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RESEARCH ARTICLE

Integrated nutrient and weed management effect on greengram under new alluvial zone of West Bengal

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ABSTRACT

Field experiment was undertaken during summer season of 2020 and 2021 to evaluate the effect of various different nutrient and weed management options for higher productivity of greengram under new alluvial zone of West Bengal. The experiment was laid out in a split plot design with three replications and 28 treatment combinations. The treatments comprised with four main plot treatment, which includes nutrient management, *viz.* 100% RD_{NPK}, 100% RD_{PK} +75% RD_N + 25% N (vermicompost), 100% RD_{PK} +75% RD_N + 25% N (FYM), and 75 % RD_{NPK} + *Rhizobium* + PSB and seven weed control measures, *viz.* pendimethalin 1.25 kg/ha *fb* one hand weeding 25 DAS, pendimethalin 1.25 kg/ha *fb* hoeing at 25 DAS, pendimethalin 1.25 kg/ha *fb* imazethapyr 100 g/ha, pendimethalin 1.25 kg/ha *fb* quizalofop-ethyl 50 g/ha, pendimethalin 1.25 kg/ha *fb f*enoxaprop-p-ethyl 100 g/ha, weed check and weed free. Dry weight of weeds at 60 DAS lower observed with the 100% RD_{PK} + 75% RD_N + 25% N through vermicompost and was statistically better to other treatments. Whereas, it was lowest under pendimethalin 1.25 kg/ha *fb* quizalofop-ethyl 50 g/ha and was at par with pendimethalin 1.25 kg/ha *fb* imazethapyr 100 g/ha and pendimethalin 1.25 kg/ha *fb* one hand weeding 25 DAS and significantly superior to other integrated treatments. More seed yields was found with 100% RD_{PK} +75% RD_N + 25% N (vermicompost) and was at par with all other main plot treatments except 100% RD_{PK} +75% RD_N + 25% N (FYM). Highest stover production was observed with 100% RD_{NPK} which was at par with 100% RD_{PK} +75% RD_N + 25% N (vermicompost). Per cent increase in seed yield in main plot due to treatment, 100% RD_{PK} +75% RD_N + 25% N (vermicompost), 100% RD_{NPK} and 75% RD_{NPK} + *Rhizobium* + PSB was 52.48, 47.03 and 44.09 %, respectively compared to 100% RD_{PK} +75% RD_N + 25% N (FYM). The corresponding increase in straw yield under these treatments were 74.91, 79.01 and 48.11% as against the lowest recorded in 100% RD_{PK} +75% RD_N + 25% N (FYM). More seed and straw yield of greengram was recorded in weed free treatment followed by pre- and post-emergence application of pendimethalin 1.25 kg/ha *fb* imazethapyr 100 g/ha. Data revealed per cent increase in seed yield due to weed free and pendimethalin 1.25 kg/ha *fb* imazethapyr 100 g/ha, which was 158.1 and 139.35%, respectively compared to weedy check. More return (₹ 50,052) and B:C ratio (2.27) was observed with 100% RD_{PK} +75% RD_N + 25% N (vermicompost) closely followed by 75 % RD_{NPK} + *Rhizobium* + PSB and 100% RD_{NPK}. With weed control measures, more return (₹ 46,584) and B: C ratio (2.23) was observed with pendimethalin 1.25 kg/ha *fb* imazethapyr 100 g/ha, pendimethalin 1.25 kg/ha and quizalofop-ethyl 50 g/ha.

Keywords: Greengram, Nutrient management, Weed control, Yield and economics

INTRODUCTION

Among the pulses, greengram (*Vigna radiata* L.) is one of the most important and extensively cultivated crops in India, which, is cultivated in arid and semi-arid region. Greengram is locally known as "moong". It contains about 25% protein, 1.3% fat, 3.5% mineral, 4.1% fiber and 56.7% carbohydrate. Despite the significance of this crop in our daily diet, the average productivity of this crop remains notably low in India. It thrives in locations with low and unpredictable rainfall, light textured soils with limited water holding capacity, and is also drought-resistant. With a short duration for growth, it adapts effectively to various multiple and intercropping systems. It is cultivated over an area of approximately 4.5 million hectares having a production of 2.64 million tons, with a productivity rate of 555 kg/ha (Anonymous, 2020-21). The primary reason for the crop's low production is attributed to inadequate nutrient supply and competition with weeds (Mukherjee 2022). Despite its wide adaptation in India, the crop faces a challenge of significantly low productivity, exacerbated by the intensive use of agrochemicals during the green revolution, negatively impacting soil health. To address this issue, there is substantial potential for growers to adopt an integrated nutrient management (INM) approach, emphasizing the use of organic amendments as an alternative or supplement to agrochemicals (Meena 2015). Noteworthy progress has been made in recent years,

