

Effects of Paraquat, Glyphosate and Atrazine on Nodulation in *Vignae unguiculata* (Cowpea)

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Abstract: The aim of this study was to investigate the effect of paraquat, glyphosate and atrazine on nodulation in *Vignae unguiculata* (cowpea). Healthy seeds of cowpea were planted and allowed for 22 days under a green house condition. Various concentrations (5% - 100% v/v) of the herbicides were applied to the crops when the seed have germinated. The 0% concentration served as the control. The average number of nodules recorded at 0% concentration was 59. High paraquat concentrations of 70%, 90% and 100% gave average of 41 nodules respectively. Similar concentrations of glyphosate and atrazine gave average of 41 and 40 nodules respectively. The analysis of variance (ANOVA) of the obtained data showed that the dose effect was highly significant at 95% and 99% confidence interval. The results of this study could serve as useful information for determining the acceptable concentrations (5-30%) of these herbicides that could be applied to leguminous crops to avoid their adverse effects on nodulation.

Key words: Paraquat • Glyphosate • Atrazine • Effect • Cowpea • Nodulation.

INTRODUCTION

Herbicides are important agrochemicals for the control of weeds on farm lands. There has been increasing use of herbicides in many developing countries because of shortages of workers to hand weed fields as millions of people migrate from rural to urban areas. Again hand weeding has never been a very efficient method of weed control and it is inevitable that herbicide use will increase in some parts of Africa because of the need to increase crop yields.

Herbicides are applied directly to the soil surface and thus their effect on soil biological activity is more profound than that of insecticides. Indiscriminate long-term and over application of pesticides have severe effects on soil ecology that may lead to alterations in or the erosion of beneficial or plant probiotic soil microflora [1]. Again report on herbicides use differs in terms of their effect on nitrogen fixing process. It has been

observed that alachlor, fluzifobutyl and metachlor reduced the yield of soybean and the amount of nitrogen fixed [2].

Among the herbicides recommended for weed control in cowpea, the post-emergence application of paraquat, glyphosate and atrazine is highly practiced in Nigeria and other West African countries. However, the yield of this crop has not improved tremendously with time and farmers often observe yellowing of leaves after prolonged application of these herbicides. This has often been attributed to the infestation of the crop by plant pathogens such as viruses [3] and its cultivation on marginal and sub-marginal lands of low fertility, where little attention is paid to adequate fertilizers [4]. Moreover, the symbiotic nitrogen fixation may not be adequate to satisfy the nitrogen need of developing pods. The aim of the present study was to determine the effect of paraquat, glyphosate and atrazine on nodulation in *Vignae unguiculata* (Cowpea).

MATERIAL AND METHODS

Collection of Seeds: Healthy seeds of *Vigna unguiculata* (Cowpea) were bought from Owerri Main Market in Imo State, Nigeria. The seeds were identified by the crop scientists in the department of Crop Science, Federal University of Technology, Owerri, Nigeria.

Planting of Seeds and Application of Herbicides: A pair of nine sets of plastic bowls of about 5 litres measurement were filled with garden soil. The seeds were planted 3 per bowl to avoid overcrowding and allowed for 22 days under a green house condition offered by the school of Agriculture and Agricultural Technology of the Federal University of Technology, Owerri. These concentrations (100%, 90%, 70%, 50%, 30%, 20%, 10%, 5% and 0% v/v) of paraquat were applied to the crops after 22 days of planting when the seeds had germinated. The procedures were repeated for glyphosate and atrazine.

Determination of Nodules per Seedling: The plants were carefully removed from the soil after five days of the herbicide application and the rhizosphere region was washed in water. The number of nodules per seedling was counted and recorded.

Statistical Analysis: The data obtained were subjected to ANOVA test to determine the significance of the treatment.

RESULTS AND DISCUSSION

The post emergence application of paraquat affected nodulation in *Vigna unguiculata* (Table 1). It was highly significant at 95% and 99% confidence intervals. The average number of nodules recorded at 0% concentration was 59. The low concentrations of 5%, 10% and 20% v/v gave the average number of nodules which ranged from 45 to 46. But high concentrations of 70%, 90% and 100% v/v paraquat gave average of 41 nodules per seedling respectively.

