

**STUDIES ON MAXIMIZING SEED YIELD AND QUALITY
IN NIGER (*Guizotia abyssinica* Cass.)**

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1. INTRODUCTION

Among the food crops, oilseed crops are considered as backbone of the Indian agricultural economy. India ranks third in the world after China and USA in the production of oilseeds. The oil seed crops have a wide adaptability and are grown under varied agro-climatic conditions throughout the world. The annual oilseed crops grown in India are soybean, groundnut, rape and mustard, linseed, sunflower, sesame, safflower and niger. The oil seeds, products and oil produced by the oilseed crops are important for cooking, preparation of pickles, flavouring the curry, animal feed, soap manufacture, industrial use etc. Oil seeds have a very significant role in Indian agriculture since almost each part of the plant is consumed either by human beings or animal depending upon the crop and in growth stage except castor. But the production and productivity of oil seeds is limited by a number of biotic and abiotic stresses. Among the abiotic factors, temperature, rainfall, relative humidity, photoperiod and soil moisture are the limiting factors in realization of maximum yield.

Niger (*Guizotia abyssinica* Cass.) is one of the important minor oilseed crops of India. It is known by various names such as Noog in Ethiopian and Ramtil or Kalatil in India. In India niger is cultivated in an area of about 3.84 lakh ha annually with a production of 1.08 lakh tonnes with an productivity of 281 kg per ha (Anon. 2007).

It is considered as minor oil seed crop but it is very important in terms of its oil content, quality and potentiality. The important feature of this crop is that it gives reasonable seed yield even under poor marginal growing conditions. Niger is mainly used for extraction (about 30-50%) of oil. Oil is inferior quality and is used for soap making, lighting, lubrication and as drying oil. Whereas, plant is used for fodder and for making silage. It is mainly cultivated to a limited extent in Ethiopia, South Africa, East Africa, West Indies, Zimbabwe and India. In India, it is chiefly cultivated in Madhya Pradesh, Orissa, Maharastra, Bihar, Karnataka and Andhra Pradesh mostly on the hill tops and slopes as a inter or mixed crop.

In Karnataka niger crop is grown in an area of 0.33 lakh ha with a production of 0.16 lakh tonnes and a productivity of 182 kg per ha (Anon., 2007).

Low production of Niger is attributed to the fact that the crop is usually grown under rainfed situation on a marginal land with less fertile soils during *kharif* season. Further, lack of improved seed production technology and suitable high yielding varieties, are the major causes for the low seed yield.

Varieties play an important role in determining the yield of a crop, the potential yield of varieties within its genetic limit is set by its environment. The release of new varieties of niger is major break through in achieving in increased production per unit area. Yield of these varieties can be further improved by providing optimum environment by manipulating agronomic practices. Varieties differ in their yield potential depending upon many physiological process which are controlled by both genetic makeup and the environment.

Time of sowing determines the time available for vegetative growth before the onset of flowering, which is mainly influenced by photoperiod, sowing time determines the plant height, number of branches, flowering, capitula bearing habits. Thus the time of sowing has prominent influence on both vegetative and reproductive process of niger which has a diverse effect on the production.

Production potentiality of niger can be fully exploited with suitable agronomic practices and genotypes. Among the different practices, sowing at optimum time plays an important role to exploit the full genetic potentiality of a variety as it provides optimum growing conditions such as temperature, light, humidity and rainfall. The growth phase of the crop should synchronize with optimum environmental conditions for better expression of growth, yield and its ancillary characters. It is the fact that a specified genotype does not exhibit the same phenotypic characteristics under all environmental conditions and different genotypes respond differentially to a specified environment and their relative ranking usually differ (Eberhort and Russel, 1966) and ultimately decides the selection of genotypes for a particular

or different sowing dates to stabilize or to get higher yields (Finlay and Wilkinson, 1963). With this background, the present investigation was planned with the following objectives.

- i. To study the effect of growing season on growth and yield parameters of niger.
- ii. To find out the optimum time of sowing in each season for maximizing seed yield and quality in niger.
- iii. To evaluate the performance of varieties for seed yield and quality parameters in different seasons.
- iv. To find out interaction of variety and date of sowing on seed yield and quality of niger.

2. REVIEW OF LITERATURE

The ability of a genotype for positive response to the season and other bio-physico environments evidently have a functional significance. Seasonal effect, cultivar choice and other agronomic practices play pivotal role in influencing the yield and quality of niger. The research work done on these aspects is reviewed in this chapter.

2.1 Performance of varieties

In an experiment carried out on sesamum under rainfed conditions at Dharwad during *kharif* 1972, indicated that cultivar Dharwad local gave higher yield compared to C-50. The higher yield in case of Dharwad local was mainly due to higher seed weight per plant, seed weight per capsule, 1000 seed weight and length of capsule (Krishnegowda and Krishnamurthy, 1977). Shivappa (1980) reported that, among four sesamum genotypes tried NP-85 gave significantly higher yield as compared to other genotypes, which could be attributed to significantly more plant height, number of capsules and weight of grains per plant. Saha and Bhargava (1980) reported that among the five sesame genotypes, NP-6 gave higher seed yield. The increased yield in NP-6 was associated with higher number of capsules and higher number of fruiting branches.

Among the 33 varieties and two wild species of sesame 51-51-51 gave higher seed yield (17.0 g/plant) whereas NP-66-173 gave very less seed yield (3.8 g/plant) (Chandramony and Padmaja, 1982). Gangakishan *et al.* (1983) concluded that new variety "Rajeshwari" (selection from N-62-39) recorded higher average yield (450 kg/ha) than national check TC-25 (265 kg/ha). The increase in seed yield was attributed to more number of effective branches and more number of capsules per plant. Khadar and Nair (1984) evaluated 15 genotypes of sesame at two locations namely upland during *rabi* at Vellayani and rice fallows during summer at Kayamkulam and reported that variety number 42-1 gave maximum yield at both the locations and this higher yield was attributed to more number of pods, longer pods, more number of seeds per pod and higher seed weight.

In a field experiment conducted during *kharif* at Tikamgarh (MP) CST-785 variety gave higher seed yield and higher net returns per hectare as compared to OMT-3, RT-46 and RAUSS-17-4 varieties (Tiwari *et al.*, 1994a). Tiwari *et al.* (1994b) evaluated four sesame varieties with different N levels under summer condition and reported that Cv. JLSC-8 produced significantly higher seed yield (2.92 q/ha) than TKG-21 (2.80 q/ha) and others. The increased seed yield was attributed to significantly more number of capsule per plant and number of seeds per capsules. Variety Co-1 gave significantly higher seed yield (3.71 q/ha) followed by TKG-9 (3.17 q/ha) and TKG-21 (2.54 q/ha) (Tiwari *et al.*, 1994). The results of the field experiment conducted at Parabhani has indicated that, JLT-7 gave significantly higher seed yield (459.1 kg/ha) than T-85 (350.6 kg/ha) (Nirval *et al.*, 1995).

Narayan and Narayanan (1987) obtained higher yield with TMV-3 as compared to all other varieties of sesamum. Arunachalam (1989) reported on effect of sowing dates. Variety T-85 recorded higher seed yield than Phule-1, but its oil content in the seed was not significantly higher than Phule-1 (Kadam *et al.*, 1989).

The results of comparative yield trial conducted during summer 1986, at Coimbatore, indicated that variety TBAV-11 (746 kg/ha) out yielded over local check (613 kg/ha) (Anon., 1986). In another experiment conducted at Berhampur, four varieties *viz.*, P-25-4-3, P-6-3-3, P-6-3-2 and P-9-4-1 recorded significantly higher yield over check RAUSS-17-16 (Anon., 1986). Delgado and Yermanos (1987) indicated that number of seeds per capsule, 1000 seed weight, days to maturity and number of capsules per plant exhibited positive and significant correlation with seed yield in sesamum.

Verulkar and Upadhyay (1989) evaluated nine varieties of niger for stability parameters with respect to seed yield and its components in nine environments, created by agronomic manipulations under rainfed conditions, CHH-1 was the only genotype found to be stable and derived for seed yield per plant, varieties Gandaguda-1 and No-71 yielded

significantly higher than other cultivars but significant deviation from regression render them unstable.

Tomar (1990) reported that N-32 (482 kg/ha) was superior to JT-7 (384 kg/ha) in yield due to more number of capsules per plant in sesame. Rao *et al.* (1990) observed that the variety Gouri gave significantly higher yield (390 kg/ha) over Madhavi (306 kg/ha) during *kharif* season at Anakapalle. The increase in sesame yield was mainly due to more number of capsules per plant, plant height and number of branches per plant was observed in Gouri variety.

At Similiguda (Orissa), experiment was conducted on niger during *kharif* 1989, 1990 and 1991 with three varieties *viz.*, Un-4, GA-10, IGP-76 with six dates of sowing from 21st July with 10 days interval. The three years results (Anon. 1991) indicated that sowing upto 20th August gave higher yield after that yield of niger reduced drastically variety GA-10 sown on 31st July gave the higher yield (517 kg/ha) closely followed by the same variety sown on 10th August (489 kg/ha) (Anon., 2007).

Misra *et al.* (1991) conducted an experiment in which eighteen improved niger varieties were tested during rainy and winter seasons for two years (1988-89 and 1989-90), average yield during rainy and winter seasons were 4.62 and 6.42 q per ha, respectively. They concluded that the varieties suitable for rainy season were ONS-7, ONS-5, GA-10 and CN-1 and for winter season were ONS-4, GA-1, ONS-2, ONS-8 and GA-5.

Padma and Madhusudhanrao (1992) reported that groundnut pod yield decreased significantly under moisture stress conditions in all cultivars. While, the magnitude was low in JL-24 (24 %). Similarly under delayed sowing both in rainy season and post-rainy season, the cultivars exhibited significant reduction in pod yield, in all cultivars whereas minimum reduction was with JL-24 (33% in both the seasons).

Sesame cultivar E-8 recorded significantly higher yield (759 kg/ha) than DS-1 (667 kg/ha) in a study conducted during summer season at Sirguppa, Karnataka. The increase in yield was attributed mainly due to significantly more capsules per plant, capsules per m² and branches per plant in 'E-8' than in DS-1 variety. The plant height was also significantly more in 'E-8' than in 'DS-1' which might have helped for bearing of more capsules per plant (Channabasavanna and Setty, 1992). Ghungarde *et al.* (1992) reported that sesame variety 'JLT-7' (639 kg/ha) produced significantly higher grain yield per ha than Punjab-1 (523 kg/ha).

The results of the experiment conducted at Bijapur under rainfed conditions by Itnal *et al.* (1993) indicated higher yields with G-Til-1 and TMV-3 than local cultivar. The increase in seed yield was due to increased number of capsules and seed weight per plant in these varieties of sesamum as compared to the local variety. Sarma (1994) reported that Madhavi and Gouri sesamum varieties recorded higher yield than TC-25.

Among the eleven promising varieties of sesamum evaluated with local standards at Vridhachalam, indicated that T-7 was superior to others with respect to yield (Parameshwar *et al.*, 1995). In another experiment conducted during summer at Vridhachalam, between the two genotypes tried, TMV-6 gave higher seed yield than to TMV-4 (Balasubramaniam, 1996).

Mishra *et al.* (1997) evaluated 12 sesame varieties and concluded that Krishna gave the highest seed yield followed by Kanaka and OMT-30. Among the six varieties tried, Kalika gave higher seed yield (790 kg/ha) than other varieties. This increased seed yield in Kalika was attributed to higher number of branches and capsules per plant (Moorthy *et al.*, 1997).

Baly Akula and Bapi Reddy (1998) conducted a trial on castor for different dates of sowing on yield, all the cultivars sown on 15th June gave higher yields when compared to delayed sowings.

Gupta *et al.* (1998) reported that the three cultivars of sesame *viz.*, cv. HT1, HT24 and HT35 were sown on 1st July, 10th July (normal date), 20th and 30th July. The oil content and acid contents did not differ significantly among the cultivars. Total oil content was 47.9, 49.6, 48.1 and 45.3 per cent with four sowing dates.

Effect of different dates of sowing on sesame varieties during summer was studied at Jabalpur. The results indicated that the highest yield (1285 kg/ha) was recorded under 19th February sowing with variety Uma gave highest yield which was at par with RT-46 (1256 kg/ha), TKG-22 (1129 kg/ha) under same date of sowing (Anon., 2001).

2.2 Dates of sowing

2.2.1 Growth parameters

Alessi *et al.* (1977) reported that the days from planting to 50 per cent flowering decreased as the planting date was delayed in sunflower.

Sheelavanthar and Patil (1987) reported that under long day condition (April-May) soybean recorded higher plant height, more number of branches and leaves per plant and also higher seed yield when compared to sowing under short day conditions (November-December) in soybean.

Mishra and Sahu (1988) recorded highest plant height and number of branches per plant in niger at early sowing compared to delayed sowing in *kharif*.

The experiment conducted on different dates of sowing at Tikamgrah (Budelkar) region of Madhya Pradesh and Uttar Pradesh revealed that sowing of niger in first week of July, was most appropriate (Anon., 1988).

Tomar and Mishra (1989) conducted that the growth parameters like plant height, number of primary and secondary branches and yield attributing characters *viz.*, number of capsules, grains per capsule, grain yield per plant, test weight and harvest index were the highest in the first date of sowing.

Mishra *et al.* (1990) conducted an experiment during *kharif* season with a view to ascertain the optimum sowing time for soybean. Period from June 17th to July 1st was considered to be optimum for sowing. One week early or late sowing than optimum time showed yield reduction of about 10 per cent. But the delayed sown crop beyond July 8th resulted in 35-85 per cent reduction in grain yield. This increased yield was mainly because of more number of pods per plant, number of seeds per pod and higher test weight.

Nayak and Paikary (1991) concluded that delayed sowing niger reduced all growth and yield attributing characters progressively.

Plant height, dry matter accumulation, number of branches per plant, leaf area per plant and leaf area index did not differ significantly due to interaction effect of soybean varieties and different dates of sowing (Jayanth Kumar, 1993).

Seed yield in soybean is strongly associated with the number of main stem nodes. Number of main stem nodes and plant height may be useful selection criteria for improving seed yield. Generally early sowing gave higher seed yield than late sowing because of more plant height and stem nodes Akthar and Shelier (1996). Tomkins *et al.* (1993) reported that soybean genotypes with long juvenile growth exhibited development more number of branches followed by greater preparation of seed yield components on branches compared to conventional type at early sowing date.

Similarly, Paul and Sharma (1993) observed the stunted growth and development and also reduction in the plant height, number of branches, number of leaves and thousand seed weight in July planted soybean due to gradually decreasing temperature during the growth as compared to May sowing.

Sharma (1994) reported that the soybean crop required 153 days to maturity when normal sowing was done during May, whereas for late sowing in August required 83 days.

Singh *et al.* (1994) reported that in soybean sown in June followed by July and August sowing caused the least variation in days to flowering, whereas April sowing resulted

in greater variations. Flowering was late when sown in February possibly due to their higher critical day length requirement.

A short photo period (12 h) with high temperature reduced the length of time to flowering, while a long photo period (13 or 14 h) with high temperature resulted in taller plants, in soybean (Camara *et al.*, 1997). Ghadekar and Darange (1995) indicated that the mean thermal demand of soybean crop was about 1450 degrees days over a period of 16 weeks and delaying sowing prolonged the maturity due to inadequate heat accumulation.

Paul *et al.* (1995) reported that the tallest plants were recorded on 5th September and 25th September sowing in 1987-88 and 1988-89, respectively in niger and concluded that plant height and number of branches per plant decreased with delay in sowing.

Paul *et al.* (1995) revealed that the plant height, number of branches per plant and grain yield (ha) decreased significantly with the delayed sowing in niger.

Sowing date had a pronounced effect on various phenophases. Delay of 45 days in sowing (5th June to 20th July) curtailed the vegetative period by 26 days and reproductive phase by 14 days. Total maturity of the crop was cut down from 145 days in 5th June sown crop at 131, 117 and 105 days in 20th June, 5th July and 20th July sown crops respectively, the crop sown on 5th June accumulated the maximum number of heat units (Dhingra *et al.*, 1995) in soybean.

Babalad *et al.* (1996) revealed that soybean sown during first fortnight to second fortnight of January differed significantly higher seed yield than early sowing in November or December. Plant height, number of branches and number of pods per plant were significantly higher with January sowing as compared to November and December sowings.

Shafshak *et al.* (1997) was of the opinion that the early sowing increased the plant height in soybean and height had significant positive correlation with seed yield. Kane *et al.* (1997) reported that cool temperature during vegetative growth suppressed the vegetative growth of early maturing cultivars and for early sowing dates.

Sudhakara *et al.* (1998) conducted experiment on sunflower and observed significant differences on growth attributes and yield components due to time of sowing and concluded that sowing of sunflower in the second fortnight of July compared to other sowings resulted in improved growth of plants.

Paikaray and Mishra (1999) reported the effects of sowing date (20th or 21st July, 20th or 30th August or 10th September) on the productivity of niger (*G. abyssinica*) in Sunabeda, Orissa during the rainy season of 1989-92. Stalk yield, number of days to flowering and maturity, plant height were decreased with the delay in sowing date. The seed yield components *viz.*, number of capitula and seeds per capitula and seed yield per plant and per hectare increased with delay in sowing upto 20th August, followed by a decrease with further delay in sowings of niger.

