Determination of Number of Manual Hoe Weeding for Optimal Yield of Castor (*Ricinus communis* L., Euphorbiaceae) in Nigeria

A.K. Gana*, A. Amosun and Baba Bida Alhaji

National Cereals Research Institute, P.M.B.8. Bida, Niger State, Nigeria

Abstract: Weeds are very detrimental to castor plant as castor plant emergence is slow. The need to determine for specific number of manual hoe weeding needed for the achievement of effective and affordable weed control for the realization of optimal yield of castor becomes very important in Nigeria. The experiment was established on the upland castor experimental field of the National Cereals Research Institute, Badeggi in 2011 and 2012 wet seasons. Three hoe weeding regimes including weeding at 1month after planting (MAP), weeding at 1&2MAP and weeding at 1,2 and 3MAP were evaluated along with the weedy check where no weeding was carried out. From the results in both years of 2011 and 2012 wet seasons, poorest weed control and crop growth along with the yield of castor were obtained from the weedy checks. Among the weeding regimes, castor plots that were hoe weeded once at 1MAP in the two years trial gave good weed control and castor yields significantly comparable to plots that were weeded 2 and 3 times both years.

Keywords: Badeggi-Nigeria, Castor plant, number of manual hoe weeding, optimal yield, weed.

INTRODUCTION

The castor oil plant*, Ricinus communis*, is a species of flowering plant in the spurge family, Euphorbiaceae [1]. The crop has been widely accepted as an agricultural solution for all subtropical and tropical climates that addresses the need for commercial crops with low input costs and at the same time provides traditional farming with a viable income from current non productive lands [2]. Castor Bean does not compete with food crops as it is non edible and can also be grown on marginal lands, which are not competitive with food production lands. It is high yielding, yielding as much as 350-650 kg of oil per hectare when no maintenance is applied to the crop i.e. fertilizers etc [3]. It has a very high oil content of approximately 50% [1]. Significant advantage of castor compared to other oil seeds crops include, nematocidal effects of the oil, high seed yield and superior quality of the oil/ diesel produced [4]. Other uses of castor oil is in the manufacturing of all purpose grease, hydraulic fluids, artificial leather, pharmaceuticals, soap, printing ink, special low temperature lubricants and flexible coating.

In Nigeria, the seed is fermented severally and detoxified to obtain a seasoning agent which is used as a condiment in soups, salads and to enhance food flavor [5]. Castor seed yield has been reported to be between 950-1,500 kg/ha in Nigeria [6]. This yield is very low compared with yields of 1.5-2.0 tones/ha obtained in India and USA [4]. Various reasons have been attributed for the low productivity among the most important is weed competition. Weed infestations are a never - ending concern for every farmer. Depending on the type of crop production practiced, farmers across Nigeria and other parts of the world often must contend with the same or similar weed species [7]. Weeds compete for nutrients, water, and sunlight and could also harbour diseases and pests in castor fields [4]. Castor seeds are large and slow to germinate; emergence of the seedlings may take 7 to 14 days. Seeds are planted at 6.3 to 7.6 cm deep, depending on texture and condition of the soil [2]. These conditions favours weed growth and thereby, encourage great competition of weed in castor field. The slow emergence and early growth of castor beans means the plants are not strong competitors against weeds. Rotary hoeing during the first few weeks after planting, followed by row cultivation should provide acceptable control [3]. Because the main lateral roots of the castor bean plant are near the soil surface, cultivation should be shallow. At present, herbicides are not registered for controlling weeds in castor in Nigeria. However, evaluations are currently on going at the research institute for appropriate herbicides for weed control in castor. The need to determine for the actual number of hoe weeding is very important to enable the castor farmers achieve effective weed control for the realization of optimal yield of castor.