Similar effect on nodulation in *Vigna unguiculata* was observed with the application of various concentrations of glyphosate (Table 2). The average number of nodules recorded at 0%, 5%, 10%, 20% and 30% v/v glyphosate concentrations were 59, 47, 46, 44 and 43 respectively. The 70% and 90% concentrations gave average of 41 nodules while the 100% concentrations gave an average of 40 nodules.

Application of various concentrations of atrazine equally affected nodulation in cowpea (Table 3). The result was highly significant at 95% and 99% confidence intervals. The 100% concentration gave an average of 40 nodules. But low concentrations of 5%, 10%, 20% and 30% v/v gave average number of nodules which ranged from 43 to 47. An average of 59 nodules was recorded at 0% concentration, when no herbicide was applied.

Table 1: Effect of paraquat on nodulation in cowpea

Conc. (v/v)	100%	90%	70%	50%	30%	20%	10%	5%	0%
Seed 1	39	49	40	39	44	49	40	50	64
Seed 2	39	32	42	39	45	40	51	51	43
Seed 3	40	40	34	43	43	42	44	45	52
Seed 4	40	42	47	40	32	43	49	43	56
Seed 5	49	38	44	47	45	44	44	44	69
Seed 6	38	46	41	42	42	46	47	45	69
Mean	41	41	41	41	42	46	46	46	59

Table 2: Effects of glyphosate on nodulation in cowpea

Conc. (v/v)	100%	90%	70%	50%	30%	20%	10%	5%	0%
Seed 1	45	49	38	44	45	40	46	42	59
Seed 2	40	44	37	32	44	41	50	51	69
Seed 3	34	34	37	35	44	48	45	45	50
Seed 4	35	34	49	46	42	35	43	46	58
Seed 5	43	38	43	46	44	55	49	43	57
Seed 6	40	45	42	50	41	46	44	52	59
Mean	40	41	41	42	43	44	46	47	59

Table 3: Effect of atrazine on nodulation in cowpea

Conc (v/v)	100%	90%	70%	50%	30%	20%	10%	5%	0%
Seed 1	44	43	49	48	45	42	46	48	64
Seed 2	38	42	42	43	46	41	49	44	55
Seed 3	33	42	45	36	39	41	44	50	54
Seed 4	46	42	34	42	42	48	49	40	54
Seed 5	42	37	40	48	38	47	49	43	61
Seed 6	35	37	37	35	46	47	38	55	63
Mean	40	41	41	42	43	44	46	47	59

There was a highly significant ($P < 0.01$) added component due to treatment effects in the mean square among groups when the results were subjected to analysis of variance. The post emergence application of different concentrations of paraquat, glyphosate and atrazine has significant effect on nodulation in *Vigna unguiculata* (Cowpea). High concentrations of the herbicides significantly reduce the number of nodules. The results of this study agree with earlier observations that the application of some selected herbicides to soil inhibited nodulation and nitrification in leguminous crops [5]. Scientists have reported a decrease in microbial activity when double quantity of glyphosate was applied to two Romanian soils [6]. On the other hand an increase in soil microbial activity was observed when a low concentration of glyphosate was applied to two Brazilian soils [7]. Low rate of herbicides have been recommended for weed control, in order to ensure effective nodulation and nitrogen fixation [8].

The reduced number of nodules recorded with high herbicide concentrations could be attributed to the inhibitory effects of these pesticides on the symbiotic *Rhizobium*-legume interactions in the soil. The antagonistic effect of agrochemicals on lectin mediated *Rhizobium*- legume interactions have been established in scientific literature. Agrochemicals which include various pesticides (Such as herbicides) and inorganic fertilizers that accumulate due to extensive application to soil, protect the *Rhizobium* recognition site on the root surface of legumes [9]. As a result, the biological nitrogen fixation and consequently the yields of leguminous crops will be reduced due to reduced nodulation. It has been reported that at normal application rates, certain post emergence pesticides have no adverse effect, but significantly inhibited nitrogen fixation in *Rhizobium* at higher concentration [10]. The negative effect of herbicides on other soil microorganisms also has been reported [11-13].

CONCLUSION

The dose effect of paraquat, glyphosate and atrazine on nodulation in *Vigna unguiculata* significantly

manifested in this study. This research work could serve as useful information for determining the acceptable concentrations (5-30%) of these herbicides that could be applied to leguminous crops to avoid their adverse effects on nodulation.

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