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Effect of Spacing and Periodical Staggered Nipping on Botrytis Disease Incidence and Quality of Castor (*Ricinus communis* L.)

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A B S T R A C T

The field experiment was conducted during the *kharif* seasons of 2013 and 2015 at ZARS, University of Agricultural Sciences, Gandhi Krishi Vigyan Kendra, Bengaluru on red sandy clay loam soil to know the influence of periodical staggered nipping and spacing on *Botrytis* disease infestation and quality of castor. Nipping and different spacing's in castor significantly influenced the disease incidence and castor oil yield. Periodical staggered nipping leaving one spike in each branch recorded lower *Botrytis* disease scoring (2.71) and chaffiness (6.43 %) as compared to non-nipping treatments. This treatment also recorded significantly higher oil content (44.34 %) and oil yield (7.75 q ha^{-1}). Among the different spacing levels lower *Botrytis* disease scoring (3.17), chaffiness (11.61 %) and significantly higher oil content (44.29 %) were noticed with the spacing of 120 x 45 cm. Whereas, significantly higher oil yield was recorded in the spacing of 90 x 45 cm (6.91 q ha^{-1}). Interaction effects between periodical staggered nipping and spacing were not significant.

Introduction

Among oilseeds, castor (*Ricinus communis* L.) is the most primitive non-edible crop belonging to family Euphorbiaceae grown under tropical, sub-tropical and temperate regions. Seeds of this crop were found during excavation in Egypt, Sudan, India and in ancient agricultural dwellings of North West Asia and Iran. Evidences indicate that the crop was originated in Ethiopia (Weiss, 1971) and in India (Moshkin, 1986). Its cultivation is spread over thirty countries of the world. India, Mozambique, China, Brazil, Angola, Philippines and Thailand are the leading countries and producing nearly 85 per cent of the total castor production of the world. As a non-edible and industrial crop, castor plays an important role in Indian economy because of better export potential. During 2014-15, the country earned a foreign exchange worth of ₹ 4364.33 crores through export of castor oil and cake (Anon, 2015).

The castor plant being perennial in nature is capable of producing branches from every auxillary bud that appears on its main axis. The lower shoots that develop from the auxillary buds many a times produce spikes not as much effective as main spike. Nutrition

to the lower branches thus gets wasted resulting in weaker spikes of short length, high susceptibility to diseases, particularly *Bortytis*, thus resulted in chaffiness, poor seed weight and lower yield (Patel *et al.,* 1976). In castor, maintenance of source to sink relationship is very important rather than allowing more vegetative growth presumably for higher yields. Hence, staggered nipping *i.e*., removal of auxillary buds assumes importance in maintaining optimum source to sink relationship. Keeping this in view, an attempt has been made in present study to find out the impact of staggered nipping and different spacing on *Botrytis* disease incidence and quality of castor.

Materials and Methods

The field experiment was conducted during the *kharif* seasons of 2013 and 2015 at ZARS, University of Agricultural Sciences, Gandhi Krishi Vigyan Kendra, Bengaluru on red sandy clay loam soil. The soils were medium in available nitrogen (295.5 kg ha^{-1}), available phosphorus (34.20 kg ha^{-1}) and available potassium (155.75 kg ha^{-1}). The organic carbon (0.51 %) content was also medium. The experiment was laid out in Randamized Complete Block Design consisting of three levels of spacing (60 × 45 cm, 90 × 45 cm and 120 × 45 cm) and nipping (no nipping, periodical staggered nipping leaving one spike in each branch and periodical staggered nipping leaving two spikes in each branch) and replicated thrice. The recommended dose of 38:38:25 kg NPK and 5t of FYM ha^{-1} was given to castor. Intercultivation and weeding were done to keep the weeds under check. Need based plant protection was followed to control sucking insects. Staggered nipping in case of castor is a selective removal of nodal buds at regular intervals. The methodology includes nipping of all the nodal buds in the primary stem except the one just below the primary spike immediately after the emergence of primary spike. The secondary branch emerging just below the primary spike is allowed to grow and it ends with a spike at the tip. Then all the nodal buds of the secondary branch will be nipped-off except the one below the secondary spike. All the nodes of tertiary branch will be nipped-off except the one below the tertiary spike. In the same way one quaternary, penta and hexa branches and spikes will be allowed respectively. It is done in the experiment according to the different nipping treatments (Fig. 1). After periodical harvesting the spikes, capsules were dried and threshed. Seed yield and stalk yield in each plot was recorded and analysed statistically.

