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Growth and yield of castor as influenced by weed management strategies

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Abstract
Experimental studies on effect of weed management practices in castor (*Ricinus communis* L.) was conducted at Agricultural College Farm, Bapatla during *kharif*, 2020 on clay soils. The results indicated that significantly the plant height, drymatter accumulation, seed and stalk yield were registered under the treatment hand weeding at 20 and 40 DAS (T_2), which was however on a par with the treatment supplied pre-emergence application of alachlor @ 1.5 kg a.i ha^{-1} fb chlorimuron @ 10 g + propaquizafop @ 63 g a.i ha^{-1} as PoE at 30 DAS (T_9) as well as pre-emergence application of alachlor @ 1.5 kg a.i ha^{-1} fb halosulfuron @ 67.5 g a.i + propaquizafop @ 63 g a.i ha^{-1} as PoE at 30 DAS (T_{10}).

Keywords: Castor, weed management, herbicides and yield

Introduction
Castor (*Ricinus communis* L.) is an important non-edible oilseed crop of India, having immense industrial and commercial value, it comprises 50-55 per cent oil and occupies second position in the production of non-edible oil in the world. India is the world leader in castor production followed by China and Brazil. Total area of castor in India is 7.51 lakh hectares, with a production of 11.97 lakh tones and a productivity of 1500 kg ha^{-1}. While in Andhra Pradesh, it is cultivated in an area of 37 thousand hectares having a production of 15.36 thousand tonnes and a productivity of 415 kg ha^{-1} (Ministry of Agriculture and Farmers Welfare, Government of India 2018-19) [6].
The productivity of castor is very low (1500 kg ha^{-1}), because of the high density incidence of weed flora. Weeds of different plant species comprising grasses, broad-leaved weeds and sedges, compete with castor resulting in yield losses of castor to the extent of 50%. The slow emergence (up to two weeks even under favourable conditions) of castor makes the plants susceptible to weeds menace and weeds cause enormous stress at the initial growth stages thus affecting in the economic yield. Yield losses due to crop-weed competition in castor have been estimated up to 73.6% (Dungarwal *et al.*, 2002) [2] and the critical period of weed competition in castor has been reported from 30 to 60 days after sowing.
In this context, herbicides can play a vital role in management of weeds. The use of herbicides are quick in action, selective in nature, cost effective and efficient to control weeds when applied alone or in combination with other weed control method reduced the crop-weed competition. The possibility of applying herbicides as pre-emergence, alone or in combination, followed by one or more post-emergence applications, can be a strategy to enhance the control of weeds.

Materials and Methods
The present research was carried out at Agricultural College Farm, Bapatla during *kharif*, 2020. The experiment laid out in Randomized Block Design with ten treatments replicated three times consisted of T_1 - Weedy check (or) control, T_2 - Hand weeding at 20 DAS and 40 DAS, T_3 - Alachlor @ 1.5 kg a.i ha^{-1} as PE, T_4 - Chlorimuron @ 10 g a.i ha^{-1} as PoE at 20 DAS, T_5 - Halosulfuron @ 67.5 g a.i ha^{-1} as PoE at 20 DAS, T_6 - Propaquizafop @ 63 g a.i ha^{-1} as PoE at 30 DAS, T_7 - Alachlor @ 1.5 kg a.i ha^{-1} as PE fb Chlorimuron @ 10 g a.i ha^{-1} as PoE at 30 DAS, T_8 - Alachlor @ 1.5 kg a.i ha^{-1} as PE fb Halosulfuron @ 67.5 g a.i ha^{-1} as PoE at 30 DAS, T_9 - Alachlor @ 1.5 kg a.i ha^{-1}as PE fb Chlorimuron @ 10 g + Propaquizafop @ 63 g a.i ha^{-1} as PoE at 30 DAS, T_{10} - Alachlor @ 1.5 kg a.i ha^{-1} as PE fb Halosulfuron @ 67.5 g a.i + Propaquizafop @ 63g a.i ha^{-1} as PoE at 30 DAS.

