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Weed management approaches and their influence on yield efficiency in niger (*Guizotia abyssinica*)

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Abstract

A field experiment was conducted during the kharif season of 2023 at the Research Farm, Project Coordinating Unit (Sesame and Niger), College of Agriculture, JNKVV, Jabalpur, Madhya Pradesh, to evaluate the effect of different weed management approaches on yield and economic efficiency of niger (*Guizotia abyssinica*). The experiment was laid out in a randomized block design with nine weed control treatments, including weedy check, hand weeding, and various pre-emergence herbicide applications alone or in combination with hand weeding. Results revealed that weed infestation caused severe yield reduction in niger, with the weedy check recording the lowest seed yield (256 kg ha⁻¹). Two hand weedings at 20 and 40 DAS produced the highest seed yield (665 kg ha⁻¹), stover yield (3168 kg ha⁻¹), biological yield (3833 kg ha⁻¹), and harvest index (17.40%). Among herbicidal treatments, pre-emergence application of oxyfluorfen 23.5% EC @ 75 g a.i. ha⁻¹ followed by one hand weeding at 20 DAS recorded significantly higher seed yield (552 kg ha⁻¹), comparable to hand weeding alone. Integrated weed management practices effectively reduced weed competition, enhanced yield attributes such as number of capitula per plant and seeds per capitulum, and improved overall productivity. The study concludes that integration of pre-emergence herbicides with one hand weeding is an efficient and economically viable alternative to sole manual weeding for sustainable niger production.

Keywords: Hand weeding, pendimethalin, oxyfluorfen, imazethapyr, *Guizotia abyssinica*

1. Introduction

Guizotia abyssinica (commonly known as Niger) is an herbaceous annual plant belonging to the Asteraceae family, characterized by its vibrant yellow inflorescences (Deme *et al.*, 2017) [3]. In the Indian agricultural context, Niger is an economically vital oilseed crop. Its cultivation is extensive across varied agro-ecologies, particularly on the hill slopes and coastal plains of eastern and peninsular India, including the states of Odisha, Chhattisgarh, Madhya Pradesh, Jharkhand, Bihar, Maharashtra, Karnataka, Andhra Pradesh, and West Bengal. Niger is predominantly cultivated by tribal communities in India on marginal and sub-marginal lands, including hill slopes. It is often regarded as the "life line of tribal agriculture and economy," playing a critical role in ensuring local food and nutritional security (Padhi *et al.* 2023) [9]. Niger seeds contain high-quality oil comparable to olive oil with great nutritional value having more than 70% unsaturated fatty acids with wide range of medicinal benefits (Deme *et al.*, 2017; Mohseni *et al.*, 2020 and Panda *et al.*, 2021) [3, 7, 10]. The seeds contain 35-45% oil and 18-20% protein with a pleasant aroma similar to desi ghee (Panda *et al.*, 2021) [10].

In India, Niger is cultivated in an area of about 2.61 lakh hectare with annual production of 0.84 lakh tonnes and productivity of 321 kg ha⁻¹ contributing only 3% to total oilseed production pool making the country a leading producer and exporter of Niger in the world. Madhya Pradesh is also playing a major role in cultivation of niger with the area of 10 thousand ha, production (3.03 thousand tonne) and productivity (303 kg/ha) (AICRP on Sesame and Niger, Annual Report 2022) [1].

As a kharif season crop, Niger is highly vulnerable to weed infestation. Weeding alone is estimated to consume 50–70% of the total labor invested in its production. Weeds impose a severe constraint, causing yield losses of up to 85%. This results from direct competition for

water, light, and nutrients, as well as allelopathic interference. The coexistence with weeds alters crop morphology, reduces biomass accumulation, and disrupts plant growth and metabolic processes, ultimately leading to significant yield decline (Oimbo *et al.*, 2018) ^[8]. Major weed flora found in niger fields are *Cuscuta spp.*, *Alternanthera spp.*, *Cynodon spp.*, *Eleusine indica*, *Thornless mimosa*, *Cyperus rotundus*, *Cyperus iria*, *Cyperus campestris*, *Parthenium hysterophorus*, *Commelina benghalensis*, *Euphorbia hirta*, *Phyllanthus niruri*, *Chenopodium album* and *Amaranthus species* (Rajput, 2017) ^[11]. Keeping in view of the above facts and the higher cost incurred in weed control, the present study aimed to find out a suitable weed control measure for improving the productivity of Niger.

