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Effect of different dates of sowing on dynamics of insect pests of pigeonpea in Tarai region of Uttarakhand

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Abstract
Manipulation of date of sowing of crops is an important cultural practice to avoid the peak infestation of insect pests on the crop. Hence, present investigation was carried out to study the impact of sowing dates on the incidence of insect pests of pigeonpea in the Tarai region of Uttarakhand during 2016 and 2017. Four different sowing dates (*viz,* 10th June, 20th June, 10th July and 10th August) were selected for this study. The crop sown at 10th June showed significantly lower incidence of *Empoasca kerri*, *Clavigralla gibbosa*, *Helicoverpa armigera* and *Maruca vitrata* at early stage of the crop as against to other three sowing dates. Hence, the crop was escaped from early infestation of insect pests. The percent pod damage caused by *H. armigera* (1.85%) and *M. vitrata* (12.80%) was also found to be lowest on the crop sown at 10th June, while the pod damage by *M. obtusa* was lowest (21.05%) on the late sown crop (10th August). The yield data indicated that the crop sown on 10th June recorded significantly higher yield (1219 kg/ha) as compared to subsequent sowing, while the lowest yield (747 kg/ha) was noticed in crop sown on 10th August. Thus, this study showed that the first flush of the pigeonpea crop was escaped from peak activity of the *M. vitrata*, *H.armigera* and other sucking pests at early sowing. It is, therefore, 10th June would be the most suitable date of sowing for pigeonpea in the Tarai region of Uttarakhand.

Keywords: Date of sowing, insect pests, pigeonpea, pod damage, yield

1. Introduction
Pigeonpea [*Cajanus cajan* (L.) Millsp.] is an important pulse crop grown in India. It ranks sixth in global grain legume production and worldwide it is cultivated in about 4.70 m ha area with an annual production of 3.69 mt and a mean productivity of 783 kg/ha [2]. It has a high nutritional quality with 20 to 25 percent of protein on dry seed basis, which is almost 2.5 to 3.0 times of the value normally found in the cereals [22]. Due to it's rich source of protein, pigeonpea is more prone to the attack of insect pests. Hence, the insect pests are the major constraints for pigeonpea production and cause 78 percent loss to pigeonpea in India [13]. On an average, 2.5 to 3.0 million tonnes of pulses are lost annually with a monetary value of nearly Rs. 6000 crore due to the devastation of insect pest complex [18]. Researchers in many parts of India have confirmed that seed yield and seed quality are being adversely affected by major insect pests of pigeonpea. To tackle this problem farmers dump large amount of pesticides in the field which cause several environmental as well as health hazards. To overcome this problem of the indiscriminate use of pesticides, eco-friendly techniques such as agronomic practices can be utilised. One such method is altering the sowing dates in order to escape the peak activity of the insect by the crop. Date of sowing has a great impact on the incidence of the pest which may be attributed to the difference in weather conditions [6, 23, 5]. Early planted crops have less harboured with lowest pest population have the corresponding increase in the yield than the late planted crops [4, 1, 17]. Hence, it is essential to find out optimum sowing times where crop can escape damage of insect pests and offer excellent opportunity for the development such technology for pest management. Therefore, the present study was conducted to study the effect of sowing time on the incidence of insect pests of pigeonpea in the Tarai region of Uttarakhand.

2. Materials and Methods
A trial was conducted at N.E.B. Crop Research Centre, G.B.P.U.A & T, Pantnagar during *Kharif* 2016 and 2017 to study the impact of different sowing times on the incidence of insect pests, damage by pod borers and yield in pigeonpea. For this study, four different dates viz.,

10th June, 20th June, 10th July and 10th August were selected for sowing of the crop. The experiment was replicated thrice with Randomized Block Design. All recommended agronomic practices were followed except insecticidal sprays to grow the crop. The observations on the incidence of insect pests were recorded fortnightly on five randomly selected plants from germination to harvest of the crop. The data on jassids was recorded on trifoliate by counting the number of nymphs or adults on five tagged plants. Similarly, the number of *C. gibbosa*, larvae of *H. armigera* and webs of *M. vitrata* were counted on five tagged plants. The observations were taken by physical count of the insects and webs during morning hours between 8.00 to 10.00 am. Pod samples were also examined for the damage of major pod borers *viz., Maruca vitrata, Helicoverpa armigera* and *M. obtusa* in the laboratory. Following criteria were adopted to differentiate the damage of pod borers [12].

