IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 13, Issue 6 Ser. I (June 2020), PP 21-26
www.iosrjournals.org

Assessment of Manual and Chemical Weed Control Methods on the Performance of Mungbean (*Vigna radiata* [L.]) in Awka, South East Nigeria.

Uko I.*, Okolie H.,Obidiebube, E.A and Orakanma, C.
Department of Crop Science and Horticulture, Faculty of Agriculture, Nnamdi Azikiwe University, Awka

Abstract: *A field trial was conducted at Awka to evaluate the effect of manual and chemical weed control methods on Mungbean (Vigna radiata L.) growth and yield parameters. The study was laid out in a randomized complete block design, replicated five times. The four treatments were hoe weeding at 4 and 8 weeks after sowing (WAS), application of atrazine at the rate of 1.5kg a.i/ha at 4 and 8WAS, hoe weeding at 4WAS followed by application of atrazine at the rate of 1.5kg a.i/ha at 5WAS, and weedy check. The various treatments had no significant effect on mungbean growth measured parameters except on the number of branches where hoe weeding at 4WAS followed by application of atrazine at 5WAS had the highest number of branches at 6WAS (35.1). At 8WAS, application of atrazine at 4 and 8WAS had the least broad leaf weeds density (1.2) which showed that it is very effective against broad leaf weeds. The control (weedy check) significantly had the highest weed fresh weight (315g) and weed dry matter (88g) which showed that the various treatments were effective in the control of weeds in mungbean production. Application of atrazine at 4 and 8WAS had the highest number of pods per plant (15), mean weight of pods (10.27g) and weight of 100 seeds (4.93g). This showed that application of atrazine at the rate of 1.5kg a.i/ha at 4 and 8WAS effectively controlled the weeds and had no significant effect on yield of mungbean. The weed control efficiency and weed index showed that application of atrazine at 4 and 8WAS (64.3%, -3.0%) and hoe weeding at 4WAS followed by application of atrazine (51.4%, -18.0%) were more efficient in weed control. The result also indicated that application atrazine at 4 and 8WAS, hoe weeding at 4WAS followed by application of atrazine significantly produced higher seed yield and heavier seeds compared to weedy check. Application of atrazine at 4 and 8WAS is recommended for large scale mungbean production and areas where labour is scarce/very expensive since it was cheap and effective in mungbean weed control. While, hoe weeding at 4WAS followed by application of atrazine is therefore recommended for small scale production since it was effective in controlling weeds and also a type of integrated weed control method.*

Key words*: Mungbean, Atrazine, Weed, manual, chemical control.*

Date of Submission: 21-05-2020 Date of Acceptance: 08-06-2020

I. Introduction

Mungbean (*Vigna radiata* (L.) R.Wilczek) also known as "green gram" is considered to be an important legume crop mostly cultivated widely and extensively in Asian countries like India, Thailand, Burma and Pakistan (Tomooka, 2003). About 90 percent of the world production of mungbean is produced in Indo-Burma region (Opoku *et al.*, 2003). The crop has high nutritional potentials and its cultivation in Nigeria is becoming popular in some northern and southern states (Agugo, 2003; Mensah and Olukoya, 2007). It is relatively a drought tolerant crop that mature in about 60-90 days depending on the variety; making it a short duration legume crop that can be cultivated more than twice in a year. The crop can be grown under a wide range of cropping systems due to the fact that its agronomic characteristics permits it to fit in as an intercrop, rotation crop and relay crop (Chadha, 2010).

Mungbean is a newly introduced crop in the South-Eastern part of Nigeria and it has many amazing potentials to the economy and ensuring food security. A study by Minh (2014) indicated that mungbean has a high nutritive value over the other pulses and its can supply the essential amino acid required in human diets. It is rich in dietary fibre, energy, vitamins, iron, magnesium, potassium, phosphorus, and copper whereas riboflavin and niacin are found in trace amount in the leaves (Khalil, 2006). Mungbean's excellent digestibility and freedom from flatulence has made it suitable for infant feed formulation, recuperating patients and aged people (Weinberg, 2002) and its residues can be used as fodder for animals (Agugo and Onimawo, 2008). Other than food, its importance stretches to its low water requirement and ability to improve soil fertility by fixing

atmospheric nitrogen into available form with the help of rhizobia species in their root nodules for their plant growth and development (Singh *et al*., 2011).