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particularly in utilizing vermicompost and implementing seed inoculation with *Rhizobium* and PSB for INM. Furthermore, effective weed control measures are crucial for enhancing productivity, as weeds compete for essential resources during the early growth period. In addition to reducing crop yield by up to 70%, weeds increase production costs, harbor insect pests and diseases, degrade the quality of farm produce, and diminish land value. Weeds are resilient, easily spreading due to their prolific seed production, and once established, they are challenging to eradicate. Aligning with the type of weed and crop-weed competition, it is reported that weed interference can significantly reduce crop yield (Mukherjee 2015). The integrated use of farmyard manure (FYM), vermicompost, crop residues, and green manure can be employed to maximize the benefits of INM (Ghosh *et al.* 2021). In this context, it is of paramount importance to evolve the strategies for integrated nutrient and weed management. Considering the miserably low amount of organic matter, low fertility status of these soils, low purchasing power of farmers for fertilizers, a study was undertaken with specific objectives of identifying appropriate integrated nutrient and weed management treatments, to sustain greengram yields and soil productivity.

MATERIALS AND METHODS

The field experiment was conducted at District Seed Farm (AB Block), Kalyani under Bidhan Chandra Krishi Viswavidyalaya, West Bengal during *pre-Kharif* season of 2020 and 2021 in an upland situation with the objective to study the performance of different nutrients along with suitable weed management in greengram (*Vigna radiata* (L.) Wilczek). The farm is situated at approximately 22^{o} 56´ N latitude and 88^{o} 32´ E longitude with an average altitude of 9.75 m above mean sea level (MSL). The soil was sandy loam with a slightly acidic pH of 7.1. The available nitrogen (N), phosphorus (P), and potassium (K) levels were reported as 198.7 kg/ha, 19.72 kg/ha, and 187.52 kg/ha, respectively (Subbiah and Asija 1956, Olsen *et al.* 1954, Jackson 1973). The experiment was laid out in a split plot design with three replications and 28 treatment combinations. The treatments comprised four main plot treatments, which includes nutrient management, *viz.* 100% RD_{NPK}, 100% RD_{PK} +75% RD_{N} + 25% N (vermicompost), 100% RD_{PK} +75% RD_{N} + 25% N (FYM), and 75% RD_{NPK} + *Rhizobium* + PSB and seven weed control measures, *viz.* pendimethalin 1.25 kg/ha *fb* one hand weeding 25 DAS, pendimethalin 1.25 kg/ha *fb* hoeing at 25 DAS, pendimethalin 1.25 kg/ha *fb* imazethapyr 100 g/ha, pendimethalin 1.25 kg/ha *fb* quizalofop-ethyl 50 g/ha, pendimethalin 1.25 kg/ha *fb* fenoxaprop-p-ethyl 100 g/ha, weed check and weed free. Pendimethalin was applied as pre-emergence 3 DAS (days after sowing) and imazethapyr, quizalofop-ethyl, and fenoxaprop-p-ethyl were applied as post emergence weed control at 25 DAS. All the fertilizer applied as per treatment. The greengram crop (cv. *Meha*) was raised during summer season with a seed rate of 25 kg/ha, with plant to plant spacing of 10 cm and row to row spacing of 30 cm. The nutrients were applied using urea, single superphosphate, and muriate of potash. The N content in organic manures was 1.54 to 1.59% in vermicompost and 0.59 to 0.66% in farmyard manure (FYM), respectively. Knapsack sprayer (16 litres' capacity) with flat fan nozzles was used for herbicide application and the spray volume was 500 L/ha. Thinning was done at 15 DAS (days after sowing) to maintain uniform crop stand. Observations on different growth parameters like plant height, dry matter accumulation, crop growth rate, number and dry weight of nodules were recorded at 30, 45 and 60 DAS and yield attributing characters and yield were noted at the time of harvest. Crop sample were analyzed for uptake of nitrogen, phosphorous and potash as per standard laboratory procedure (Jackson 1973). Benefit: cost ratio (B:C) was obtained by dividing the gross income with cost of cultivation. The effect of treatments was evaluated on pooled analysis basis on yield attributes and yields. Data obtained from the 2 years were pooled and statistically analyzed using the F test as per the procedure given by Gomez and Gomez (1984). The experimental data were analyzed statistically by applying the technique of analysis of variance (ANOVA) prescribed for the design to test the significance of overall difference among treatments by the F test and conclusions were drawn at 5% probability level.

RESULTS AND DISCUSSION

Weed flora

Sixteen weed species were observed in experimental field; among them, grasses were four, sedges one and remaining weed flora were from broad-leaf category. The predominant weed species were *Digitaria sanguinalis*, *Cynodon dactylon*, *Eleusine indica*, *Echinochloa colona* among grasses; *Cyperus rotundus* among the sedges and the broad-leaf weeds were *Cleome viscose*, *Convolvulus arvensis*, *Eclipta alba*, *Amaranthus viridis*, *Euphorbia hirta*, *Digeria arvensis*, *Trianthema* *portulacastrum*, *Tribulus terrestris* and *Physalis minima*.

