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Weed and Nutrient Management Strategies for Enhancing Productivity and Soil Fertility in Kharif Sown

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Abstract

An experiment was conducted during *kharif* 2024 at GBPUA&T Pantnagar. To study the effect of weed and nutrient management on yield, yield attributes and quality of *kharif* sown mungbean (*Vigna radiata*) in the tara*i* region of Uttarakhand. To evaluate the effect of weed and nutrient management practices on yield, yield attributes, nutrient uptake, soil fertility, microbial population, and quality of kharif-sown mungbean. The study also aimed to identify suitable integrated weed and nutrient management practices to enhance productivity and maintain soil health under tarai conditions. The experiment was laid out in Factorial - Randomized Block Design (FRBD) keeping weed management practices, viz. W_1: Weedy check W_2: Two hand weedings, 20 and 40 DAS W_3: Fomesafen (11.1%) + fluazifop -p-butyl (11.1%) SL @ 220 g a.i./ha, 18 DAS (Ready mix) and W_4: Propaquizafop (2.5%) + imazethapyr (3.75%) ME @ 125 g a.i./ha, 18 DAS (Ready mix) and nutrient management practices, viz. F_1: 100 % RDF (18 kg N ,48 kg P_2O_5, 24 kg K_2O**)** F_2: 75% RDF + seed inoculation with NPKZn microbial consortia @ 20 g/kg seed and F_3: 75% RDF + soil application of 100 kg/ha FYM fortified with NPKZn microbial consortia @ 2 kg/ha with three replications. Significantly higher yield attributes and grain yield (1179 kg/ha), NPK uptake, OC (%), NPK & microbial population (cfu/g soil) were found under W_2 treatment than others, Similarly, application of F_1 was noticed higher yield attributes and grain yield (1069) kg/ha), NPK uptake and NPK content in soil. In which more OC (%) & microbial population (cfu/g soil) was observed in F_3.

Clinical trial registration

Not applicable. This study was an agricultural field experiment and was not a clinical trial.

Introduction

Mungbean, one of Asia's most important pulse crops due to dual use in food and medicine purpose. China is cultivated more than two thousand years. Mungbean gown in almost all the state of India however, Rajasthan is leading contributor to mungbean cultivation is about 46% area and 45% production (**Choudhary *et al.,* 2025)**. Mungbean are contain 2-3 times more protein (20-25%) than cereals **(Jing *et al*., 2025)**. Mungbean is a warm - season legume crop which enriched proteins, vitamins and minerals. But it grown all the three major agriculture seasons like *kharif*, *rabi* and *summer*. It is also known as golden gram or green gram (**Mekonnen *et al.,* 2024).** The mungbean crop is increasingly adopted by the farmers because of short duration which fit for any cropping system. It helps in reducing soil erosion, hard pan in soil and enhancing soil fertility through atmospheric N fixation by symbiotic micro-organism. The potential yield of mungbean is also challenged by many biotic and abiotic stress such as weed infestation. Weed management is an important factor for enhancing productivity of mungbean. Weed compete with sun light, space, nutrient and water with crop plant during early crop growth stages. In India, presence of weeds causes losses in yield 31.5%, 22.7% and 36.5% in winter, summer and *kharif* seasons in some cases can causes extermination of crop **(Kumar *et al.,* 2024).** Chemical weed control provides weed free environment in early crop growth stages (20-40 DAS) which good alternative

