EFFECT OF PHOSPHORUS AND NITROGEN FERTILIZATION AND WEED CONTROL METHOD ON WEED INCIDENCE AND MUNGBEAN PRODUCTION

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ABSTRACT

Optimum mungbean yield was obtained when the crop was fertilized with 30 kg P_2O_5/ha. Beyond this level, a reduction in yield occurred. The addition of nitrogen fertilizer at the rate of 30 and 60 kg/ha decreased mungbean yield.

Weed count and weed weights increased with increasing rate of nitrogen fertilization. On the other hand, phosphorus fertilization showed no effect on these parameters.

Handweeding resulted in higher yield, but required more labor. Preemergence application of butralin or butachlor followed by handweeding 21 days after seeding gave yields higher than that obtained with single application of either herbicide, indicating the need for supplementary weeding for better control of weeds. Off-barring followed by hilling-up provided some degree of weed control but did not adequately control weeds.

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KEY WORDS: Mungbean [*Vigna radiata* (L.) Wilzeck]. Phosphorus. Nitrogen. Butachlor. Butralin. Weed incidence.

INTRODUCTION

Mungbean [*Vigna radiata* (L.) Wilzeck] is a legume crop which is widely grown for human food at low and intermediate elevations. It is primarily grown as a rainfed crop frequently following rice, or as a main crop in regions with short rainy season.

Weeds constitute one of the major problems in mungbean production. Yield losses due to weeds in mungbean are relatively high ranging from 77% during the dry season to 90% during the wet

season (Castin et al., 1976). However, the magnitude of yield loss due to weed competition is greatly influenced by fertilizer management (Panwar et al., 1976) and weed control practices.

Among the macroelements, phosphorus can significantly increase mungbean yield (Panwar et al., 1978). On the other hand, nitrogen fertilization has been shown to increase weed infestation in many crops (De Datta et al., 1977 and Madrid, 1973). Herbicides used were either phytotoxic to the crop or have failed to control some predominant weed species (Moody, 1977). On the other hand, handweeding and mechanical weeding are time consuming, laborious, and oftentimes undertaken too late to prevent substantial yield loss.

Based on the above findings, it appears essential that the effects of nitrogen and phosphorus fertilization and of the method of weed control on mungbean production and weed incidence be studied so as to develop suitable integrated weed control schemes in mungbean, hence this study.

MATERIALS AND METHODS

Experimental Design and Field Layout

The experiment was laid out in an area of 3,240 m^2 using a split-split plot arranged in randomized complete block design with three replications. Plot dimension was 3 m wide and 5 m long. The three levels of phosphorus were assigned as the mainplots, the three levels of nitrogen as the subplots, and the eight methods of weed control as the sub-subplots. The treatments were as follows:

Mainplots (Levels of Phosphorus)
- P_1 - No phosphorus fertilization
- P_2 - 30 kg P_2O_5/ha
- P_3 - 60 kg P_2O_5/ha

Subplots (Levels of Nitrogen)
- N_1 - No nitrogen fertilization
- N_2 - 30 kg N/ha
- N_3 - 60 kg N/ha

Sub-subplots (Methods of Weed Control)
- WC_1 - Butralin 1.5 kg a.i./ha
- WC_2 - Butralin 1.5 kg a.i./ha followed by (fb) handweeding 21 days after seeding (DAS)
- WC_3 - Butachlor 1.5 kg a.i./ha
- WC_4 - Butachlor 1.5 kg a.i./ha fb handweeding 21 DAS
- WC_5 - Off-barring 14 DAS fb hilling-up 28 DAS (conventional method)
- WC_6 - Row weeding at 2, 4, and 6 weeks after seeding (WAS)
- WC_7 - Handweeding at 2, 4, 6 and 8 WAS
- WC_8 - Unweeded control

In the fertilizer treatments, the source of phosphorus was superphosphate (20% P_2O_5) while the source of nitrogen was ammonium sulfate (21%N). The actual amount of fertilizer materials applied were

adjusted based on the result of initial soil analysis. Half of the amount of N was applied together with all of P at planting. The remaining half of N was sidedressed 30 days after seeding.

Two herbicides applied alone or followed by handweeding 21 DAS together with the conventional method (off-barring fb hilling-up) and row weeding were used for weed control. The handweeded and unweeded control were maintained for comparison. Butralin [4 (1,1-dimethylethyl)-N-(1-methylpropyl) 2,6-dinitrobenzenamine] and butachlor [N - (butoxymethyl) 2-chloro-2',6'— diethyl acetanilide] were applied at preemergence of both crops and weeds at the rate of 1.5 kg a.i./ha. The herbicides were applied using a knapsack sprayer that delivered 234 liters of spray solution per hectare.