As a newly introduced crop in Nigeria, it is faced with several constraints in its production and weeds are one of the major problems in cultivation of mungbean (Ali and Kumar, 2007). Mansoor, *et al*. (2004) reported about 47-91% yield losses in mungbean whereas Yadav and Sing (2005) reported about 69% reduction in mungbean grain yield due to weeds. So far in Nigeria, hoe weeding which is a type of manual weeding has been reported to be labour intensive, expensive, and availability of labour to carry out hoe weeding is uncertain, thus making timeliness of weeding difficult to attain in large scale mungbean production (Imoloame, 2014). Ekeleme (2013) reported that about 25-55% of the cost of production is spent on labour and weeding operations. In Nigeria, these labour and weeding operations are mostly carried out by women and children who spend a lot of time weeding crop farms (Ekeleme, 2013). It is, therefore, important to evaluate suitable weed management or control approaches in order to reduce mungbean yield losses in Nigeria as recommended by Douglas *et al*.(1982). Furthermore, integrated weed management is very important particularly in increasing agricultural sustainability since there is no perfect single weed control method (Post, 2015). Hence, the application of herbicides in combination with hoeing or mechanical weeding may pose as the only options under such situations although a number of herbicides have been developed for controlling weeds in other legume crop like mungbean at different stages of its production in Nigeria (Adigun and Lagoke, 2003). This study, therefore, was designed to evaluate the effect of different weed control methods either alone or in combination, on growth and yield performance of mungbean in Southeastern Nigeria.

II. Materials and methods

The study was conducted in the Teaching and Research Farms, of the Department of Soil Science and Land Resources Management, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria. Awka is locatedat447 meters above sea level, with geographical coordinates of 6°15'N and 7°07'E. The average annual rainfall ranges from 1650-2000mm, mean minimum and maximum temperatures of 27°C and 30°C, respectively and average relative humidity of 75-80% (Ezenwaji *et al*., 2014). The experimental site had a relatively uniform topography with a well-drained soil. The soil parent material is predominantly sedimentary and classified as ferralitic, red yellow soils of the Humid Tropics. Land preparation was done by ploughing, harrowing and pulverizing with hand-hoe. The experiment was laid out in a randomized complete block design (RCBD) with 5 replications. Four weed control methods were used: T1= no weeding (weedy check); T2= manual weeding at 4 and 8 weeks after sowing (WAS); T3= application of pre-emergence herbicide [atrazine at the rate of 1.5kg a.i/ha] at 4 and 8 WAS; T4= hoe weeding at 4 WAS followed by application of atrazine (at the rate of 1.5kg a.i/ha) at 5 WAS. The mungbean seeds were sourced from Federal University of Agriculture, Umudike. The variety of mungbean used was 'Umudike AB'. Each mungbean seeds were sown at 2 seeds per hole at a spacing of 50cm x 50cm and were later thinned down to one plant per stand.

III. Data Collection:

Crop growth parameters: The crop growth parameters include: mungbean number of leaves, plant height and number of branches. These quantitative characters were measured either with a meter rule or visual count as the case implies. The various growth components were taken at 2, 4, and 6 WAS.

Yield parameters: The following yield parameters of mungbean were recorded at harvest at weekly intervals either with a weighing balance or by visual count: mungbean number of pods per plant, pod length, pod diameter, weight of pods, number of seeds per pod, pod yield, seed yield, 100 seed weight.

Weed Parameters: A quadrat of 50 cm x 50 cm was placed diagonally per plot to assess weed density and weed biomass at 4 and 8WAS. The total number of weeds present was recorded by identifying and counting the weeds present in each of the plots. The density was expressed as number of weeds per plot. The various weed species were categorized as either broadleaf, grasses or sedges. Thereafter the fresh weights of the weeds were taken, after which the weeds were dried to a constant weight for 2 weeks. The fresh and dry weights were determined with an electronic scale (Model SF-400).