Botrytis disease scoring

Gray mould (*Botrytis ricini*) is a major disease in castor infecting flowers and capsules. The extent of damage goes even up to 85 per cent depending on the humidity. Night temperatures below 22 ^{o}C followed by rains are highly favourable for the spread of disease (Diraviam, 2006). The severity of *Botrytis* disease was assessed by adopting 1-9 scale (Subramanyam *et al.,* 1982) as given below.

Scale: Per cent of infestation

0: No incidence
1: 1 per cent of capsule infected
3: 2-10 per cent of capsule infected
5: 11-25 per cent of capsule infected
7: 26-50 per cent of capsule infected
9: >50 per cent of capsule infected

Results and Discussion

Effect of spacing

Spacing has significant influence on *Botrytis* diseases and chaffiness of castor. The incidence of disease was observed maximum in the lower spacing.

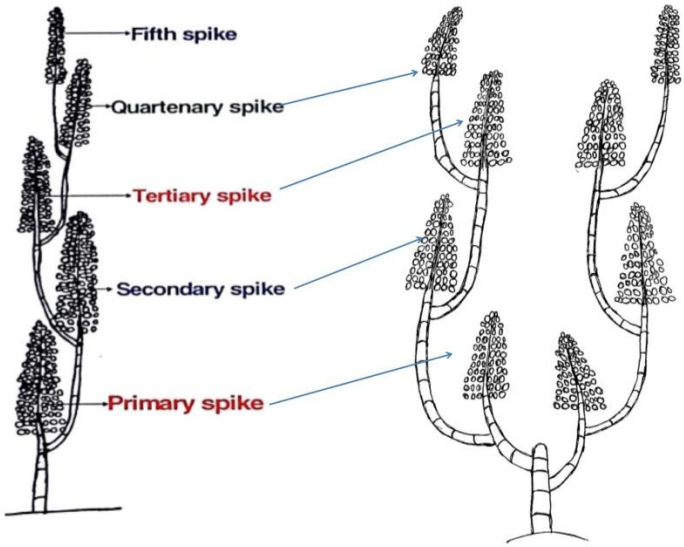

Fig. 1: a) Nipping leaving one spike b) Nipping leaving two spike

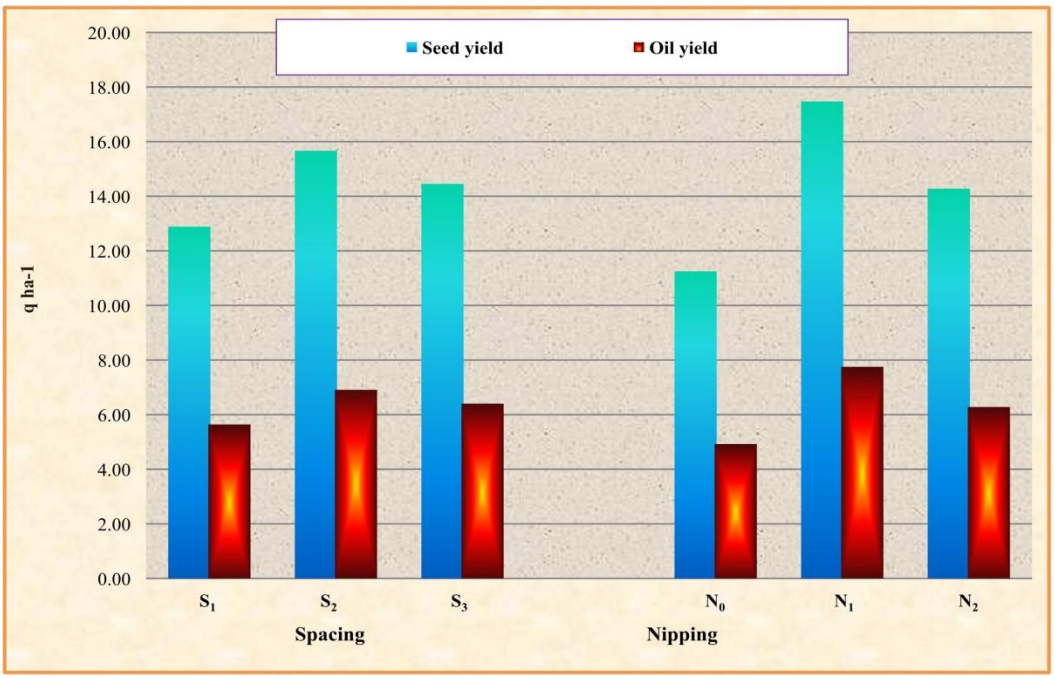

Fig. 2: Seed yield and oil yield of castor as influenced by spacing and nipping

Table.1 *Botrytis* disease scoring (0-9 Scale) study in castor at different pickings as influenced by spacing and nipping