option for manual weeding. Due to timelines, low cost, successive weed controlling **(Butter *et al*., 2008)**. Balanced fertilization and effective weed management practices may help in realizing higher grain yield of mungbean (**Hasanain *et al.,* 2020).** The accomplished amount of nutrient content in FYM is not prepared available to the plant. It has been applied and these depend upon the rate of mineralization. Therefore, use of both Integration of organic (FYM, Vermicompost and biofertilizer) and inorganic sources (Urea, DAP and NPK mixture etc.) of nutrient has been promising not only increase yield of crop but also for providing substantiality in crop production besides, improving physical, biological and chemical property of soil. They supply all the macro and micronutrient in available form of the plant through mineralization of organic materials **(Chauhan *et al.,* 2024).** Biofertilizer play and important role in increasing nitrogen, Phosphorus and potassium. Inoculation of seed with biofertilizer is low-cost method for enhanced soil quality and availability of nutrient in soil **(Sartaj *et al*., 2025).** Against this background, the present investigation was undertaken to evaluate the effect of different weed and nutrient management practices on yield, yield attributes, nutrient uptake, soil fertility, microbial population, and quality of kharif-sown mungbean (*Vigna radiata* L.) under tarai conditions. The specific objectives of the study were: (i) to assess the effectiveness of different weed management practices on growth and productivity of mungbean; (ii) to evaluate the influence of integrated nutrient management approaches on nutrient uptake, soil health, and microbial activity; and (iii) to identify the most suitable combination of weed and nutrient management practices for improving productivity and quality of mungbean under tarai agro-ecosystems.

Material and methods

The field experiment was conducted during *kharif* 2024 in D-6 Pulse Agronomy Block of N. E. Borlaug Crop Research Centre at G.B Pant University of Agriculture and Technology, Pantnagar, Uttarakhand. The soil of experiment was silty clay loam having medium organic carbon (0.68%), low available nitrogen (196 kg/ha) and medium available phosphorus (12.4 kg/ha) and potassium (153.6 kg/ha) having near neutral pH (7.2). The experiment was conducted in Factorial – Randomized Block Design (FRBD) with 3 Replication. The experiment was comprised of 4 level of weed management W_1: Weedy check W_2: Two hand weedings, 20 and 40 DAS W_3: Fomesafen (11.1%) + fluazifop -p-butyl (11.1%) SL @ 220 g a.i./ha, 18 DAS (Ready mix) and W_4: Propaquizafop (2.5%) + imazethapyr (3.75%) ME @ 125 g a.i./ha, 18 DAS (Ready mix) and 3 level of nutrient management practices F_1: 100% RDF (18 kg N ,48 kg P_2O_5, 24 kg K_2O**)** F_2: 75% RDF + seed inoculation with NPKZn microbial consortia @ 20 g/kg seed and F_3: 75% RDF + soil application of 100 kg/ha FYM fortified with NPKZn microbial consortia @ 2 kg/ha. NPK mixture of 12:32:16 grade @ 150 kg/ha was applied as basal at the time of sowing. Pant mung-9 @ 15 kg seed /ha was used for sowing and furrows was opened manually at a distance of 30 cm apart with the help of furrow opener to a depth of 5–7 cm. Hand weeding operation as per treatment, was carried out using *khurpi* at 20 and 40 DAS and foliar spray of herbicide as per treatment was carried out using knapsack sprayer at 18 DAS. Yield attributes, yield, NPK uptake by crop plants, OC (%), NPK and microbial population (cfu/g soil) content in soil were recorded during the year of experiment and expressed in

standard units. The grain yield from each net plot it was recorded in kilogram and then convert in kg/ha by multiplying with conversion factor based on net plot size.

Result and Discussions

Weed flora

The major weed species (weed flora) was recorded in weedy check plot was *Cyperus rotundus, Cyperus irria, Cynodon dactylon, Echinochloa colona, Dectyloctenium aegyptium, Digera arvensis* and *Celosia argentea.* The major monocot/sedge viz. *Cyperus rotundus (*61.3/$m^{2)}$ were found in weedy check plot at 30 DAS. While dominant dicot weed *Celosia argentea (*20.4/m^2) at 30 DAS of crop. However relative density of weed was observed higher in *Celosia argentea* (57.5%), *Cyperus rotundus* (11.2%), *Echinochloa colona* (9.9%) followed by Other (21.4%).

Weed control efficiency

highest weed control (WCE%) was observed in W_2 (87.6%) **(Poonam et al**., **2022)** followed by application of W_3 (56%) treatment. The lowest weed control efficiency (29.9%) which was recorded in W_4 similar, results was also reported by (**Mishra et al.**, **2024**) at 60 DAS on dry weight basis.