Weed Control Efficiency (%): Data on weed dry weight were used to calculate the efficiency (E) of the different treatments relative to the untreated control by the following formula used by Ravisanker *et al.* (2013) which is expressed in percentage (%).

$$E\ (\%) = \frac{Wu - Wt}{Wu} \times 100$$

where,

Wu = weed dry weight in untreated plots.
Wt = weed dry weight in treated plots.

Weed index (%): The weed index (WI) defined as the reduction in yield due to the presence of weeds in comparison with the weedy plot was worked out for each plot with the formula used by Abdul Khaliq *et al*., (2014) and expressed in percentage (%).

$$WI = \frac{X - Y}{X} \times 100$$

where,
X = yield from minimum weed competition plot
Y = yield from treated plot
WI = weed index.

IV. Results

Initial physico-chemical properties of the soil at the study site

The physical and chemical properties of the soil at the study site are presented in Table 1. This was carried out to ascertain the characteristics of the soil at the study site. The soil test result obtained showed that the soil was sandy loam and acidic pH (5.14).

Table1: Initial physical and chemical properties of the soil taken at 0-15cm depth of the experimental site before planting

Physical	
Sand (%)	69.6
Silt (%)	22.0
Clay (%)	8.4
Textural class	Sandy-loam (SL)
Chemical	
pH (H_20)	5.14
Total N (%)	0.97
Organic carbon (%)	1.14
Organic matter(%)	1.98
Ca (Cmolkg-1)	2.27
Mg (Cmolkg-1)	1.33
K (Cmolkg-1)	0.25
Na (Cmolkg-1)	0.12
EA (Cmolkg-1)	1.63
ECEC (Cmolkg-1)	4.97
BS (%)	80.23
Available P (mgkg-1)	5.53

***Abbreviations*:** P- Phosphorus, N- Nitrogen, Ca-Calcium, Mg- Magnesium, K-Potassium, Na- Sodium, EA-Exchangeable acidity, ECEC- Effective Cation Exchange Capacity, BS- Base saturation.

Effect of weed control method on mungbean growth parameters

Selected mungbean growth parameters as influenced by weed control methods are presented in Table 2. The result obtained showed that there were no significant difference ($P \leq 0.05$) in mungbean number of leaves except at 6 weeks after sowing (WAS) whereas mungbean height and number of branches at 2, 4 and 6WAS did not differ significantly among the different weed control methods. The result indicated that at 6WAS, hoe weeding at 4WAS followed by application of atrazine (at the rate of 1.5 kg a.i./ha) at 5WAS (T4) significantly ($P \leq 0.05$) had the highest number of leaves(35.1) followed by hoe weeding at 4 and 8WAS (T2).

Table 2: Effect of weed control method on mungbean growth parameters at 2, 4 and 6 weeks after sowing (WAS)

Treatment	Number of leaves			Plant height (cm)			Number of branches		
	2WAS	4WAS	6WAS	2WAS	4WAS	6WAS	2WAS	4WAS	6WAS
T1	6.40	15.93	27.9	15.93	11.62	24.02	1.533	4.60	8.93
T2	6.73	15.33	33.5	15.33	12.08	24.41	1.600	4.60	10.93
T3	5.80	15.27	26.0	15.27	10.95	19.82	1.267	4.47	8.83

T4	6.80	15.20	35.1	15.20	10.85	21.88	1.600	4.47	11.87
$LSD_{0.05}$	Ns	Ns	9.10	Ns	Ns	Ns	Ns	Ns	Ns

T1= no weeding (weedy check), T2= hoe weeding at 4 and 8WAS, T3= application of atrazine (at the rate of 1.5 kg a.i./ha) at 4 and 8WAS, T4= hoe weeding at 4WAS followed by application of atrazine (at the rate of 1.5 kg a.i./ha) at 5WAS, Ns= not significant.