1. Healthy clear pods without any external damage symptom.
2. Pods attacked by *M. vitrata* having relatively small holes with scrapped margins, plugging of entrance hole with larval excreta.
3. Pods attacked by *Helicoverpa armigera* having big circular holes without larvae exuviae on the pods.
4. Pods damaged by *M. obtuse* having grains affected by maggots and small pin head size emergence hole and presence of puparia inside the pods after splitting up.

Besides, the total number of pods and number of damaged pods by various pod borers were recorded separately for each sample and converted into percent pod damage as indicated below:

$$\text{Percent pod damage} = \frac{\text{No. of damaged pods}}{\text{Total no. of pods}} \times 100$$

The data obtained was subjected to analysis of variance (ANOVA).

3. Results and Discussion

The data recorded on the incidence of insects *viz., Maruca vitrata, Helicoverpa armigera, Clavigralla gibbosa and Empoasca kerri* during different sowing dates is presented in Table 1 and 2.

3.1 Effect of dates of sowing of pigeonpea on spotted pod borer, *Marucavitrata*

It is evident from the data that the incidence of *M. vitrata* was reported at 100 days after germination (DAG) in crops sown on 10th June and 10th August, while on other dates of sowing i.e. on 20th June and 10th July, its incidence was reported at 85 DAG of the crop during both 2016 and 2017 (Fig 1). During 2016, the peak infestation of *M. vitrata* was found in 10th June sown crop at 130 DAG (22.62 webs/plant) while, in 20th June and 10th July sown crop, the maximum webs (28.22 and 32.44 webs/plant, respectively) was reported at 115 DAG and in 10th August sown crop, the peak of webs (35.00 webs/plant) was noticed at 100 DAG (Table 1). Similar observations were recorded during next year where the peak infestation in 10th June sown crop was found at 130 DAG (28.20 webs/plant) whereas, in 20th June and 10th July sown crops it was at 115 DAG (30.40 and 34.02 webs/plant, respectively) and in 10th August sown crop, the maximum webs (36.25 webs/plant) was noticed at 100 DAG (Table 2). The pod damage by *M. vitrata* was found minimum (12.70%) in early sown crop (10th June) with grain yield 1219.0 kg/ha as compared to the crop sown on other dates as 12.80%, 19.65% and 31.90% (20th June, 10th July and 10th August) during 2016-2017 (Table 3). The data on number of webs and percent pod damage by spotted pod borer revealed that the first flush of the 10th June sown crop was escaped from insect attack.

3.2 Effect of dates of sowing of pigeonpea on gram pod borer, *Helicoverpa armigera*

During 2016, the *H. armigera* infestation was not recorded in the crop sown on 10th June (Fig 2). The peak infestation of *H. armigera* was found maximum in crop sown on 10th August (0.22 larvae /plant) as compared to other dates with peak activity as 0.00, 0.20 and 0.20 larvae/plant at 10th June, 20th June and 10th July, respectively at 115 DAG (Table 1). During 2017, *H. armigera* larvae (0.22 larvae/plant) were reported only at 100 DAG in 10th June sown crop. In 10th August sown crop, the peak infestation was found at 115 DAG with maximum 0.60 larvae /plant as compared in the crops sown on other dates (Table 2).

The mean pod damage by *H. armigera* was found minimum (1.85%) in early sown crop (10th June) with grain yield 1219.0 kg/ha as compared to crop sown on 20th June, 10th July and 10th August with 2.10%, 4.35% and 5.90% pod damage, respectively (Table 3). Thus, the data on insect population and pod damage indicated that to reduce the damage caused by gram pod borer, pigeonpea crop should be sown early.