Thanki *et al.* (2004) reported that sowing of sesame in 17th February gave the highest plant height (104 cm) and pooled seed yield (1290 kg/ha) as compared to other sowing dates.

Damavandi *et al.* (2005) conducted an experiment to study the effect of sowing date (24th April, 7th May, 21st May and 2nd June) on the growth and development, yield and yield components of sunflower and early sowing date had a significant effect on number of seeds per head and kernel yield as compared to the delayed sowing dates.

Priya *et al.* (2007) concluded that sowing of niger on July 1st produced highest plant height (129.1 cm), number of primary and secondary branches (11.5 and 21.5), leaf area (511.0), leaf area index (1.23) and also per cent disease incidence (74.4) as compared to other sowings.

2.2.2 Yield parameters

Gopalkrishnan *et al.* (1967) reported that, among three strains of sesame tried, TMV-2 gave higher yield under winter season as compared to summer and *kharif*. Varieties sown in two different seasons showed large yield differences with higher yields in winter than in summer. Narayanan and Narayan (1987) reported that *rabi* sown crop gave significantly higher yield (31.1 g/m²) than summer (16.2 g/m²) and monsoon (13.4 g/ m²) sown crop, mainly due to higher number of capsules per square meter cm⁻² and significantly higher test weight in sesamum.

In the field trial with 20 *Sesamum indicum* strains and four sowing dates, it was found that varieties *viz.*, C-1036 and TMV-3 gave the highest yield when sown on 15th February (Astana and Bhup Narain, 1977) as compared to other strains.

Krishnarajan *et al.* (1979) conducted a critical scrutiny of the yield recorded over different dates of sowing in sunflower and revealed that there was increasing trend in the yield starting from the sowing in the first fortnight of July and the yield reached the maximum at the first fortnight of August.

Ashok Kumar *et al.* (1985) reported that seed yield obtained in different seasons and plant densities differed significantly for higher seed yield as obtained with summer (2078 kg/ha) and it was on par with *rabi* yield (2000 kg/ha). While significantly lower yield was realized during *kharif* (1548 kg/ha) in sunflower.

Chaonkar and Arvind Kumar (1985) observed that yield contributing characters *viz.*, pod yield and oil content were significantly higher in early planting over delayed planting in groundnut.

Rao *et al.* (1985) conducted that the sowing date had significant effect on growth and development. The yield attributing characters such as plant height and number of fruits per plant were maximum under first date of sowing (July 10) and significant reduction of these attributes were noticed with progressive delay in sowing of sesamum.

Hiruy Belayneh *et al.* (1986) reported that locations and year were greatly affected for seed yield and reduction in yields in niger was observed when planting was delayed beyond July.

In field trials during *kharif* 1987 soybean Cv. Bragg and JS-2 were sown on 1st or 16th April, May, June, July, August or September. Seed yield was not significantly differed between cultivars. However, sowing on 16th June gave the highest seed yield, delaying in sowing thereafter greatly reduced the seed yield (Paul and Guha, 1994).

More and Khade (1987) observed that groundnut shown on various sowings, 28th February gave the highest yield of dry pod (31.17 q/ha) which was on par with sowings on 7th February and 21st March but significantly superior over sowings on 15th January.

Narayanan and Narayan (1987) reported that maximum yield was obtained when sesame was grown during summer season in all the cultivars. However, the yield did not vary among the cultivars in this season.

Raghuwanshi *et al.* (1988) revealed that sowing of soybean in the first week of July produced higher grain yield as compared to that sown in the last week of July in both the years of experimentation.

Sharma *et al.* (1991) found that soybean sown on 15th July and 30th July, yields were reduced by 17 and 32 per cent, respectively as compared to the sowing on 20th July during *kharif*. In contrast to this, Nagre *et al.* (1991) reported that soybean yield was not significantly affected due to delay in sowing upto 16th July.

The experiment conducted at Bundelkhand (MP) on niger with three dates of sowing (D₁, D₂ and D₃) starting from 23rd June, 1988 having 15 days interval. The results revealed that D₂ (sown on 23rd July) gave significantly higher yield (271 and 262 kg/ha) than D₁ (sown on 23rd June) with 121 kg/ha (Anon., 1988).

Tomar (1989) revealed that date of sowing in linseed had significant effect on seed yield. The seed yield was higher (846.58 kg/ha) under first date of sowing but not differed significantly from 2nd date of sowing. Oil per cent, plant height, primary and secondary branches per plant, siliquae per plant, number of grains per siliquae and test weight were also maximum under first date of sowing.

Potdar and Asmotaddin (1991) conducted a field experiment with different dates of sowing and reported that soybean seed yield did not differ significantly between 9th June and 17th June. However, these seed yields were significantly higher as compared to sowing on 5th July. Ramesh and Gopalswamy (1992) reported that seed yield obtained from 1st July sowing was higher as compared to other two dates of sowing (16th June and 16th July). Singh and Bajpai (1992) observed a reduction in seed yield due to delay in sowing after 22nd June during *kharif*.

Rani *et al.* (1991) reported that average seed yield of sesame Cv. Madhavi and Gouri sown on 16th May and 15th June gave significantly higher yield than delayed sowings. Chimanshette and Dhoble (1992) reported that JLT-7 when sown in first fortnight of July gave significantly higher seed yield (652.87 kg/ha) as compared to other sowing dates. In another experiment, Punjab-1 sown on 12th February (1065 kg/ha) recorded significantly higher yield (1065 kg/ha) when compared to other sowing dates and other varieties (Patil *et al.*, 1992). Tiwari *et al.* (1994b) reported that, sesame variety JLSC-8 when sown on first July gave significantly higher seed yield (633 kg/ha) when compared to other sowing dates and increased the yield was attributed to more number of capsules per plant and number of seeds per capsules.

Results indicated that sowing of niger on 10th August gave higher yield (453 kg/ha) sowing at 21st July and 31st July were all at par with 10th August sowing. However, the yield reduced significantly and drastically in later dates, variety GA-10 gave significantly higher yield followed by IGP-76 both being at par (Anon., 1991).

Bhalerao *et al.* (1994) conducted a field experiment trail in sunflower cv. Morden and MSRH-17 and observed highest seed yield and was highest (mean 1.28 t) from sowing on 10th September. The highest oil yield (495 kg/ha) was given by sowing on 10th October, Sowing between 10th September and 25th October in recommended.

Billore *et al.* (1994) found that sowing of soybean during first week of July gave significantly higher seed yield than sowing in the fourth week of July in Madhya Pradesh.

Padhi (1994) revealed that groundnut shown during first June sowing recorded significantly the highest pods/plant, filled pods per plant, while consequently revealed in highest pod yield and shelling percentage followed by 14th June sowing.

Sharma and Kewat (1994) reported that seed yield of niger was significantly reduced as the sowing was delayed beyond mid July.

Tiwari *et al.* (1994) conducted a field experiment at Takamgarh (MP) in the *kharif* 1990 with sesame cv. TKG-9, TKG-21, JLSC-8 and JT-7 and they obtained the mean seed yield of 2.53, 2.80, 2.92 and 2.86 t per ha, respectively, when sown at on set of monsoon (1st July), or 10th or 20th days after this date.

Tiwari *et al.* (1994a) reported that sowing of sesamum at the onset of monsoon (1st July) proved to be most advantageous for yield than delayed sowing.

Nirval *et al.* (1995) conducted the field trails on sesamum in *kharif* (monsoon) 1982-92 at Parabhani, Maharashtra, sesame cultivates were sown at the onset of monsoon or late by 10, 20, 30 days after and seed yield of 351 kg per ha in T-85 and 459 kg in JLT-7 were obtained and yield was with delayed sowing after monsoon.

Shesodia *et al.* (1995) reported that soybean seed yield decreased with delay in sowing date and was highest on 22nd June sowing.

Agarwal *et al.* (1996) noticed that time of sowing had a significant influence on yield and yield attributes of niger, the crop sown on 1st and 19th November produced maximum yield of 10.19 and 9.65 q per ha, but reduced significantly by delayed sowing on 10th or 30th December sowing dates.

Choudhary and Thakuria (1996) reported that during *rabi* 1994-95, four rainfed niger (*Guizotia abyssinica*) varieties were evaluated at four different sowing dates. Seed yields decreased with delay in sowing and they concluded that sowing should not be delayed beyond 20th November.

Patil *et al.* (1996) conducted that groundnut cultivars sown on 15th and 30th June recorded significantly higher pod yield than 15th and 30th July sowings.

Reddy and Kumar (1996) observed significantly higher seed yield in sunflower over later dates of sowing, however the seed yields drastically decreased when the crop was sown on January 8. The decrease in seed yield was 55 per cent when compared to that sown on October 10.

Seed yield of soybean differed significantly due to sowing time and early sowing during second fortnight of June produced significantly higher seed yield compared to delay in sowing time (Lingaraj *et al.*, 1996).

However, Kane *et al.* (1997) reported that under favourable moisture conditions sowing date appeared to be less important for early maturing cultivars of soybean.

Madhavi *et al.* (1997) conducted that sowing of soybean on 1st July found superior in respect to plant height (75 DAS), total dry matter and finally grain yield and decreased progressively with corresponding delay in sowing.

Sowing of soybean is normally done from first week of June to last week of July and some times it is delayed, due to non-receipt of rains. Delay in sowing of soybean during *kharif* has been reported to bring about a reduction in the seed yield (Chandel *et al.*, 1995, Kane *et al.*, 1997 and Rani (1997).

Chavan *et al.* (1998) revealed that soybean crop sown on 31st January and 15th February recorded higher values of all yield attributes *viz.*, number of branches per plant, pods per plant, seeds per pod and 1000 seed weight compared to earlier sown crop on 5th and 15th January.

Patra *et al.* (1998) conducted that groundnut pod yield reduced in the sowings done on 15th January and 15th March by 22.9 and 26.0 per cent respectively over 15th February sowing.

Padhi and Sahoo (1999) conducted an experiment for three pre *rabi* season during 1989-92 to find out the effect of sowing date and nitrogen level on yield of niger, sowing on 15th August gave the highest yield as compared to other dates of sowing.

Billore *et al.* (2000) reported that the average soybean seed yield decreased linearly by 118.77 kg per ha for every 5 days delay in sowing from the normal date (25 June).

Vyakaranahal *et al.* (2001) reported that early sowing of sunflower in *kharif* (July) recorded 38.4 per cent higher processed seed yield, other yield attributes and seed quality parameters as compared to the late planting (August).

Calskan *et al.* (2002) studied the effect of sowing date on the phenological development, seed yield and oil content of sunflower Cv. C207 and Istranca sown at two weeks interval from 1 March to 15 July. Delay in sowing shortened the period of emergence head initiation and total duration. Seed yield increased until 1st April and then onwards

decreased greatly. With further delay in sowing in both the cultivars. The higher oil contents were also recorded with earlier sown crop.

Gaurilow *et al.* (2003) studied the effect of various sowing dates on the production of early maturity sunflower cultivar and they found that the optimum sowing time was from 30th April to 5th May and there was reduction in the seed yield in later sowings.

Karanjekar *et al.* (2004) observed the decreased pod yield in groundnut with delay in sowing. The number of pods per plant, shelling percentage and 100 kernel weight were decreased with delay in sowings.

Reddy *et al.* (2004) conducted the experiment on influence of dates of sowing on sunflower. Early sowing resulted in better growth and recorded higher seed yield of 1016 kg per ha and 1010 kg per ha during 1997 and 1998, respectively.

Asghar Ali *et al.* (2005) conducted that effect of sowing dates on sesame. It was highly significant and maximum seed yield was produced when the crop was sown on 8th and 15th July due to higher number of capsules per plant and more seeds per capsule.

Murali and Balasubramanian (2005) conducted an experiment on sowing date influence on sunflower. Among the different yield components of sunflower, head diameter alone showed significant difference for sowing taken during 15th meteorological standard week (S2) during both the years of experiment.

At Kanke, the data on seed yield showed that maximum seed yield of 420 kg/ha in T₂ (D₁I₂) was followed by 391 kg/ha in T₆ (D₁I₃) and 389 kg/ha in T₁ (D₁I₁) which were at par to each other (Anon., 2007) in niger.

At semiliguda, the data revealed that the maximum seed yield of 735 kg/ha in T₃ (D₁I₃) was followed by 705 kg/ha in T₂ (D₁I₂) and significantly superior to 641 kg/ha in T₁ (D₁I₁) (Anon., 2007) in niger.

Experiment conducted at Chindwara to study the effect of date of sowing and irrigations on niger under pre rabi season concluded that the perusal of data show that during 2007, the maximum seed yield of 249 kg/ha in T₂ (D₁I₂) was followed by 242 kg/ha in T₃ (D₁I₃) and 211 kg/ha in T₁ (D₁I₁) being at par to each other. The minimum seed yield 107 kg/ha was recorded in T₉ (D₃I₃). The mean of three years showed the maximum yield of 441 kg/ha in T₃ (D₁I₃) followed by 415 kg/ha in T₂ and 387 kg/ha in T₁. The minimum value of 198 kg/ha was recorded from T₇ (D₃I₁) (Anon., 2007).

Experiment conducted at Igatpuri on niger to study the effect of date of sowing and irrigation on niger yield under pre rabi season, the three years pooled maximum seed yield of 567 kg/ha in T₃ was significantly maximum followed by 516 kg/ha in T₆ and 502 kg/ha in T₂. The later two being at par the minimum seed yield of 371 kg/ha was reported in T₇ (Anon., 2007).

Experiment conducted on effect of date of sowing and irrigations on niger yield under pre-rabi season at semiliguda, the results indicated that the mean maximum niger yield were recorded when the crop was sown on 1st date (1st September) from followed by second date (15th September) and then third date (30th September) (Anon., 2007).

Kathmale *et al.* (2007) reported that the pooled performance of sunflower clearly indicated that early sown crop during 28th standard meteorological week produced significantly higher seed yield (569 kg/ha) than other sowing date tried.

Umesh *et al.* (2007) obtained the better results from the crop sown during *rabi* season, recorded higher number of filled seeds per capitulum (318), seed yield per plant (16.9 g) and 100 seed weight (5.7 g) as compared to *kharif* season in sunflower.

Vijaya Bhaskar Reddy *et al.* (2007) conducted the sowing of castor during the month of July recorded the highest seed yield and delayed sowings during August reduced the yield significantly.

2.2.3 Seed quality parameters

Kathiresan and Ramaswamy (1978) conducted an experiment with sunflower to study the effect of time of sowing on seed yield and seed quality. Maximum seed yield was obtained in the October sown crop (3179 kg/ha) followed by March (2631 kg/ha) and November (1851 kg/ha) and the minimum in January sown crop (776 kg/ha). Seed germination was maximum in the seed produce of September sown crop (97%).

Saini *et al.* (1980) reported that delayed planting from June to September produced higher percentage of sound seeds with higher germinability and storability. Seeds obtained from August and September planting gave significantly higher germination and maintained higher viability and vigour during storage than the seeds obtained from June and July in soybean.

The results of an experiment with 30 indigenous and 24 introduced varieties indicated that ES-21 and ES-22 from USA had the highest oil content in sesame and cross 91-99 from Andhra Pradesh and N-66-173 from Jabalpur had the highest protein content (Trehan *et al.*, 1974). Among the four varieties tested, Variety No-98-2 gave significantly higher germination per cent than other varieties of sesamum (Gaur and Trehan, 1980).

Tomar and Bhargava (1980) obtained higher oil content under short day condition (47.13%). Further it was observed that as day length increased the oil content reduced drastically (33.46%) in sesame.

Chandramony and Padmaja (1982) evaluated 33 varieties of sesame along with two wild species. The results indicated that the variety P10 produced highest oil content (64%). Whereas, TMV-2 produced lower oil content (28%) and type-2 that is wild species, gave lowest (18%) oil content. Ogunremi (1988) reported that oil content in sesame decreased significantly after early May.

Raheja *et al.* (1989) reported that among 70 promising genotypes in sesame seed oil content ranged from 46.2 to 56.8 per cent and 11 genotypes had more than 54 per cent oil. The results of a field experiment conducted at Parbhani, indicated that the variety Punjab-1 produced significantly higher oil yield (3.71 q/ha) compared to other two varieties (Phule-1 and T-85) in sesame (Patil *et al.*, 1992).

Revati *et al.* (1991) reported that soybean seed protein content increased from 41 to 44 per cent and oil content decreased from 23 to 20 per cent with delay in sowing. Similarly, Helms *et al.* (1990) found increase in the protein content and decrease in the oil content along with decrease in the seed yield of soybean with the advanced sowings.

The chemical composition of the soybean seeds as influenced by the mean temperature during the crop growth. The oil content in seeds found to be decreased with increasing altitude and delay in sowing. However, the protein content did not change (Hu, *et al.*, 1993).

Jasani *et al.* (1994) reported that seed protein content was higher from the early sowing and delay in sowing reduced the seed oil content. In contrast to this, Kane *et al.* (1997) indicated that delay in sowing increased the protein and linolenic acid content and reduced the oil contents and oleic acid levels. But, had little or no influence on palmitic, stearic or linoleic acid levels.

Moorthy *et al.* (1997) studied six genotypes in a field trial conducted at Central Rice Research Institute, Cuttack in sesame, during 1993-95 in rice follows. The results indicated that variety Vinayak recorded highest oil content (49.4%), whereas variety OMT-10 produced lowest oil content (39.4%).

3. MATERIAL AND METHODS

The field experiment was conducted to study the response of niger (*Guizotia abyssinica* Cass.) cultivars to different dates of sowing for seed yield and quality during 2007-08. The details of the materials used and the techniques adopted during the course of investigation are described in this chapter.

