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Effect of staggered date of sowing and fertilizer application on yield and yield attributing characters of Niger (*Guizotia abyssinica* Cass.)

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Abstract
The investigation was carried out under AICRP on Niger and Sesame at JNKVV, Jabalpur in split plot design (SPD) with three replications having treatments comprised of main plot, dates of sowing *viz*., Before RDS at sufficient moisture under pre monsoon rainfall, Recommended date of sowing [RDS], One week after RDS and Two weeks after RDS and sub plot, fertilizer applications *viz*., Control, Recommended dose of fertilizer [N,P,K] and RDF [50%N and 100% P,K was applied as basal application and 50%N was given in two split doses].]. Last week of August date of sowing and F3 (100% P & K and 50% N as basal and 50% N in two split doses) fertilizer dose was found best for most of the yield and yield attributing characters *viz*., plant height, number of primary branches, number of secondary branches, length of capitulum, No. of seeds capitulum^{-1}, No. of seeds capitulum^{-1}, test weight, biological yield, economic yield and harvest index and seed quality parameters.

Keywords: Niger, date of sowing, fertilizer application, Yield attributes

Introduction
Oilseeds are as important as the pulses in the country. India is one of the largest producer and consumer of vegetable oils in the world. Oilseeds are the backbone of agricultural economy of India since long time. The Indian vegetable oil economy is the fourth largest in the world next to US, China and Brazil producing about 25 million tons of oilseeds against the world production of 250 million tons per annum (Anonymous, 2012) [1]. Oilseed crops occupies second most important position in the Indian agricultural economy next to food grains in terms of area and production. The seed contains about 40% oil with fatty acid composition of 75-80% linoleic acid, 7-8% palmitic and stearic acids, and 5-8% oleic acid (Getinet and Teklewold, 1995) [5]. The Indian types contain 25% oleic and 55% linoleic acids (Nasirullah *et al*., 1982) [9].

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 and this was also observed by the Nayak and Paikaray (1991) [10]. The study was conducted to determine optimum sowing dates for Niger Cv. No. 71 and RCR-18. Among the different cultivation practices, optimum sowing 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 (Eberhort and Russel, 1966) [4]. The time of sowing determines the time available for vegetative growth before the onset of flowering, which is mainly influenced by photoperiod. It also determines the plant height, number of branches, flowering and capitula bearing habits.

Material and Methods
A field experiment was conducted at the research farm (23.90^0 North latitude, 79.58^0 East longitudes and located at 411.78 m (above mean sea level) of under AICRP on Niger and Sesame at JNKVV, Jabalpur (M.P) The revealed experiment was laid out in split plot design (SPD). It lies in subtropical region and thus enjoys the feature of hot dry summers and cool winters. The average annual rainfall of this region is about 1350 mm, which is mostly received from July to September. The maximum temperature reaches as high as 45 ^{0}C in the month of

May or June while minimum temperature goes down to 40 ^{0}C in December and January months followed by occasional frost. The relative humidity remains low (30 to 40%) during summer months, moderate (60 to 75%) during winter and attains high value (80 to 90%) in rainy season.

Results and Discussion

A. Yield and yield attributes

1. Plant height (cm)

Plant height of niger crop was significantly affected by main treatment and sub treatment. Treatment D3 (Last week of August) date of sowing recorded maximum plant height (123.40 cm) and the minimum was recorded in D4 (1st week of September) date of sowing (78.93 cm) as compare to other dates of sowing. The main and sub treatment interaction significantly influenced plant height. The combination of D3F3 exhibited the highest plant height (127.10 cm). Chhabra *et al*. (1982) [2] reported that sunflower varieties EC- 68415 and Romusum when sown in March, May, July, September, October, November and January the November sown crop had long vegetative growth period and maximum plant height.

2. Primary branches (plant^{-1})

In the present experiment, D3 (Last week of August) date of sowing attained maximum (plant^{-1}) number of primary branches while, F3 (100% P & K and 50% N as basal and 50% N in two split doses) fertilizer dose attained highest number of primary branches (14.07 plant-1) and lowest was recorded in F1 (Control) fertilizer dose (13.13 plant-1) as compared to other doses of fertilizer. The interaction D3F3 (16.33 plant-1) attained highest number of primary branches and lowest was noted in D4F1 (10.44 plant-1).Thakuria and Gogoi (1992) [15] found significantly highest primary branches per plant (6.8) with application of 40:20:10 NPK kg ha-1 over 20:10:10 NPK kg ha^{-1}).

3. Secondary branches (plant^{-1})

The numbers of secondary branches plant^{-1} were significantly correlated with seed yield in Niger (Pritarani *et al*., 2005) [12]. Here, D3 (Last week of August) date of sowing recorded highest number of secondary branches (32.83 plant^{-1}).The higher (30.12 plant-1) number of secondary branches was exhibited in F3 (100% P & K and 50% N as basal and 50% N in two split doses) fertilizer dose while the lower was noted in F1 (Control) fertilizer dose (31.41 plant^{-1}).