Data pertaining to yield attributing characters and yield of mungbean has been given in Table 1. The result revealed that the maximum pods/plant (24.4), grains/pod (9.4), 1000 grains weight (24.62 g), biological yield (5432 kg/ha), grain yield (1179 kg/ha) and straw yield (4253 kg/ha) were recorded with W_2 similar result was given by **(Kaur et al**., **2010, Das et al**., **2025)**. With respect of biological yield (kg/ha) and grain yield (kg/ha) followed by was W_3. The lowest grain yield was obtained in W_1 due to severe crop-weed competition faced by crop. Similarly, reported by **Bhandari et al.**, **2004, Rukinderpreet et al**., **2019).** Other yield attributing character and yield like number of pods/plant (24.4), grains/pod (9.4), 1000 grains weight (24.62 g), biological yield (5432 kg/ha), grain yield (1179 kg/ha) and straw yield (4253 kg/ha) were found significant except harvest index (%) with respect to different weed management practices **(Shown** Fig. 1&2**)**. The yield increased due to increased number of pods/plants, grains/pod, 1000 grains weight. Similarly, reported by **Yadav et al.**, **(2022)** that application of W_3 significantly higher yield attributes and yield.

Table 1
Influence of weed and nutrient management practices on yield attributes of mungbean

Treatment	Pods/ plant	Grains/ pod	1000 grains weight (g)	Biological yield (kg/ha)	Grain yield (kg/ha)	Straw yield (kg/ha)	Harvest index (%)
Weed Management							
W_1	17.6	7.8	22.80	2392	540	1852	22.8
W_2	24.4	9.4	24.62	5432	1179	4253	21.8
W_3	22.3	8.9	24.47	4568	1006	3561	22.1
W_4	21.4	8.7	23.21	4105	887	3218	21.6
SEm ±	0.5	0.2	0.53	141	27	137	1.0
C.D at 5%	1.4	0.5	1.56	416	79	406	NS
Nutrient Management							
F_1	22.7	9.1	23.85	4653	1069	3584	22.9
F_2	19.8	8.1	22.37	3565	760	2805	21.6
F_3	21.9	8.9	23.59	4155	880	3275	21.9
SEm ±	0.4	0.2	0.46	122	23	119	0.9
C.D at 5%	1.2	0.5	NS	360	69	351	NS
CV(%)	6.7	6.5	6.8	10.2	9.0	13.0	6.3

Among the nutrient management practices, significantly higher pods/plant (22.7), grains/pod (9.1), 1000 grains weight (23.85 g), biological yield (4653 kg/ha) and grain yield (1069 kg/ha) were recorded with application of F_1. 1000 grain weight (g) and harvest index was did not influenced by different nutrient management practices. In case of pods/plant (22.7), grains/pod (9.1), and straw yield (3584 kg/ha) F_1 was at par with F_3. Integrated application of fertilizer with biofertilizer may be attributed to the activation of metabolic process, faster cell division, cell elongation, enhanced assimilation rates and enhanced nitrogen activity, in plant which is turn positively effect on growth and yield attributes similar result was given by (**Barakzai**, **et al**., **2020).**

Data pertaining to NPK uptake by grain, straw and total have been given in Table 2. The weed and nutrient management practices significantly influenced the NPK uptake by grain: straw and total uptake. Among the weed management practices, W_2 was recorded significantly higher in gran: straw ant total

NPK uptake by plant. N content and uptake is increasing due beneficial effect of weed management practices, which improve nutrient availability to the plant. P content and uptake is increasing due application of weed management practices increase root growth, phosphorus absorbing mechanism result more P uptake. Uptake of K is increasing due weed free environment get more dry matter accumulation and yield ultimately result more content and uptake of K. Similar result are showed by **(Kumar et al**., **2024)**. Followed by W_3 which was at par with W_4 in case of P uptake by straw, in which K uptake by straw and total uptake was at par with W_4. Among the nutrient management practices, F_1 was observed significantly higher grain: straw ant total NPK uptake, F_1 which was at par with F_3 in respect of NPK uptake by straw.