The experimental soil was classified as clay in texture, neutral in reaction (pH 7.3), medium in organic carbon (0.61%), low in available nitrogen (210.5 kg ha^{-1}), medium in available phosphorus (25.1 kg ha^{-1}) and medium in available potassium (305.9 kg ha^{-1}). The castor hybrid (PCH-111) was sown at 90 cm x 60 cm spacing by hand dibbling method followed by thinning and gap filling done at 10 DAS. A fertilizer dose of hybrid castor 60 kg N, 40 kg P_2O_5 and 30 kg K_2O ha^{-1} in the form of urea, single superphosphate and muriate of potash were utilized. Nitrogen was applied in three split doses (30, 60, 90 DAS) by pocketing method, while the entire quantity of phosphorous and potassium were applied basally at the time of sowing. Pre-emergence herbicide (Alachlor) was sprayed one day after sowing and post-emergence herbicides (chlorimuron, halosulfuron and propaquizafop) were sprayed by using knapsack sprayer fitted with flood jet nozzle at 20 and 30 DAS in corresponding treatments. Hand weeding was done twice at 20 and 40 DAS. Observations on plant height and drymatter accumulation (kg ha^{-1}), seed yield (kg ha^{-1}) and stalk yield (kg ha^{-1}) were recorded following standard procedures.

Results and Discussion

Plant height (cm)

The plant height was significantly influenced by different weed management practices. The highest plant height (135.8 cm) recorded under hand weeding practice implemented at 20 and 40 DAS (T_2). The treatment with pre-emergence application of alachlor @ 1.5 kg a.i ha^{-1} fb chlorimuron @ 10 g + propaquizafop @ 63 g a.i ha^{-1} as PoE at 30 DAS (T_9) and pre-emergence application of alachlor @ 1.5 kg a.i ha^{-1} fb halosulfuron @ 67.5 g a.i + propaquizafop @ 63 g a.i ha^{-1} as PoE at 30 DAS (T_{10}) were however exhibited on par values among them and with hand weeding treatment (T_2). A weed free situation persisting for a comfortable availability of essential growth factors *viz.*, nutrition, moisture, space and light availability throughout the crop growth period might have created, a favourable environment for the crop as a result of herbicide application, thus reducing the impact of critical period of crop weed competition which reflected on enhanced crop growth. Weedy check recorded significantly low height (100.6 cm) due to increased weed density throughout the crop growth period due to competition for growth factors, affecting growth and development of castor. As projected in the present investigation agrees with the findings of Naik *et al.* (2016), Kalaichelvi *et al.* (2016) and Vaghasia *et al.* (2015) [7, 3, 11].

Drymatter accumulation (kg ha^{-1})

The highest drymatter accumulation (5683 kg ha^{-1}) recorded at harvest under hand weeding treatment at 20 and 40 DAS (T_2) as well as pre-emergence application of alachlor @ 1.5 kg a.i ha^{-1} fb chlorimuron @ 10 g + propaquizafop @ 63 g a.i ha^{-1} as PoE at 30 DAS (T_9) and pre-emergence application of alachlor @ 1.5 kg a.i ha^{-1} fb halosulfuron @ 67.5 g a.i + propaquizafop @ 63 g a.i ha^{-1} as PoE at 30 DAS (T_{10}) with the drymatter accumulation of 5497 and 5419 kg ha^{-1} respectively, exhibited on par relationship among them. Significantly increased drymatter accumulation in castor under these treatments could be attributed to dextured weed control by sequential application of blended herbicides compared to alone herbicide application. Similarly, maximum weed control efficiency and improved nutrient uptake lead to superior drymatter accumulation and increased plant height in these treatments. Similar findings were reported by Patel *et al.* (2014), Costa *et al.* (2015) and Lakshmi and Luther (2017) [8, 1, 5].