2. Materials and Methods

Field experiment was conducted at Research Farm, Project Coordinating Unit (Sesame and Niger), College of Agriculture, JNKVV, Jabalpur, Madhya Pradesh during kharif season, 2023. Jabalpur is situated at 23° 90' N latitude and 79° 58' E longitude at an altitude of 411.78 meter above the mean sea level. It falls under subtropical climatic conditions, which is characterized by the features of hot dry summers and cool dry winters. Annual rainfall of the area is 1284 mm and nearly 90% of the total annual rainfall is mainly receives during the period between end of June to end of September. The maximum and minimum temperature ranges between 24°C to 45°C; and 4°C to 32°C, respectively within a year.

The soil of the experimental field is classified as “Vertisols” in texture. The field had a uniform topography with a gentle slope (0.2%), well drained and Neutral in reaction (pH 7.20) with low organic carbon (0.56%). The soil available nitrogen content was medium (252.00 kg/ha), available phosphorus content was medium (16.38 kg/ha) and the available potassium content was high (334 kg/ha) with normal electrical conductivity.

Seeds of the variety, JNS-28 were sown on 27 November, 2023. Sowing of seeds was done manually at the depth of 1.5-2 cm in rows 40 cm apart by drilling with the rate of 5 kg/ha in all plots. The recommended dose of fertilizers (RDF) was 60 kg N + 40 kg P₂O₅ + 20 kg K₂O/ha. The entire quantity of phosphorous and potassium was applied as basal dose in all the treatments through single super phosphate and muriate of potash, respectively whereas, the nitrogen was applied as per the treatment.

The experiment was laid out in randomised block design assigned with nine treatment combinations, T₁- Weedy check, T₂- Two hand weedings at 20 and 40 DAS, T₃- Glufocinate 13.5% w/w SL @ 250ml/ha at 10 days before sowing, T₄- Application of Pendimethalin 30% EC @ 750g a.i./ha as PE, T₅- Application of Pyroxasulfone 85% WG @ 50g a.i./ha as PE, T₆- Application of Pendimethalin 30% EC + Imazethapyr 2% SL @ 250g a.i./ha as PE, T₇- Application of Oxyfluorfen 23.5% EC @ 75g a.i./ha as PE, T₈- Application of Pendimethalin 30% EC @ 750g a.i./ha as PE fb one hand weeding at 20 DAS and T₉- Application of Oxyfluorfen 23.5% EC @ 75g a.i./ha as PE fb one hand weeding at 20 DAS as pre emergence (PE) spray to evaluate the efficacy of herbicides and cost effective weed management option in niger. A knapsack sprayer equipped with a flat fan nozzle was used to apply pre-emergence herbicides within 24 hours of sowing using 500 litres of water per hectare. In case of hand weeding treatments, weeds were removed manually with a trowel at 20 and 40 DAS. Weed density were taken at 20, 40 DAS and harvest using quadrant 1.0 m². The number of monocot and dicot weeds falling within the quadrat

were counted separately and recorded. The crop was harvested at physiological maturity on 15 January, 2024. The periodical biometric and post-harvest observations were taken at regular intervals. The harvested produce from each treatments were tied in separate bundles and weighed with the help of a spring balance and converted into kg ha⁻¹.

Weed control efficiency (WCE) and Weed Index (WI) were calculated by using the prescribed formulae.

$$WCE (\%) = \frac{DWC - DWT}{DWC} \times 100$$

Where,

WCE = Weed control efficiency in percent

DWC = weed dry weight in control plot.

DWT = weed dry weight in treated plot.

$$\text{Weed index (WI)} = \frac{X - Y}{X} \times 100$$

Where,

X = Weight of seed yield (q ha⁻¹) in treatment which has highest yield

Y = Weight of seed yield (q ha⁻¹) in treatment for which weed index is to be calculated, it is expressed in percentage.

The experimental data collected during the crop growth and harvest were analysed statistically following the procedure as described by Gomez and Gomez (1984) ^[14].

3. Results and Discussion

3.1 Yield attributes

3.1.1 Number of capitula plant⁻¹

Data pertaining to number of capsules/plant as influenced by the different treatments is presented in Table 1. Two hand weedings at 20 and 40 DAS recorded the significantly higher number of capitula plant⁻¹ (41.28) and it was at par with oxyfluorfen 23.5% EC fb one hand weeding at 20 DAS (40.68), pendimethalin 30% EC fb one hand weeding at 20 DAS (40.09), Oxyfluorfen 23.5% EC @ 75g a.i./ha as PE (39.51) followed by pyroxasulfone 85% WG @ 50g a.i./ha as PE (37.73), Pendimethalin @ 750g a.i./ha as PE (36.97), glufocinate @ 250ml/ha at 10 days before sowing (36.66) and Pendimethalin 30% EC+Imazethapyr 2% SL (34.95). This treatment was notably superior to the weedy check (34.49) indicating effective weed control enhances the reproductive potential of the crop by allowing more capitula to develop per plant (Saha *et al.* 2021 and Shanmugapriya *et al.* 2022) ^[13, 17].