Weed density and weed dry weight

Different nutrient and weed management treatments had significant effect on all the growth and yield attributing characters (**Table 1** and **2**). All the weed control treatments significantly reduced the density of narrow and BLW. At 30 DAS, lowest grasses and BLW density was observed with the 75 % RD_{NPK} + *Rhizobium* + PSB, and was at par with 100% RD_{PK} +75% RD_{N} + 25% N through vermicompost for grasses only, and significantly better to other treatments. Lowest sedges density was observed with 100% RD_{PK} +75% RD_{N} + 25% N through vermicompost which was statistically better to all other main plot treatments. Total number of less weeds were observed with 75% RD_{NPK} + *Rhizobium* + PSB which were significantly superior to other treatments. However, higher number of weeds population was observed with the 100% RD_{PK} +75% RD_{N} + 25% N through FYM, which might be due to more invasion of weed via compost. At 30 DAS, lowest grassy and BLW population observed with pendimethalin 1.25 kg/ha *fb* one hand weeding 25 DAS with various sub-plot treatments, which was at par only with pendimethalin 1.25 kg /ha *fb* hoeing at 25 DAS. This was statistically better to all other treatments except weed free situation. Least sedges population was observed with pendimethalin 1.25 kg/ha *fb* hoeing at 25 DAS, which was at par with pendimethalin 1.25 kg/ha *fb* imazethapyr 100 g/ha, pendimethalin 1.25 kg/ha and one hand weeding at 25 DAS. Total weed density was observed lowest at 30 DAS with pendimethalin 1.25 kg/ha *fb* one hand weeding at 25 DAS, which showed parity only with pendimethalin 1.25 kg/ha *fb* hoeing at 25 DAS and was statistically superior to all other treatment except weed free treatments. This corroborates with the earlier finding of Mukherjee (2021) and Verma *et al.* (2015). At 60 DAS, less density of weeds observed with 100% RD_{PK} +75% RD_{N} + 25% N through vermicompost, and was statistically better to all other main plot treatments. This was closely followed by 75% RD_{NPK} + *Rhizobium* + PSB and 100% $RD_{NPK.}$ Whereas, less number of all category of weed observed with pendimethalin 1.25 kg/ha *fb* imazethapyr 100 g/ha and was at par with pendimethalin 1.25 kg/ha *fb* quizalofop-ethyl 50 g/ha for grasses only and it was statistically better to all other subplot treatments except weed free situation. The total weed density in pendimethalin 1.25 kg/ha *fb* quizalofop-ethyl 50 g/ha, pendimethalin 1.25 kg/ha *fb* imazethapyr 100 g/ha and pendimethalin 1.25 kg/ha *fb* fenoxaprop-p-ethyl 100 g/ha was 8.27, 10.2 and 11.56/m^2, respectively as against 17.67/m^2 in weedy check plot.

Lowest dry weight of BLW and sedges was observed with 75 % RD_{NPK} + *Rhizobium* + PSB and was at par with 100% RD_{PK} +75% RD_{N} + 25% N through FYM for BLW and 100% RD_{PK} +75% RD_{N} + 25% N through vermicompost for sedges, and notably better to all other treatments for reducing weed population. Less total dry weight of weed at 30 DAS observed with 75 % RD_{NPK} + *Rhizobium* + *PSB* was at par only with 100% RD_{PK} + 75% RD_{N} + 25% N through vermicompost to check dry weight of weed. Lowest dry weight of narrow and BLW observed with pendimethalin 1.25 kg/ha *fb* one hand weeding at 25 DAS was at par with pendimethalin 1.25 kg/ha *fb* quizalofop-ethyl 50 g/ha and pendimethalin 1.25 kg/ha *fb* imazethapyr 100 g/ha for grasses, and was statistically superior to all other treatments except weed free treatment. Least total dry weight observed with pendimethalin 1.25 kg/ha *fb* one hand weeding at 25 DAS was found comparable to pendimethalin 1.25 kg/ha *fb* one hand weeding at 25 DAS and pendimethalin 1.25 kg/ha *fb* hoeing at 25 DAS (**Table 1** and **2**).