3.3 Effect of dates of sowing of pigeonpea on pod bug, *Clavigralla gibbosa*

During both years of experiment, the pod bug incidence was not reported in the crop sown on 10th June (Fig 3). During 2016, the infestation of *C. gibbosa* was started at 115 DAG in 20th June sown crops, whereas, in 10th July and 10th August sown crops, it was started at 100 DAG. The peak infestation of *C. gibbosa* was found at 145 DAG with maximum population (1.00 bugs/plant) in crop sown on 10th August, while the maximum bug population (0.40 and 0.60 bugs/plant) was reported at 130 DAG in both 20th June and 10th July sown crops (Table 1). Similarly during 2017, the maximum 1.00 pod bug/plant was reported at 145 DAG in crop sown on 10th August as compared to 0.40 bugs/plant at 130 DAG and 0.63 bugs/plant at 115 DAG in crops sown on 20th June and 10th July, respectively (Table 2). Hence, it is revealed from the study that the late sown crop had maximum infestation of pod bug as compare to early sown crop.

3.4 Effect of dates of sowing of pigeonpea onjassids, *Empoasca kerri*

During the year 2016, the peak infestation of *E. kerri* was found at 115 DAG with a maximum population (2.22 nymphs/trifoliate/plant) in late sown crop (10th August) as compared to maximum 1.42, 1.62 and 2.00 nymphs/trifoliate/plant in 10th June, 20th June and 10th July sown crops, respectively at 115 DAG (Table 1). Similarly during 2017, the peak infestation was found at 100 DAG with a maximum population (5.26 nymphs/trifoliate/plant) in late sown crop (10 August) as compared to other dates with peak activity during 115 DAG with 2.42, 3.63 and 4.03 nymphs/trifoliate/plant in 10th June, 20th June and 10th July crop, respectively (Table 2). It was evident from the results that the crop sown on 10th June had less incidence of *E. kerri* as compare to crops sown on other three dates (Fig 4).

3.5 Effect of dates of sowing of pigeonpea on pod fly, *Melanagromyza obtusa*

The pod damage by pod fly was taken during the harvest of the pigeonpea crop and the data indicated (Table 3) that lowest pod fly damage (21.05%) was observed at 10th August as compared to the crop sown on other dates as 29.40%, 27.20% and 25.30% at 10th June, 20th June and 10th July, respectively. This showed that with the advancement of sowing dates of the pigeonpea crop, an increase in the activity of pod fly was noticed. So, it can be concluded that the mid and late sown conditions are better to escape the pod damage by pod fly in the pigeonpea crop.

The studies on the impact of different dates of sowing on the incidence of insect pests and the damage by pod borers during a course of two years suggested that the population of *H. armigera* (0.20 larvae/plant) was lowest in the early sown crop (10 June). The population of *M. vitrata* (0.20 webs/plant) was also lowest on the crop sown on 10th June *i.e*., early sown conditions concluding to escape the first flush of pigeonpea from the attack of *M. vitrata*. The webbing and the pod damage were also lowest in the early sown conditions. Past studies have also noted minimum incidence of pod borer in early sowing [11, 8]. In another report, it was observed that early sowing resulted in lower incidence of lepidopteran pod borers *viz*., *Maruca testulalis*, *Exelastis atomosa* and *Helicoverpa armigera* and highest grain yield was recorded in early sowing of indeterminate varieties [20]. The significant highest percent pod damage by *H. armigera* and *M. vitrata* was recorded when the crop was sown on 10th August (5.9% and 31.9%). While, the lowest percent pod damage was observed during crop sown on 10 June (1.85% and 12.70%). This revealed that the pod damage by *H. armigera* and *M. vitrata* was low during early sown conditions of the crop. The same conclusion was also drawn for jassids (0.23 nymphs/trifoliate) and pod bug (0.16 bugs/plant), which showed lowest population during early sown conditions. Whereas, the percent pod damage by pod fly was highest (29.4%) when early sowing was done and lowest (21.05%) during late sown conditions. Present finding was in accordance with the earlier work where the lowest pod bug population was reported in 15th July sown crop [14]. The late sowing caused lower incidence of pod fly, *M. obtusa*. It was evident that late sowing of pigeonpea crop lowers the pod fly infestation [8, 20]. The yield of the crop was also lowered in the late sown conditions. The data indicated that the crop sown on 10 June (early sowing) recorded significantly higher yield (1219 kg/ha) as compared to the subsequent sowings, while the lowest yield was noticed in crop sown on 10 August (747 kg/ha). Other researchers also reported sharp decline in the grain yield of pigeonpea with delay in sowing time [15, 19, 7]. Results of present findings were validated with the past research works which also reported that the sowing dates had greater effect on pod damage and grain yield of chickpea [10, 3, 16]. Highest grain yield in chickpea was reported when sown early and lowest yield in late sown crop [1, 9]. Increased infestation of *H. armigera* was observed on late sown crop as compared to early sown crop [21].

