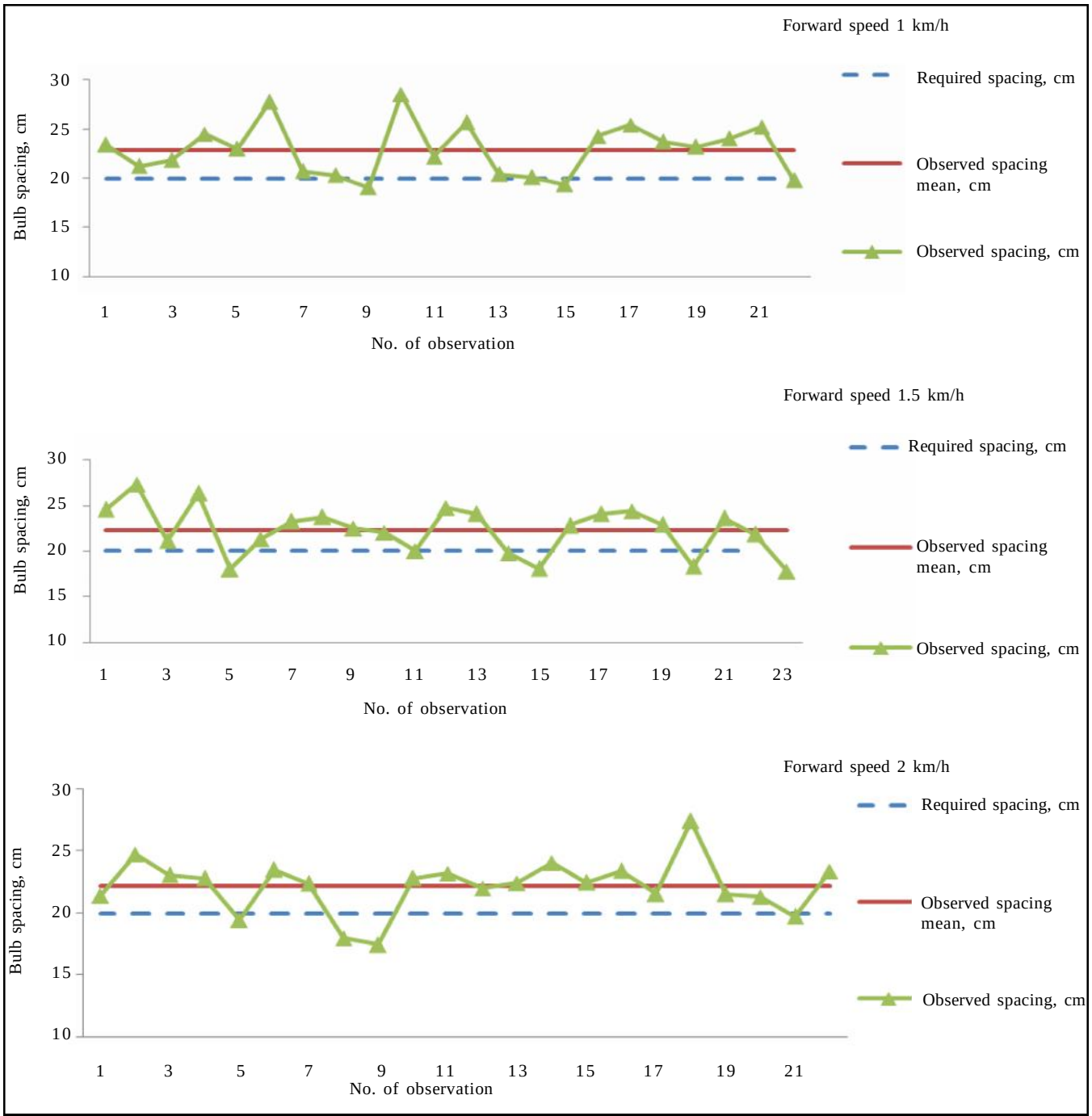

Fig. 2 : Variation in observed corm to corm spacing at different forward speed for nominal spacing of 20 cm

speeds and the result has been presented in Table 2. The observed corm spacing ranged from 22.5 cm to 34.9 cm with an average of 29.08 cm at a forward speed of 1km/h. when forward speed was increased to 1.5 and 2 km/h. average observed corm spacing was found as 28.41 and 28.52 cm, respectively.