Lowest dry weight of grasses at 60 DAS observed with 100% RD_{PK} +75% RD_{N} + 25% N through vermicompost was comparable with all other main plot treatments except 100% RD_{PK} +75% RD_{N} + 25% N through FYM. Further, observation on subplot treatments revealed less dry biomass of narrow-leave weeds with pendimethalin 1.25 kg /ha *fb* quizalofop-ethyl 50 g/ha which was at par with pendimethalin 1.25 kg/ha *fb* imazethapyr 100 g/ha, pendimethalin 1.25 kg/ha and one hand weeding at 25 DAS which was significantly superior to other treatments except weed free situation. Post-emergence application of quizalofop-ethyl 50 g/ha resulted significantly less narrow-leaved weed density and dry biomass over all other treatments. Better response of quizalofop-ethyl in controlling narrow-leaved weeds might be due to the fact that aryloxyphen - oxypropionates (AOPP) class to which this herbicide belongs is readily absorbed and translocated to meristematic region and exert herbicide activity. It acts by inhibiting the enzyme Acetyl Coenzyme–A carboxylase (ACCase) in susceptible species (Burton *et al.* 1997). Acetyl coenzyme catalyzes, the first committed step of fatty acid biosynthesis, is adenosine triphosphate dependent carboxylation of acetyl Co A to malonyl Co A. Grass species have a eukaryotic type ACCase in the chloroplasts which is sensitive to ACCase

Table 1. Effect of different treatments on weed density of weeds at 30 and 60 DAS in greengram (pooled data of two years)

Treatment	Weed density at 30 DAS (no./m^2)				Weed density at 60 DAS (no./m^2)			
	Grasses	BLW	Sedges	Total	Grasses	BLW	Sedges	Total
Nutrient management								
100% RD_{NPK}	4.56** (20.25)*	6.42 (40.66)	4.19 (17.03)	8.86 (77.94)	5.64 (31.26)	7.73 (59.33)	6.45 (41.15)	11.5 (131.7)
100% RD_{PK} +75% RD_N + 25% N (vermicompost)	3.85 (14.33)	5.62 (31.08)	3.49 (11.66)	7.59 (57.07)	4.87 (23.23)	6.17 (37.63)	4.97 (24.2)	9.25 (85.06)
100% RD_{PK} +75% RD_N + 25% N (FYM)	5.01 (24.64)	6.1 (36.74)	4.47 (19.44)	9.02 (80.82)	7.74 (59.36)	7.2 (51.36)	7.1 (49.98)	12.7 (160.7)
75 % RD_{NPK} + *Rhizobium* + PSB	3.44 (11.36)	4.38 (18.65)	3.85 (14.36)	6.7 (44.37)	5.92 (34.58)	6.98 (48.25)	5.79 (33.05)	10.79 (115.9)
LSD (p=0.05)	0.41	0.64	0.57	0.79	0.55	0.73	0.64	0.77
Weed management								
Pendimethalin 1.25 kg/ha *fb* one hand weeding 25 DAS	3.03 (8.66)	3.75 (13.56)	3.71 (13.25)	5.84 (33.58)	5.64 (31.36)	7.41 (54.35)	5.46 (29.36)	10.75 (115.1)
Pendimethalin 1.25 kg/ha *fb* hoeing at 25 DAS	3.41 (11.15)	4.38 (18.69)	3.44 (11.36)	6.6 (43.09)	6.79 (45.65)	6.44 (41.02)	5.71 (32.15)	10.92 (118.8)
Pendimethalin 1.25 kg/ha *fb* imazethapyr 100 g/ha	4.71 (21.66)	4.57 (20.36)	4.24 (17.45)	7.74 (59.47)	4.96 (24.12)	5.26 (27.19)	4.68 (21.36)	8.27 (67.91)
Pendimethalin 1.25 kg/ha *fb* quizalofop-ethyl 50 g/ha	4.32 (18.2)	5.76 (32.69)	4.31 (18.11)	8.34 (69.00)	4.46 (19.36)	6.68 (44.11)	5.99 (35.36)	10.2 (103.6)
Pendimethalin 1.25 kg/ha *fb* fenoxaprop-p-ethyl100 g/ha	3.85 (14.36)	6.69 (44.25)	4.57 (20.36)	8.91 (78.97)	5.58 (30.65)	7.32 (53.06)	7.06 (49.36)	11.56 (133.3)
Weed check	7.18 (51.06)	9.73 (94.25)	5.64 (31.26)	13.3 (176.6)	10.5 (109.23)	11.2 (125.36)	8.81 (77.16)	17.67 (311.8)
Weed free	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
LSD (p=0.05)	0.53	0.74	0.60	1.26	0.61	0.91	0.73	1.27

*Figure in parentheses are original values. **Square root transformed value" (x+0.5)

Table 2. Effect of different treatments on dry weight of weeds at 30 and 60 DAS in greengram (pooled data of two years)