3.1 Experimental site

The field experiment was conducted during 2007-08 at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad, which is situated on a latitude of 15° 26' north and 75° 07' east longitude and at an altitude of 678 meters above mean sea level.

3.1.1 Soil

The experimental site consisted of black clayey textured soil and was neutral in reaction. A composite soil sample (to a depth of 0-30 cm) was drawn from the experimental area before sowing and was analyzed for physical and chemical properties. The soil physical and chemical compositions are presented in Table 1.

3.2 Climatic conditions

The meteorological data during crop growth, seed development and maturity from April 2007 to May 2008 are presented in Table 2.

3.3 Experimental material

The breeder seeds of niger varieties No-71 and RCR-18 produced at the Regional Agricultural Research Station (RARS), Raichur were used as a basic seed material for the experiment and sown from June 2007 to February, 2008.

3.4 Design and layout

The experiment was laid out in split plot design with three replications (Fig. 1 and Plate 1 and 2).

3.5 Experimental details

3.5.1 The details of the treatments are given below

3.5.1.1 Main plot : Varieties (V)

V₁ – No-71

V₂ – RCR-18

3.5.1.2 Sub plot : Sowing dates (D)

D₁ – First fortnight of June

D₂ – Second fortnight of June

D₃ – First fortnight of July

D₄ – Second fortnight of July

D₅ – First fortnight of September

D₆ – Second fortnight of September

Table 1: Soil physical and chemical properties of the experimental site

Particulars	values
A. Physical properties	
Clay (%)	32.70
Silt (%)	9.50
Fine sand (%)	31.24
Coarse sand (%)	26.56
B. Chemical properties	
Total N (kg/ha)	265.0
Available P ₂ O ₅ (kg/ha)	10.8
Available K ₂ O (kg/ha)	245.0
p ^H	6.7
Available Fe (ppm)	6.0
Available Zn (ppm)	0.6
Available Ca (ppm)	1.2
Available S (ppm)	25.0
Available Ca (c mol (+)kg) (exchangeable)	25.0

Table 2: Monthly meteorological data for the experimental year 2006-07 and 2007-08 of Main Agricultural Research Station, Dharwad, University of Agricultural Sciences, Dharwad

Month	Rainfall (mm)		Temperature ($^{\circ}$ C)				Relative humidity (%)	
	2006-07	2007-08	Mean maximum		Mean minimum		2006-07	2007-08
			2006-07	2007-08	2006-07	2007-08		
April	1.5	86.4	37.1	36.7	20.3	21.4	49	55
May	166.8	65.0	35.1	34.6	20.9	21.3	61	61
June	212.4	220.1	29.5	29.7	20.6	21.3	78	80
July	176.1	211.2	26.6	27.0	20.4	21.1	87	85
August	115.2	176.0	26.3	27.1	19.6	20.5	85	85
September	91.4	180.8	29.2	27.2	19.2	20.3	77	83
October	38.6	74.8	30.0	29.7	19.1	19.4	67	68
November	55.4	54.0	29.2	29.5	18.1	15.1	70	53
December	-	Trace	29.1	29.0	12.8	14.6	61	65
January	-	0.0	30.4	29.7	14.0	12.9	52	46
February	-	0.0	31.9	31.1	15.7	16.3	62	49
March	12.8	111.0	35.3	32.4	19.7	18.9	45	53
Total	870.2	1208.5						



Fig. 1 : Plan of layout

Fig.1: Plan of layout



Plate.1: General view of the experimental plots



Plate.2: General view of the experimental plots

D₇ – First fortnight of October

D₈ – Second fortnight of October

D₉ – First fortnight of January

D₁₀ – Second fortnight of January

D₁₁ – First fortnight of February

D₁₂ – Second fortnight of February

3.5.2 Treatment combinations : 2 x 12 x 3 = 72

V ₁ D ₁	V ₁ D ₃	V ₁ D ₅	V ₁ D ₇	V ₁ D ₉	V ₁ D ₁₁
V ₂ D ₁	V ₂ D ₃	V ₂ D ₅	V ₂ D ₇	V ₂ D ₉	V ₂ D ₁₁
V ₁ D ₂	V ₁ D ₄	V ₁ D ₆	V ₁ D ₈	V ₁ D ₁₀	V ₁ D ₁₂
V ₂ D ₂	V ₂ D ₄	V ₂ D ₆	V ₂ D ₈	V ₂ D ₁₀	V ₂ D ₁₂

3.5.3 Other details of the experiment

Gross plot size : 3.0 m x 3.0 m

Net plot size : 2.4 m x 2.8 m

Varieties : Two

Fertilizer : 30:20:10 kg N, P and K per ha

Spacing : 30 cm x 10 cm

After care

Thinning was done about twenty days after sowing (DAS) to maintain the healthy plant at a distance of 10 cm between plant to plant in the row. Hand weeding was carried out twice for every sowing at 20 and 40 DAS depending upon the weed population and light earthingup was made. Dimethoate 30 EC (1.7 ml /l of water) was sprayed against leaf eating cater pillar.

Fifty per cent of recommended nitrogen and full dose of phosphorous and potassium were applied at the time of sowing and remaining 50 per cent of nitrogen was applied at 25 DAS.

3.6 Observations recorded

The observations on growth parameters *viz.*, plant height, number of leaves per plant, number of primary branches per plant, number of secondary branches per plant and days to 50 per cent flowering and yield parameters *viz.*, number of capitula per plant, number of seeds per capitula, 1000 seed weight (g), seed yield per plant (g), seed yield per ha (kg), oil content (%) and quality parameters *viz.*, germination (%), root length (cm), shoot length (cm), vigour index of seedling, seed infection and field emergence (%) were recorded for each sowings.

3.6.1 Growth parameters

3.6.1.1 Plant height (cm)

The plant height was measured from the base of the plant to the tip of the main head of the plant at 30, 60 and 90 DAS on five randomly selected plants and the mean of the five plants was worked out and expressed in centimeters.

3.6.1.2 Number of leaves per plant

The number of leaves were counted and mean number of leaves per plant was worked out. It was expressed as number of leaves per plant.

3.6.1.3 Number of branches per plant

Number of primary and secondary branches were counted on five randomly selected plants and the mean was taken as number of primary branches and secondary branches per plant.

3.6.1.4 Days to 50 per cent flowering

Number of days taken from sowing to opening of 50 per cent of disc florets in a capitulum was recorded in five randomly tagged plants in each treatment and the average was worked out.

3.6.2 Yield parameters

3.6.2.1 Number of capitula per plant

The number of capitula produced per plant were counted and recorded at harvest.

3.6.2.2 Number of seeds per capitulum

The total number of seeds were counted from five randomly selected capitula from each plant. Then seeds per capitulum were worked out by taking of average of five capitula.

3.6.2.3 Seed yield per plant (g)

The weight of the seeds from five randomly selected plants from each sub plot was recorded and then average seed yield per plant was calculated.

3.6.2.4 Seed yield (kg/ha)

The heads from each treatment were harvested and threshed separately and after thorough cleaning. The seeds were dried upto safe moisture content. The seed weight was recorded for each treatment. Based on net plot yield, the seed yield was computed in kg/ha.

3.6.2.5 Thousand seed weight (g)

Thousand seeds were randomly taken from net plot produce in four replicates and average weight was recorded and expressed in grams.

3.7 Seed quality parameters

3.7.1 Seed germination (%)

The germination test was conducted by following the ISTA procedure (Anon., 1999), using between paper method. One hundred seeds were equally placed on the germination paper in four replications and these rolled paper towels were placed in a slanting position in the cabinet seed germinator maintained at the constant temperature of $25\pm 1^{\circ}\text{C}$ and 95 ± 1 per cent relative humidity respectively. The number of normal seedlings were counted at the end of 10th day and was expressed as germination percentage.

3.7.2 Root length (cm)

Ten normal seedlings in each treatment were randomly chosen for measurement of root on the day of final count (10th day) and the average was calculated. The length of the root is measured from collar region to tip of the root in centimeter.

3.7.3 Shoot length (cm)

Ten normal seedlings in each treatment were randomly chosen for measurement of shoot on the day of final count (10th day) and the average was calculated. Shoot length was measured from the collar region to the point of attachment of cotyledon in centimeters.

3.7.4 Seedling vigour index (SVI)

The seedling vigour index was calculated by adopting the formula as suggested by Abdul-Baki and Anderson (1973) as described below. The average was calculated and expressed as whole number.

$$\text{SVI} = (\text{Root length} + \text{shoot length in cm}) \times \text{Germination percentage}$$

3.7.5 Field emergence (%)

One hundred seeds in four replicates were taken at random from each treatment and used for field emergence. Seeds were hand dibbled with a spacing of 20 cm between rows and 10 cm between seeds. Seedlings which emerged 3 cm above the soil surface on the tenth day after sowing were counted and recorded as field emergence and expressed in percentage.

3.7.6 Per cent seed infection

Selection and identification was done by blotter method as recommended by ISTA (Anon., 1999). Twenty five seeds were placed equidistantly in glass petriplates placed with moist blotters. The plates were incubated for 7 days at 28^oC. After incubation, seed mycoflora were recorded on 8th day by observing fungal growth on seed under stereoscopic binocular microscope and their frequency of occurrence was expressed in percentage (Anon., 1999).

3.7.7 Oil content (%)

Oil content was estimated by using nuclear magnetic resources (NMR) spectrometer available at RARS, Raichur and was expressed in percentage.

3.7.8 Statistical analysis

The experimental data were statistically analysed as per the methods outlined by Sundarajan *et al.* (1972) adopting the analysis of variance technique appropriate to the level of treatments and the data were formulated. Critical differences were calculated whenever 'F' test was significant. The necessary percentage data was transformed into arcsine root transformation and then statistical analysis was taken up.

4. EXPERIMENTAL RESULTS

The results of the experiment conducted to study the response of niger (*Guizotia abyssinica* Cass) cultivars to different dates of sowing during *kharif*, *rabi* and summer during 2007-08 are presented in this chapter.

4.1 Growth parameters

4.1.1 Plant height (cm)

The plant height of niger was significantly influenced by different dates of sowing at all the growth stages (30, 60 and 90 DAS) but the varieties were found to be non-significant and presented in Table 3.

At 30 DAS, when different dates of sowing, crop sown amongst during first fortnight of June (D_1) recorded the highest plant height (38.13 cm) which was on par with D_2 (33.58 cm), D_3 (32.93 cm), D_4 (32.85 cm) and followed by D_5 (30.99 cm). Whereas, the lowest plant height was observed in D_{12} (18.81 cm).

Between, the varieties V_2 (RCR 18) recorded the highest plant height (28.61 cm) as compared to V_1 (No-71) (27.50 cm). The interaction effect of sowing dates and varieties were significant for plant height at 30 DAS. Among interactions, the highest plant height was recorded in D_1V_2 (RCR-18) seeds sown during first fortnight of June (38.42 cm), followed by D_2V_2 (RCR-18 seed sown during second fortnight of June) (33.65 cm), whereas lower plant height was recorded in $D_{12}V_1$ (No-71) seeds sown during second fortnight of February (18.24 cm). The similar trend was noticed at 60 and 90 DAS.

At 60 DAS, the niger grown during first fortnight of June (D_1) recorded the highest plant height (132.20 cm) which was on par with D_2 , D_3 , D_4 (128.40, 125.62 and 124.66 cm, respectively) and followed by D_5 (77.57 cm) on contrary, lowest plant height was observed in D_{12} (40.67 cm).

Between the varieties V_2 recorded the highest plant height (81.45 cm) as compared to V_1 (79.90 cm). The interaction effect of sowing dates and varieties were significant.

At 90 DAS, among the dates of sowing crop sown during first fortnight of June (D_1) recorded the highest plant height (152.66) which was on par with D_2 (149.57), D_3 (147.77 cm), D_4 (143.35 cm) followed by D_5 (97.77 cm). On contrary the lowest plant height was observed in D_{12} (50.70cm).

Between the varieties, the V_2 recorded the highest plant height (101.74 cm) as compared to V_1 (98.57 cm). The interaction effect of sowing dates and varieties were significant.

4.1.2 Number of leaves per plant

The number of leaves per plant were significantly influenced by the dates of sowing and varieties at all the growth stages (Table 4).

At 30 DAS, the niger sown during first fortnight of June (D_1) recorded the highest number of leaves per plant (14.85) which was on par with D_2 (14.48) on contrary the lowest number of leaves per plant was recorded in D_{12} (9.72). Between the varieties, V_2 recorded the highest number of leaves per plant (12.15) compared to V_1 (11.8). The interaction effect of sowing dates and varieties were significant. Among interactions, the highest number of leaves per plant was recorded in D_1V_2 (RCR-18 seeds sown during first fortnight of June) (15.20), followed by D_2V_2 (RCR-18 seed sown during second fortnight of June) (14.95), whereas lower number of leaves per plant was recorded in $D_{12}V_1$ (No-71 seed sown during second fortnight of February) (9.50). The similar trend was noticed at 60 and 90 DAS.

Table 3: Effect of sowing dates and varieties on plant height (cm) at 30, 60 and 90 DAS in Niger Cv. No-71 (V₁) and RCR 18 (V₂)

Treatments	30 DAS			60 DAS			90 DAS		
	V ₁	V ₂	Mean	V ₁	V ₂	Mean	V ₁	V ₂	Mean
D ₁	37.84	38.42	38.13	132.17	132.20	132.19	151.56	153.75	152.66
D ₂	33.50	33.65	33.58	126.54	128.25	127.40	148.76	150.38	149.57
D ₃	32.23	33.63	32.93	124.93	126.85	125.89	147.20	148.34	147.77
D ₄	32.18	33.52	32.85	124.38	124.38	124.38	144.50	146.19	145.35
D ₅	30.35	31.62	30.99	72.50	82.63	77.57	96.76	98.77	97.77
D ₆	29.50	30.73	30.12	68.38	77.43	72.91	94.13	95.34	94.74
D ₇	27.86	28.54	28.20	63.30	68.71	66.01	90.36	92.73	91.55
D ₈	26.10	26.13	26.12	60.21	66.18	63.20	86.43	89.64	88.04
D ₉	22.36	23.43	22.90	43.58	44.83	44.21	62.31	66.88	64.60
D ₁₀	21.17	22.27	21.72	42.33	43.16	42.75	60.20	61.50	60.85
D ₁₁	18.53	19.14	18.84	40.52	41.58	41.05	59.45	60.23	59.84
D ₁₂	18.24	19.38	18.81	40.12	41.21	40.67	41.23	60.17	50.70
Mean	27.50	28.61	28.06	79.90	81.45	80.68	98.57	101.74	100.16
For comparing	S.Em ±		CD at 5%	S.Em ±		CD at 5%	S.Em ±		CD at 5%
Varieties(V)	0.51		NS	0.97		NS	1.09		NS
Dates (D)	0.90		2.7	3.35		10.05	2.65		7.95
D at the same level of V	1.27		3.81	4.74		14.22	3.74		11.22
V at the same level of D	1.32		3.96	4.64		13.92	3.75		11.25

D₁ – First fortnight of June

D₄ – Second fortnight of July

D₇ – First fortnight of October

D₁₀ – Second fortnight of January

V₁ – No-71

D₂ – Second fortnight of June

D₅ – First fortnight of September

D₈ – Second fortnight of October

D₁₁ – First fortnight of February

V₂ – RCR-18

D₃ – First fortnight of July

D₆ – Second fortnight of September

D₉ – First fortnight of January

D₁₂ – Second fortnight of February

NS – Non-significant

At 60 DAS, among the dates of sowing, the crop grown during first fortnight of June (D_1) recorded the highest number of leaves per plant (28.73), which was on par with D_2 (28.38) and was followed by D_3 (26.87). On contrary the lowest number of leaves per plant was recorded in D_{12} (16.62). Between the varieties V_2 recorded the highest number of leaves per plant (22.61) compared to V_1 (21.76). The interaction effect of sowing dates and varieties were significant.

At 90 DAS, niger sown during first fortnight of June (D_1) recorded the highest number of leaves per plant (39.68) which was on par with D_2 (39.10), D_3 (38.26) and followed by D_4 (37.75) on contrary the lowest number of leaves per plant was recorded in D_{12} (21.68). Between the varieties V_2 recorded the highest number of leaves per plant (31.53) as compared to V_1 (31.12). The interaction effect of sowing dates and varieties were significant.

4.1.3 Number of primary branches per plant

Number of primary branches per plant was significantly influenced by sowing dates and varieties at all the growth stages of niger (Table 5).

Among the dates of sowing, the crop sown during first fortnight of June (D_1) recorded the highest number of primary branches per plant (16.23) followed by D_2 (15.70). Whereas, the lowest number of primary branches per plant was recorded in D_{12} (9.04). Between the varieties, V_2 recorded the highest number of primary branches per plant (13.69) as compared to V_1 (11.55). The interaction effect of sowing dates and varieties were found to be significant. Among the interactions, the highest number of primary branches per plant was recorded in D_1V_2 (RCR-18 seeds sown during first fortnight of June) (17.25), followed by D_2V_2 (RCR-18 seed sown during second fortnight of June) (16.55), whereas lower number of primary branches per plant was recorded in $D_{12}V_1$ (No-71 seed sown during second fortnight of February) (8.00).

4.1.4 Number of secondary branches per plant

The number of secondary branches per plant was significantly influenced by the dates of sowing and varieties at all the growth stages of niger (Table 5).