The overall observed spacing was found 14.68 per cent higher than the nominal corm to corm spacing of 25cm. Standard deviation was found as 3.93, 4.04 and 3.94 cm for 1, 1.5 and 2km/h forward speeds, respectively. The co-efficient of variation was observed as 13.52, 14.23 and 13.8 per cent for all the three forward speeds, the reason for variation could be due to reason already explained.

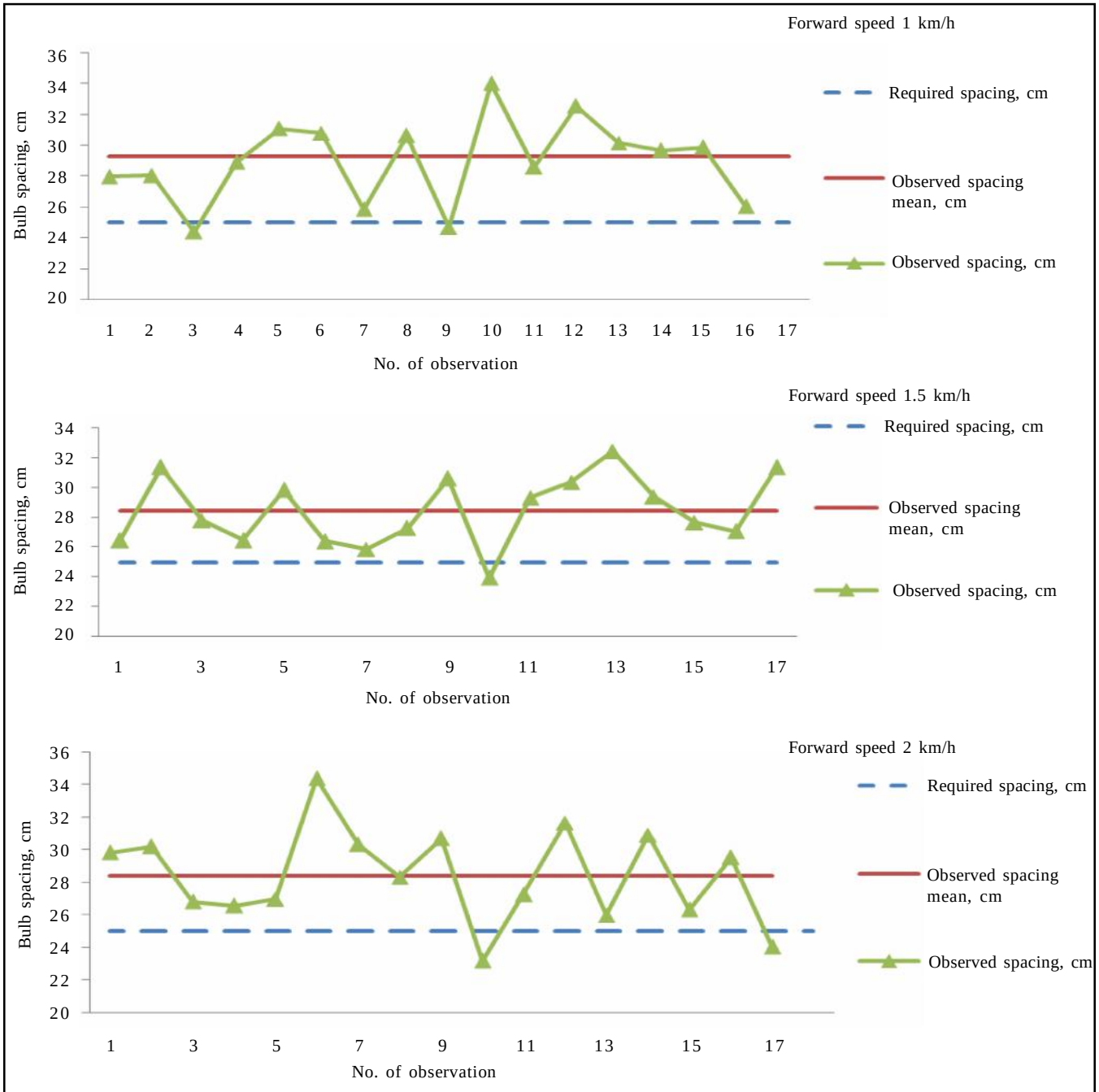

Fig. 3 : Variation in observed corm to corm spacing at different forward speed for nominal spacing of 25 cm