Treatment	Dry weight of weeds at 30 DAS (g/m^2)				Dry weight of weeds at 60 DAS (g/m^2)			
	Grasses	BLW	Sedges	Total	Grasses	BLW	Sedges	Total
Nutrient management								
100% RD_{NPK}	2.42 (5.36)	4.67 (21.32)	3.97 (15.26)	6.51 (41.94)	5.27 (27.26)	7.86 (61.21)	5.58 (30.69)	10.94 (119.2)
100% RD_{PK} +75% RD_N + 25% N (vermicompost)	2.18 (4.25)	4.09 (16.25)	3.43 (11.25)	5.68 (31.75)	4.48 (19.54)	6.87 (46.65)	5.48 (29.54)	9.81 (95.73)
100% RD_{PK} +75% RD_N + 25% N (FYM)	3.2 (9.74)	3.97 (15.25)	4.23 (17.39)	6.55 (42.38)	6.14 (37.16)	7.69 (58.58)	6.31 (39.32)	11.64 (135.1)
75 % RD_{NPK} + *Rhizobium* + PSB	2.2 (4.36)	3.46 (11.46)	3.22 (9.88)	5.12 (25.71)	5.24 (26.93)	6.06 (36.26)	5.26 (27.12)	9.52 (90.31)
LSD (p=0.05)	0.49	0.52	0.67	1.09	0.76	1.02	0.93	1.21
Weed management								
Pendimethalin 1.25 kg/ha *fb* one hand weeding 25 DAS	1.87 (2.98)	2.85 (7.65)	3.26 (10.12)	4.54 (20.13)	4.66 (21.21)	6.34 (39.66)	6.85 (46.36)	10.38 (107.2)
Pendimethalin 1.25 kg/ha *fb* hoeing at 25 DAS	2.77 (7.15)	3.69 (13.11)	3.14 (9.33)	5.49 (29.59)	4.31 (18.05)	7.09 (49.75)	6.76 (45.23)	10.66 (113.0)
Pendimethalin 1.25 kg/ha *fb* imazethapyr 100 g/ha	2.04 (3.65)	3.88 (14.56)	3.97 (15.28)	5.83 (33.49)	4.56 (20.32)	5.73 (32.36)	4.97 (24.25)	8.79 (76.93)
Pendimethalin 1.25 kg/ha *fb* quizalofop-ethyl 50 g/ha	1.69 (2.36)	4.22 (17.35)	4.22 (17.32)	6.18 (37.65)	4.22 (17.32)	6.59 (42.98)	4.44 (19.21)	8.94 (79.55)
Pendimethalin 1.25 kg/ha *fb* fenoxaprop-p-ethyl100 g/ha	2.61 (6.32)	4.78 (22.36)	4.78 (22.36)	7.18 (51.04)	4.95 (24.02)	5.59 (30.78)	5.46 (29.26)	9.19 (84.06)
Weed check	4.46 (19.36)	6.46 (41.23)	4.97 (24.25)	9.24 (84.84)	7.93 (62.33)	10.5 (109.15)	7.68 (58.49)	15.18 (230.0)
Weed free	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
LSD (p=0.05)	0.67	0.57	0.91	1.19	0.97	1.03	0.99	1.51

inhibitors. Whereas most broad-leaved species have a prokaryotic type of ACCase, which is not sensitive to ACCase inhibitors (Incledon and Hall 1997). Less BLW biomass found with pendimethalin 1.25 kg/ha *fb* fenoxaprop-p-ethyl 100 g/ha was at par with pendimethalin 1.25 kg/ha *fb* imazethapyr 100 g/ha, pendimethalin 1.25 kg/ha *fb q*uizalofop-ethyl 50 g/ha and pendimethalin 1.25 kg/ha *fb* one hand weeding 25 DAS. Less dry weight of sedges with pendimethalin 1.25 kg/ha *fb* quizalofop-ethyl 50 g/ha showed parity with pendimethalin 1.25 kg /ha *fb* imazethapyr 100 g/ ha.

Growth parameters

Observations on different growth parameters revealed more plant height with 100% $RD_{NPK,}$ which was notably better than other main plot treatments (**Table 3**). Among weed control measures, more plant height found with weed free treatment was statistically improved to all other subplot measures except weedy check plot. Further, **Table 3** revealed that LAI failed to give any statistical difference at 30 DAS either in main plot or subplot treatments, however at 45 and 60 DAS, more LAI observed with 100% RD_{PK} +75% RD_{N} + 25% N (vermicompost) was significantly better to all other treatment except 100% $RD_{NPK.}$ With different subplot treatments, more LAI at 45 and 60 DAS was observed with pendimethalin 1.25 kg/ha *fb* quizalofop-ethyl 50 g/ha and was at par with all the treatments except pendimethalin 1.25 kg/ha *fb* hoeing at 25 and 50 DAS and weedy check and statistically superior to other treatments.

