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Study on Periodical Water Stress in Drip Irrigated *Rabi* Castor with and without Mulch under South Gujarat Condition

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To find out suitable water stress period for *rabi* castor, a field experiment was conducted during *rabi* season of 2008-09 to 2010-11 at Soil and Water Management Research Farm, Navsari Agricultural University, Navsari (Gujarat) in FRBD design with three replications. The treatments consisting combination of mulching (M) viz., M_1: no mulch, M_2: black plastic mulch (25µ thick, 40 % coverage) and water stress period imposed from 50 per cent spike initiation stage (S) i.e., S_1: No stress, S_2: 20 days, S_3: 30 days and S_4: 40 days along with two surface controls i.e., with and without mulch irrigated at 0.8 IW/CPE ratio. The results indicated that the treatment M_2 recorded significantly higher values of yield attributes viz., length of main spike (MS), length of effective main spike (EMS) and number of capsules/EMS as compared to treatment M_1. Among the water stress period, treatment S_1 recorded significantly higher values of EMS as compared to S_4, but it remained at par with S_3 and S_2. All the yield attributes of castor were not differed significantly due to M x S interactions. With respect to control v/s rest analysis, it was turned out to be significant on leaf area and MS only. In both the cases, control mean was significantly higher than drip mean. Mulching with black plastic significantly increased the seed yield of castor whereas periodical stress failed to exert significant influence on seed yield. The results implies that imposing water stress of 20 days period without mulch and 40 days with mulching after 50 per cent spike emergence did not reduce the seed yield of castor significantly. Ultimately, this resulted in additional saving of irrigation water without reduction in seed yield of castor.

(***Key words**: Castor, Irrigation, Mulching, Stress)*

On account of heavy rainfall coupled with assured canal water supply from Ukai-Kakrapar irrigation project, paddy – paddy and paddy – sugarcane are the predominant sequences being adopted since long by the farmers of South Gujarat. The high requirement of irrigation water of these sequences resulted in salinity and water logging conditions in canal command area. Though, closed subsurface drainage technology has been recommended for reclaiming the water logged and salt affected soils, yet there exist good scope for avoiding the problem through introduction of less water requiring crops in canal command *i.e.,* crop diversification. In this direction, some studies were conducted under South Gujarat conditions and *rabi* castor *i.e.,* less water requiring but having excellent yield potential and highly remunerative showed good promise. Some workers have reported higher yield and higher net profit realized from *rabi* castor irrigated by drip method in inland and coastal areas of South Gujarat (Desai *et al.,* 2009; Savani *et al.,* 2012). Based on the results of these experiments conducted in inland and coastal areas of South Gujarat, cultivation of castor during *rabi* season was recommended for the farmers of South Gujarat. Not only this, but package of practices covering variety, method of planting and irrigation, fertilizer doses, mulching *etc.* were also recommended (Naik *et al.,* 2013). Accordingly, in South Gujarat area under *rabi* castor is increasing gradually from an area of about 8000 ha during 2010-11 (Naik *et al.,* 2013). However, it is our observation that castor grown under drip irrigation during *rabi* season results in profuse vegetative growth along with delay in maturity. This observation was also substantiated by the farmers growing *rabi* castor, an experiment was conducted to find out optimum period of water stress in presence and absence of mulching. Imposition of water stress will not only facilitate to divert more photosynthates towards reproductive parts rather than vegetative parts, but will also enable to save additional water over drip method of irrigation.

MATERIALS AND METHODS

A field experiment was conducted consecutively for three *rabi* seasons of 2008-09 to 2010-11 at Soil and

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Water Management Farm, Navsari Agricultural University, Navsari (Gujarat). The soil of the experiment site is clay in texture with low in available N (210 kg ha^{-1}), medium in available P_2O_5 (56 kg ha^{-1}) and high in available K_2O (465 kg ha^{-1}) status. In all 10 treatments comprising of combinations of two mulching treatments *viz.,* M_1: no mulch, M_2: black plastic mulch (25μ thick, 40% coverage) and four water stress period imposed from 50 per cent spike initiation stage *viz.,* S_1: No stress, S_2: 20 days, S_3: 30 days and S_4: 40 (with drip irrigation at 0.6 PEF) days along with two surface controls *i.e.,* C_1: surface irrigation (0.8 IW/CPE) without mulch and C_2: surface irrigation (0.8 IW/CPE) with black plastic mulch were tested in randomized block design with factorial concept. During the year 2008-09, 2009-10 and 2010-11 the crop (castor GCH-4) was sown on 29th November, 24th October and 22nd October, respectively. The corresponding dates for final harvesting were 4th May, 25th March and 6th April respectively. During all the years of experiment, 3 pickings were done. All the observation were recorded from five tagged plants and the seed yield was recorded from net plot during all the

Table 1. *Growth and yield attributes of castor as affected by different treatments (pooled)*