Table 3
NPK uptake by plant was influenced by different weed and nutrient management practices.

Treatment	**N uptake (kg/ha)**			**P uptake (kg/ha)**			**K uptake (kg/ha)**		
Weed management	**Grain**	**Straw**	**Total**	**Grain**	**Straw**	**Total**	**Grain**	**Straw**	**Total**
W_1	15.3	21.0	36.3	2.9	3.3	6.2	3.7	20.8	24.5
W_2	33.6	49.6	83.2	6.5	7.2	13.7	8.6	51.2	59.8
W_3	30.2	41.4	71.6	5.4	6.6	12.0	7.2	40.7	47.9
W_4	24.8	37.6	62.4	4.8	5.6	10.4	6.3	36.3	42.6
SEm ±	1.0	1.8	1.8	0.2	0.4	0.4	0.2	1.8	1.8
C.D at 5%	3.0	5.3	5.3	0.5	1.0	1.3	0.7	5.3	5.3
Nutrient management									
F_1	31.6	41.1	72.7	5.8	6.5	12.3	7.7	41.2	48.9
F_2	21.7	33.0	54.7	4.0	4.9	8.9	5.4	32.6	38.0
F_3	24.6	37.5	62.1	4.9	5.7	10.6	6.3	37.9	44.2
SEm ±	0.9	1.6	1.6	0.1	0.3	0.4	0.2	1.6	1.5
C.D at 5%	2.6	4.6	4.6	0.4	0.9	1.1	0.6	4.6	4.6

Data pertaining to OC (%), NPK and microbial population in soil have been given in Table 3. Among the weed management practices significantly influenced OC (%), NPK and microbial population (cfu/g soil**)**, while nutrient management practices influenced only OC (%), N and microbial population (cfu/g soil).

Table 3
Effect of weed and nutrient management on OC (%), NPK and microbial (cfu/g soil) on soils.

Treatment	**Soil parameters**				**Microbial population (cfu/g soil)**		
Weed management	**OC%**	**N**	**P**	**K**	**Bacteria ($10^{\wedge 6}$)**	**Fungi ($10^{\wedge 4}$)**	**Actinomycetes ($10^{\wedge 5}$)**
W_1	0.60	143	14.4	142.6	15.5	12.0	12.3
W_2	0.74	245	17.6	158.9	23.0	14.3	26.0
W_3	0.65	208	16.8	156.7	18.3	12.2	23.6
W_4	0.62	187	15.7	154.5	15.7	12.0	21.7
SEm ±	0.01	4.2	0.65	3.78	0.6	0.5	0.5
C.D at 5%	0.04	12.4	1.93	11.14	1.7	1.5	1.5
Nutrient management							
F_1	0.53	236	16.5	157.6	16.9	10.5	19.7
F_2	0.66	147	15.7	151.1	18.7	12.4	20.5
F_3	0.76	205	16.3	151.2	18.8	15.0	22.5
SEm ±	0.01	3.6	0.56	3.27	0.5	0.5	0.4
C.D at 5%	0.04	10.7	NS	NS	1.5	1.3	1.3

Among the weed management practices maximum OC (%), NPK and microbial population (cfu/g soil) was observed in W_2 in which, W_2 was statically at par with W_3 in respect of P & K content in soil. The lowest OC (%), NPK and microbial population (cfu/g soil) was observed in W_1. W_1 was at par with W_4 in case of fungi population. Herbicide application suppresses the weed without adversity affect growth of bacteria, fungi and actinomycetes affecting various soil microbial process such as nitrogen fixation and organic matter decomposition similar result was reported by **(Kade et al**., **2014).** Among the nutrient management practices maximum OC (%) and microbial population (cfu/g soil) was recorded in F_3. Application of farmyard manure (FYM) improve nutrient availability (Macro and micro) **(Patel et al**., **2019)** and nutrient uptake by plant through enhanced soil fertility. The increase nutrient uptake might be attributed to improved soil structure, microbial population, microbial activity and better nutrient release from FYM similar result was showed by **(Giri et al**., **2022).**

Conclusion

Two hand weedings, 20 and 40 DAS (W_2) along with 100% RDF (F_1) proved most effective for maximizing yield, yield attributes and NPK uptake, while 75% RDF + soil application of 100 kg/ha FYM fortified with NPKZn microbial consortia @ 2 kg/ha (F_3) enhanced soil microbial population. Thus, W_2 + F_1 ensure higher productivity, whereas F_3 improves long-term soil health.