Plant dry biomass production failed to give any response at 30 DAS with different nutrient management options. Moreover, among subplot treatments, more plant biomass was seen with weed free which showed parity with pendimethalin 1.25 kg/ha *fb* one hand weeding at 30 DAS which was statistically superior to other subplot treatments. At 45 and 60 DAS, more plant biomass production was observed with 100% RD_{PK} +75% RD_{N} + 25% N and 100% RD_{NPK}, respectively. They were at par to each other and statistically better to all other main plot treatments. With subplot treatments, increased dry biomass at 45 DAS found with pendimethalin 1.25 kg/ha *fb* hoeing at 25 and 50 DAS was significantly better to all other treatments. At 60 DAS, more crop biomass found with weed free treatment was at par only with pendimethalin 1.25 kg/ha *fb* imazethapyr 100 g/ha, which was statistically superior to all other weed management treatments.

Increased number of branches per plant seen with 75% RD_{NPK} + *Rhizobium* + PSB was at par with all the treatments except 100% RD_{PK} +75% RD_{N} + 25% N (FYM), which gave least number of branches per plant. Moreover, more branches per plant observed with pendimethalin 1.25 kg/ha *fb* quizalofop-ethyl 50 g/ha was at par with pendimethalin 1.25 kg/ha *fb* one hand weeding 30 DAS and weed free situation.

More nodules per plan more found with 100% RD_{NPK} was significantly better to all other treatments at 30 DAS. However, at 45 and 60 DAS, more nodule per plant observed with 75% RD_{NPK} + *Rhizobium* +

Table 3. Effect of different treatments on different growth parameters of greengram (pooled data of two years)

Treatment	Plant height (cm) (60 DAS)	Leaf area index (DAS)			Dry biomass production (g/m^2)			Branches/plant (no.)	Nodules/plant (no.)			Dry weight of nodules (g/plant)		
		30	45	60	30	45	60		30	45	60	30	45	60
Nutrient management														
100% RD_{NPK}	49.16	3.03	4.32	3.11	27.8	132.4	342.8	4.29	18.63	38.41	25.25	0.047	0.077	0.06
100% RD_{PK} +75% RD_{N} + 25% N (Vermicompost)	47.39	3.00	4.41	3.61	27.4	137.4	321.6	4.19	16.34	34.65	25.09	0.046	0.081	0.067
100% RD_{PK} +75% RD_{N} + 25% N (FYM)	46.11	2.87	3.21	3.52	26.1	124.2	234.8	3.17	13.53	38.44	21.61	0.032	0.059	0.041
75 % RD_{NPK} + *Rhizobium* + PSB	46.98	2.89	3.44	3.13	28.1	136.2	264.6	4.38	17.69	40.24	30.33	0.035	0.078	0.068
LSD (p=0.05)	1.04	NS	0.70	0.58	NS	9.9	25.2	0.44	0.46	1.65	1.36	0.007	0.011	0.010
Weed management														
Pendimethalin 1.25 kg /ha *fb* one hand weeding 25 DAS	48.23	2.75	4.01	3.54	30.3	144.0	224.5	4.32	19.09	41.03	31.29	0.031	0.089	0.062
Pendimethalin 1.25 kg /ha *fb* hoeing at 25 DAS	46.38	2.92	3.63	3.11	28.3	161.4	256.2	4.02	14.37	36.53	28.75	0.049	0.061	0.057
Pendimethalin 1.25 kg /ha *fb* imazethapyr 100 g/ha	49.25	3.11	4.08	3.02	28.1	121.5	366.5	4.11	16.03	38.78	20.51	0.054	0.087	0.051
Pendimethalin 1.25 kg /ha *fb* quizalofop-ethyl 50 g/ha	46.25	2.98	4.11	3.98	27.6	129.4	287.9	4.65	17.89	42.39	27.81	0.032	0.081	0.068
Pendimethalin 1.25 kg/ha *fb* fenoxaprop-p-ethyl100 g/ha	45.69	3.02	4.03	3.41	25.1	134.7	301.8	3.85	18.69	34.74	21.54	0.041	0.065	0.044
Weed check	44.32	2.63	3.06	2.73	22.5	91.6	211.8	3.13	11.36	29.92	17.11	0.020	0.049	0.033
Weed free	51.66	3.06	4.7	3.69	31.2	144.9	381.5	4.23	19.44	42.46	31.63	0.051	0.09	0.069
LSD (p=0.05)	1.36	NS	0.68	0.59	2.3	10.2	16.1	0.34	0.87	1.98	1.69	0.003	0.012	0.005

PSB was significantly better to all other main plot treatments. With different weed management treatments, increased parameters observed with weed free plot showed parity only with pendimethalin 1.25 kg/ha *fb* one hand weeding 30 DAS at all stages, and pendimethalin 1.25 kg/ha *fb* quizalofop-ethyl 50 g/ha at 45 DAS only (**Table 3**).