The data on the following study showed that out of the four treatments *i.e.* 10 June, 20 June, 10 July and 10 August, the early sown conditions were most suitable for the crop. The early sown crop was damaged less by insect pests as compared to the crop sown on other sowing dates. The early sown crop also managed to escape the first flush of *Maruca vitrata* and hence less pod damage was observed. The yield of the crop was also found to be related with the different dates of sowing. The early sown crop yielded more as compared to the other three treatments.

Table 1: Effect of different sowing dates on incidence of insect pests of pigeonpea during 2015-16.

Observations	*Marucavitrata*/plant				*H. armigera*/plant				*C. gibbosa*/plant				*E. kerri*/trifoliate			
	10 June	20 June	10 July	10 August	10 June	20 June	10 July	10 August	10 June	20 June	10 July	10 August	10 June	20 June	10 July	10 August
85 DAG	0.00 (1.00)*	0.25 (1.11)	0.28 (1.12)	0.25 (1.11)	0.00 (1.00)	0.00 (1.00)	0.28 (1.12)	0.41 (1.22)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.25 (1.11)	1.00 (1.41)	1.26 (1.45)	1.43 (1.81)
100 DAG	5.60 (2.57)	10.18 (3.31)	12.62 (3.58)	35.00 (4.72)	0.00 (1.00)	0.20 (1.10)	0.21 (1.11)	0.40 (1.21)	0.00 (1.00)	0.00 (1.00)	0.20 (1.10)	0.23 (1.13)	1.00 (1.41)	1.20 (1.35)	1.40 (1.59)	1.70 (1.62)
115 DAG	8.20 (2.95)	28.22 (4.34)	32.44 (4.53)	18.41 (4.10)	0.00 (1.00)	0.20 (1.10)	0.20 (1.10)	0.22 (1.12)	0.00 (1.00)	0.40 (1.21)	0.20 (1.10)	0.42 (1.22)	1.42 (1.58)	1.62 (1.60)	2.00 (1.85)	2.22 (1.87)
130 DAG	22.62 (4.25)	8.22 (3.01)	11.22 (3.37)	12.02 (3.42)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.40 (1.21)	0.60 (1.25)	0.62 (1.25)	0.10 (1.05)	0.40 (1.16)	0.80 (1.34)	1.20 (1.35)
145 DAG	2.20 (1.86)	5.80 (2.55)	8.40 (2.68)	10.23 (2.88)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	1.00 (1.41)	0.11 (1.02)	0.20 (1.09)	0.40 (1.21)	0.50 (1.22)
SEm±	(0.21)	(0.25)	(0.33)	(0.38)	-	(0.05)	(0.17)	(0.19)	-	(0.11)	(0.13)	(0.16)	(0.10)	(0.14)	(0.19)	(0.23)
CD @ 5%	(0.63)	(0.74)	(0.99)	(1.14)	-	(0.15)	(0.51)	(0.57)	-	(0.33)	(0.39)	(0.48)	(0.31)	(0.42)	(0.57)	(0.63)