MATERIALS AND METHODS

The experiment was established at the upland castor experimental field of the National Cereals Research Institute, Badeggi in 2011 and 2012 wet seasons. The National Cereals Research Institute, Badeggi has latitude of 9°45 N, longitude of 0.6°07 E; 70.5 meters above sea level and is situated in the

*Address correspondence to this author at the National Cereals Research Institute, P.M.B.8.Bida, Niger State, Nigeria; Tel: +2348036576563;
E-mail: andrewgana2@yahoo.com

E-ISSN: 2311-858X/14

Southern Guinea Savannah ecological zone of Nigeria. The soil of the experimental site had been classified as ultisol and sandy loam in texture with a bulk density of 1.459gcm^{-3} [8]. The area has an average annual rainfall of 1124mm and mean temperature of 23.0° - 33.0°C. Three hoe weeding regimes evaluated included weeding at 1month after planting (MAP), weeding at 1&2MAP and weeding at 1,2and 3MAP along with the weedy check where no weeding was carried out. The treatments were accommodated in a gross plot size of 6.0m^2 (4.0m x 1.5m) containing four rows of castor plants, while the net plot was 2.0m^2 (4.0m x 0.5m). The trial was set up in a randomized complete block design with three replications. Castor seeds were planted at 0.5m inter-row and 0.75m intra row spacing. The recommended inorganic fertilizer rate of 60Nkg/ha- 60-P_2Okg/ha and 20 K_2Okg/ha for castor production was applied at 1MAP. The variety of castor used for the trial was a local small seeded variety called Amshi. This variety can yields castor bean seeds of between 950 - 1500kg/ha depending on the soil fertility, weed control and level of soil moisture or rainfall available. It withstands some drought, although at least 600 mm of precipitation during the vegetative period is needed for growth. With moisture deficits, seed yield is sharply reduced. Requires fertile soil; produces high yield on fertile, well-aerated soils with a pH of 6-7.3. It is a short-day species, photophilous. Vegetative period (from shoot emergence to maturing of first raceme) lasts 120-150 days. This variety was obtained from the National Cereals Research Institute Bida and was sown at the seed rate of 15.0kg ha^{-1}. The data taken included:- identification of major weeds and their levels of occurrence as being shown in Table **1**. Soil sample was collected from the experimental field for the determination of physicochemical properties of the soil of the experimental field before planting. The soil analysis was carried out in the NCRI laboratory. The result of the physico chemical properties is presented in Table **2**.

Further data collected include weed cover score at 3MAP. This observation was taken through visual observation using the scale (0 – 10), 0 = Clean plot, 10 = completely weed covered plots, number of branches per plant at 4MAP, length of spike at 4MAP, days to capsule formation at 4MAP and yield kg/ha. Castor was harvested between November and December 2011 and 2012.

Table 1: List of Common Weeds Present at the Castor Experimental Field before the Establishment of the Trial in 2011

S/N	Weed Species	Class	Life Cycle	Level of Occurrence
1	*Dactyloctenium aegyptium (L)*	Grass	Annual	***
2	*Eragrotis tremula (Hochst)*	" "	Annual	**
3	*Elytrophorus spicatus (A.Camus)*	" "	Annual	**
4	*Rottboellia cochinchinensis (L)*	" "	Annual	*
6	*Digitaria horizontalis (Wild)*	" "	Annual	***
7	*Imperata cylindrica (Anderrs)*	" "	Perennial	*
8	*Paspalum orbiculare (Forst)*	" "	Annual	*
9	*Hyparrhenia invlucrata (Stapf)*	" "	Annual	*
10	*Andropogon gayanus (Kanth)*	" "	Annual	*
11	*Cenchrus biflorus (Roxb)*	" "	Annual	*
Broad leaves				
12	*Hibiscus asper (Hook)*	" "	Annual	***
13	*Commelina diffusa (L)*	" "	Perennial	*
14	*Sida rhombifolia*	" "		*
15	*Ipomoea triloba (Linn)*	" "	Annual	*
16	*Cleome viscosa (L)*	" "	Annual	**
17	*Hyptis suaveolens*	" "		***
18	*Cochlospermum planchoni (Hook)*	" "	Annual	*
Sedges				
19	*Cyperus esculentus*		Perennial	**

Key: *** ------ High Occurrence; ** ------ Moderate Occurrence; * ------ Minor Occurrence

All the data that were obtained from the experiment in 2011 and 2012 were subjected to statistical analysis of variance (ANOVA) to test for the significance of treatment effects using 'F' test as described by Snedecor and Cochran (1969) [9]. Where the 'F' test showed significance, the means were then partitioned using the Duncan's multiple range test (DMRT).