Among different dates of sowing the crop sown during first fortnight of June (D_1) recorded the highest number of secondary branches per plant (36.08) and was on par with D_2 (35.70), followed by D_3 (33.40). While, the lowest number of secondary branches per plant was recorded in D_{12} (17.29). Between the varieties, V_2 recorded higher number of secondary branches (27.86) as compared to V_1 (25.58). The interaction effect of sowing dates and varieties were significant. Among interactions, the highest number of secondary branches per plant was recorded in D_1V_2 (RCR-18 seeds sown during first fortnight of June) (37.13), followed by D_2V_2 (RCR-18 seed sown during second fortnight of June) (36.80), whereas lower number of secondary branches per plant was recorded in $D_{12}V_1$ (No-71 seed sown during second fortnight of February) (16.17).

4.1.5 Days to 50 per cent flowering

In the present study, days to 50 per cent flowering was significantly influenced by the dates of sowing and varieties of niger (Table 5).

Among the different dates of sowing, the crop sown during first fortnight of June (D_1), took higher number of days to 50 per cent flowering (65). Whereas, the crop sown during second fortnight of February took lower number of days to 50 per cent flowering (38).

The interaction effect sowing date and varieties on days to 50 per cent flowering was found to be significant. Among the interactions, more days to 50 per cent flowering was recorded in D_1V_2 (RCR-18 seeds sown during first fortnight of June) (64), followed by D_2V_2 (RCR-18 seed sown during second fortnight of June) (63), whereas lesser days to 50 per cent flowering was recorded in $D_{12}V_1$ (No-71 seed sown during second fortnight of February) (38).

Table 4: Effect of sowing dates and varieties on number of leaves per plant at 30, 60 and 90 DAS in Niger Cv. No-71 (V₁) and RCR 18 (V₂)

Treatments	30 DAS			60 DAS			90 DAS		
	V ₁	V ₂	Mean	V ₁	V ₂	Mean	V ₁	V ₂	Mean
D ₁	14.50	15.20	14.85	28.60	28.85	28.73	39.50	39.86	39.68
D ₂	14.00	14.95	14.48	28.25	28.50	28.38	39.00	39.20	39.10
D ₃	13.35	13.53	13.44	26.38	27.35	26.87	38.13	38.38	38.26
D ₄	12.83	13.28	13.06	25.14	25.76	25.45	37.54	37.96	37.75
D ₅	12.25	12.56	12.41	22.24	23.58	22.91	33.78	33.83	33.81
D ₆	12.00	12.23	12.12	21.85	23.10	22.48	33.20	33.45	33.33
D ₇	11.25	11.58	11.42	20.13	21.53	20.83	31.75	31.62	31.69
D ₈	11.16	11.27	11.22	19.03	21.31	20.17	31.23	31.47	31.35
D ₉	10.50	10.75	10.63	18.48	18.87	18.68	23.54	24.32	23.93
D ₁₀	10.21	10.43	10.32	18.16	18.30	18.23	22.82	23.96	23.39
D ₁₁	10.05	10.10	10.08	16.58	17.21	16.90	21.63	22.31	21.97
D ₁₂	9.50	9.93	9.72	16.24	17.00	16.62	21.31	22.04	21.68
Mean	11.80	12.15	11.98	21.76	22.61	22.19	31.12	31.53	31.33
For comparing	S.Em ±		CD at 5%	S.Em ±		CD at 5%	S.Em ±		CD at 5%
Varieties(V)	0.19		0.57	0.27		0.81	0.65		1.95
Dates (D)	0.29		0.87	0.62		1.86	0.66		1.98
D at the same level of V	0.41		1.23	0.88		2.64	0.93		2.79
V at the same level of D	0.43		1.29	0.89		2.67	1.10		3.30

D₁ – First fortnight of June

D₄ – Second fortnight of July

D₇ – First fortnight of October

D₁₀ – Second fortnight of January

V₁ – No-71

D₂ – Second fortnight of June

D₅ – First fortnight of September

D₈ – Second fortnight of October

D₁₁ – First fortnight of February

V₂ – RCR-18

D₃ – First fortnight of July

D₆ – Second fortnight of September

D₉ – First fortnight of January

D₁₂ – Second fortnight of February

NS – Non-significant

Table 5: Effect of sowing dates and varieties on number of secondary branches/plant and days to 50 per cent flowering in Niger Cv. No-71 (V₁) and RCR 18 (V₂)

Treatments	Number of primary branches/plant			Number of secondary branches/plant			Days to 50 per cent flowering		
	V ₁	V ₂	Mean	V ₁	V ₂	Mean	V ₁	V ₂	Mean
D ₁	15.20	17.25	16.23	35.03	37.13	36.08	67.00	64.00	65.50
D ₂	14.85	16.55	15.70	34.60	36.80	35.70	64.00	63.00	63.50
D ₃	14.30	16.32	15.31	32.30	34.50	33.40	57.60	54.00	55.80
D ₄	13.53	15.54	14.54	30.80	32.48	31.64	55.30	53.00	54.15
D ₅	13.23	15.20	14.22	27.63	30.41	29.02	47.00	44.00	45.50
D ₆	13.08	15.03	14.06	27.18	29.51	28.35	44.36	42.00	42.80
D ₇	10.28	12.35	11.32	25.38	27.85	26.62	43.30	42.30	42.80
D ₈	10.13	12.21	11.17	24.87	26.34	25.61	43.30	40.60	41.95
D ₉	9.00	12.03	10.52	18.43	20.98	19.71	42.60	40.30	41.47
D ₁₀	8.80	11.25	10.03	18.21	20.17	19.19	43.30	40.30	41.80
D ₁₁	8.20	10.41	9.31	16.63	18.53	17.58	41.30	40.30	40.80
D ₁₂	8.00	10.08	9.04	16.17	18.41	17.29	38.30	37.30	37.80
Mean	11.55	13.69	12.62	25.58	27.76	26.67	48.88	46.76	47.82
For comparing	S.Em ±		CD at 5%	S.Em ±		CD at 5%	S.Em ±		CD at 5%
Varieties(V)	0.20		0.60	0.36		1.08	0.06		0.18
Dates (D)	0.17		0.51	0.23		0.69	0.36		1.08
D at the same level of V	0.24		0.72	0.33		0.99	0.51		1.53
V at the same level of D	0.24		0.72	0.47		1.41	0.49		1.47

D₁ – First fortnight of June

D₄ – Second fortnight of July

D₇ – First fortnight of October

D₁₀ – Second fortnight of January

V₁ – No-71

D₂ – Second fortnight of June

D₅ – First fortnight of September

D₈ – Second fortnight of October

D₁₁ – First fortnight of February

V₂ – RCR-18

D₃ – First fortnight of July

D₆ – Second fortnight of September

D₉ – First fortnight of January

D₁₂ – Second fortnight of February

NS – Non-significant

4.2 Yield and yield components

4.2.1 Number of capitula per plant

The number of capitula per plant was significantly influenced by dates of sowing and varieties in niger at harvest stage (Table 6).

Among the sowing dates, niger crop sown during first fortnight of June (D_1) had maximum number of capitula per plant (40.12), which was on par with second fortnight of June (38.68). Whereas, niger crop sown during second fortnight of February produced lesser number of capitula per plant (21.30).

Among the varieties V_2 recorded higher number of capitula per plant (32.76) as compared to V_1 (30.54). Interaction effect of dates of sowing and varieties with respect to number of capitula per plant were found to be significant. Among interactions, higher number of capitula per plant was recorded in D_1V_2 (RCR-18 seeds sown during first fortnight of June) (41.34), followed by D_2V_2 (RCR-18 seed sown during second fortnight of June) (40.91), whereas lower number of capitula per plant was recorded in $D_{12}V_1$ (No-71 seed sown during second fortnight of February) (20.31).

4.2.2 Number of seeds per capitulum

The number of seeds per capitulum was influenced by dates of sowing and varieties are given in Table 6.

Among the sowing dates, seeds sown during first fortnight of June (D_1) recorded the highest number of seeds per capitulum (21.61) which was on par with the sowing of seeds at second fortnight of June (21.35) and was followed by first fortnight of July (20.97). Whereas, the second fortnight sown crop recorded minimum number of seeds per capitulum (18.12).

Niger varieties (V_1 and V_2) differed significantly for number of seeds per capitulum. The interaction effect of dates of sowing and varieties were found to be significant. Among the interactions, more number of seeds per capitulum was recorded in D_1V_2 (RCR-18 seeds sown during first fortnight of June) (21.72), followed by D_2V_2 (RCR-18 seed sown during second fortnight of June) (21.49), whereas lesser number of seeds per capitulum was recorded in $D_{12}V_1$ (No-71 seed sown during second fortnight of February) (18.02).

4.2.3 Thousand seed weight (g)

The data on thousand seed weight was significantly influenced by sowing dates and varieties and their interactions (Table 7).

Of the various sowing dates, crop sown during first fortnight of June (D_1) recorded maximum thousand seed weight (3.42 g), which was on par with D_2 sowing (3.25 g) and was followed by D_3 sowing (3.17 g). While, minimum thousand seed weight was recorded in D_{12} sowing (1.42 g).

Between the varieties, variety V_2 recorded maximum thousand seed weight (2.62 g) as compared to V_1 (2.37 g). The interaction effect of dates of sowing and varieties with respect to 1000 seed weight were found to be significant. Among interactions, the highest thousand seed weight was recorded in D_1V_2 (RCR-18 seeds sown during first fortnight of June) (3.61 g), followed by D_2V_2 (RCR-18 seed sown during second fortnight of June) (3.32 g), whereas the lowest thousand seed weight was recorded in $D_{12}V_1$ (No-71 seed sown during second fortnight of February) (1.31 g).

4.2.4 Seed yield per plant (g)

The sowing dates and varieties of niger crop significantly influenced the seed yield per plant (g) (Table 7).

Table 6: Effect of sowing dates and varieties on number of capitulas per plant and number of seeds per capitulas in Niger Cv. No-71 (V₁) and RCR 18 (V₂)

Treatments	Number of capitula per plant			Number of seeds per capitula		
	V ₁	V ₂	Mean	V ₁	V ₂	Mean
D ₁	38.90	41.34	40.12	21.50	21.72	21.61
D ₂	38.83	40.91	39.87	21.20	21.49	21.35
D ₃	37.62	39.74	38.68	20.60	21.34	20.97
D ₄	37.15	39.26	38.21	20.17	21.18	20.68
D ₅	33.46	35.93	34.70	19.82	20.74	20.28
D ₆	33.13	35.44	34.29	19.54	20.33	19.94
D ₇	31.34	33.89	32.62	19.20	20.43	19.82
D ₈	30.84	32.17	31.51	19.00	19.83	19.42
D ₉	22.31	25.10	23.71	18.24	18.49	18.37
D ₁₀	22.16	24.34	23.25	18.13	18.33	18.23
D ₁₁	20.39	22.68	21.54	18.08	18.31	18.20
D ₁₂	20.31	22.28	21.30	18.02	18.22	18.12
Mean	30.54	32.76	31.65	19.46	20.03	19.75
For comparing	S.Em ±		CD at 5%	S.Em ±		CD at 5%
Varieties(V)	0.35		1.05	0.09		0.27
Dates (D)	0.26		0.78	0.17		0.51
D at the same level of V	0.37		1.11	0.24		0.72
V at the same level of D	0.50		1.50	0.25		0.75

D₁ – First fortnight of June

D₄ – Second fortnight of July

D₇ – First fortnight of October

D₁₀ – Second fortnight of January

V₁ – No-71

D₂ – Second fortnight of June

D₅ – First fortnight of September

D₈ – Second fortnight of October

D₁₁ – First fortnight of February

V₂ – RCR-18

D₃ – First fortnight of July

D₆ – Second fortnight of September

D₉ – First fortnight of January

D₁₂ – Second fortnight of February

NS – Non-significant

Among the various sowing dates, the crop sown during first fortnight of June produced higher seed yield per plant (2.98 g) followed by crop sown during second fortnight of June (2.76 g). Whereas, the crop sown during second fortnight of February recorded lesser seed yield per plant (0.54 g).

The highest seed yield per plant (1.85 g) was noticed in V_2 variety as compared to V_1 (1.54 g). Interaction effect of dates of sowing and varieties with respect seed yield per plant was found to be significant. Among interactions, the highest seed yield per plant was recorded in D_1V_2 (RCR-18 seeds sown during first fortnight of June) (3.23 g), followed by D_2V_2 (RCR-18 seed sown during second fortnight of June) (2.91 g), whereas the lowest seed yield per plant was recorded in $D_{12}V_1$ (No-71 seed sown during second fortnight of February) (0.47 g).

4.2.5 Seed yield (kg/ha)

The seed yield was significantly influenced by dates of sowing and varieties are presented in Table 8.

Of the various sowing dates, niger crop sown during first fortnight of June recorded higher seed yield (600.09 kg/ha), followed by the crop sown during second fortnight of June (587.76 kg/ha). While, the crop sown during second fortnight of February recorded lower seed yield (130.24kg per hectare).

Between the varieties, variety V_2 recorded significantly higher seed yield (384.10 kg/ha) than V_1 variety (340.50 kg/ha). Interaction effect of dates of sowing and varieties were found to be significant. Among the interactions, the highest seed yield was recorded in D_1V_2 (RCR-18 seeds sown during first fortnight of June) (614.35 kg/ha), followed by D_2V_2 (RCR-18 seed sown during second fortnight of June) (599.62 kg/ha), whereas the lowest seed yield was recorded in $D_{12}V_1$ (No-71 seed sown during second fortnight of February) (106.91 kg/ha).

4.2.6 Oil content (%)

The sowing dates and varieties significantly influenced the oil content in niger are presented in Table 8.

Among the different sowing dates crop sown during first fortnight of June produced higher oil content (40.68 %), which was on par with the crop sown during second fortnight of June (40.33%) and followed by the crop sown during first fortnight of July (38.72 %). On the contrary, the lowest oil content (31.42%) was recorded when the crop was sown during second fortnight of February.

The oil content in seed was significantly influenced by niger varieties. Between the varieties, variety V_2 produced higher oil content (35.83%) than variety V_1 (35.14%). The interaction effect of sowing dates and varieties were found to be significant. Among the interactions, the highest oil content was recorded in D_1V_2 (RCR-18 seeds sown during first fortnight of June) (40.84%), followed by D_2V_2 (RCR-18 seed sown during second fortnight of June) (40.53%), whereas the lowest oil content was recorded in $D_{12}V_1$ (No-71 seed sown during second fortnight of February) (31.28%).

4.3 Seed quality parameters

4.3.1 Germination (%)

The data presented in Table 9, indicated that the germination higher percentage as influenced by date of sowing and varieties. The results indicated that higher germination percentage (95.0) was recorded in the crop sown during first fortnight of June. Whereas, lesser germination percentage (87.0) was recorded in the crop sown during the second fortnight of February. Between the variety higher germination was recorded in V_2 (92.03) compared to V_1 (90.50)

Table 7: Effect of sowing dates and varieties on 1000 seed weight (g) and seed yield per plant (g) in Niger Cv. No-71 (V₁) and RCR 18 (V₂)

Treatments	1000 seed weight (g)			Seed yield per plant (g)		
	V ₁	V ₂	Mean	V ₁	V ₂	Mean
D ₁	3.23	3.61	3.42	2.72	3.23	2.98
D ₂	3.18	3.32	3.25	2.61	2.91	2.76
D ₃	3.07	3.27	3.17	2.34	2.77	2.56
D ₄	3.01	3.18	3.10	2.25	2.64	2.45
D ₅	2.78	3.05	2.92	1.84	2.27	2.06
D ₆	2.54	2.89	2.72	1.63	2.08	1.86
D ₇	2.23	2.58	2.41	1.40	1.74	1.57
D ₈	2.16	2.37	2.27	1.26	1.51	1.39
D ₉	1.80	2.03	1.92	0.73	0.94	0.84
D ₁₀	1.68	1.89	1.79	0.67	0.84	0.76
D ₁₁	1.43	1.70	1.57	0.52	0.70	0.61
D ₁₂	1.31	1.53	1.42	0.47	0.61	0.54
Mean	2.37	2.62	2.50	1.54	1.85	1.70
For comparing	S.Em ±		CD at 5%	S.Em ±		CD at 5%
Varieties(V)	0.03		0.09	0.03		0.09
Dates (D)	0.08		0.24	0.05		0.15
D at the same level of V	0.12		0.36	0.07		0.21
V at the same level of D	0.12		0.36	0.07		0.23

D₁ – First fortnight of June

D₄ – Second fortnight of July

D₇ – First fortnight of October

D₁₀ – Second fortnight of January

February

V₁ – No-71

D₂ – Second fortnight of June

D₅ – First fortnight of September

D₈ – Second fortnight of October

D₁₁ – First fortnight of February

V₂ – RCR-18

D₃ – First fortnight of July

D₆ – Second fortnight of September

D₉ – First fortnight of January

D₁₂ – Second fortnight of

NS – Non-significant

The interaction effect of date of sowing and varieties were found to be significant. Among the interactions, the highest germination per cent was recorded in D_1V_2 (RCR-18 seeds sown during first fortnight of June) (95.00%), followed by D_2V_2 (RCR-18 seed sown during second fortnight of June) (95.00%), whereas the lowest germination per cent was recorded in $D_{12}V_1$ (No-71 seed sown during second fortnight of February) (85.00%).