Yield (kg ha^{-1})

Hand weeding practice 20 and 40 DAS (T_2), documented the higher seed yield (2482 kg ha^{-1}) was superior to rest of the treatments except the pre-emergence application of alachlor @ 1.5 kg a.i ha^{-1} fb chlorimuron @ 10 g + propaquizafop @ 63 g a.i ha^{-1} as PoE at 30 DAS (T_9) and pre-emergence application of alachlor @ 1.5 kg a.i ha^{-1} fb halosulfuron @ 67.5 g a.i + propaquizafop @ 63 g a.i ha^{-1} as PoE at 30 DAS (T_{10}) with the seed yield of 2388 and 2326 kg ha^{-1} respectively, which were comparable among them including treatment T_2. The lowest seed yield (1352 kg ha^{-1}) was recorded with weedy check (T_1). Similar trend was observed in straw yield as well under different weed control treatments. The increased yield in these treatments was perhaps due to reduced weed competition at critical period and complete utilization of growth factors by the crop. Further, improvement of soil physical condition, adequate nutrient uptake and better crop growth parameters *viz.*, plant height and drymatter accumulation might have resulted in higher yields. The lower yield in weedy check could be attributed to severe weed competition, poor weed control as evidenced by maximum weed density and dry weight, which resulted reduced crop growth, lower crop drymatter and yield attributing characters. These results are in close conformity with the earlier findings of Patel *et al.* (2014), Shwetha *et al.* (2016), Kowser *et al.* (2018) and Rahil *et al.* (2019) [8, 10, 4, 9]

Conclusion

Among various weed management practices, the highest plant height, drymatter accumulation and yield of castor were registered under pre-emergence application of alachlor @ 1.5 kg a.i ha^{-1} fb chlorimuron @ 10 g + propaquizafop @ 63 g a.i ha^{-1} as PoE at 30 DAS and pre-emergence application of alachlor @ 1.5 kg a.i ha^{-1} fb halosulfuron @ 67.5 g a.i + propaquizafop @ 63 g a.i ha^{-1} as PoE at 30 DAS (T_{10}). However, these treatments were equally effective with hand weeding treatment.

Table 1: Plant height, dymatter accumulation and yield of castor as influenced by different weed management strategies

Treatments	Plant height (cm)	Drymatter accumulation (kg ha^{-1})	Seed yield (kg ha^{-1})	Stalk yield (kg ha^{-1})
T_1 - Weedy check (or) control	100.6	3409	1352	2050
T_2 - Hand weeding at 20 DAS and 40 DAS	135.8	5683	2482	3167
T_3 - Alachlor @ 1.5 kg a.i ha^{-1} as PE	107.3	4083	1622	2366
T_4 - Chlorimuron @ 10 g a.i ha^{-1} as PoE at 20 DAS	112.1	4491	1884	2519
T_5 - Halosulfuron @ 67.5 g a.i ha^{-1} as PoE at 20 DAS	111.1	4385	1828	2503
T_6 - Propaquizafop @ 63 g a.i ha^{-1} as PoE at 30 DAS	115.5	4655	1940	2629
T_7 - Alachlor @ 1.5 kg a.i ha^{-1} as PE fb Chlorimuron @ 10 g a.i ha^{-1} as PoE at 30 DAS	120.5	4999	2116	2721
T_8 - Alachlor @ 1.5 kg a.i ha^{-1} as PE fb Halosulfuron @ 67.5 g a.i ha^{-1} as PoE at	119.0	4891	2065	2712

30 DAS				
T_9 - Alachlor @ 1.5 kg a.i ha^{-1}as PE fb Chlorimuron @ 10 g + Propaquizafop @ 63 g a.i ha^{-1} as PoE at 30 DAS	129.2	5497	2388	3068
T_{10} - Alachlor @ 1.5 kg a.i ha^{-1} as PE fb Halosulfuron @ 67.5 g a.i + Propaquizafop @ 63g a.i ha^{-1} asPoE at 30 DAS.	126.4	5419	2326	3040
S.Em±	4.41	204.7	79.0	91.5
CD (P=0.05)	14.1	655	253	293
CV (%)	6.5	7.5	6.8	5.9

DAS = Days after sowing, fb = followed by, PE = Pre-emergence, PoE = Post-emergence

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