Declarations

Source of research: The study formed part of the M.Sc. thesis research work entitled **"Weed and Nutrient Management Strategies for Enhancing Productivity and Soil Fertility in Kharif-Sown Mungbean"**, Department of Agronomy, College of Agriculture, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand-263145, India.

Conflict of interest

The authors declare no competing interests.

Ethics approval

Not applicable.

Consent to participate

Not applicable.

Consent for publication

Not applicable.

Ethics, Consent to Participate, and Consent to Publish declarations

not applicable.

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Author Contribution

Sumit: Conceptualization, methodology, investigation, data collection, data analysis, and manuscript preparation.Sumit Gaur: Conceptualization, methodology, investigation, data collection, data analysis, visualization, and writing—original draft preparation.Anchal Kumari: Investigation, data collection, field experimentation, and data curation.Sambita Bhattacharyya: Investigation, data collection, data analysis, and manuscript review.Vijai Kumar Singh (Corresponding Author): Conceptualization, supervision, methodology, project administration, interpretation of results, manuscript review and editing, and overall supervision of the research.Paras Arya: Investigation, field experimentation, data collection, and manuscript review.Anoop Kumar Maurya: Data analysis, interpretation, and manuscript review.Utkarsh Singh: Data collection, investigation, and manuscript review.All authors: Read and approved the final manuscript and agreed to its submission for publication