Effect of weed control method on weed density

The effect of weed control methods on weed density is presented in Table 3. The result obtained indicated that weed specie densities were not significantly ($P<0.05$) affected by the different weed control methods except at 8WAS under broad leaf weeds. At 8WAS, application of atrazine (at the rate of 1.5 kg a.i./ha) at 4 and 8WAS (T3) significantly ($P<0.05$) had the least broad leaf density(1.2) when compared with the other weed control methods.

Table 3: Effect of weed control method on broad leaves, sedges and grass densities at 4 and 8 weeks after sowing (WAS).

Treatment	Sedges		Grass		Broad leaves	
	4WAS	8WAS	4WAS	8WAS	4WAS	8WAS
T1	0	8.6	25.0	10.2	28.2	52.8
T2	0	11.0	25.8	19.4	25.2	20.2
T3	0	17.4	23.6	17.8	18.4	1.2
T4	0	9.4	23.4	15.6	25.4	11.4
$LSD_{0.05}$	Ns	Ns	Ns	Ns	Ns	13.36

T1= no weeding (weedy check), T2= hoe weeding at 4 and 8WAS, T3= application of atrazine (at the rate of 1.5 kg a.i./ha) at 4 and 8WAS, T4= hoe weeding at 4WAS followed by application of atrazine (at the rate of 1.5 kg a.i./ha) at 5WAS, Ns= not significant.

Effect of weed control method on weed biomass and dry matter

Weed fresh weight and dry matter as influenced by weed control methods are presented in Table 4. The result obtained showed that at there was significance difference ($P<0.05$) among the various weed control methods as regards to the fresh weight of weeds at 4 and 8WAS. At 4WAS, hoe weeding at 4WAS followed by application of atrazine (at the rate of 1.5 kg a.i./ha) at 5WAS (T4)had the highest fresh weight of weeds (97g) followed by T3 (69.6g). While at 8WAS, the weedy check had the highest fresh weight of weeds (315g) and the lowest weed fresh weight were observed in T3.

Weed dry matter at 4WAS was not significant whereas at 8WAS, weed dry matter significantly varied among the various weed control methods. The highest weed dry matter was obtained in the weedy check (88.g) which was significantly ($P<0.05$) higher than the other weed control methods used in this study.

Table 4: Effect of weed control method on fresh and dry weights of weed at 4 and 8 weeks after sowing (WAS).

Treatment	4WAS	8 WAS	4WAS	8WAS
	Fresh (g)	Fresh (g)	Dry (g)	Dry (g)
T1	63.0	315.0	18.4	88.0
T2	68.6	169.0	22.4	46.6
T3	69.6	100.0	22.2	28.6
T4	97.0	133.0	25.6	40.8
$LSD_{0.05}$	31.29	74.8	Ns	21.62

T1= no weeding (weedy check), T2= hoe weeding at 4 and 8WAS, T3= application of atrazine (at the rate of 1.5 kg a.i./ha) at 4 and 8WAS, T4= hoe weeding at 4WAS followed by application of atrazine (at the rate of 1.5 kg a.i./ha) at 5WAS, Ns= not significant.

Effect of weed control methods on yield of mungbean

The effect of weed control methods on the yield of mungbean is shown on Table 5. The result obtained showed there were no significance difference among the various weed control methods as regards to the pod length, pod diameter, total weight of pods, total weight of seeds and number of seeds per pod. But there were significant differences ($P\leq0.05$) as regards to the mungbean number of pods per plant, weight of pods and weight of 100 seeds per plant. The result indicated that application of atrazine (at the rate of 1.5 kg a.i./ha) at 4 and 8WAS gave the highest number of pods (15.1), heaviest mean weight of pods (10.27) and the highest 100 seed weight pods (8.2g).

Table 5: Effect of weed control methods on mungbean yield parameters.