Planting

Clean mungbean (var. CES ID-1) seeds were used in this study. The inoculated seeds were drilled in furrows and covered with 2-3 cm layer of soil. A population of 10 plants per linear meter was maintained to achieve the desired population of 400,000 plants per hectare.

RESULTS AND DISCUSSION

Leaf Area Index (LAI)

Nitrogen fertilization and method of weed control significantly influenced LAI at early podding stage while phosphorus fertilization did not produce a differential response on said parameter (Table 1).

The application of nitrogen fertilizer significantly decreased LAI values. Apparently, the rates of nitrogen fertilizer used were excessive for mungbean thereby adversely affecting its growth and development. Abundant supply of nitrogen can only stimulate plant growth if there is sufficient supply of growth hormone(s), carbohydrates, water and other elements, and if the environmental condition is suitable for rapid growth. It is possible that one of the above factors was limiting, thereby affecting mungbean response and consequently hindering leaf area development.

Higher LAI values were obtained in the handweeded plot and in those treated with butralin and butachlor followed by handweeding 21 days after seeding (DAS). Plants subjected to all other weed control treatments gave lower LAI with the unweeded plants having the lowest. Higher LAI values in plots with adequate weed control can be attributed to less crop-weed competition for growth factors, thus providing more favorable growing conditions and rendering mungbean more competitive against weed regrowths and late emerging weeds. This result agrees with that of Enyi (1973) wherein reduction in LAI due to weed competition was observed.

Effective Nodule Count

The effective nodules from the lateral and tap roots were counted at

Table 1. Leaf area index (LAI) and number of effective nodules per plant of mungbean as affected by phosphorus and nitrogen fertilization and methods of weed control.

Treatment	LAI	Nodule Count (No./Plant)
Level of Phosphorus ($kg\ P_2O_5$/ha)		
No phosphorus fertilization	1.58	28.54 b
30	1.58	30.26 a
60	1.60	25.92 c
Level of Nitrogen (kg N/ha)		
No nitrogen fertilization	1.62 a	30.43 a
30	1.59 b	28.24 b
60	1.55 b	26.15 c
Method of Weed Control		
Butralin 1.5 kg a.i./ha	1.51 d	28.48 c
Butralin 1.5 kg a.i./ha fb HW 21 DAS	1.83 ab	32.11 b
Butachlor 1.5 kg a.i./ha	1.49 d	28.78 c
Butachlor 1.5 kg a.i./ha fb HW 21 DAS	1.89 ab	31.89 b
Off-barring 14 DAS fb hilling-up 28 DAS	1.60 c	26.48 d
Row weeding at 2, 4 and 6 WAS	1.54 d	26.81 d
Handweeding at 2, 4, 6 and 8 WAS	2.01 a	34.37 a
Unweeded control	0.93 e	17.26 e
C. V. (%) a	6.17	8.09
b	8.50	7.01
c	5.89	9.43

Means within each column (levels of phosphorus and nitrogen and methods of weed control considered separately) followed by a common letter are not significantly different at 5% level, DMRT.

early podding stage. The effective nodules were those that showed a reddish tinge when dissected and this was considered indicative of active nitrogen fixation (Iswaran, 1974).

Mungbean plants fertilized with 30 kg P_2O_5/ha produced more effective nodules than the unfertilized plants and those applied with 60 kg P_2O_5/ha (Table 1). It appears that 30 kg P_2O_5/ha is the optimum rate of phosphorus fertilization for nodule formation in this experiment. The good number of effective nodules formed in plots without added phosphorus fertilizer could be due to the presence of sufficient amounts of native phosphorus in the soil (21 kg available P/ha). The application of 60 kg P_2O_5/ha appeared excessive for the plants resulting in formation of few nodules. High level of phosphorus fertilization was reported to be deleterious to nodule formation (Pandey, 1979) and to lead to phosphorus toxicity and zinc deficiency which would consequently affect nodule formation (Sinha, 1977).