Data on dry weight of nodule revealed more value obtained with 100% RD_{NPK}, which was at par with 100% RD_{PK} +75% RD_N + 25% N (vermicompost) and significantly better to other treatments. At 45 and 60 DAS, more dry weight observed with 100% RD_{PK} +75% RD_N + 25% N (vermicompost) was at par with all the main plot treatments except 100% RD_{PK} +75% RD_N + 25% N (FYM). At 60 DAS, increased dry weight of nodule observes with 75% RD_{NPK} + *Rhizobium* + PSB was closely followed by 100% RD_{PK} +75% RD_N + 25% N (vermicompost) and 100% RD_{NPK}, and they were at par with each other. Among various subplot treatments, more nodule dry weight at 30 DAS, observed with pendimethalin 1.25 kg/ha *fb* imazethapyr 100 g/ha was at par with weed free treatment. At 45 and 60 DAS, more dry weight of nodule observed with weed free showed parity only with pendimethalin 1.25 kg/ha *fb* one hand weeding at 30 DAS, pendimethalin 1.25 kg/ha *fb* imazethapyr 100 g/ha and pendimethalin 1.25 kg/ha *fb* quizalofop-ethyl 50 g/ha at 45 DAS (**Table 3**).

Yield and yield attributing characters

Yield attributing character revealed significant difference with diverse main and subplot treatments. Increased number of pods/plant and seeds/plant, observed with 100% RD_{NPK} was at par with all the treatments except 100% RD_{PK} +75% RD_N + 25% N (FYM). With different subplot treatments, added pods/plant was found with weed free treatment and showed parity with pendimethalin 1.25 kg /ha *fb* imazethapyr 100 g/ha and pendimethalin 1.25 kg /ha *fb* hoeing at 25 DAS (**Table 4**). Additional number of seed per pod established with weed free was closely followed by pendimethalin 1.25 kg/ha *fb* imazethapyr 100 g/ha and pendimethalin 1.25 kg/ha *fb* quizalofop-ethyl 50 g/ha, and was statistically better to other treatments. The increase in growth and yield attributes under these treatments might be attributed due to the reduction in weed competitiveness with the crop which ultimately favoured better environment for growth and development of crop, while, weedy check recorded significantly lowest values for growth, yield attributes and yields of greengram crop.

Increased seed yield realized with 100% RD_{PK} +75% RD_N + 25% N (vermicompost) was at par with all other main plot treatments except 100% RD_{PK} +75% RD_N + 25% N (FYM). Highest stover production observed with 100% RD_{NPK} was at par with 100% RD_{PK} +75% RD_N + 25% N (vermicompost), notably better to other main plot treatments. Per cent increase in seed yield in main plot due to treatments was 52.48, 47.03 and 44.09% in 100% RD_{PK} +75% RD_N + 25% N (vermicompost), 100% RD_{NPK} and 75 % RD_{NPK} + *Rhizobium* + PSB, respectively compared to 100% RD_{PK} +75% RD_N + 25% N (FYM). The corresponding increase in straw yield under these treatments was 74.91, 79.01 and 48.11% as against the lowest recorded in 100% RD_{PK} +75% RD_N + 25% N (FYM). Increased vegetative growth and balanced C: N ratio led to higher carbohydrate synthesis, enhancing yield attributing characters in greengram due to combined organic and inorganic fertilizer application (Mukherjee and Mandal 2017). Improved nutrient supply from both sources and weed control treatments boosted seed and straw yields significantly. Maintaining a weed-free environment during critical growth stages reduced crop-weed competition, fostering better growth and development, resulting in higher seed and stover yields. It was found that the highest seed and straw yield of greengram was recorded in weed free treatment followed by pre- and post-emergence application of pendimethalin 1.25 kg/ha *fb* imazethapyr 100 g/ha. They were at par to each other and significantly better to other treatments. The highest yield under weed free treatment due to the fact that this treatment controlled early as well as late flushes of weeds and provided weed free environment to the crop during critical period of crop weed competition. The results are in conformity with the findings of Verma *et al.* (2015) and Singh and Singh (2020). On the other hand, pendimethalin 1.25 kg/ha *fb* imazethapyr 100 g/ha had significantly controlled grassy weeds and the most dominated broad-leaved weed and saved the crop efficiently from its infestation and it reflected in terms of significant increase in growth and yield attributes which ultimately resulted into higher yield of crop. This result indicated that appreciable increase in seed yield and decrease total dry weight of weeds were recorded under these treatments are also responsible for better seed and stover yield of greengram. These findings are accordance with the finding of Chhodavadia *et al.* (2014). Lowest seed yield observed with weedy check and was statistically poor to all the treatments. Increased stover production found with pendimethalin 1.25 kg/ha *fb* imazethapyr 100 g/ha was statistically at par with the weed free and pendimethalin 1.25 kg/ha *fb* quizalofop-ethyl 50 g/ha, and significantly better to other subplot treatments. Data revealed per cent increase in seed yield due to weed free, pendimethalin 1.25 kg/ha *fb* imazethapyr 100 g/ha, pendimethalin 1.25 kg/ha *fb* one hand weeding 25 DAS and pendimethalin 1.25 kg/ha *fb* quizalofop-ethyl 50 g/ha, was 158.1, 139.35, 111.41 and 108.61%, respectively compared to weedy check. The corresponding increase in straw yield under these treatments was 123.36, 131.21, 100.77 and 119.43% as against the lowest recorded in weedy check. More harvest index observed with 100% RD_{PK} +75% RD_N + 25% N (FYM) showed parity only with 75% RD_{NPK} + *Rhizobium* + PSB and was statistical better to all other main plot treatments. Further with different weed management treatments, more harvest index found with pendimethalin 1.25 kg /ha *fb* hoeing at 25 DAS was at par only with weed free and significantly better to other treatment.