4.3.2 Field emergence (%)

The data recorded on field emergence is presented in Table 9. There was a significant difference noticed between the varieties among the sowing dates for field emergence.

Higher field emergence was recorded for the seed produce obtained for the first fortnight of June (D_1) (89%) followed by the seed produce obtained for second fortnight of June (D_2) (88%). On contrary the lower field emergence was recorded in second fortnight of February (D_{12}) (76%).

RCR-18 (V_2) recorded higher field emergence with 84.17 per cent as compared to No-71 (V_1) (81.79%).

The interaction effect of date of sowing and varieties were found to be significant for field emergence. Among the interactions, the highest field emergence was recorded in D_1V_2 (RCR-18 seeds sown during first fortnight of June) (90.00%), followed by D_2V_2 (RCR-18 seed sown during second fortnight of June) (89.00%), whereas the lowest field emergence (75.00%) was recorded in $D_{12}V_1$ (No-71 seed sown during second fortnight of February).

4.3.3 Shoot length (cm)

The data on shoot length were significantly influenced by sowing dates and variety. While, the interaction effect was found to be non-significant (Table 10).

Among the dates of sowing, the seeds harvested from the crop sown during first fortnight of June showed higher shoot length (11.50 cm) which was on par with the crop sown during second fortnight of June (11.33 cm) and was followed by the crop sown during first shoot length was recorded in the seed harvested from the crop which was sown during second fortnight of February (8.07 cm).

Between the varieties, the variety V_2 seeds showed maximum shoot length (9.60 cm) than variety V_1 seed (9.33 cm).

Interaction effect of dates of sowing and varieties with respect to shoot length was found to be significant. Among interactions, the highest shoot length was recorded in D_1V_2 (RCR-18 seeds sown during first fortnight of June) (11.80 cm), followed by D_2V_2 (RCR-18 seed sown during second fortnight of June) (11.65 cm), whereas lowest shoot length was recorded in $D_{12}V_1$ (No-71 seed sown during second fortnight of February) (8.00 cm).

4.3.4 Root length (cm)

The observations on root length were significantly influenced by different dates of sowing, but the varieties were found to be non-significant and are presented in Table 10.

Of the various sowing dates, the seeds harvested from the crop sown during first fortnight of June recorded higher root length (10.53 cm), followed by the crop sown during second fortnight of June (10.02 cm). While, the seeds obtained from the crop sown during second fortnight February recorded significantly lowest root length (8.00 cm) compared to other sowing dates.

Among the varieties, variety V_2 harvested seeds showed higher root length (9.21 cm) over of variety V_1 (9.01 cm).

Interaction effect of dates of sowing and varieties with respect to root length (cm) was found to be significant. Among interactions, the highest root length was recorded in D_1V_2

Table 8: Effect of sowing dates and varieties on seed yield per hectare (kg) and oil content (%) in Niger Cv. No-71 (V₁) and RCR 18 (V₂)

Treatments	Seed yield per hectare (kg)			Oil content (%)		
	V ₁	V ₂	Mean	V ₁	V ₂	Mean
D ₁	585.83	614.35	600.09	40.52	40.84	40.68
D ₂	575.90	599.62	587.76	40.13	40.53	40.33
D ₃	519.22	581.41	550.32	38.25	39.18	38.72
D ₄	503.71	556.26	529.99	38.18	38.23	38.21
D ₅	405.59	461.51	433.55	35.43	36.18	35.81
D ₆	362.04	416.53	389.29	34.73	36.06	35.40
D ₇	311.24	351.64	331.44	34.38	35.60	34.99
D ₈	282.24	319.89	301.07	33.21	35.21	34.21
D ₉	161.87	200.09	180.98	32.16	32.48	32.32
D ₁₀	153.84	188.16	171.00	32.03	32.24	32.14
D ₁₁	117.55	166.19	141.87	31.37	31.84	31.61
D ₁₂	106.91	153.56	130.24	31.28	31.56	31.42
Mean	340.50	384.10	362.30	35.14	35.83	35.49
For comparing	S.Em ±		CD at 5%	S.Em ±		CD at 5%
Varieties(V)	4.31		12.93	0.05		0.15
Dates (D)	4.29		12.87	0.21		0.63
D at the same level of V	6.07		18.21	0.29		0.87
V at the same level of D	7.23		21.69	0.29		0.89

D₁ – First fortnight of June

D₄ – Second fortnight of July

D₇ – First fortnight of October

D₁₀ – Second fortnight of January

V₁ – No-71

D₂ – Second fortnight of June

D₅ – First fortnight of September

D₈ – Second fortnight of October

D₁₁ – First fortnight of February

V₂ – RCR-18

D₃ – First fortnight of July

D₆ – Second fortnight of September

D₉ – First fortnight of January

D₁₂ – Second fortnight of February

NS – Non-significant

Table 9: Effect of sowing dates and varieties on germination (%) and field emergence (%) in Niger Cv. No-71 (V₁) and RCR 18 (V₂)

Treatments	Germination (%)			Field emergence (%)		
	V ₁	V ₂	Mean	V ₁	V ₂	Mean
D ₁	94.00 (75.79)	95.30 (77.49)	94.67 (76.64)	88.00 (69.71)	90.00 (71.55)	89.00 (70.63)
D ₂	94.00 (75.79)	94.50 (76.41)	94.25 (76.10)	87.00 (68.85)	89.00 (70.61)	88.00 (69.73)
D ₃	93.50 (75.20)	94.00 (75.79)	93.75 (75.49)	85.50 (67.59)	87.00 (68.84)	86.25 (68.21)
D ₄	92.00 (73.54)	93.00 (74.63)	92.50 (74.08)	84.00 (66.40)	86.00 (68.01)	85.00 (67.20)
D ₅	91.00 (72.51)	93.00 (74.63)	92.00 (73.57)	83.00 (65.63)	86.00 (68.00)	84.50 (66.81)
D ₆	91.00 (72.51)	92.50 (74.08)	91.75 (73.29)	83.00 (65.62)	85.00 (67.19)	84.00 (66.40)
D ₇	91.00 (72.51)	92.00 (73.54)	91.50 (73.03)	82.00 (64.87)	86.00 (68.00)	84.00 (66.43)
D ₈	90.00 (71.54)	91.50 (73.02)	90.75 (72.23)	81.00 (64.13)	84.00 (66.40)	82.50 (65.26)
D ₉	89.00 (70.60)	91.00 (72.51)	90.00 (71.56)	79.00 (62.70)	81.00 (64.14)	80.00 (63.42)
D ₁₀	88.50 (70.15)	90.00 (71.54)	89.25 (70.84)	78.00 (62.00)	81.00 (64.14)	79.50 (63.97)
D ₁₁	87.00 (68.84)	89.50 (71.06)	88.25 (69.95)	76.00 (60.64)	78.00 (62.01)	77.00 (61.32)
D ₁₂	85.00 (67.19)	88.00 (69.70)	86.50 (68.45)	75.00 (59.98)	77.00 (61.32)	76.00 (60.65)
Mean	90.50 (72.15)	92.03 (73.70)	91.26 (72.00)	81.79 (64.84)	84.17 (66.68)	82.98 (65.76)
For comparing	S.Em ±		CD at 5%	S.Em ±		CD at 5%
Varieties(V)	0.09		0.27	0.09		0.27
Dates (D)	0.25		0.75	0.26		0.78
D at the same level of V	0.36		1.08	0.36		1.08
V at the same level of D	0.35		1.05	0.36		1.08

D₁ – First fortnight of June

D₄ – Second fortnight of July

D₇ – First fortnight of October

D₁₀ – Second fortnight of January

February

V₁ – No-71

* - Figures in paranthesis are tranformed values

D₂ – Second fortnight of June

D₅ – First fortnight of September

D₈ – Second fortnight of October

D₁₁ – First fortnight of February

V₂ – RCR-18

D₃ – First fortnight of July

D₆ – Second fortnight of September

D₉ – First fortnight of January

D₁₂ – Second fortnight of

NS – Non-significant

Table 10: Effect of sowing dates and varieties on root length (cm) and shoot length (cm) in Niger Cv. No-71 (V₁) and RCR 18 (V₂)

Treatments	Root length (cm)			Shoot length (cm)		
	V ₁	V ₂	Mean	V ₁	V ₂	Mean
D ₁	10.20	10.85	10.53	11.20	11.80	11.50
D ₂	9.84	10.20	10.02	11.00	11.65	11.33
D ₃	9.68	9.82	9.75	10.00	10.30	10.15
D ₄	9.50	9.73	9.62	9.80	10.00	9.90
D ₅	9.20	9.42	9.31	9.50	9.80	9.65
D ₆	9.00	9.20	9.10	9.30	9.46	9.38
D ₇	8.90	9.05	8.98	9.00	9.25	9.13
D ₈	8.89	8.96	8.93	9.00	9.16	9.08
D ₉	8.50	8.60	8.55	8.60	8.80	8.70
D ₁₀	8.30	8.43	8.37	8.40	8.50	8.45
D ₁₁	8.10	8.21	8.16	8.20	8.32	8.26
D ₁₂	8.00	8.06	8.03	8.00	8.13	8.07
Mean	9.01	9.21	9.11	9.33	9.60	9.47
For comparing	S.Em ±		CD at 5%	S.Em ±		CD at 5%
Varieties(V)	0.02		NS	0.04		0.12
Dates (D)	0.02		0.06	0.08		0.24
D at the same level of V	0.02		0.06	0.12		0.36
V at the same level of D	0.03		0.09	0.12		0.38

D₁ – First fortnight of June

D₂ – Second fortnight of June

D₃ – First fortnight of July

D₄ – Second fortnight of July

D₅ – First fortnight of September

D₆ – Second fortnight of September

D₇ – First fortnight of October

D₈ – Second fortnight of October

D₉ – First fortnight of January

D₁₀ – Second fortnight of January

D₁₁ – First fortnight of February

D₁₂ – Second fortnight of

February

V₁ – No-71

V₂ – RCR-18

NS – Non-significant

Table 11: Effect of sowing dates and varieties on per cent seed infection and seedling vigour index in Niger Cv. No-71 (V₁) and RCR 18 (V₂)

Treatments	Per cent seed infection			Seedling vigour index		
	V ₁	V ₂	Mean	V ₁	V ₂	Mean
D ₁	5.00 (12.92)	3.00 (9.97)	4.00 (11.45)	1993	2206	2100
D ₂	5.00 (12.92)	4.00 (11.53)	4.50 (12.23)	1978	2154	2066
D ₃	7.00 (5.34)	5.00 (12.92)	6.00 (9.13)	1830	1974	1902
D ₄	7.00 (15.34)	5.00 (12.92)	6.00 (14.13)	1776	1875	1826
D ₅	8.00 (16.42)	6.00 (14.17)	7.00 (15.30)	1720	1800	1760
D ₆	8.00 (6.42)	7.00 (15.34)	7.50 (10.88)	1702	1750	1726
D ₇	9.00 (17.45)	7.00 (15.34)	8.00 (16.40)	1683	1800	1742
D ₈	9.00 (17.45)	8.00 (16.42)	8.50 (16.94)	1658	1683	1671
D ₉	10.00 (18.43)	9.00 (17.45)	9.50 (17.94)	1573	1583	1578
D ₁₀	11.00 (19.36)	9.00 (17.45)	10.00 (18.41)	1525	1558	1542
D ₁₁	12.00 (20.26)	10.00 (18.43)	11.00 (19.35)	1501	1542	1522
D ₁₂	14.00 (21.96)	10.00 (18.43)	12.00 (20.20)	1400	1481	1441
Mean	8.75	6.92	7.83	1695	1784	1740
For comparing	S.Em ±		CD at 5%	S.Em ±		CD at 5%
Varieties(V)	0.06		0.18	8.12		24.36
Dates (D)	0.28		0.84	22.80		66.24
D at the same level of V	0.40		1.20	32.24		96.72
V at the same level of D	0.39		1.17	31.92		95.76

D₁ – First fortnight of June
 D₂ – Second fortnight of June
 D₃ – First fortnight of July
 D₄ – Second fortnight of July
 D₅ – First fortnight of September
 D₆ – Second fortnight of September
 D₇ – First fortnight of October
 D₈ – Second fortnight of October
 D₉ – First fortnight of January
 D₁₀ – Second fortnight of January
 D₁₁ – First fortnight of February
 D₁₂ – Second fortnight of February

V₁ – No-71
 V₂ – RCR-18
 NS – Non-significant

* - Figures in paranthesis are tranformed values

(RCR-18 seeds sown during first fortnight of June) (10.85 cm), followed by D_2V_2 (RCR-18 seed sown during second fortnight of June) (10.20 cm), whereas lowest root length was recorded in $D_{12}V_1$ (No-71 seed sown during second fortnight of February) (8.00 cm).

4.3.5 Seedling vigour index (SVI)

The data on seedling vigour index was significantly influenced by different dates of sowing and varieties are given in Table 11.

Among the dates of sowing, the seed obtained from the crop sown during first fortnight of June recorded higher seedling vigour index (2100) which was on par with the crop sown during second fortnight of June (2066) followed by the crop sown during second fortnight of February (1441).

Niger varieties showed significant effect on seedling vigour index. Between the varieties V_2 seeds recorded higher seedling vigour index (1784) over variety V_1 seeds (1695).

Interaction effect of sowing dates and varieties with respect to seedling vigour index was found to be significant. Among interactions, the highest seedling vigour index was recorded in D_1V_2 (RCR-18 seeds sown during first fortnight of June) (2206), followed by D_2V_2 (RCR-18 seed sown during second fortnight of June) (2154), whereas lowest seedling vigour index was recorded in $D_{12}V_1$ (No-71 seed sown during second fortnight of February) (1400).

4.3.6 Seed infection (%)

The observations on the per cent seed infection were presented in Table 11. There was a significant effect of dates of sowing and varieties on seed infection.

Among the dates of sowing, June first fortnight sowing recorded minimum seed infection (4.00%) followed by the crop sown during second fortnight of June (D_2) (4.50%). Whereas, higher seed infection was recorded in February second fortnight (D_{12}) (12.00%).

Between the varieties, RCR-18 (V_2) recorded lower per cent seed infection (6.92) over No-71 (8.75%).

The interaction effect between date of sowing and varieties was found to be significant for seed infection. Among the interactions, the lower seed infection was recorded in D_1V_2 (RCR-18 seeds sown during first fortnight of June) (3%), followed by D_2V_2 (RCR-18 seed sown during second fortnight of June) (4%), whereas higher seed infection was recorded in $D_{12}V_1$ (No-71 seed sown during second fortnight of February) (14%).

5. DISCUSSION

The results from the investigation on maximizing seed yield in niger (*Guzotia abyssinica* Cass) cultivars with respect to different dates of sowing during *kharif*, *rabi* and summer in 2007-08 at the Main Agricultural Research Station, University of Agricultural Sciences, Dharwad, are discussed in this chapter.

Seed yield is the net result of inter play of diverse metabolic activities that taking place among the different plant parts at various stages, which is largely influenced by environmental factors and seed production manipulations. The production of economic yield of a crop is an out come of interaction between crop, soil, environmental and seed production manipulations. Seed production manipulations can modify an environmental effects to a certain extent and thereby help the crop to utilize the available resources efficiently resulting in higher production. Thus, maximum seed yields are obtained only when optimum conditions are provided to a crop. Therefore, the time of sowing and selection of suitable varieties for seed production are important practices for enhancing the productivity per unit area.

5.1 Effect of varieties (V)

5.1.1 Growth parameters

Among the varieties, the V₂ (RCR-18) recorded the highest plant height (28.61, 81.45 and 101.74 cm at 30, 60 and 90 DAS, respectively), number of leaves per plant (12.15, 22.61 and 31.53 at 30, 60 and 90 DAS, respectively), number of primary branches per plant (13.69), number of secondary branches per plant (27.76) and took minimum days (46.76) to complete 50 per cent flowering. This was followed by V₁ (No-71) which recorded lower plant height (27.50, 79.90 and 98.57 cm at 30, 60 and 90 DAS, respectively), number of leaves per plant (11.8, 21.76 and 31.12 at 30, 60 and 90 DAS, respectively), number of primary branches per plant (11.55), number of secondary branches per plant (25.58) and more days (48.88) to complete 50 per cent flowering (Fig. 2). Such as variability in growth pattern among the varieties of niger was reported by Mishra *et al.* (1991) and Tiwari (1994) in sesame.

5.1.2 Yield parameters

RCR-18 (V₂) recorded higher number of capitula per plant (32.76), number of seeds per capitulum (20.03), thousand seed weight (2.62 g), seed yield per plant (1.85 g), seed yield per hectare (384.10 kg) and oil content (35.83%). On the contrary, No-71 (V₁) recorded lower number of capitula per plant (30.54), number of seeds per capitula (19.46), thousand seed weight (2.37 g), seed yield per plant (1.54 g), seed yield per hectare (340.50 kg) and oil content (35.14%) (Fig. 3). Seed yield is the manifestation of morphological, physiological, biochemical aspects of growth parameters and is considered to be the result from the trapping and utilization of solar energy efficiently. Seed yield is polygenic in nature and is influenced by several internal and external factors throughout the crop growth period and even during reproductive phase also. Similar variability in growth and yield parameters were documented by Mishra *et al.* (1991) in niger, varieties and various research workers on niger (Anonymous, 1991 and 2007).

5.1.3 Seed quality parameters

After the harvest of the crop, the progeny seeds of each treatments were analyzed for various seed quality parameters, the seeds of both the varieties were significantly influenced the seed quality parameters.