4. Length of capitulum (cm)

This result supported the findings of treatment D3 (Last week of August) date of sowing attained maximum length of capitulum (1.90 cm), while minimum was recorded by D4 (1st week of September) date of sowing (1.60 cm). F3 (100% P & K and 50% N as basal and 50% N in two split doses) fertilizer dose had highest length of capitulum (1.81 cm) and lowest was recorded in F1 (Control) fertilizer dose (1.71 cm). The combination D3F3 (1.98 cm) noted highest length of capitulum and lowest was noted in D4F1 (1.56 cm).

5 No. of seeds capitulum^{-1}

Number of seeds per capsule plays important role in determining yield of crop. In this experiment, treatment D3 (Last week of August) date of sowing recorded highest number of seeds capsule^{-1} (27.43). However, F3 fertilizer dose recorded significantly highest number of seeds capitulum-1 (26.70). The combination of D3F3 (29.66) noted significantly maximum number of seeds capitulum-1 and minimum was noted in D4F1 (19.66). Similar result found by Mili *et al*. (2012) [7] where, number of seeds capitulum-1 decrease significantly due to delay in sowing time of the crop.

6 No. of capitulum plant^{-1}

This result showed that D3 date of sowing recorded highest number of capitulum plant-1 (88.77) and D4 date of sowing had lowest (73.24) as compared to other dates of sowing. The result of fertilizer application showed that, F3 fertilizer dose had maximum number of capitulum (79.69). The combination of D3F3 exhibited the highest number of capitulum plant-1 (90.76). Pritarani *et al*., (2005) [12]. They also noted that seed yield per plot and per plant were significantly correlated with number of capitulum plant-1.

7. Test weight (g)

Test weight is a density measurement that is used as an indication of seed quality. Mohankumar *et al.* (2011) [8] where they found that test weight in Niger was higher in June first fortnight sowing as compared to other later sowings. The crop sown during second fortnight of February recorded the lower test weight. The result had shown that D3 (Last week of August) date of sowing recorded maximum test weight (4.021 g). F3 fertilizer dose recorded significantly highest test weight (3.843 g), while the lowest was recorded in F1 (Control) (3.765 g). The combination of D3F3 (4.077 g) noted significantly maximum test weight.

8. Biological yield (Kg ha^{-1})

Biological yield is a function of growth duration and crop growth rate at successive growth stages. Here, F3 fertilizer dose had higher biological yield (2862.927). Among the different dates of sowing, D3 date of sowing attained highest biological yield (3255.177). The biological yield was highest in combination D3F3 (3346.763) and lowest was noted in D4F1 (2242.573).Similar result was found by Patil and Ballal (1964) [11]

Table 1: Yield and yield attributes of Niger crop affected by different dates of sowing and doses of fertilizer

S. No.	Treatments	Plant height (cm)	Primary branches (plant^{-1})	Secondary branches (plant^{-1})	Length of Capitulum (cm)	No of seeds capitulum^{-1}	No of Capitulum plant^{-1}	Test Weight (g)	Harvest index (%)
A	**Dates of sowing**								
D1	Last week of July	114.28	14.96	31.60	1.83	26.66	83.96	3.839	16.017
D2	2nd week of August	97.10	12.77	30.55	1.72	23.44	79.58	3.733	15.699
D3	Last week of August	123.40	15.99	32.83	1.90	27.43	88.70	4.021	16.877
D4	1st week of Sep.	78.93	10.70	28.03	1.60	21.57	73.24	3.618	14.761
	S.Em+	0.55	0.09	0.061	0.006	0.141	0.161	0.003	0.021
B	**Doses of fertilizer**								
F1	Control	100.16	13.13	30.12	1.71	22.86	79.69	3.765	15.518
F2	100%RDF(as basal)	103.4	13.58	30.72	1.77	24.77	81.44	3.800	15.809

F3	100% P & K and 50% N as basal and 50% N in two split doses.	106.70	14.07	31.41	1.81	26.70	83.05	3.843	16.188
	S.Em+	0.34	0.08	0.053	0.004	0.083	0.090	0.003	0.019
	Interaction (DXF)								
	D1F1	112.44	14.33	31.00	1.83	25.20	82.00	3.813	15.910
	D1F2	113.33	15.11	31.36	1.83	26.46	84.03	3.837	15.957
	D1F3	117.07	15.44	32.44	1.84	28.33	85.86	3.867	16.183
	D2F1	92.87	12.33	30.22	1.64	21.26	78.13	3.703	15.467
	D2F2	95.77	12.33	30.44	1.74	23.60	79.56	3.733	15.760
	D2F3	102.66	13.55	31.00	1.77	25.46	81.06	3.763	15.870
	D3F1	117.16	15.44	32.29	1.83	25.33	86.53	3.970	16.427
	D3F2	125.93	16.22	33.00	1.90	27.29	89.03	4.017	16.630
	D3F3	127.10	16.33	33.22	1.98	29.66	90.76	4.077	17.573
	D4F1	78.16	10.44	27.00	1.56	19.66	72.10	3.573	14.270
	D4F2	78.65	10.66	28.11	1.61	21.73	73.13	3.613	14.890
	D4F3	79.98	10.99	29.00	1.63	23.33	74.50	3.667	15.123
	S.Em+	0.792	0.165	0.106	0.010	0.196	0.216	0.006	0.038