The similarity in performance between mechanical (hand weeding) and chemical (herbicide) methods suggests both approaches are effective in achieving weed control and thereby enhancing crop yield potential (Kaur and Singh 2017) ^[15]. Weeds compete vigorously with the crop for resources, limiting the number of capitula formed and ultimately reducing potential seed yield. Implementing integrated weed management strategies that combine mechanical and chemical methods can significantly enhance crop productivity by minimizing weed interference (Sanbagavalli *et al.* 2016) ^[12].

3.1.2 Number of seed capitula⁻¹

Table 1 presents data on the number of seeds per capsule under different treatments. The significantly higher number of seed capitula⁻¹ (33.56) was recorded under two hand weedings at 20 and 40 DAS (33.56) which was found significantly superior over weedy check (26.95) and it was at par with oxyfluorfen 23.5%

EC @ 75g a.i./ha as PE (32.12), Pendimethalin 30% EC fb one hand weeding at 20 DAS (32.59) and oxyfluorfen 23.5% EC fb one hand weeding at 20 DAS (33.07) followed by pyroxasulfone @ 50g a.i./ha as PE (30.68), pendimethalin @ 750g a.i./ha as PE (30.07) and glufocinate @ 250ml/ha at 10 days before sowing (29.82). Similar result recorded by Singh *et al.* 2017^[15], Thakur and Dantre (2018)^[18] and Verma *et al.* 2022^[19].

3.1.3 Test weight (g)

The data regarding effect of different treatments on test weight (g) which are presented in Table 1 and depicted in Figure 1. The test weight was non-significantly influenced due to different treatments. The maximum test weight was recorded under the application of two hand weedings at 20 and 40 DAS (4.25 g). Whereas, the minimum test weight was registered under weedy check (4.09 g). This finding suggests that effective weed control through manual weeding positively influenced seed weight, potentially due to reduced competition for resources and optimal growth conditions provided to the crop (Panda *et al.*, 2021)^[10]. The non-significant differences observed among other treatments, including those involving herbicide applications (such as oxyfluorfen and pendimethalin), suggest that these treatments effectively controlled weeds, they did not significantly alter the seed test weight compared to the hand weeding treatment (Padhi *et al.* 2023)^[9]. This corroborates with the findings of Saha *et al.* 2021^[13], Shanmugapriya *et al.* 2022^[17] and Mishra and Choudhary 2022^[6].

3.1.4 Seed yield (kg ha⁻¹)

Data pertaining to seed yield as influenced by the different treatments is presented in Table 2 and depicted in Figure 2. The significantly higher seed yield (665 kg ha⁻¹) was recorded in two hand weedings at 20 and 40 DAS followed by oxyfluorfen 23.5% EC fb one hand weeding at 20 DAS (552 kg ha⁻¹), pendimethalin 30% EC fb one hand weeding at 20 DAS (539 kg ha⁻¹). Oxyfluorfen had the highest seed yield (483 kg ha⁻¹) among the herbicidal treatments followed by pyroxasulfone at 50g a.i./ha (445 kg ha⁻¹), pendimethalin at 750g a.i./ha (427 kg ha⁻¹), glufocinate at 250ml/ha applied 10 days before sowing (362 kg ha⁻¹) and Pendimethalin 30% EC + Imazethapyr 2% SL (359 kg ha⁻¹). This suggests that combining chemical herbicides with manual weeding can be an efficient strategy. All treatments found significantly superior over weedy check (256 kg ha⁻¹) which was recorded lowest seed yield. Overall, these findings justify the need for integrated weed management strategies that combine chemical and manual methods to achieve higher seed yields. The significant differences in yield between treated plots and the weedy check emphasize the critical role of effective weed control in maximizing crop production. The possible reason might be due to efficient control of weeds, less competition between crop-weeds and better nutrient uptake by crop plants resulting in more accumulation of photosynthates in the sink and thereby higher yield in the treatments. This corroborates the findings of Suryavanshi *et al.*, (2015)^[16], Wanjari *et al.*, (2000)^[20], Joshi *et al.* (2022)^[5] and Sahoo *et al.* (2023)^[14].