Table 2: Soil Physico-Chemical Characteristics of Castor Experimental Field before the Establishment of the Trial in 2011

Soil properties	Value
Physical property	
Sand (%)	77.60
Silt (%)	12.00
Clay (%)	10.40
Textural class	Sandy loam
Chemical property	
pH in water	6.2
Organic carbon (g/kg)	0.50
Organic matter (g/kg)	1.10
Total nitrogen (g/kg)	0.0039
Available phosphorus (Meq/kg)	20.95
Exchangeable base (cmol / kg soil)	
K	0.35
Mg	0.29
Ca	1.00
Na	0.16
CEC	1.8

RESULT AND DISCUSSION

The major weeds at the experimental site in both years of the experimentations in 2011 and 2012 were *Dactyloctenium aegyptium (L)* and *Digitaria horizontalis* (*Wild* (Table **1**)). These were annual grass weeds which are not difficult to control. While *Hibiscus asper (Hook)* and *Hyptis suaveolens* were annual broad leaved weeds and are not also difficult to control. Annual weeds are very easy to control particularly grasses and broad leaved weeds which are shallow rooted [10]. The control of these weeds is made easier as the time of castor establishment or planting at NCRI Badeggi, Nigeria is between first to second weeks of August and at this period, these weeds are at the stage of completing their annual life cycle to die off. Therefore, they need little rate of herbicide or reduced number of manual hoe weeding for their effective control. The only disadvantage is where the weeds have formed seeds and either dropped or shattered on the ground before the control the dropped seeds will germinate when the condition for germination resumes particularly rainfall or irrigation water [11]. The soil nutrients levels were very low particularly the major nutrients such as nitrogen (N) which helps in vegetative growth and phosphorus (P) a vital element which facilitates energy exchange within biological organisms; along with organic matter (OM) and cat ion exchange capacity (CEC) present in the soil (Table **2**). However, the level of phosphorus was moderately enough for castor production (Table **2**). The moderate level of phosphorus in the soil may be as a result of past applied phosphate fertilizer to castor field. And phosphate fertilizer being very slow in its nutrient release to the soil thereby, making its presence higher in the soil.

From the results shown on Tables **3** and **4** in both years of experimentation in 2011 and 2012 wet seasons, poorest weed control, and growth along with the yield of castor plant were obtained from the weedy check. This could be as a result of high weed competition for nutrients, water, space and sunshine with the castor plants as the weeds were not removed or weeded throughout the growth cycle of castor plant. According to Grichiar *et al.* (2004) [12], weed competition between crop and weeds in weedy checks

Table 3: Effect of Weeding Regimes on the Weed and Yield of Castor at Badeggi, 2011

Treatments	Weed cover score 3 MAP	No of branches/ plant 4MAP	Length of spike (cm) 4 MAP	Days to capsule formation 4 MAP	Yield (kg/ha) 4MAP
Hoe weeding at 1MAP	2.5	3.0	35.3	99.6	549.24
Hoe weeding at1 &2MAP	2.3	3.3	38.0	99.0	573.23
Hoe weeding at 1,2& 3MAP	2.2	3.6	39.6	97.6	575.91
Weedy check (control)	4.0	1.9	26.6	92.0	257.26
SE (±)	0 .01	0.39	2.9	5.17	24.01

Plot size 6.0m^2 (4.0m x 0.5m)
MAP = Months After Planting
Weed cover score: - This observation was taken through visual observation using the scale (0 – 10), 0 = Clean plot, 10 = completely weed covered plots

Table 4: Effect of Weeding Regimes on the Weed and Yield of Castor at Badeggi, 2012

Treatments	Weed cover score 3 MAP	No of branches/ plant 4 MAP	Length of spike (cm) 4 MAP	Days to capsule formation 4 MAP	Yield (kg/ha) 4 MAP
Hoe weeding at 1MAP	2.5	3.0	35.3	99.6	549.24
Hoe weeding at 1 &2 MAP	2.3	3.3	38.0	99.0	573.23
Hoe weeding at 1,2 & 3MAP	2.2	3.6	39.6	97.6	575.91
Weedy check (control)	4.0	1.9	26.6	92.0	257.26
SE (±)	0 .01	0.39	2.9	5.17	24.01