Between the varieties, seeds harvested from RCR-18 (V₂) recorded higher germination (92.03%), field emergence (84.17%), shoot length (9.60 cm), root length (9.12 cm), seedling vigour index (1784) and lower seed infection (6.92), compared to the seeds of No-71 (V₁) variety with lower germination percentage (90.50), field emergence (81.79%), shoot length (9.33 cm), root length (9.01 cm), seedling vigour index (1695) and with higher seed infection (8.75%) (Fig. 4).

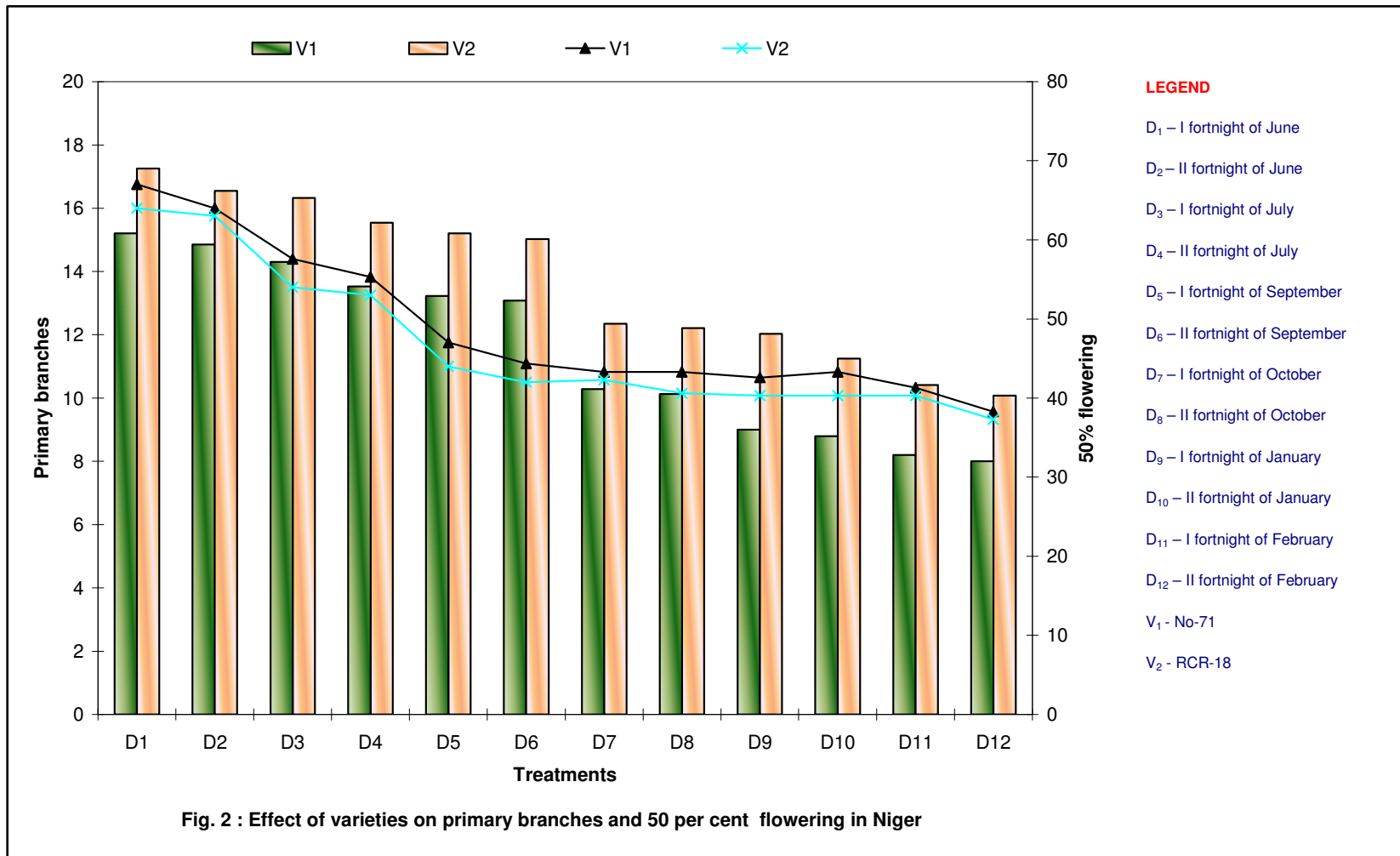


Fig.2: Effect of varieties on primary branches and 50 percent flowering in Niger

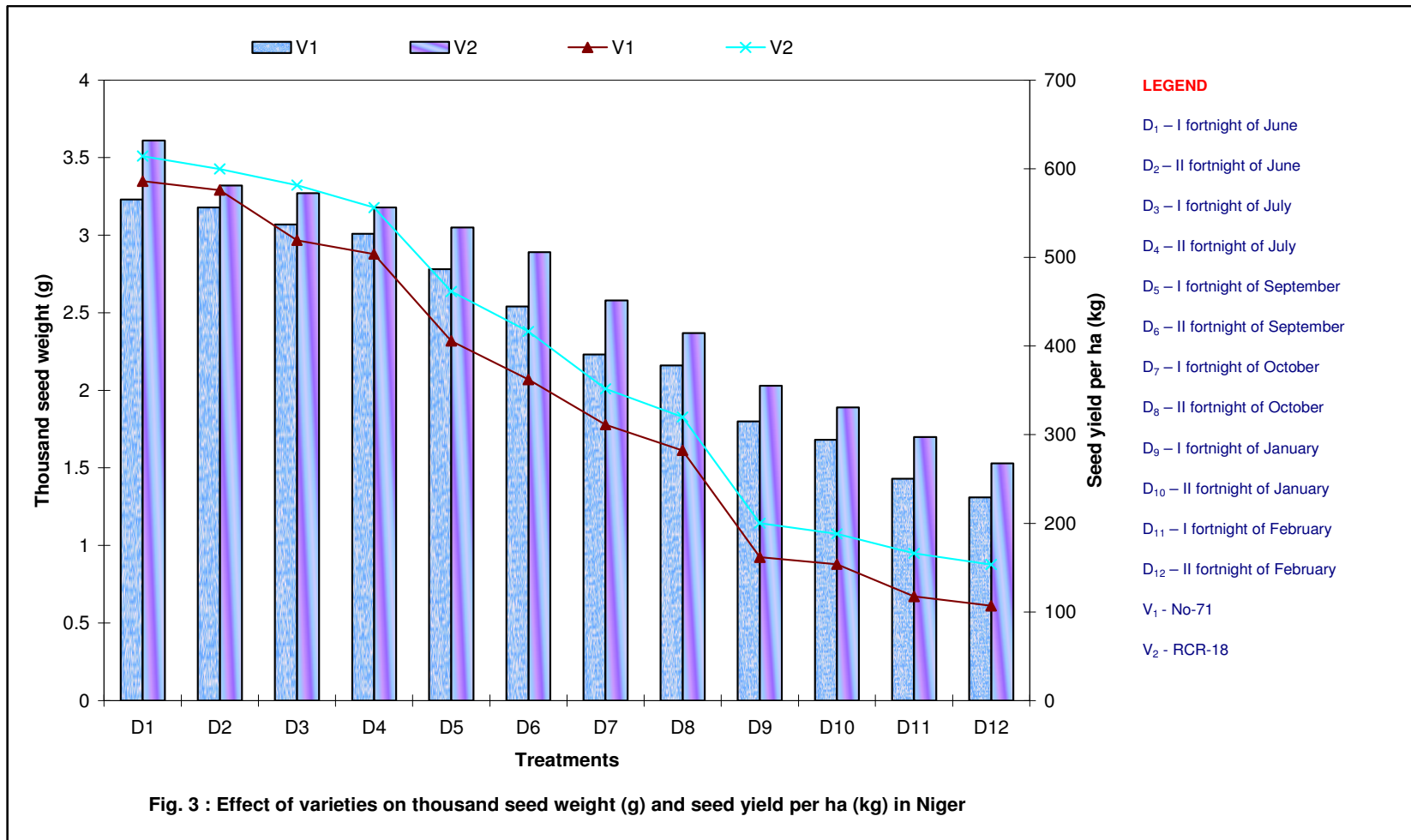


Fig.3 : Effect of varieties on thousand seed weight (g) and seed yield per ha (Kg) in Niger

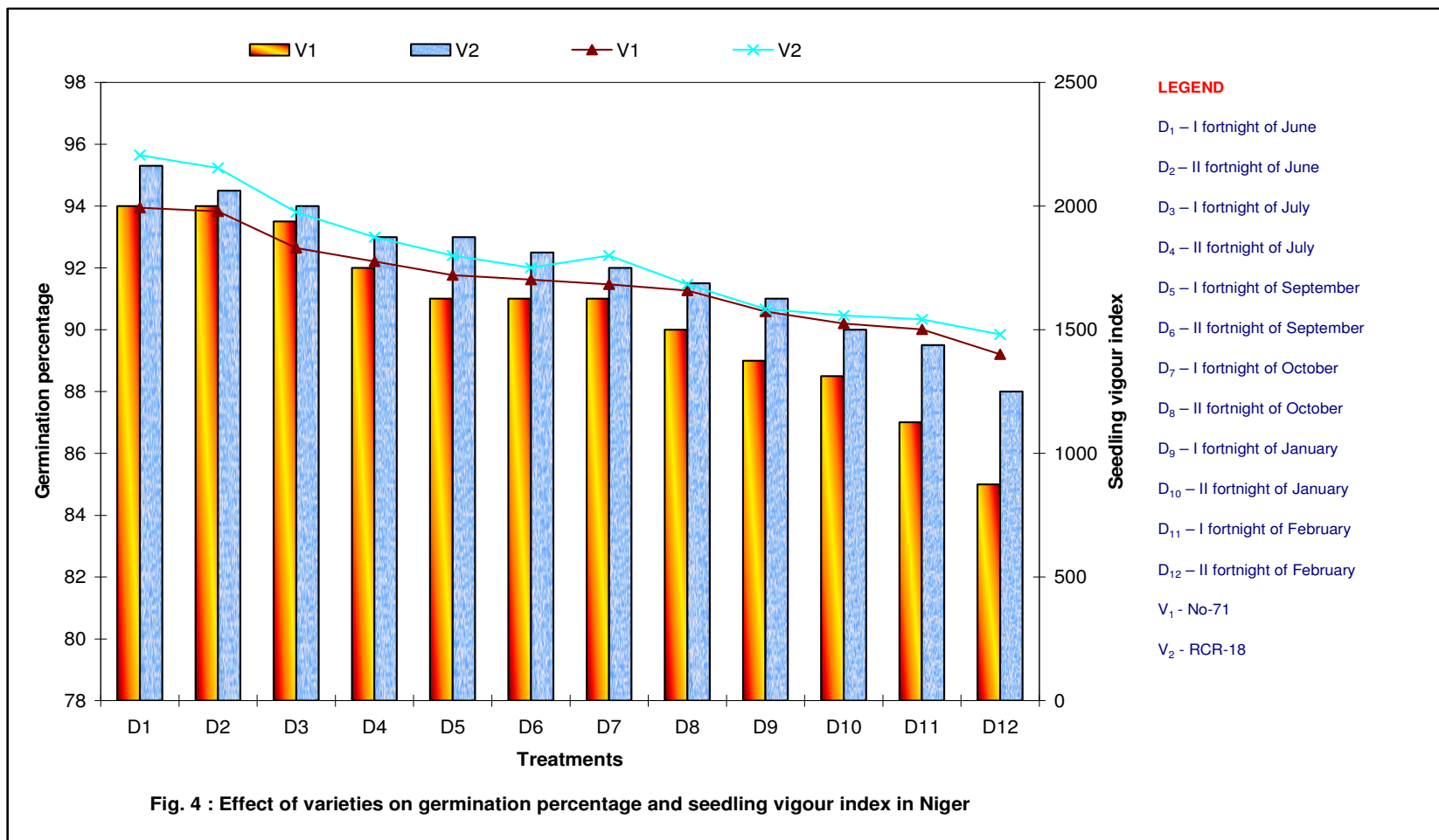


Fig.4: Effect of varieties on germination percentage and seedling vigour index in Niger

The variation between the varieties may be due to variation in expression of characters fully in the favourable environmental conditions. These findings on variability between the varieties are in conformity with the results of Tiwari *et al.* (1994) in sesamum, Nirval (1995) in sesamum and Gupta *et al.* (1998) in sesamum.

5.2 Effect of dates of sowing (D)

Date of sowing plays an important role to fully exploit the genetic potentiality of a variety as it provides optimum growing conditions such as temperature, light, relative humidity and rainfall. Sowing dates determine the time available for vegetative phase before the onset of reproductive phase (flowering) which is mainly influenced by photoperiod (day length). These environmental factors certainly influence the growth of a crop. These results are in conformity with Mishra *et al.* (1991) in niger and Tiwari (1994) in sesame, who have observed the luxuriant growth particularly in sowings of *kharif* rather than other sowing dates in *rabi* and summer seasons.

5.2.1 Growth parameters

Among the dates of sowing, D₁ planting (June first fortnight) recorded significantly higher plant height (38.13, 132.19 and 152.66 cm at 30, 90 and 90 DAS, respectively), number of leaves per plant (14.85, 28.73 and 39.68 at 30, 60 and 90 DAS, respectively), number of primary branches per plant (36.08) and days to 50 per cent flowering (66 days) followed by D₂ (June second fortnight) and D₃ (July first fortnight) recorded plant height in *kharif* season as compared to the sowings in *rabi* and summer season (Fig. 5, 6 and 7).

The variation in growth parameters among the date of sowing might be due to the influence of environmental factors such as temperature, sunshine, rainfall and relative humidity. The late sowing crop recorded significantly lower values in plant height, number of leaves and reduction in the duration of vegetative and reproductive phase and also due to soil moisture stress compared to early sown crop, as was observed by the Nayak and Paikaray (1991) niger, Paul *et al.* (1995) and Agarwal *et al.* (1996) in niger and Sudhakar *et al.* (1998) in sunflower.

5.2.2 Yield parameters

Among the dates of sowing, D₁ sowing (June first fortnight) recorded higher number of capitula per plant (40.12), number of seeds per capitulum (21.61), thousand seed weight (3.42 g), seed yield per plant (2.98 g), seed yield per hectare (600.09 kg) and oil content (40.68%) followed by D₂ (June second fortnight) and D₃ sowing (July first fortnight) which recorded moderate number of capitula per plant (39.87 and 38.68, respectively), number of seeds per capitulum (21.35 and 20.97 g), thousand seed weight (3.25 and 3.17 g), seed yield per plant (2.76 and 2.56), seed yield per hectare (587.76 and 550.32 kg) and oil content (40.33 and 38.72%) (Fig. 8).

On the contrary, D₁₂ (February second fortnight) recorded lowest number of capitula per plant (21.30), number of seeds per capitulum (18.12), thousand seed weight (1.42 g), seed yield per plant (0.54 g), seed yield per hectare (130.24 kg) and oil content (31.42%) during summer season.

The dates of sowing had a significant influence on number of capitula per plant and number of seeds per capitulum. These two yield components recorded the highest values because of increased yield attributing characters like plant height, number of leaves, number of primary and secondary branches per plant. These results are in conformity with the findings of Agarwal *et al.* (1996) in niger, Baly Akula and Bapi Reddy (1998) in castor and in niger (Anon., 2007).