3.1.5 Stover yield (kg ha⁻¹)

The data regarding effect of different treatments on stover yield

was significantly influenced due to different treatments are presented in Table 2 and depicted in Figure 2. Two hand weedings at 20 and 40 DAS was recorded significantly higher stover yield (3168 kg ha⁻¹) and it was at par with oxyfluorfen 23.5% EC fb one hand weeding at 20 DAS (3123 kg ha⁻¹), pendimethalin 30% EC fb one hand weeding at 20 DAS (3080 kg ha⁻¹) and oxyfluorfen 23.5% EC @ 75g a.i./ha as PE (2947 kg ha⁻¹) and these treatments found significantly superior over weedy check where (2357 kg ha⁻¹). This suggests that thorough manual weeding effectively reduces weed competition, allowing for better crop growth and biomass production. The significantly higher yields obtained from treatments involving both manual weeding and combinations of herbicides with manual weeding demonstrate the importance of an integrated approach to weed control. Manual weeding, though labor-intensive, provides precise weed removal, while herbicides offer broad-spectrum control. Combining these methods leverages the strengths of both approaches resulting in optimal weed management and higher stover yields. Effective weed management not only enhances seed yield but also improves overall crop health and productivity which reflected in higher stover yields. In similar result observed by Suryavanshi *et al.*, (2015)^[16], Wanjari *et al.*, (2000)^[20], Suryavanshi *et al.* (2015)^[16] and Sahoo *et al.* (2023)^[14].

3.1.6 Biological yield (kg ha⁻¹)

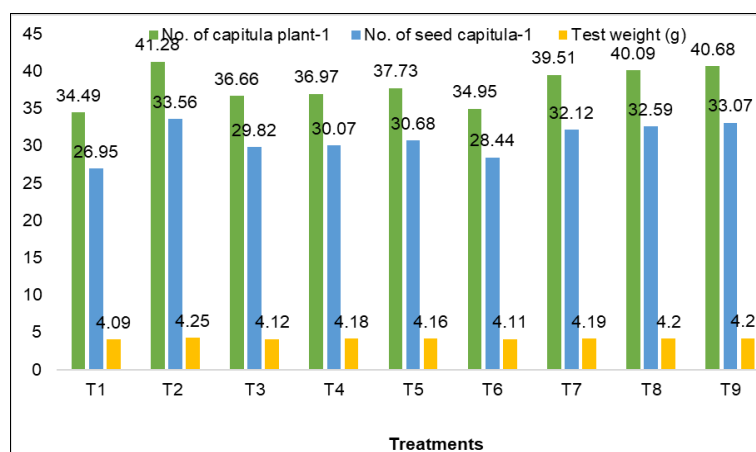
The data regarding effect of different treatments on biological yield was significantly influenced due to different treatments are presented in Table 2 and depicted in Figure 2. Two hand weedings at 20 and 40 DAS resulted in a significantly higher biological yield of 3833 kg ha⁻¹ which was at par with oxyfluorfen 23.5% EC with one hand weeding at 20 DAS (3675 kg ha⁻¹), pendimethalin 30% EC with one hand weeding at 20 DAS (3619 kg ha⁻¹), application of oxyfluorfen 23.5% EC @ 75g a.i./ha as pre-emergence (3430 kg ha⁻¹), pyroxasulfone @ 50g a.i./ha as PE (3227 kg ha⁻¹) and pendimethalin also showed significantly higher biological yield compared to the weedy check where no herbicide was applied (2613 kg ha⁻¹). Similar findings was reported by Suryavanshi *et al.* (2015)^[16] and Sahoo *et al.* (2023)^[14].

3.1.7 Harvest index (%)

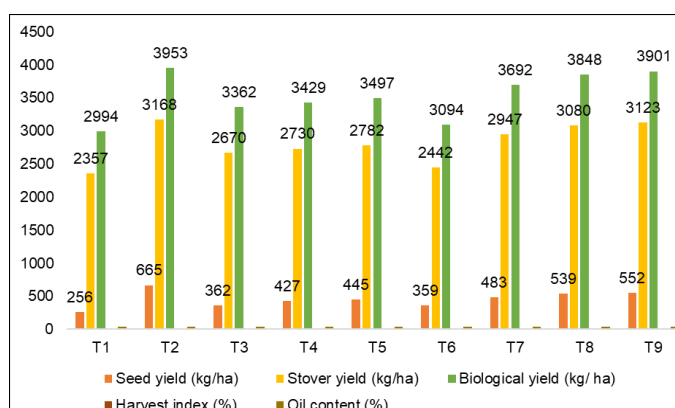
The data regarding effect of different treatments on harvest index are presented in Table 2 and depicted in Figure 2. The harvest index was significantly influenced due to different treatments on crop. Significantly higher harvest index was recorded with two hand weedings at 20 and 40 DAS (17.40%) followed by oxyfluorfen 23.5% EC with one hand weeding at 20 DAS (15.02%), Pendimethalin 30% EC with one hand weeding at 20 DAS (14.89%) and oxyfluorfen 23.5% EC at 75g a.i./ha as PE (14.06%). These treatments were significantly better than the weedy check with no herbicide applied (9.81%). Highest HI in hand weeding treatment might be due to lower crop-weed competition at early stages of crop growth, efficient utilisation of nutrients and insolation for optimum expression of growth and yield parameters and ultimately yield. This corroborates with the findings of Choudhary *et al.* 2022^[2] and Sahoo *et al.* (2023)^[14].