Plot size 6.0m^2 (4.0m x 0.5m)
MAP = Months After Planting
Weed cover score: - This observation was taken through visual observation using the scale (0 – 10), 0 = Clean plot, 10 = completely weed covered plots

is always great. However, the severity of the competition depends on the type of weeds present in the weedy check [10]. Baig *et al*. (2001) observed yield reduction of 95% in maize in a weedy check. According to them weed competition in field crop can cause yield loss of crop of between 12 – 99% depending on the type of weeds, density and soil fertility. Weed competition affects castor plant adversely by reducing castor plant height, number of branches, length of spikes, and number of capsules per plant and yield kg/ha and finally makes harvesting difficult [4]. Competition is most serious at the early stage of crop establishment and being critical between 4-6 weeks after planting of castor [4]. Weeds also harbor certain diseases and pests that attack castor and thus lead to indirect losses. Thus weeds essentially harm young germinated castor by depriving them of moisture, nutrients and sunlight. Poor growth of castor resulting from weed infestation also affects quality. Weeds that are present in the furrows i.e., along the cane rows cause more harm than those present in the inter-row spaces during early crop growth sub-periods [4].

Among the weeding regimes, castor plots that were hoe weeded once at 1MAP gave good weed control and castor yields significantly comparable to plots that were hoe weeded 2 and 3 times respectively.

Coupled with the type of major weeds (Table **1**) found at the experimental, poor fertility nature of the experimental site (Table **2**) and the time of planting castor seed (between 1st -2nd week of August) in Nigeria, all these factors might had assisted in making one hoe weeding enough for weed control in castor. Castor being a slow germinating plant but fast canopy-forming crop, which between 2-3 month after planting have produced dense canopy thereby assisting in weed control in plots either weeded once or more than once.

CONCLUSION

From the results, the worst treatment was the weedy check where no weeding was carried out. Where the one hoeing at 1MAP gave good weed control significantly comparable to the two hoe weeding carried out at 1 and 2MAP, and three times hoe weeding at 1,2 and 3MAP. Therefore, one hoe weeding at1MAP could be recommended for castor farmers particularly farmers that shares similar ecology, physicochemical soil properties and weed species similar with the ecology where the trial was carried out.

REFERENCES

[1] Brigham R.D. Registration of castor variety Hale. *Crop Sci* 1970; 10: 457.

[2] Anonymous. 2000. Castor bean, castor oil plant: http://www.vet.perdue.edu/depts/addl/toxic/plant11.htm

[3] Robertus J.D. "The Structure and Action of Ricin, A Cytotoxic N-glycosidase." *Seminar in Cell Biology* 1991; 2: 23-30.

[4] Horton S., Brian S.B. and Kyle B. Row spacing and population density effects on castor seed yield a preliminary study. *European Journal of Agronomy* 2006; 84: 75-93.

[5] Onyeike E.N. and Onwuka O. Chemical composition of some fermented tables seeds used as soup condiments in Nigeria East of the Niger. *Global Journal of Pure and Applied Sciences* 1999; 5(3): 337-342.

[6] NCRI. In- house review report on castor research activities in 2013. National Cereals Research Institute Badeggi Research *Review and Planning Workshop* 10-12th June, 2013; pp. 163-185.

[7] Gana A.K. *Agronomy of Sugarcane*. Jude –Evans Books and Publications 2010; 93 pp.

[8] Ayotade K.A, and Fagade S.O. Wet land utilization for rice production in sub-saharan Africa. *Proceedings of an International Conference on Wet Land Utilization* held at Ibadan, Nigeria 4 - 8 Nov. 1993; pp. 25-26.

[9] Snedecor G.W. and Cochran W.G. *Statistical Methods*. Iowa State University Press, Ames, Iowa, USA 1967; 425 pp.

[10] Baig M.K., Nanjappa H. and Ramachandrappa B.K. Weed dynamics due to difference organic sources of nutrients and their effect on growth and yield of maize (*Zea mays* L.). *Res on Crops* 2001; 2(3): 283-288.

[11] Culpepper A.S. and York A.C. Weed management in ultra narrow row cotton (*Gossypium hirsutum*). *Weed Technology* 2000; 14: 19-29. http://dx.doi.org/10.1614/0890-037X(2000)014[0019:WMIUNR]2.0.CO;2

[12] Grichiar W.J., Besler B.A. and Brewer K.D. Effect of rowspacing and herbicide dose on weed control and grain sorghum yield. *Crop protection* 2004; 23: 263-267. http://dx.doi.org/10.1016/j.cropro.2003.08.004

Received on 07-10-2013 Accepted on 10-01-2014 Published on 09-09-2014

DOI: http://dx.doi.org/10.12974/2311-858X.2014.02.01.3