Table 2 : Mean of observed corm to corm spacing as well as forward speeds

Trial (test run 5 meter)	Nominal corm spacing, cm								
	15			20			25		
	Forward speed, km/h								
	1.0	1.5	2.0	1.0	1.5	2.0	1.0	1.5	2.0
1	17.01	17.64	17.05	22.27	21.19	21.55	29.26	29.43	28.19
2	17.44	17.17	16.77	23.30	23.72	22.23	28.58	27.86	27.92
3	16.80	18.72	18.13	23.46	24.43	23.79	29.41	27.95	29.46
Mean	17.08	17.84	17.32	23.01	23.11	22.19	29.08	28.41	28.52
SD	3.45	3.21	3.28	3.75	4.06	3.77	3.93	4.04	3.94
CV	20.18	18.01	18.97	16.27	17.97	17	13.52	14.23	13.80
Miss index, %	8.64	8.64	6.17	4.76	7.94	3.17	0	0	4.17
Multiple index, %	0	0	0	0	0	0	0	0	0
Quality feed index, %	91.36	91.36	93.83	95.24	92.06	96.83	100	100	95.83

Miss index :

The miss index was determined and the results have been presented in Table 2. The result reveals a lower miss index for higher value of nominal corm spacing (*i.e.* 25 cm) compared to lower value of nominal spacing *i.e.* for 15 and 20 cm, respectively. Similarly it was observed less for higher speed of operation (*i.e.* 2km/h) compared to lower speeds of operation. This may be due to the reason that 2 km/h forward speed the machine operation was comparatively smoother. Also for wider nominal corm spacing of 25 cm, probably more time available for self filling of the cups leading to lower miss index

Multiple index :

The multiple index for observed corm to corm spacing for all the treatments was determined and the same was found to be zero (Table 2). This indicated that observed corm to corm spacing was not found lesser than or equal to half of the nominal (desired) corm spacing for all the treatments included in the study.

Quality of feed index :

Table 2 shows the result related to this parameter for all the nominal corm to t corm spacing as well as forward speeds of operation. The overall quality of feed index was found to be 92.18, 94.41 and 98.61 per cent for nominal corm spacing of 15, 20 and 25 cm, respectively. The data reveals higher value of quality of feed indeed for wide spacing. When it was compared for various forward speeds, the result indicates that quality of feed index is higher for 2 km/h forward speed compared to the lower forward speeds accept for 25 cm nominal corm spacing, this is due to variation in miss index for various treatments.