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Figures

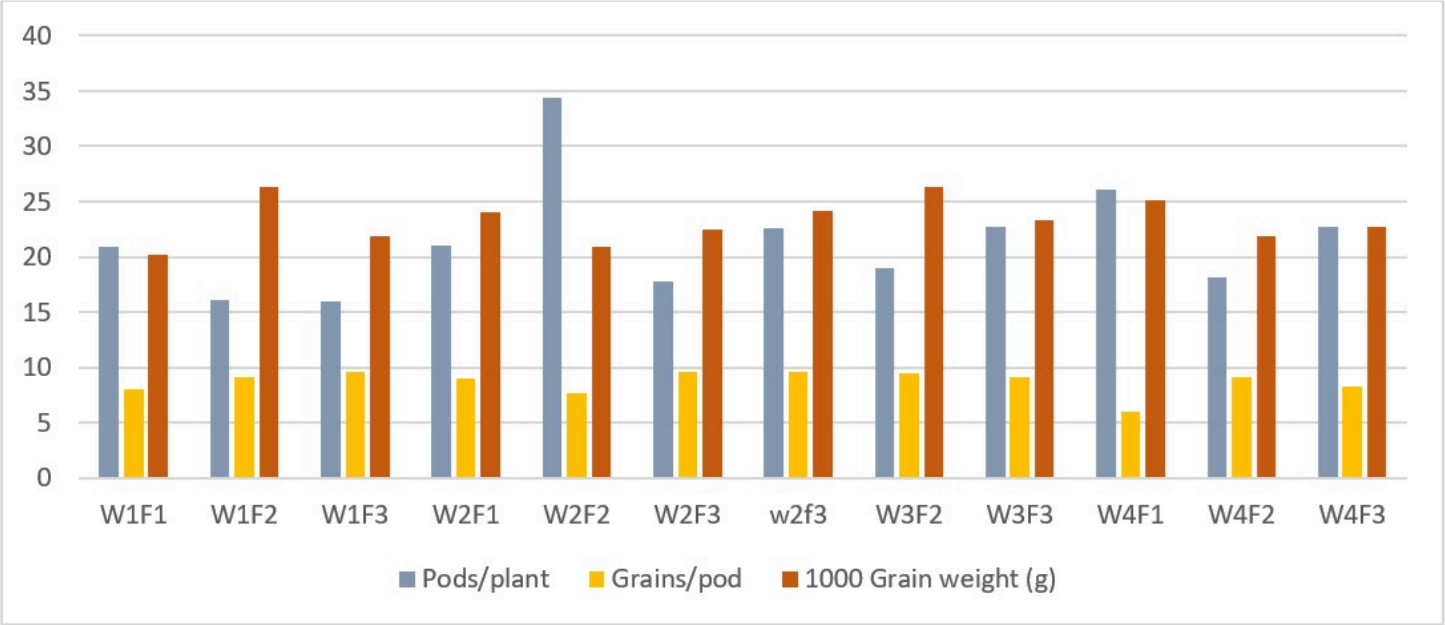


Figure 1

Effect of weed and nutrient management on pods/plant, grains/pod and 1000 grain weight (g)

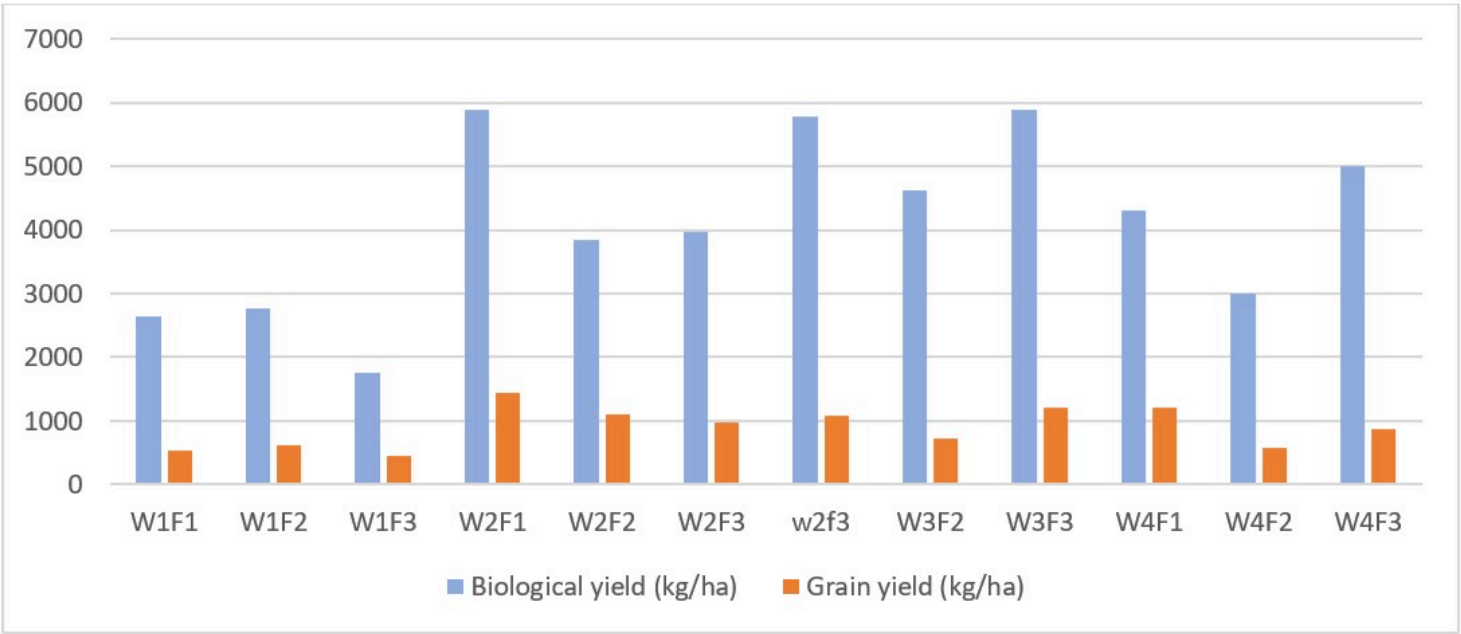


Figure 2

Effect of weed and nutrient management on biological yield (kg/ha) and grain yield (kg/ha)