*Figures in the parentheses are $\sqrt{X + 0.5}$ transformed values

Table 2: Effect of different sowing dates on incidence of insect pests of pigeonpea during 2016-17

Observations	*Marucavitrata*/plant				*H. armigera*/plant				*C. gibbosa*/plant				*E. kerri*/trifoliate			
	10 June	20 June	10 July	10 August	10 June	20 June	10 July	10 August	10 June	20 June	10 July	10 August	10 June	20 June	10 July	10 August
85 DAG	0.00 (1.00)*	0.15 (1.11)	0.20 (1.10)	0.35 (1.15)	0.00 (1.00)	0.20 (1.10)	0.33 (1.16)	0.57 (1.75)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.83 (1.01)	1.00 (1.41)	1.40 (1.56)	1.70 (1.52)
100 DAG	5.46 (2.53)	14.25 (3.66)	14.66 (3.68)	36.25 (4.29)	0.22 (0.82)	0.20 (1.10)	0.40 (1.21)	0.40 (1.21)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	1.00 (1.41)	1.40 (1.55)	4.03 (2.23)	5.26 (2.54)
115 DAG	7.25 (2.84)	30.40 (4.19)	34.02 (4.22)	20.20 (3.95)	0.00 (1.00)	0.00 (1.00)	0.35 (1.15)	0.60 (1.24)	0.00 (1.00)	0.20 (1.09)	0.63 (1.25)	0.00 (1.00)	2.42 (1.52)	3.63 (2.15)	1.82 (1.71)	2.22 (1.75)
130 DAG	28.20 (4.02)	9.40 (3.17)	17.21 (3.71)	18.00 (3.75)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.40 (1.21)	0.53 (1.23)	0.60 (1.26)	0.80 (1.01)	1.00 (1.41)	1.81 (1.71)	2.77 (1.93)
145 DAG	11.68 (3.22)	6.00 (2.61)	9.40 (3.15)	11.20 (3.51)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.20 (1.10)	1.00 (1.41)	0.23 (1.11)	0.40 (1.18)	0.63 (1.27)	1.80 (1.67)

SEm±	(0.18)	(0.20)	(0.26)	(0.34)	-	(0.07)	(0.10)	(0.15)	-	(0.06)	(0.07)	(0.09)	(0.12)	(0.20)	(0.24)	(0.31)
CD @ 5%	(0.54)	(0.60)	(0.78)	(1.02)	-	(0.21)	(0.30)	(0.45)	-	(0.18)	(0.21)	(0.27)	(0.36)	(0.60)	(0.72)	(0.92)

*Figures in the parentheses a are $\sqrt{X + 0.5}$ transformed values

Table 3: Impact of different sowing dates on pod damage by pod borers

Date of sowing	Percent Pod Damage (Pooled mean of two years)			Pooled Mean Yield
	Helicoverpa armigera	*Maruca vitrata*	*Melanagromyza obtusa*	
10th June	1.85(0.81)	12.80(2.47)	29.40(3.26)	1219.00
20th June	2.10(0.96)	17.56(2.53)	27.20(3.28)	1090.05
10th July	4.35(1.72)	19.65(2.84)	25.30(3.19)	977.90
10th August	5.90(1.22)	31.90(3.45)	21.05(2.87)	747.00
SEm±	(0.72)	(1.02)	(1.55)	(69.3)
CD @ 5%	(2.02)	(3.08)	(4.65)	(20.81)