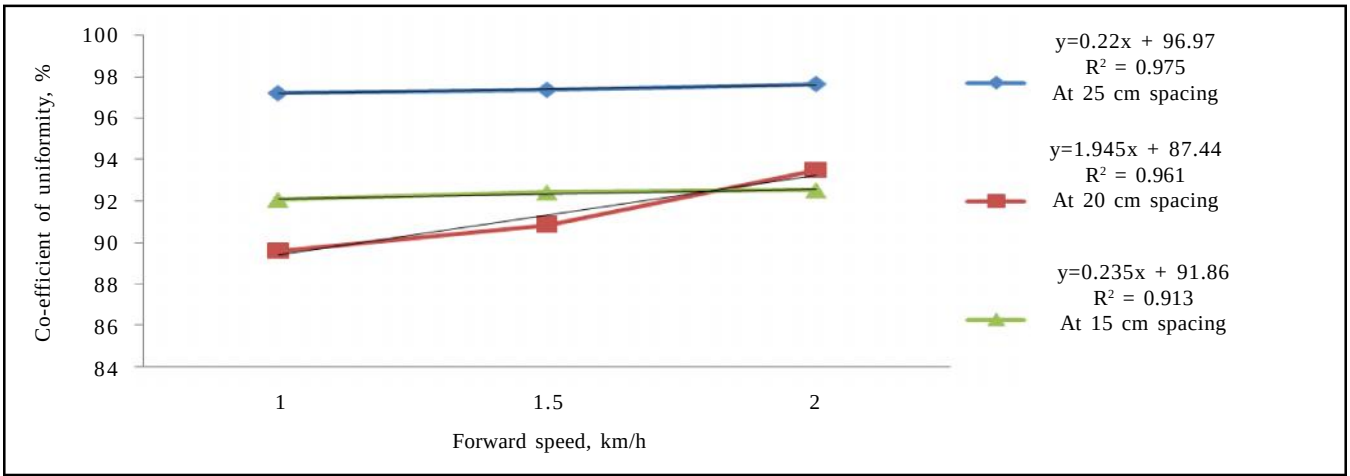

Fig. 4 : Relationship between forward speed and co-efficient of uniformity

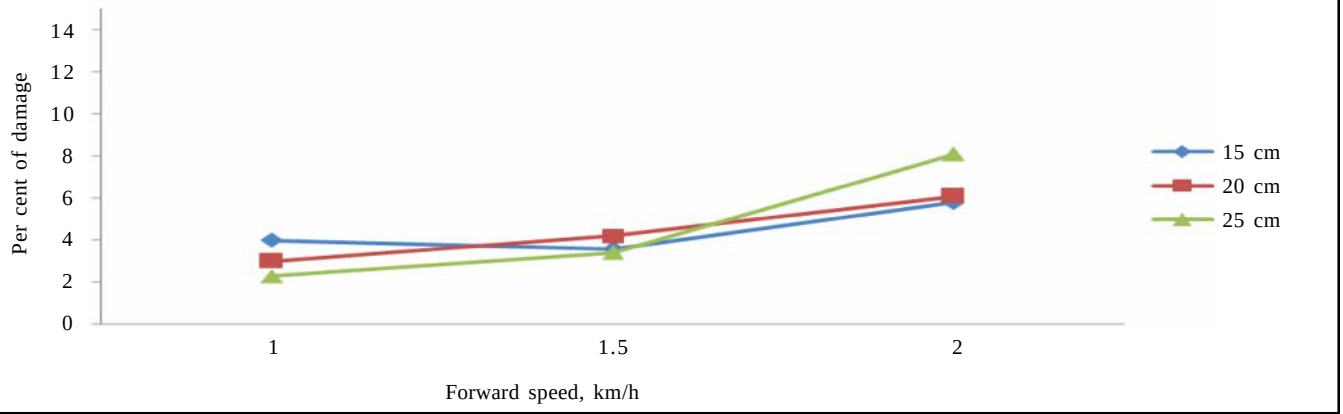

Fig. 5 : Relationship between visible mechanical damage and speed of operation

Co-efficient of uniformity :

Co-efficient of uniformity was determined to observe the evenness in spacing the corms at desired spacing by the metering unit and the result has been illustrated in Fig. 4. The confident of uniformity, for 15 cm nominal spacing, was found as 92.06, 92, 42 and 92.53 per cent for forward speed of 1, 15 and 2.0km/h, respectively. Similarly for 20 cm nominal spacing, it was observed as 89.61, 90.88 and 93.5 per cent, respectively for all the three speeds in order. Further, for 25 cm nominal corm spacing, the co-efficient of uniformity was observed as 97.21, 97.65 per cent for all the three speeds. A linear relationship was found to exist between forward speed and co-efficient of uniformity which when higher confident of uniformity for wider (25cm) corm to corm spacing, the co-efficient to other requited spacing, it was also found higher for higher speeds compared to lower speed of 1 km/h. the reason for higher co-efficient of uniformity at higher forward speed and co-efficient of uniformity which show higher co-efficient of uniformity for wider (25cm) corm to corm spacing compared to other required spacing. It was also found higher for higher speeds compared to lower speed of 1km/h. the reason for higher co-efficient of uniformity at higher forward speed may be due to the smooth operation of the planter compared to lower forward speed. This suggests operating the planter between 1.5 to 2 km/h forward speed.

Mechanical damage :

External damage caused by metering unit to the corms was determined and the result has been illustrated in Fig. 5. The average mechanical damage for 15 cm nominal spacing was found as 4.0, 3.6 and 5.8 per cent, respectively, for all the three levels of forward speeds, the mechanical damage for 20 and 25 cm nominal corm to corm spacing as observed 3.0, 3.1,6.1; 2.3, 3.4 and 6.1 per cent, respectively, for 1, 1.5, 2 km/h forward speed. The per cent damage increase with increase in forward speed of operation for all desired corm to corm spacing's. This was due to the fact that at higher speed corms could not fit into the cell of metering unit due to less available time and also due to accumulation of the corms at the bottom exit of the metallic hopper leading to higher damage per cent. However, the overall mechanical damage was found to be 4.16 per cent which is well within the accept able limit of 5 per cent.

Conclusion :

Based on the study it was conclude that cup in belt type metering unit developed for gladiolus bulb planting performed satisfactorily. The metering unit delivered the corms quite closer to the desired corm spacing with a maximum standard deviation of about 4 cm. the co-efficient of uniformity was found about 97 per cent for higher nominal spacing and forward speed of operation. The miss index was found lower values. The multiple index was found lower for higher speed of operation and wider corm to corm spacing compared to their lower values. The multiple index was found zero where as the quality feed index was found about 96 per cent. The result suggests adjusting the belt speed (forward speed) between 1.5 to 2 km/h for satisfactory performance.

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