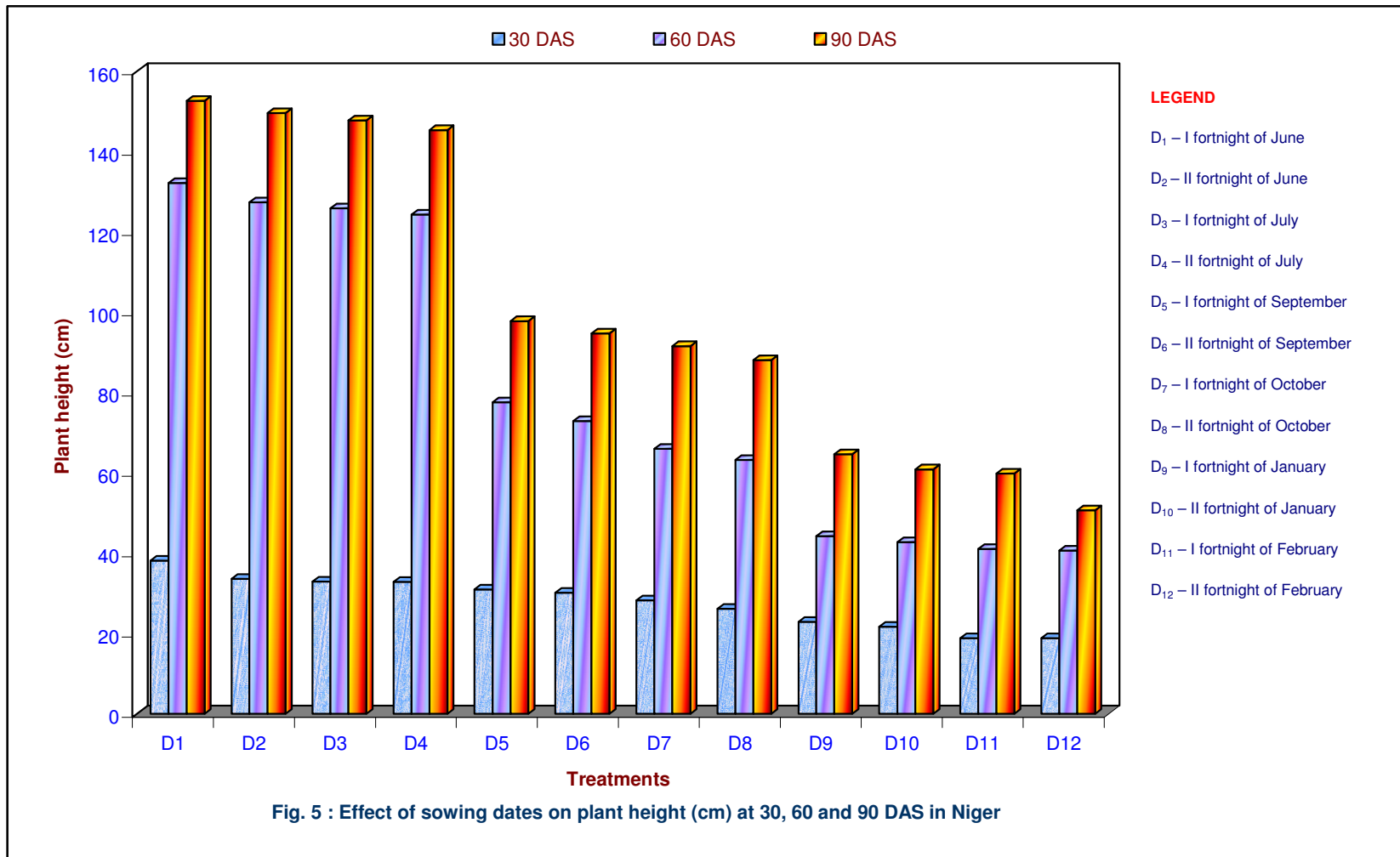


Fig.5: Effect of sowing dates o plant height (cm) at 30,60 and 90 DAS in Niger

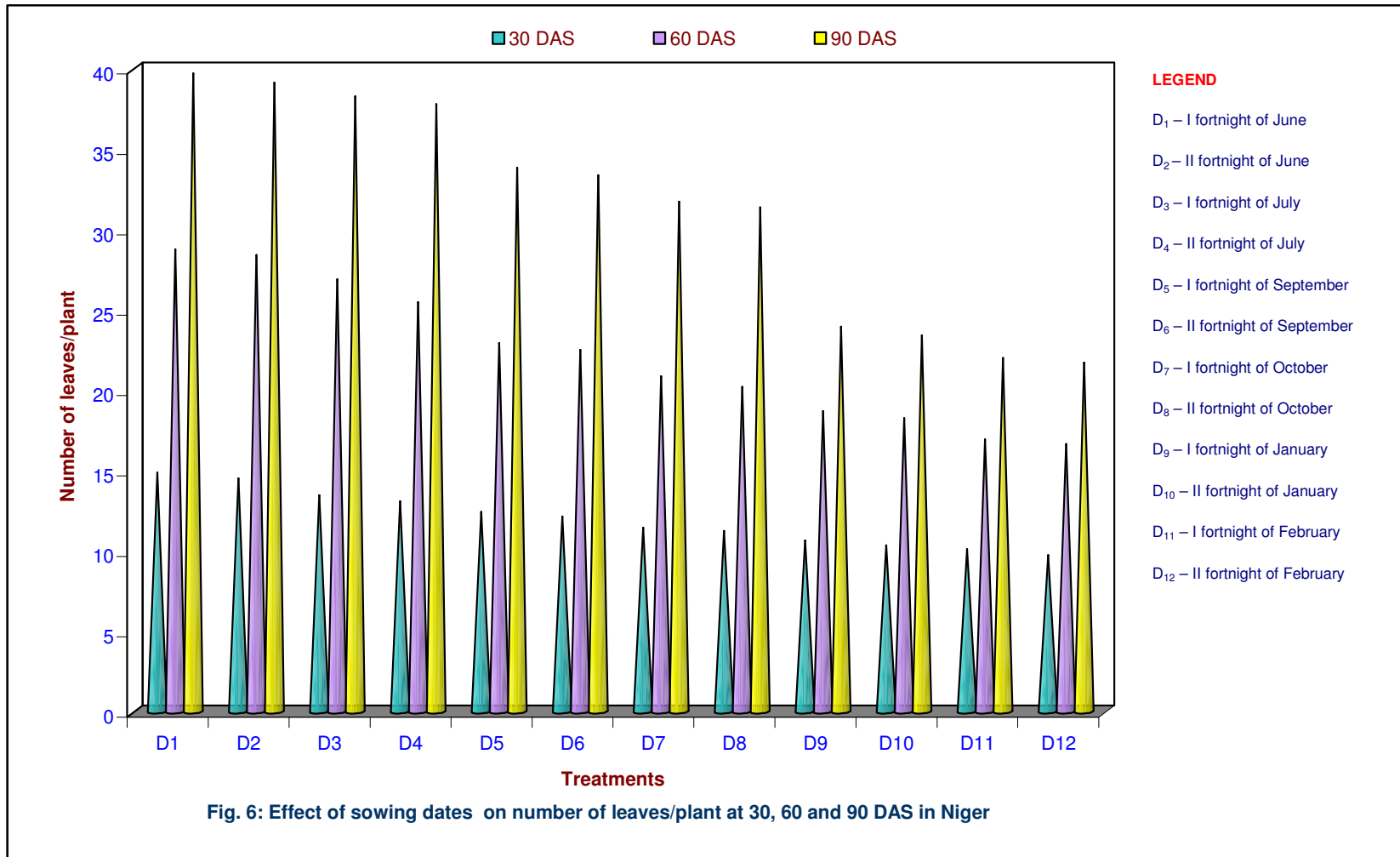


Fig.6: Effect of sowing dates on number of leaves/plant at 30, 60 and 90 DAS in Niger

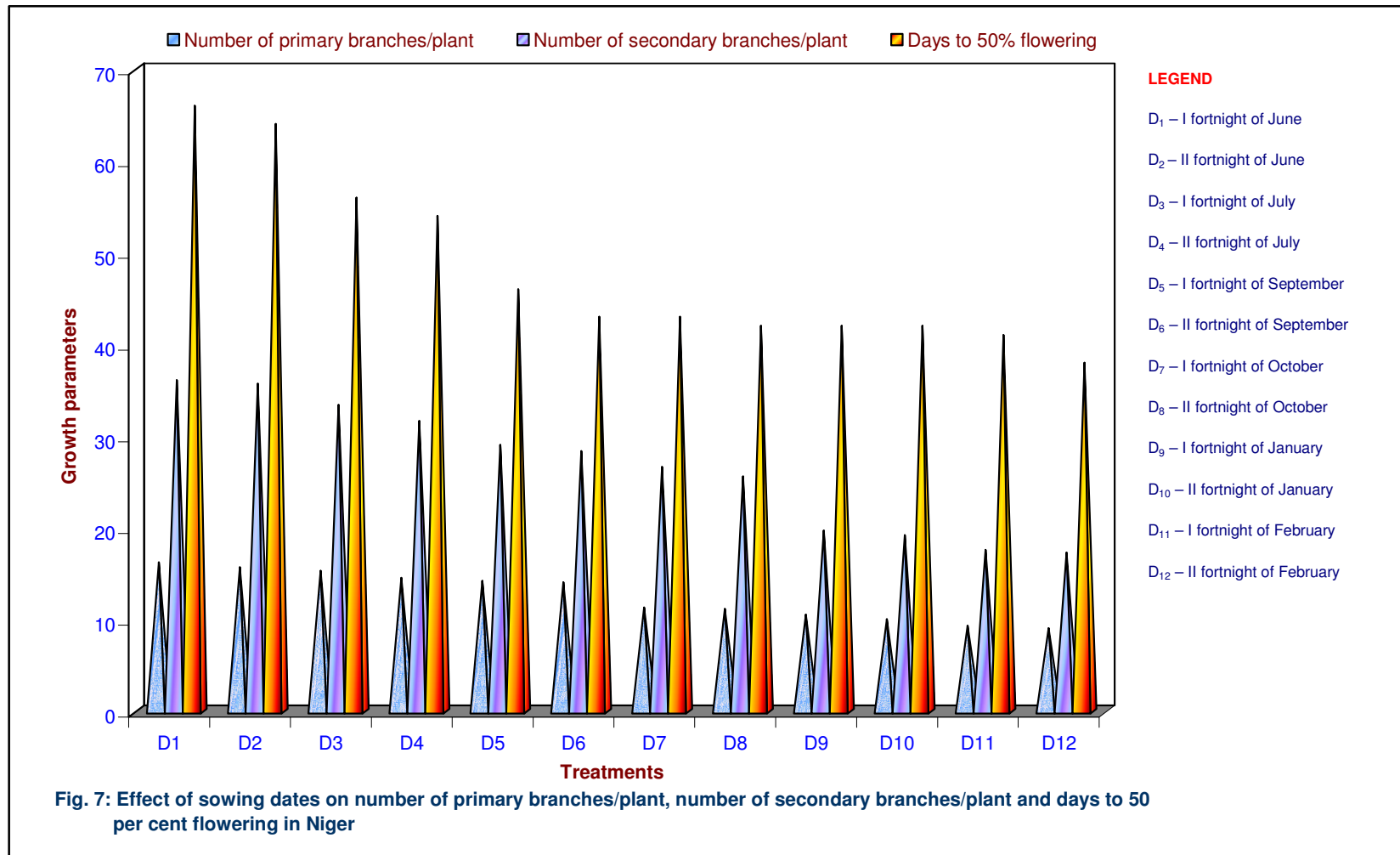


Fig.7: Effect of sowing dates on number of primary branches/plant, number of secondary branches/plant and days to 50 percent flowering in Niger

5.2.3 Seed quality parameters

Among the dates of sowing, D₁ (June first fortnight) recorded higher germination percentage (95.00%), field emergence (89.00%), shoot length (11.50 cm), root length (10.53), seedling vigour index (2099) and lower seed infection (4.00%) followed by D₂ (June second

fortnight) and D₃ (July first fortnight) which recorded germination percentage (94.00 and 94.00), field emergence (88.00 and 86.00), shoot length (11.33 and 10.15 cm), root length (10.02 and 9.75 cm), seedling vigour index (2066 and 1902) and seed infection (4.50 and 6.00%) (Fig. 9 and 10).

Whereas, D₁₂ (February second fortnight) recorded lower germination percentage (87.00%), field emergence (6.00%) shoot length (8.07 cm), root length (8.03 cm), seedling vigour index (1440) and higher seed infection (12.00%).

This might be due to the favourable condition existed during the grain filling stage in early sown crop compared to delayed sowings. These results are in agreement with the findings of Saini *et al.* (1980) in soybean, Padma *et al.* (1992) in groundnut and in niger (Anon., 1988).

5.3 Interaction of varieties of dates of sowing (V x D)

5.3.1 Growth parameters

Among the interactions, RCR-18 seeds (V₂) sown during June first fortnight (D₁₂) recorded significantly higher plant height (38.42, 132.20 and 153.75 cm at 30, 60 and 90 DAS, respectively), number of leaves (15.20, 28.85 and 39.86 at 30, 60 and 90 DAS, respectively), number of primary branches per plant (17.25), number of secondary branches per plant (37.13), days to 50 per cent flowering (64.00 days) followed by June second fortnight (D₂ V₂) which recorded, moderate plant height (33.65, 128.25 and 150.38 at 30, 60 and 90 DAS, respectively), number of leaves per plant (14.95, 28.50 and 39.20 at 30, 60 and 90 DAS), number of primary branches (16.55), number of secondary branches (36.80) and days to 50 per cent flowering (63.00 days) as compared to D₁₂V₁ (No-71 seeds) sown during February second fortnight) which recorded lower plant height (18.24, 40.12, 41.23 cm at 30, 60 and 90 DAS, respectively), number of primary branches (8.00), number of secondary branches (16.17) and days to 50 per cent flowering (38.00). These results are in conformity with the findings of Mishra *et al.* (1991), in niger, Padma *et al.* (1992) in groundnut and in niger (Anon., 2007).

5.3.2 Yield parameters

The interaction effect of dates of sowing and varieties were significantly influenced the yield parameters and the results were presented in Table 6, 7 and 8.

Among the interactions the D₁V₂ combination recorded higher number of capitula per plant (41.34), number of seeds per capitulum (21.72), thousand seed weight (3.61 g), seed yield per plant (3.23 g), seed yield per hectare (614.35 kg) and oil content (40.84%) followed D₂ V₂ recorded moderate number of capitula per plant (40.91), number of seeds per capitulum (21.49), thousand seed weight (3.32 g), seed yield per plant (2.91 g), seed yield per hectare (599.62 kg) and oil content (40.53%) compared to D₁₂ V₁ which was recorded lower number of capitula per plant (20.31), number of seeds per capitulum (18.02), thousand seed weight (1.31 g), seed yield per plant (0.47 g), seed yield per hectare (106.91 kg) and oil content (31.28%). These results are in conformity with the findings of Saini *et al.* (1980) in soybean, Shelke (1987) in groundnut and in niger (Anon., 1988), who have observed varietal response of varieties to the different dates of sowing.

5.3.3 Seed quality parameters

The interaction effect of dates of sowing and varieties were significantly influenced the seed quality parameters and the results were presented in Table 9, 10 and 11.

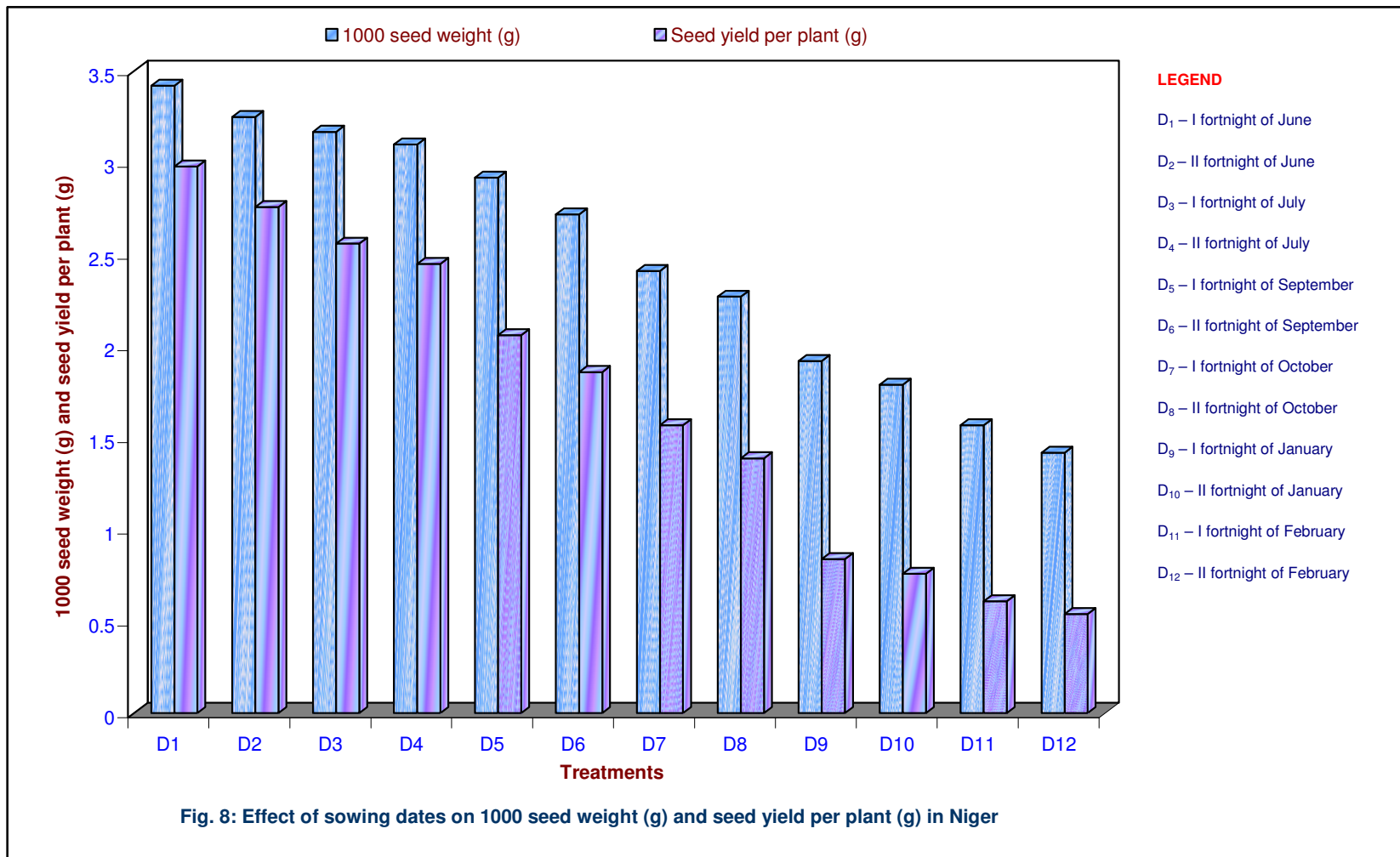


Fig.8: Effect of sowing dates on 1000 seed weight (g) and seed yield per plant (g) in Niger