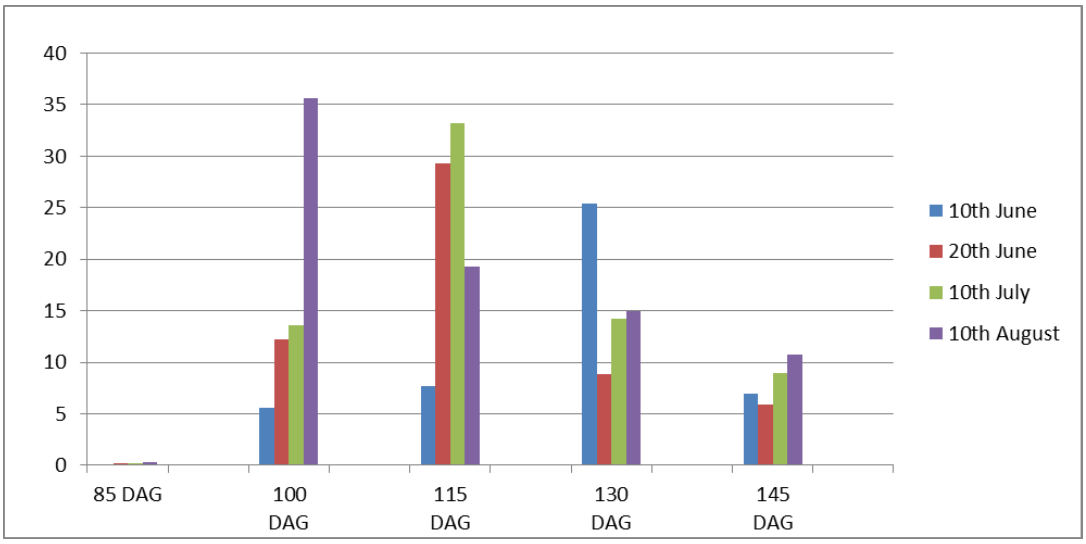

Fig 1: Effect of date of sowing on dynamics of *M. vitrata* during 2016 and 2017

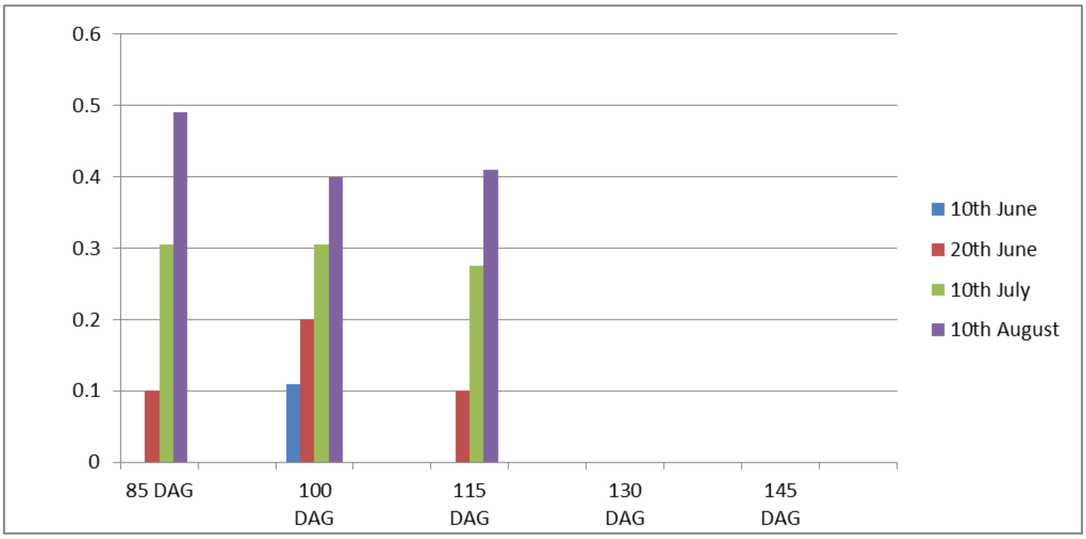

Fig 2: Effect of date of sowing on dynamics of *H. armigera* during 2016 and 2017