Table 2: Yield attributes and Seed quality traits of Niger crop affected by different dates of sowing and doses of fertilizer

S. No.	Treatments	Biological Yield (kg ha^{-1})	Economical Yield (kg ha^{-1})	Seed germination (%)	Root length (cm)	Vigour index-I	Vigour index-II
A	**Dates of sowing**						
D1	Last week of July	2951.354	491.243	93.88	4.17	734.47	0.34
D2	2nd week of August	2560.172	422.728	87.33	4.20	600.14	0.27
D3	Last week of August	3255.177	517.511	97.33	5.11	839.81	0.48
D4	1st week of Sep.	2354.951	395.062	81.55	3.46	495.93	0.23
	S.Em+	4.132	0.270	0.106	0.025	5.33	0.008
B	Doses of fertilizer						
F1	Control	2684.932	455.848	88.58	4.22	630.44	0.30
F2	100%RDF(as basal)	2793.384	456.633	90.25	4.36	666.42	0.32
F3	100% P & K and 50% N as basal and 50% N in two split doses.	2862.927	457.427	91.58	4.53	705.90	0.36
	S.Em+	3.111	0.119	0.083	0.033	3.17	0.007
	Interaction (DXF)						
	D1F1	2871.970	490.303	92.00	4.54	692.14	0.301
	D1F2	2985.017	491.350	94.00	4.78	746.04	0.332
	D1F3	2997.077	492.077	95.66	4.80	765.22	0.392
	D2F1	2484.480	421.813	85.00	4.05	536.91	0.245
	D2F2	2534.170	422.837	87.00	4.13	592.76	0.270
	D2F3	2661.867	423.533	90.00	4.42	670.76	0.294
	D3F1	3140.703	516.703	97.33	5.12	829.26	0.461
	D3F2	3278.066	517.400	98.00	5.08	837.90	0.467
	D3F3	3346.763	518.430	98.00	5.13	852.27	0.532
	D4F1	2242.573	394.573	80.00	3.18	463.46	0.221
	D4F2	2376.280	394.947	82.00	3.43	488.99	0.235
	D4F3	2446.000	395.667	82.66	3.78	535.35	0.242
	S.Em+	6.549	0.332	0.173	0.059	7.413	0.014

9. Economic yield (Kg ha^{-1})

In the present investigation, D3 (Last week of August) date of sowing exhibited the higher value (517.511). F3 (100% P & K and 50% N as basal and 50% N in two split doses) fertilizer dose had highest economic yield (457.427). The interaction of D3F3 (518.430) and lowest economic yield was noted in D4F1 (395.667). The result was in confirmation with Sarkar (1976) [14] he reported that seed yields of yields of niger with NPK and without were 466 and 236 kg ha-1 respectively.

10. Harvest Index (%)

Salim and Saxena (1993) [13] noticed that early flowering was associated with high harvest index, large number of pods and high seed mass. In the present research the main treatment affected harvest index significantly. D3 (Last week of August) date of sowing recorded maximum harvest index (16.877). F3 (100% P & K and 50% N as basal and 50% N in two split doses) fertilizer dose had maximum harvest index (16.188), while, the minimum was recorded in F1 (Control) fertilizer dose (15.518). The main and sub treatment interaction significantly influenced harvest index. The combination of D3F3 exhibited maximum harvest index (17.573).

B. Seed Quality Traits

1. Germination (%)

This result showed that D3 (Last week of August) date of sowing recorded highest germination percentage (97.77%). F3 (100% P & K and 50% N as basal and 50% N in two split doses) fertilizer dose had higher germination percentage (91.58%). The interaction of D3F3 exhibited the highest germination percentage (98.00%) and lowest was noted in D4F1 (80.00%).

2. Root length (cm)

The result related to root length revealed that the D3 date of

sowing recorded maximum root length (5.11 cm).F3 fertilizer dose recorded significantly longer root length (4.53 cm), while the smaller was recorded in F1 (Control) fertilizer dose (4.22 cm) than other doses of fertilizer. The combination of D3F3 (5.13 cm) noted significantly maximum root length. Similar result was recorded by Kathiresan and Ramaswamy (1978) [6].

3. Vigour index-I

A widely accepted definition of vigour is the sum total of those properties of the seed that determine the potential level of activity and performance of the seed during germination and seedling emergence". The highest (495.93) vigour index-I was exhibited in D3 date of sowing. F3 fertilizer dose recorded maximum vigour index-I (705.90).The combination D3F3 (852.27) attained highest vigour index-I and lowest was noted in D4F1 (463.46).

4. Vigour index-II

This result showed that D3 (Last week of August) date of sowing recorded the maximum vigour index-II (0.48). F3 (100% P & K and 50% N as basal and 50% N in two split doses) fertilizer dose recorded the highest vigour index-II (0.36). The interaction of dates of sowing and fertilizer application also revealed significant variation of vigour index-II in which highest was noted in D3F3 (0.532) and lowest vigour index-II was noted in D4F1 (0.221). Similar result was recorded by Dharmalingam and Basu (1990) [3].

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