Treatment	1st picking			2nd picking			3rd picking			Overall mean		
	2013	2015	Pooled	2013	2015	Pooled	2013	2015	Pooled	2013	2015	Pooled
Spacing (S)												
S_1: 60 x 45 cm	3.74	5.09	4.42	4.08	5.42	4.75	4.32	5.51	4.92	4.05	5.34	4.69
S_2: 90 x 45 cm	2.73	4.31	3.52	3.33	4.96	4.14	3.41	5.01	4.21	3.16	4.76	3.96
S_3: 120 x 45 cm	2.24	3.23	2.74	2.84	3.78	3.31	3.03	3.89	3.46	2.71	3.63	3.17
Nipping (N)												
N_0	4.07	5.79	4.93	4.46	6.44	5.45	4.69	6.54	5.62	4.40	6.26	5.33
N_1	1.84	2.79	2.32	2.46	3.27	2.86	2.57	3.33	2.95	2.29	3.13	2.71
N_2	2.81	4.06	3.43	3.34	4.44	3.89	3.51	4.53	4.02	3.22	4.34	3.78
Interactions (S X N)												
S_1N_0	4.93	7.13	6.03	5.03	7.57	6.30	5.40	7.70	6.55	5.12	7.47	6.29
S_1N_1	2.63	3.53	3.08	3.07	3.80	3.43	3.17	3.87	3.52	2.96	3.73	3.34
S_1N_2	3.67	4.60	4.13	4.13	4.90	4.52	4.40	4.97	4.68	4.07	4.82	4.44
S_2N_0	4.00	6.07	5.03	4.57	7.03	5.80	4.60	7.10	5.85	4.39	6.73	5.56
S_2N_1	1.67	2.73	2.20	2.33	3.23	2.78	2.43	3.27	2.85	2.14	3.08	2.61
S_2N_2	2.53	4.13	3.33	3.10	4.60	3.85	3.20	4.67	3.93	2.94	4.47	3.71
S_3N_0	3.27	4.17	3.72	3.77	4.73	4.25	4.07	4.83	4.45	3.70	4.58	4.14
S_3N_1	1.23	2.10	1.67	1.97	2.77	2.37	2.10	2.87	2.48	1.77	2.58	2.17
S_3N_2	2.23	3.43	2.83	2.80	3.83	3.32	2.93	3.97	3.45	2.66	3.74	3.20

N_0: No nipping N_1: Nipping leaving one spike in each branch N_2: Nipping leaving two spikes in each branch NS: Non-significant

Table.2 Chaffiness percentage, oil content and oil yield of castor as influenced by spacing and nipping

Treatment	Chaffiness (%)			Oil content (%)			Oil yield(q ha^{-1})		
	2013	2015	Pooled	2013	2015	Pooled	2013	2015	Pooled
Spacing (S)									
S_1: 60 x 45 cm	21.17	17.82	19.49	43.38	44.11	43.74	5.32	5.96	5.64
S_2: 90 x 45 cm	15.98	13.64	14.81	43.80	44.29	44.04	6.58	7.24	6.91
S_3: 120 x 45 cm	12.67	10.54	11.61	44.02	44.56	44.29	6.18	6.63	6.41
S. Em. ±	0.51	0.45	0.42	0.10	0.11	0.06	0.22	0.23	0.18
C. D. at 5 %	1.52	1.36	1.26	0.29	0.32	0.19	0.65	0.69	0.53
Nipping (N)									
N_0	27.39	23.19	25.29	43.49	44.04	43.77	4.71	5.14	4.93
N_1	6.97	5.90	6.43	44.07	44.62	44.34	7.38	8.12	7.75
N_2	15.46	12.92	14.19	43.64	44.29	43.97	5.98	6.58	6.28
S. Em. ±	0.51	0.45	0.42	0.10	0.11	0.06	0.22	0.23	0.18
C. D. at 5 %	1.52	1.36	1.26	0.29	0.32	0.19	0.65	0.69	0.53
Interactions (S X N)									
S_1N_0	32.60	27.73	30.17	43.20	43.90	43.55	4.13	4.49	4.31
S_1N_1	9.60	8.40	9.00	43.67	44.33	44.00	6.78	7.46	7.12
S_1N_2	21.30	17.33	19.32	43.27	44.10	43.68	5.05	5.93	5.49
S_2N_0	26.43	22.57	24.50	43.50	44.03	43.77	5.11	5.43	5.27
S_2N_1	6.57	5.23	5.90	44.17	44.60	44.38	8.11	9.19	8.65
S_2N_2	14.93	13.13	14.03	43.73	44.23	43.98	6.52	7.11	6.81
S_3N_0	23.13	19.27	21.20	43.77	44.20	43.98	4.90	5.49	5.20
S_3N_1	4.73	4.07	4.40	44.37	44.93	44.65	7.25	7.71	7.48
S_3N_2	10.13	8.30	9.22	43.93	44.53	44.23	6.38	6.69	6.54
S. Em. ±	0.88	0.78	0.73	0.17	0.19	0.11	0.38	0.40	0.31
C. D. at 5 %	2.64	NS	2.19	NS	NS	NS	NS	NS	NS
CV %	9.17	9.70	8.26	0.67	0.73	0.44	10.81	10.42	8.40