Treatment	Leat area (cm^2)	Length of MS* (cm)	Length of EMS (cm)	No. of capsules EMS^{-1}	No. of capsules cm^{-1} of spike length
Mulch					
M_1	11797	58.64	54.2	62.3	1.15
M_2	12730	63.69	58.1	68.3	1.18
SEm ±	388	2.55	0.7	1.58	-
CD (0.05)	NS	7.73	2.2	4.81	-
Periodical stress					
S_1	12878	63	57.8	65	1.12
S_2	12530	63	57.8	65	1.12
S_3	12051	60	55.6	66	1.19
S_4	11597	59	53.7	63	1.17
SEm ±	549	3.61	1.0	2.24	–
CD (0.05)	NS	NS	3.1	NS	–
Interaction					
SEm ±	776	5.10	1.4	9.51	–
CD @ 5 %	NS	NS	NS	NS	–
Drip mean	12336	61.17	56.1	65,3	1.16
Control-1	14149	61.23	55.7	59.5	1.07
Control-2	14880	65.84	58.5	70.2	1.20
Control mean	14514	63.54	57.1	64.86	1.14
Treat. *v/s* Control-1					
SEm ±	263	0.775	0.8	3.170	–
CD (0.05)	746	2.197	NS	NS	–
Treat. *v/s* Control-2					
SEm ±	358	1	1.1	2	–
CD (0.05)	1018	2.99	NS	NS	–
Treat. *v/s* Control					
SEm ±	360	1	1.1	2	–
CD (0.05)	1204	NS	NS	NS	–
CV %	9.47	4.81	4.6	8.5	–

MS : Main spike, EMS : Effective main spike

three year. The data were analyzed statistically using standard procedure as suggested by Panse and Sukhatme (1969).

RESULTS AND DISCUSSIONS

Growth and yield attributes

The results pertaining to growth and yield attributes of castor *viz.*, leaf area, length of main spike (MS), length of effective main spike (EMS) and number of capsules EMS^{-1} as influenced by the different treatments are given in Table 1. Effect of mulching was significant on MS, EMS and no. of capsules per EMS. But it was not so in the case of leaf area. In all the cases M_2 showed superiority over M_1. Similar results were also reported by Naik *et al.* (2010) from Navsari. While the effect of water stress period could exert significant effect only on length of EMS. Among the water stress period, S_1 recorded significantly higher values of EMS (57.8 cm) as compared to S_4 (53.7 cm) but it was at par with S_2 (57.4 cm) and S_3 (55.6 cm). All the yield attributes of castor were not differed significantly due to interaction effect of mulching (M) and water stress period (S). With respect to control *v/s* rest, it was turned out to be significant on leaf

Table 2. *Castor seed yield (kg ha^{-1}) as affected by different treatments*

Treatment	Year			Pooled
	2008-09	2009-10	2010-11	
Mulch				
M_1	1420	3068	3044	2511
M_2	1660	3294	3226	2727
SEm ±	52	129	110	54
CD (0.05)	158	NS	NS	163
Periodical stress				
S_1	1645	2943	3055	2548
S_2	1601	3296	3130	2676
S_3	1516	3292	3257	2688
S_4	1398	3193	3097	2563
SEm ±	74	182	155	76
CD (0.05)	NS	NS	NS	NS
Interaction				
SEm ±	105	258	219	108
CD (0.05)	NS	NS	NS	NS
Drip mean	1540	3181	3135	2619
Control-1	1447	2785	1768	2000
Control-2	1928	3062	2501	2497
Control mean	1687	2924	2135	2249
Treat. *v/s* Control-1				
SEm ±	–	–	–	85
CD (0.05)	–	–	–	240
Treat. *v/s* Control-2				
SEm ±	–	–	–	84
CD (0.05)	–	–	–	NS
Treat. *v/s* Control				
SEm ±	111	248	204	62
CD (0.05)	330	NS	607	176
CV %	12	14	12	7

area and MS only. In both the cases, control mean value was significantly higher than drip mean. Further, individual control *i.e.,* C_1 without mulch and C_2 with mulch were compared with drip mean. Here also the pattern of treatment effect remained the same. In order to know the compactness of spike, no. of capsules per cm was computed. The compactness of spike was found to increase in stress period up to 30 days. This is an important yield attribute in castor which can be improved by imposing water stress at main spike initiation stage.

Seed yield

The results pertaining to seed yield of castor as affected by individual effect of mulching and water stress period are presented in Table 2. The treatment of mulching exerted significant effect on seed yield of castor during 1st year as well as in pooled analysis. While, it failed to produce any significant effect during 2nd and 3rd year of experimentation. The treatment with black plastic mulch (M_2) recorded significantly higher yield of castor seeds (2727 kg ha^{-1}) as compared to the treatment without mulching (2511 kg ha^{-1}). Mulching conserve moisture and also moderate soil temperature which might have enhanced the growth and yield attributes and finally resulted in to higher yield of castor. The beneficial effect of mulching on castor were also reported by Patel *et al.* (1999) and Desai *et al.* (2009). The perusal of results further indicated that the treatment of water stress period (S) could not change the seed yield of castor significantly during all the three years of experimentation as well as in pooled analysis. But the overall mean value of seed yield recorded in the treatment of mulching under paired row planting with drip in conjunction with water stress period (S) were significantly higher than the mean seed yield values recorded in the treatment of normal planting without mulch (M_1) and with black plastic mulch (M_2) under flood method of irrigation. The results implies that imposing water stress of even 40 days after spike emergence did not reduce the seed yield of castor significantly *i.e.,* not necessary to operate drip system for 40 days after emergence of main spike which results in addition saving of irrigation water.

From the results of present experiment, it can be concluded that it is necessary to impose water stress to drip irrigated paired row planted *rabi* castor after 50 per cent emergence of main spikes for getting higher yield as well as additional saving in irrigation water. The results of present study clearly suggest that crop like castor is a viable option in place of the high water requiring crop like summer season paddy under South Gujarat conditions.

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