Nodule formation significantly declined with increasing rate of nitrogen fertilization. Low nodule formation in nitrogen fertilized plots could be attributed to narrow C/N ratio which is usually observed with nitrogen fertilization. A narrow C/N ratio inhibits infection of root hairs which precludes the entry of bacteria and thus, leads to non-formation of nodules. Moreover, nitrogen fertilization could enhance vegetative growth which would lead to greater uptake of copper and other micronutrients essential to both the crop and *Rhizobium* (Sinha, 1977). This could result in deficiency of micronutrients for *Rhizobium* and consequently suppress nodulation or render the nodules ineffective for nitrogen fixation.

Significantly more effective nodules were observed in the handweeded plot. This was followed by plots treated with butralin or butachlor with supplementary handweeding at 21 DAS. The rest of the treatments produced fewer nodules with the least number of nodules produced in unweeded plots. Enhanced nodule formation in plots with adequate weed control could be attributed to less crop-weed competition. This condition favored mungbean growth and development. Since efficient symbiosis normally depends on the healthy growth and metabolism of the host plants, more nodules were thus formed.

Yield and Yield Components of Mungbean

The number of pods/plant, number of grains/pod, and seed weight were not affected by phosphorus and nitrogen fertilization, but were significantly influenced by the method of weed control used (Table 2).

Mungbean plants in handweeded plots and in plots treated with butralin or butachlor supplemented with handweeding at 21 DAS produced more pods/plant, grains/pod, and heavier grains than those in the other weed control treatments. Higher values obtained in plots with adequate weed control suggest that weed control is essential in mungbean production in order to

Table 2. Yield and yield components of mungbean as affected by phosphorus and nitrogen fertilization and methods of weed control.

Treatment	No. of Pods/ Plant	No. of Grains /Pod	Seed Weight (g/500 seeds)	Grain Yield (kg/ha)
Level of Phosphorus (kg P_2O_5/ha)				
No phosphorus fertilization	12.09	11.89	22.29	546 c
30	12.61	11.45	23.23	633 a
60	12.55	11.58	22.37	621 b
Level of Nitrogen (kg N/ha)				
No nitrogen fertilization	12.27	11.42	23.42	628 a
30	12.60	11.45	22.92	614 b
60	12.37	11.44	22.72	552 c
Method of Weed Control				
Butralin 1.5 kg a.i./ha	12.79 c	11.79 c	22.74 b	548 c
Butralin 1.5 kg a.i./ha fb HW 21 DAS	13.54 b	12.37 b	23.40 ab	876 b
Butachlor 1.5 kg a.i./ha	11.99 d	11.38 d	21.69 c	527 c
Butachlor 1.5 kg a.i./ha fb HW 21 DAS	13.53 b	12.53 b	23.81 a	771 b
Off-barring 14 DAS fb hilling-up 28 DAS	13.13 b	11.30 d	23.04 ab	493 d
Row weeding at 2, 4 and 6 WAS	12.25 d	11.46 d	22.60 b	477 e
Handweeding at 2, 4, 6 and 8 WAS	14.14 a	12.99 a	23.83 a	940 a
Unweeded control	8.65 e	7.99 c	22.29 c	171 f
C. V. (%) a	4.15	4.63	6.42	4.97
b	5.20	4.10	7.53	3.85
c	4.51	3.90	8.39	4.85

Means within each column (levels of phosphorus and nitrogen and methods of weed control considered separately) followed by a common letter are not significantly different at 5% level, DMRT.

eliminate the adverse effect of crop-weed competition on mungbean growth and yield.

Grain Yield

The grain yield of mungbean was significantly influenced by phos-

phorus and nitrogen fertilization and method of weed control (Table 2). Higher yield was obtained when plants were fertilized with 30 kg P_2O_5/ha. This rate appeared optimum for mungbean production in this experiment. Beyond this level, a significant reduction in grain yield occurred.

Lower grain yield was obtained in plots fertilized with 60 kg P_2O_5/ha but the lowest yield was noted in unfertilized plots. In the unfertilized plots, the amount of phosphorus was probably insufficient to satisfy the requirements of mungbean. On the other hand, fertilizing mungbean with 60 kg P_2O_5/ha appeared excessive. As mentioned earlier, excessive phosphorus fertilization could result in phosphorus toxicity and zinc deficiency and could have deleterious effects on nodule formation and nitrogen fixation such that yield reduction could occur.

Nitrogen fertilization had a different effect on mungbean yield. Higher grain yield was obtained in unfertilized plots than in the nitrogen fertilized ones. The lowest grain yield was noted at the highest level of nitrogen fertilization. Lower yield in fertilized plots could be due to the detrimental effect of nitrogen fertilizer on nodulation and nitrogen fixation which could have adversely affected the growth, development and yield of mungbean plants.