Treatment	Pod length(cm)	Total pod diameter(mm)	Total weight of pods(g)	Total weight of seeds(g)	No. of pods per plant	No. of seeds per pod	Mean weight of pods(g)	Weight of 100 seeds(g)
T1	7.44	17.0	13.5	11.0	7.0	9.72	5.15	3.03
T2	7.73	16.1	22.2	17.6	13.1	11.76	8.65	4.73
T3	6.97	14.9	16.9	13.7	15.0	10.06	10.27	4.93
T4	6.53	13.5	19.2	15.4	9.5	9.79	6.56	4.07
$LSD_{0.05}$	Ns	Ns	Ns	Ns	7.95	Ns	5.09	1.708

T1= no weeding (weedy check), T2= hoe weeding at 4 and 8WAS, T3= application of atrazine (at the rate of 1.5 kg a.i./ha) at 4 and 8WAS, T4= hoe weeding at 4WAS followed by application of atrazine (at the rate of 1.5 kg a.i./ha) at 5WAS, Ns= not significant.

Effect of weed control methods on weed control efficiency and weed index

Application of atrazine (at the rate of 1.5 kg a.i./ha) at 4 and 8WAS gave the highest weed efficiency (64.5%) which was significantly ($P<0.05$) higher than the other weed control methods (Table 6). Weed index (9.0%) was the highest with the weedy check which was significantly higher over the other weed control methods.

Table 6: Effect of weed control methods on weed control efficiency and weed index.

Treatment	Weed control efficiency (%)	Weed index (%)
T1	0.00	9.0
T2	42.6	0.0
T3	64.5	-3.0
T4	51.4	-18.0
$LSD_{0.05}$	12.00	3.67

T1= no weeding (weedy check), T2= hoe weeding at 4 and 8WAS, T3= application of atrazine (at the rate of 1.5 kg a.i./ha) at 4 and 8WAS, T4= hoe weeding at 4WAS followed by application of atrazine (at the rate of 1.5 kg a.i./ha) at 5WAS, Ns= not significant.

V. Discussion

The soil test result showed that the soil was sandy loam and acidic pH (5.14). According to (Ramel *et al*., 2009), Atrazine is a member of triazine family of herbicides that break down readily within a few weeks in slightly acidic soils. So the residual effect of the herbicide was expected to be short. The various treatments had no significant effect on mungbean growth measured parameters except on mungbean number of branches in which T4 [application of atrazine (at the rate of 1.5 kg a.i./ha)] at 4 and 8WAS) had the highest at 6WAS (35.1). At 8WAS, T3 [application of atrazine (at the rate of 1.5 kg a.i./ha) at 4 and 8WAS] significantly had the least broad leaf weeds population (1.2) which showed that it was very effective against broad leaf weeds (Bhadauria *et al*., 2012). The control (Weedy check) significantly had the highest fresh (315g) and dry weed (88g) weights which showed that the various treatments were effective on weed control. This corroborated the report of Harker *et al*., (2013) that both chemical and integrated weed management practices are effective in weed control. Application of atrazine (at the rate of 1.5 kg a.i./ha) at 4 and 8WAS (T3) had the highest number of pods per plant (15), mean weight of pods (10.27g) and weight of 100 seeds (4.93g). This showed that atrazine application at 4 and 8WAS were effective in weed control as verified by (Vencill *et al*., 2012). The weed control efficiency and weed index showed that T3 (64.3%,-3.0%) and T4 (51.4%, -18.0%) were more efficient in controlling weeds. Based on yield, atrazine application T3 and T4 significantly had higher seed yield and heavier seeds compared to weedy check which produced the least mungbean seed yield due to the weed competition for growth resources resulting in lower seed yield (Kraehmer *et al.*, 2014).

VI. Conclusion

The results obtained from this study suggested that application of atrazine (at the rate of 1.5 kg a.i./ha) at 4 and 8WAS (T3) was cheapest and effective in weed control in mungbean production. For profitability and reduction of amount of time most women and children spend in hoe weeding, T3 is therefore recommended for large scale mungbean production or in areas were labour is scarce and very expensive. Hoe weeding at 4WAS followed by application of atrazine (at the rate of 1.5 kg a.i./ha) at 5WAS (T4) which is a type of integrated weed control as postulated by Bastiaans *et al*. (2008) should also be encouraged since it produced effective result like T3 in small scale mungbean production or in areas where labour is cheap and readily available.

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