N_0: No nipping N_1: Nipping leaving one spike in each branch N_2: Nipping leaving two spikes in each branch NS: Non-significant

Spacing of 120 x 45 cm recorded minimum disease scoring (3.17) and chaffiness (11.61 %) as compared to 90 x 45 cm (3.96 and 14.81 %, respectively) and 60 x 45 cm (4.69 and 19.49 %, respectively) (Table 1 and 2). The lower plant spacing resulted higher plant population attributed to canopy overlapping and shading. Thicker plant density along with prolonged humid conditions coupled with continuous rainfall with cloudy weather leads to severe infestation of spikes with *Botrytis* disease. The results are inconformity with the findings of Patel *et al.,* (1976).

Significant difference in oil content was noticed among the different spacings. Spacing of 120 x 45 cm recorded significantly higher oil content (44.29 %) as compared to 90 x 45 cm (44.04 %) and 60 x 45 cm (43.74 %). The higher yield attributing parameters were achieved due to better growth and growth components, which helped in better uptake of nutrients and better translocation of photosynthates from source to sink lead to higher oil content in seeds. These results are in conformity with the findings of Porwal *et al.,* (2006) and Rana *et al.,* (2006). Oil yield was found to be significant among the spacings. Significantly higher oil yield was recorded in 90 x 45 cm (6.91 q ha^{-1}) as compared to other two spacings (Table 2). This might be attributed to higher yield and yield attributing parameters in this row spacing (Fig. 2).

Effect of staggered nipping

The severity of *Botrytis* disease infestation of spikes was more in non-nipped plots compared to periodical staggered nipping plots. The lower incidence of *Botrytis* disease noticed in nipping leaving one spike in each branch with disease scoring of 2.71 as against 5.33 in non-nipped plot and 3.78 in nipping leaving two spikes in each branch (Table 1). This might be due to crowded canopy coverage, humidity in the microclimate and canopy overlapping with less light penetration as compared to nipping plots.

Lower percentage of chaffiness was recorded in nipping leaving one spike in each branch (6.43 %) and nipping leaving two spikes in each branch (14.19 %) as against 25.29 per cent in non-nipped (Table 2). The increased disease severity and higher percentage of chaffiness under non-nipping conditions of castor are in agreement with the findings of Venkate Gowda *et al.,* (2011) and Shivaramu and Krishna Murthy (2008).

Significantly higher oil content was recorded in nipping of castor leaving one spike in each branch (44.34 %) as compared to that in no-nipping (43.77 %) and nipping leaving two spikes in each branch (43.97 %). This treatment also recorded significantly higher oil yield (7.75 q ha^{-1}). The oil yield is the resultant of oil content of seeds and seed yield of the crop. Higher oil content and higher seed yield of castor obtained from nipped treatments resulted in higher oil yield over non-nipping treatments (Table 2 and Fig. 2).

These results are in conformity with the findings of VenkateGowda *et al.,* (2011) and Shivaramu and Krishna Murthy (2008). Interaction effects of both spacing and periodical staggered did not showed any significant effect on disease incidence, chaffiness, oil content, oil yield and seed yield.

Thus, the wider spacing of castor planting at 120 x 45 cm along with nipping leaving one spike in each branch found better for reducing the disease infestation and chafiness whereas, castor with spacing of 90 x 45 cm along with nipping leaving one spike in each branch found better for oil yield and seed yield under dryland conditions of the Eastern Dry Zone of Karnataka.

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