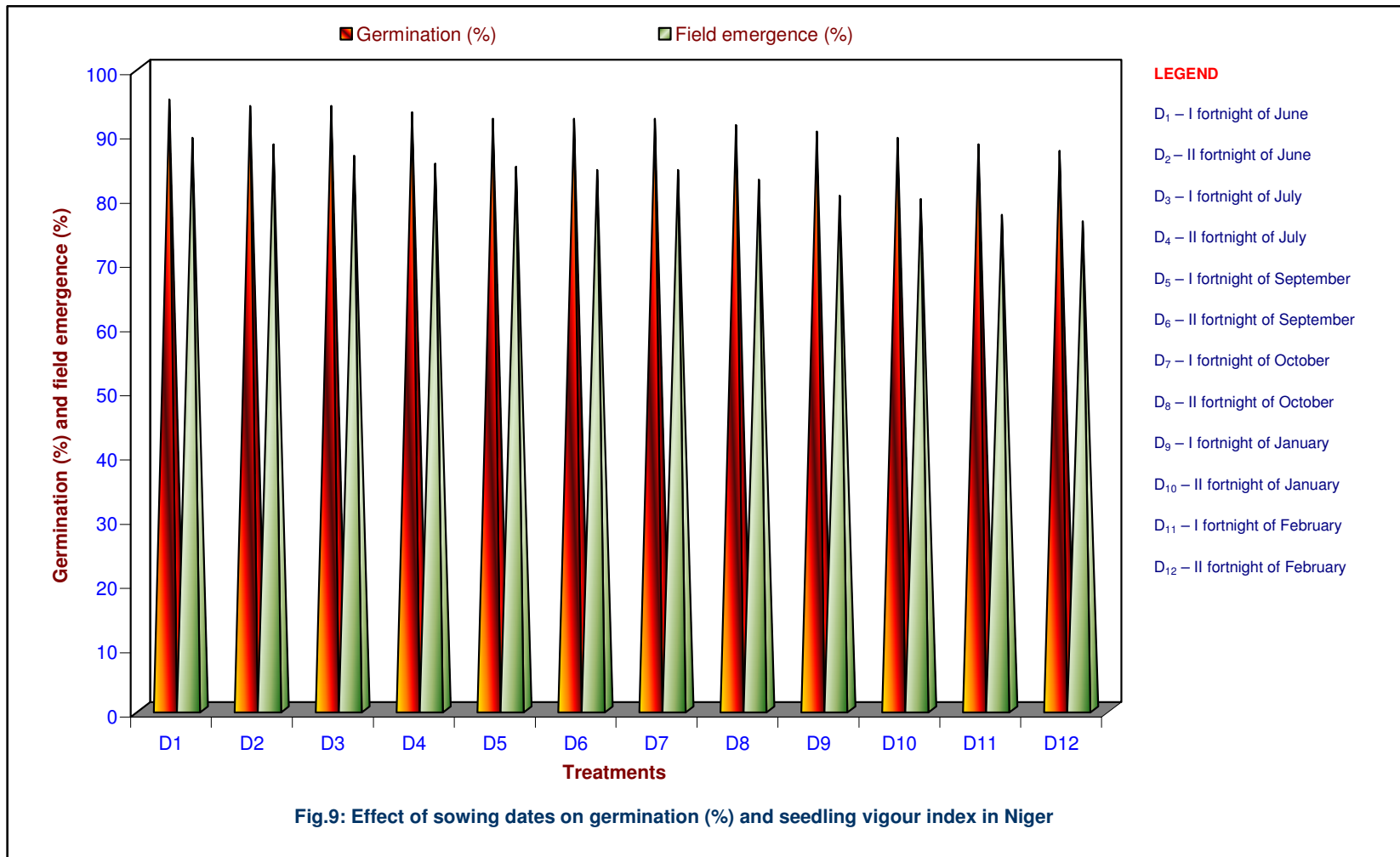


Fig.9: Effect of sowing dates on germination (%) and seedling vigour index in Niger

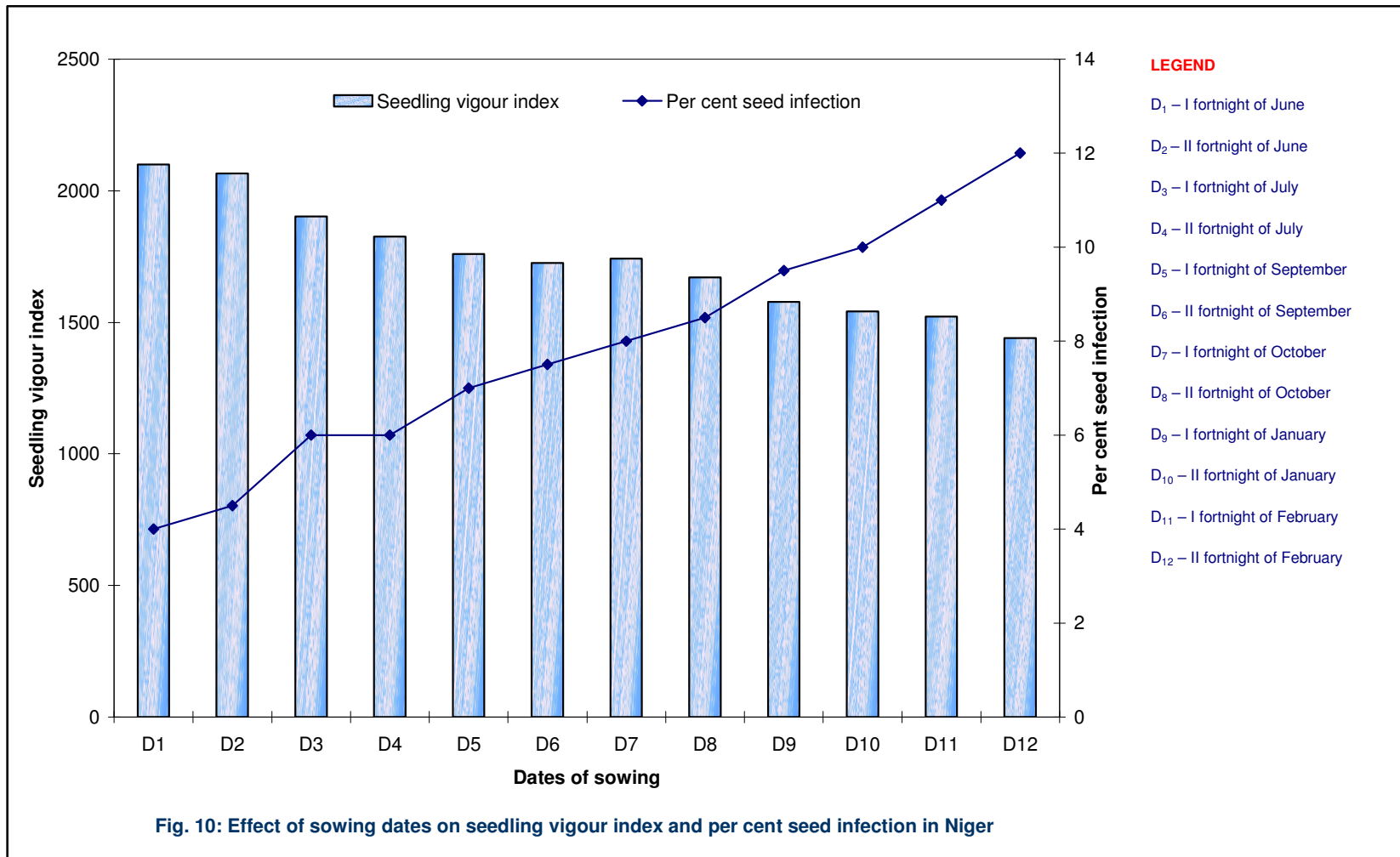


Fig.10: Effect of sowing dates on seedling vigour index and percent seed infection in Niger

Among the interactions, D₁V₂ recorded higher germination percentage (90.00), field emergence (90.00), shoot length (11.80 cm), root length (10.85 cm), seedling vigour index (2206) and lower seed infection (3.0%), followed by D₂V₂ which recorded germination percentage (95.00%), field emergence (89.00%), shoot length (11.65 cm), root length (10.23 cm), seedling vigour index (2154) and seed infection (4.00%), compared to D₁₂V₁ which recorded lower germination percentage (85.00%), field emergence (75.00%), shoot length (8.00 cm), root length (8.00 cm), seedling vigour index (1400) and higher seed infection (14.00). The higher yield and seed quality parameters might be due to sufficient rainfall, optimum temperature in early sown crop which was beneficial for the early establishment of crop and subsequent proper growth resulting in producing more height, foliage and higher number of seeds per capitula which ultimately resulted in higher yield and seed quality and fully expression of the varietal characters during favourable conditions which are existed during early sown crops.

These results are in conformity with the reports of Saini *et al.* (1980) in soybean, Mishra *et al.* (1991) in niger, Padma *et al.* (1992) in groundnut, Babalad *et al.* (1996) in soybean and in niger (Anon., 1988 and 2007).

Looking to the above discussion, it can be concluded that No-71 and RCR-18 seeds sown during first fortnight of June gave higher growth, yield and seed quality attributes compared to rest of the sowings.

Practical utility of the results

The present investigation generated the following results of practical utility.

1. Variety RCR-18 yielded significantly higher seed yield (384.10 kg/ha) than No-71 (340.50 kg/ha).
2. Sowing of niger in *kharif* season has been found better than *rabi* and summer season sowings.
3. Niger sown on first fortnight of June recorded significantly higher seed yield and seed quality (614.35 kg) followed by second fortnight of June (599.62 kg) as compared to other dates of sowing from June to February.

Future line of work

1. Newly identified or pre released and promising genotypes need to be evaluated for their superiority over existing varieties/local or national check (RCR-18).
2. There is need to find out the response of niger to combination of different levels of N, P and K during *kharif*, *rabi* and summer season.
3. Seed pelleting in niger will help in obtaining the good quality of seeds and the storability can be studied.
4. The present investigation is restricted to Dharwad, same may be extended to different regions of Karnataka
5. In the present investigation only dates of sowing studied, other agronomic manipulation may be studied for maximizing seed yield.

6. SUMMARY AND CONCLUSIONS

A field experiment was conducted at Main Agricultural Research Station, Dharwad during 2007-08 in order to study the response of niger varieties to dates of sowing during *kharif*, *rabi* and summer season. There were 24 treatment combinations comprising of two varieties as main plot (No. 71 and RCR-18) and 12 dates of sowing as sub plots (June first fortnight (D₁), June second fortnight (D₂), July first fortnight (D₃), July second fortnight (D₄), September first fortnight (D₅), September second fortnight (D₆), October first fortnight (D₇), October second fortnight (D₈), January first fortnight (D₉), January second fortnight (D₁₀), February first fortnight (D₁₁) and February second fortnight (D₁₂). Treatments were replicated three times and laid out in a split plot design.

The growth parameters of niger differed significantly to different dates of sowing. Higher plant height was recorded in June first fortnight (D₁) (38.13, 132.19, 152.66 cm at 30, 60 and 90 DAS, respectively) followed by June second fortnight (D₂) (34.58, 127.25, 149.57 cm at 30, 60 and 90 DAS, respectively). The lowest plant height was recorded in the crop sown during second fortnight of February (D₁₂) (18.81, 40.67 and 50.74 cm at 30, 60 and 90 DAS, respectively). Number of leaves per plant was higher in the crop sown during the June first fortnight (D₁) (14.85, 28.73, 39.88 cm, respectively) followed by June second fortnight (D₂) (14.48, 28.50, 39.10 cm) at 30, 60 and 90 DAS, respectively. Lower number of leaves per plant were recorded in the crop sown during second fortnight of February (D₁₂) (9.72, 16.62, 21.68 cm at 30, 60 and 90 DAS, respectively).

Number of primary branches and secondary branches per plant were higher in June first fortnight (D₁) (16.23, 36.08, respectively) sowing followed by June second fortnight (D₂) (16.55, 36.80, respectively) sowing. The lower number of primary and secondary branches per plant were recorded lower in February second fortnight sowing (D₁₂) (9.04, 17.29, respectively). With regard to days to 50 per cent flowering, June first fortnight took more number of days (66) which was followed by June second fortnight (D₂) (64) whereas, lower number of days to 50 per cent flowering was seen in the crop sown during the second fortnight of February (D₁₂) (38).

The niger genotype, RCR-18 (V₂) registered significantly higher plant height (28.61, 81.45, 101.74 at 30, 60 and 90 DAS, respectively), number of leaves (12.15, 22.61, 31.53 at 30, 60 and 90 DAS, respectively), primary and secondary branches per plant (13.69, 27.76, respectively at harvest) and days to 50 per cent flowering (46.76) over No-71 (V₁) (plant height 27.50, 79.90, 98.57 cm) at 30, 60 and 90 DAS, respectively and number of leaves (11.80, 21.76, 31.12/plant at 30, 60 and 90 DAS, respectively).

The niger genotype RCR-18 (V₂) registered significantly higher seed yield (384.10 kg/ha) over No-71 (V₁) (340.50 kg/ha). Maximum seed yield of niger was obtained when crop sown on first fortnight of June (600.9 kg/ha) followed by second fortnight of June (587.76 kg/ha). Minimum seed yield per ha was obtained in the crop sown on second fortnight of February (130.24 kg/ha).

The genotype RCR-18 recorded significantly higher number of capitula per plant (32.76) compared to No-71 variety (30.54). The crop sown during the first fortnight of June (D₁) recorded significantly higher number of capitula per plant (40.12) followed by second fortnight of June (D₂) (39.87). Whereas, lower number of capitula per plant was recorded in the crop sown during second fortnight of February (20.31).

The genotype RCR-18 recorded significantly higher number of seeds per capitula (20.03) compared to No-71 (19.46). The crop sown during first fortnight of June (D₁) recorded significantly higher number of seeds per capitulum (21.61) followed by June second fortnight (D₂) (21.35). But lower number of seeds per capitulum recorded in secondary fortnight of February (D₁₂) (18.12).

The niger genotype RCR-18 (V₂) recorded higher 1000 seed weight (g) (2.62 g) over No-71 (V₁) (2.37 g). The crop sown during first fortnight of June (D₁) recorded higher 1000

seed weight (3.42 g) followed by second fortnight of June (3.25 g). Lower 1000 seed weight was recorded in the crop sown in during second fortnight of February (1.42 g).

The niger genotype RCR-18 (V_2) recorded higher seed yield per plant (1.85 g) over No. 71 (V_1) (1.54 g). The crop sown during first fortnight of June (D_1) recorded higher seed yield per plant (2.98 g) followed by second fortnight of June (2.91 g). But lower seed yield per plant was recorded in the crop sown during second fortnight of February (0.47 g).

The niger genotype RCR-18 (V_2) recorded more oil content (35.88%) over No-71 (V_1) (35.28%). The crop sown during first fortnight of June recorded higher oil content of 40.84 per cent whereas lower oil content was recorded in the crop sown in February second sowing fortnight 31.28 per cent.

Between the varieties RCR-18 observed higher germination (92.03%), root length (9.21 cm), shoot length (9.60 cm), vigour index of seedling (1740), field emergence (84.17%). With lower seed infection (6.92) as compared to No-71 (90.50%, 9.01cm, 9.33 cm, 1703, 81.79 and 8.75, respectively).

Among the dates of sowing the crop sown during June first fortnight (D_1) recorded higher germination (95.0%), root length (10.53 cm), shoot length (11.43 cm), seedling vigour index (2206) and field emergence (89%) with lower seed infection (4.0). Whereas, lower seed quality parameters were recorded in February second fortnight (D_{12}) (87.0, 10.20, 10.40 cm, 2010, 76 and 12, respectively).

From the present investigation following conclusions can be drawn.

- Genotype RCR-18 has produced significantly higher growth, seed yield and seed quality parameters as compared to No-71 genotype.
- The crop sown during the *kharif* season recorded higher seed yield and its attributes as compared to the *rabi* and summer seasons.
- Niger crop sown during June first fortnight performed better in all the growth, yield and its attributes and seed quality parameters followed by June second fortnight but poor performance was noticed in the crop sown during February second fortnight.

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STUDIES ON MAXIMIZING SEED YIELD AND QUALITY IN NIGER (*Guizotia abyssinica* Cass)

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ABSTRACT

An investigation was carried out to study the effects of dates of sowing on growth, yield and quality of niger Cv. No. 71 and RCR-18 during 2007-2008 at Main Agricultural Research Station, College of Agriculture, Dharwad. The experimental results revealed that plant height, number of leaves, number of primary and secondary branches and days to 50 per cent flowering were higher in June first fortnight sowing as compared to later sowings. Between the genotypes, RCR-18 recorded higher growth parameters like plant height, number of primary and secondary branches, number of leaves and early in days to 50 per cent flowering as compared to genotype No. 71. Among the different seasons, *kharif* season recorded higher growth parameters as compared to *rabi* and summer. The crop sown during second fortnight of February recorded significantly lower growth and yield parameters as compared to other dates of sowing. The interaction (DxV) was significant for growth and yield parameters. Number of capitula, number of seeds per capitula, 1000 seed weight, seed yield per plant, seed yield kg per hectare were found to be higher in June first fortnight sowing as compared to other later sowings. The crop sown during second fortnight of February recorded the lower yield parameters like number of capitula, number of seeds per capitula, 1000 seed weight, seed yield per plant, seed yield kg per hectare. Seed quality parameters like germination percentage, root length, shoot length, field emergence and vigour index were maximum with June first fortnight as compared to other sowings. The crop sown during the second fortnight of February recorded the lower seed quality parameters like germination percentage, root length, shoot length, field emergence and vigour index. The interaction (DxV) was significant for seed quality parameters.