Table 1: Effect of different weed control treatments on Number of capitula plant⁻¹, Number of seed capitula⁻¹, Test weight (g)

S. No.	Treatment	No. of capitula plant ⁻¹	No. of seed capitula ⁻¹	Test weight (g)
T ₁	Weedy check	34.49	26.95	4.09
T ₂	Two hand weedings at 20 and 40 DAS	41.28	33.56	4.25
T ₃	Glufocinate @ 250ml/ha at 10 days before sowing	36.66	29.82	4.12
T ₄	Pendimethalin @ 750g/ha as PE	36.97	30.07	4.18
T ₅	Pyroxasulfone @ 50g /ha as PE	37.73	30.68	4.16
T ₆	Pendimethalin + Imazethapyr @250g/ha as PE	34.95	28.44	4.11
T ₇	Oxyfluorfen @ 75g /ha as PE	39.51	32.12	4.19
T ₈	Pendimethalin @ 750g/ha as PE <i>fb</i> one hand weeding at 20 DAS	40.09	32.59	4.20
T ₉	Oxyfluorfen @ 75g /ha as PE <i>fb</i> one hand weeding at 20 DAS	40.68	33.07	4.23
SEm±		1.16	0.96	0.04
CD (<i>p</i> =0.05)		3.36	2.97	NS

**Fig 1:** Effect of different weed control treatments on Number of capitula plant⁻¹, Number of seed capitula⁻¹, Test weight (g)**Table 2:** Effect of different weed control treatments on Seed yield (kg/ha), Stover yield (kg/ha), Biological yield (kg/ ha) and Harvest index (%)

S. No.	Treatment	Seed yield (kg/ha)	Stover yield (kg/ha)	Biological yield (kg/ ha)	Harvest index (%)
T ₁	Weedy check	256	2357	2613	9.81
T ₂	Two hand weedings at 20 and 40 DAS	665	3168	3833	17.40
T ₃	Glufocinate @ 250ml/ha at 10 days before sowing	362	2670	3020	12.03
T ₄	Pendimethalin @ 750g/ha as PE	427	2730	3157	13.62
T ₅	Pyroxasulfone @ 50g /ha as PE	445	2782	3227	13.95
T ₆	Pendimethalin + Imazethapyr @250g/ha as PE	359	2442	2801	12.86
T ₇	Oxyfluorfen @ 75g /ha as PE	483	2947	3430	14.06
T ₈	Pendimethalin @ 750g/ha as PE <i>fb</i> one hand weeding at 20 DAS	539	3080	3619	14.89
T ₉	Oxyfluorfen @ 75g /ha as PE <i>fb</i> one hand weeding at 20 DAS	552	3123	3675	15.02
SEm±		14.79	124.65	123.48	0.70
CD (<i>p</i> =0.05)		44.33	382.5	378.90	2.16

**Fig 2:** Effect of different weed control treatments on Seed yield (kg/ha), Stover yield (kg/ha), Biological yield (kg/ ha) and Harvest index (%)

4. Conclusion

The study clearly demonstrates that effective weed management

is crucial for improving yield and productivity of Niger (*Guizotia abyssinica*). Uncontrolled weed infestation caused severe yield reduction, with the weedy check recording the lowest seed yield, biomass, and harvest index. Two hand weedings at 20 and 40 DAS proved to be the most effective practice, resulting in the highest yield attributes, seed yield, stover yield, biological yield, and harvest index due to minimum crop-weed competition throughout the critical growth period. However, among herbicidal options, pre-emergence application of oxyfluorfen (75g a.i./ha) or pendimethalin (750g a.i./ha) followed by one hand weeding at 20 DAS performed comparably well and produced significantly higher yields than sole herbicide application. Overall, the results indicate that integrated weed management combining pre-emergence herbicides with one timely hand weeding is an efficient and practical alternative to repeated manual weeding, offering effective weed control, higher productivity, and better economic feasibility in Niger cultivation under *Kharif* conditions.

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