Among the methods of weed control used, handweeding gave higher yields but required more labor. Butralin or butachlor with supplemental weeding at 21 DAS gave higher yields than the unsupplemented application of either herbicide. Off-barring and hilling-up provided some degree of weed control. However, these operations did not adequately control weeds and might have injured the roots of the crop, thus resulting in lower grain yield.

Weed Density and Weed Weight

The effectiveness of the different methods of weed control and of phosphorus and nitrogen fertilization on weed incidence was assessed using weed count and dry weed weight (Table 3). Among the methods of weed control used, handweeding at 2, 4, 6, and 8 WAS was the most effective in controlling weeds as indicated by lowest weed count and weed weights. However, this method is laborious and time consuming. Butralin or butachlor followed by handweeding at 21 DAS provided better control of weeds than the unsupplemented application of either herbicide. This indicates the need for supplementary weeding for better control of weeds. Off-barring followed by hilling-up did not provide adequate weed control, hence the growth of more weeds. More weeds and higher weed weights were observed in all other treatments.

Fertilizer management is considered an equally important factor influencing weed population. Application of fertilizer may suppress non-responsive weed species but may contrarily favor the build-up of

Table 3. Weed density and dry weed weight as affected by phosphorus and nitrogen fertilization and methods of weed control.

Treatment	Weed Count At Harvest (no./m^2)	Weed Weight At Harvest (g/m^2)
Level of Phosphorus (kg P_2O_5/ha)		
No phosphorus fertilization	25.18	254.46
30	26.18	270.10
60	27.53	266.51
Level of Nitrogen (kg N/ha)		
No nitrogen fertilization	24.93 c	253.75 c
30	26.26 b	263.50 b
60	28.43 a	274.23 a
Method of Weed Control		
Butralin 1.5 kg a.i./ha	21.55 d	247.67 e
Butralin 1.5 kg a.i./ha fb HW 21 DAS	17.55 e	145.03 g
Butachlor 1.5 kg a.i./ha	22.48 d	269.89 d
Butachlor 1.5 kg a.i./ha fb HW 21 DAS	17.56 e	167.84 f
Off-barring 14 DAS fb hilling-up 28 DAS	31.15 c	291.33 c
Row weeding at 2, 4 and 6 WAS	33.96 b	311.90 b
Handweeding at 2, 4, 6 and 8 WAS	4.78 f	11.34 h
Unweeded control	63.29 a	655.67 a
C.V. (%) a	9.11	10.28
b	8.50	11.51
c	8.78	9.35

Means within each column (levels of phosphorus and nitrogen and methods of weed control considered separately) followed by a common letter are not significantly different at 5% level, DMRT.

those which positively respond to added nutrients. Phosphorus showed no relative influence on weed population and dry weed weight. On the other hand, these weed parameters increased with increasing rates of nitrogen (Table 3). The addition of nitrogen increased weed

infestation because weeds appeared to be responsive to nitrogen fertilization. Mercado (1976) reported that *Echinochloa crusgalli* L. predominated in the field because it was responsive to nitrogen fertilization. Similarly, Bantilan et al. (1974) provided evidence on the increased dry weight of weeds in soil containing relatively high nitrogen.

Rottboellia exaltata L. f., *Commelina benghalensis* L., and *Cyperus rotundus* L. were the most common weed species in the experimental area with *R. exaltata* as the most predominant. The predominance of *R. exaltata* in the experimental area could be due to weed seed reserve in

Table 4. Common weed species present in the experimental area, Central Experiment Station (CES), UP at Los Baños.

Weed Group	Scientific Name [1]	Common Name
Grasses	*Rottboellia exaltata* L.f.	Itchgrass
	Echinochloa colona (L.) Link	Jungle rice
	Digitaria sanguinalis (L.) Scop.	Large crabgrass
	Eleusine indica (L.) Gaertn.	Goosegrass
Broadleaves	*Commelina benghalensis* L.	Day flower
	Cleome rutidosperma L.	Spider flower
	Amaranthus spinosus L.	Spiny amaranth
	Ipomoea triloba L.	3-lobe morning glory
	Euphorbia hirta L.	Garden spurge
Sedges	*Cyperus rotundus* L.	Purple nutsedge
	Cyperus iria L.	Rice flatsedge

[1] Ranking per weed group is according to predominance in decreasing order.

the soil from the previous cropping. Other weed species which appeared to be of minor importance are shown in Table 4.

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