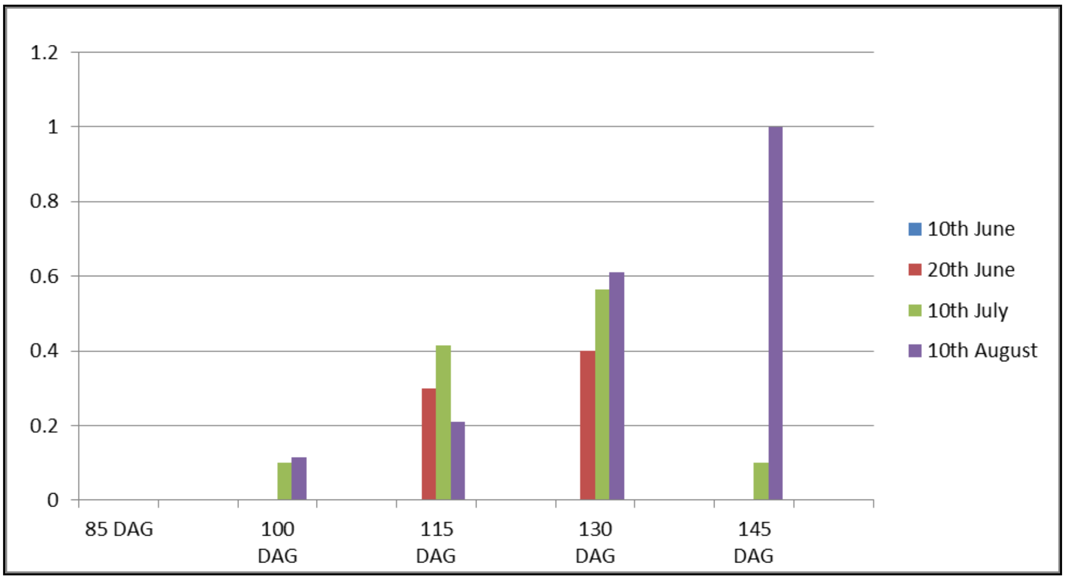

Fig 3: Effect of date of sowing on dynamics of *C. gibbosa* during 2016 and 2017

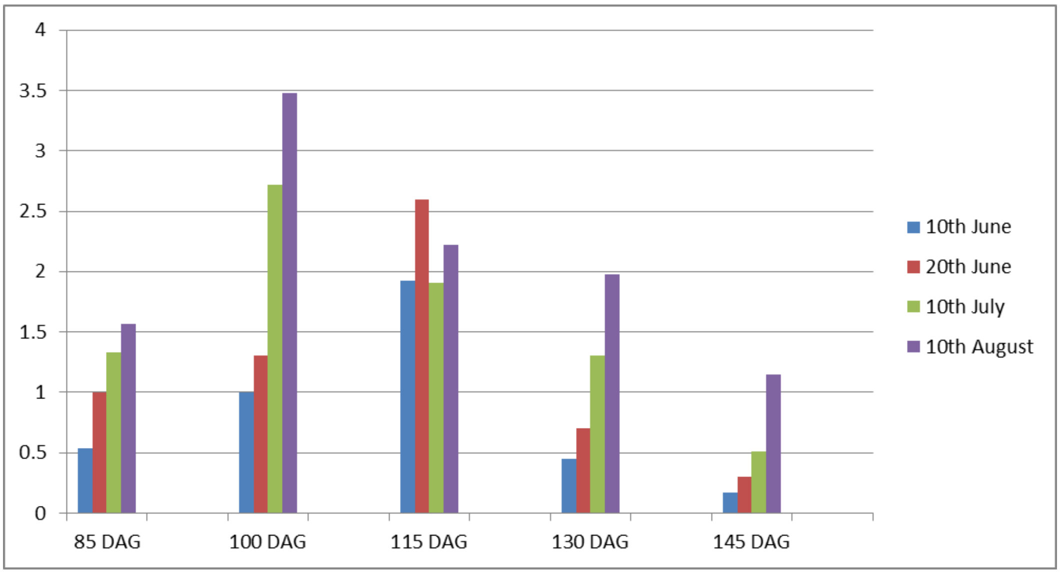

Fig 4: Effect of date of sowing on dynamics of *E. kerri* during 2016 and 2017

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