Nutrient uptake

Nutrient uptake by crop significantly influenced with different nutrient and weed management option. Increased crop nutrient uptake was recorded with the application of 100% RD_{PK} +75% RD_N + 25% N (vermicompost) and showed at par result with all major nutrient uptake with 100% $RD_{NPK,}$ and nitrogen and potassium uptake with 75% RD_{NPK} + *Rhizobium* + PSB, and significantly better to other treatments (**Table 4**). With different subplot treatments, increased nitrogen uptake observed with weed free treatments was at par with pendimethalin 1.25 kg/ha *fb* imazethapyr 100 g/ha, pendimethalin 1.25 kg/ha *fb* quizalofop-ethyl 50 g/ha, and pendimethalin 1.25 kg/ha *fb* one hand weeding 25 DAS which was statistically better to other treatments. This corroborates with the finding of Chhodavadia *et al.* (2013). Phosphorus uptake more found with weed free and significantly better to all other treatments of weed management options. Further, more potassium uptake with weed free showed parity with pendimethalin 1.25 kg/ha *fb* imazethapyr 100 g/ha and pendimethalin 1.25 kg/ha *fb* quizalofop-ethyl 50 g/ha, which was significantly better to other treatments.

Economics

The economics of greengram was varied with the variation in the treatment impact of different nutrient and weed management practices applied to the crops (**Table 4**). The total treatment cost in greengram has varied with the difference in the cost for nutrient and weed management. Economics revealed that with different nutrient management measures, more return (₹ 50,052) and B:C ratio (2.27) was observed with 100% RD_{PK} +75% RD_N + 25% N (vermicompost) and was closely followed by 75 % RD_{NPK} + *Rhizobium* + PSB and 100% RD_{NPK} (**Table 4**). With subplot treatments, more net return was observed with weed free (₹ 56044) followed by pendimethalin 1.25 kg /ha, *fb* imazethapyr 100 g/ha (₹ 46,584) and pendimethalin 1.25 kg/ha *fb* quizalofop-ethyl 50 g/ha (₹ 43,099). However, with weed management options, more B:C ratio was observed with pendimethalin 1.25 kg/ha *fb* imazethapyr 100 g/ha (2.26) which was closely followed by weed free treatment (2.23).

Table 4. Effect of different treatments on yield attributes, yield and economics of greengram (pooled data of two years)

Treatment	Pods/ plant (no.)	Seeds/ pod (no.)	Test weight (g)	Seed yield (t/ha)			Stover yield (t/ha)	Harvest index (%)	Nutrient uptake (kg/ha)			Cost of cultivation (x10^3 `/ha)	Net returns (`/ha)	B:C ratio
				2020	2021	Pooled			N	P	K			
Nutrient management														
100% RD_{NPK}	25.05	11.09	31.08	0.91	1.06	0.99	2.81	26.03	88.51	13.14	78.63	41.49	46.51	2.12
100% RD_{PK} +75% RD_N + 25% N (vermicompost)	23.39	10.03	32.19	104	1.01	1.02	2.74	27.20	90.47	14.01	85.11	39.28	50.05	2.27
100% RD_{PK} +75% RD_N + 25% N (FYM)	18.66	8.34	28.06	0.71	0.64	0.67	1.57	30.01	61.21	10.15	65.64	37.15	17.35	1.46
75 % RD_{NPK} + *Rhizobium* + PSB	22.87	9.33	29.39	102	0.91	0.97	2.32	29.41	81.41	11.31	75.96	36.06	43.29	2.20
LSD (p=0.05)	2.32	1.01	0.73	0.07	0.07	0.07	1.60	0.93	12.19	1.31	11.36			
Weed management														
Pendimethalin 1.25 kg /ha *fb* one hand weeding 25 DAS	22.36	9.48	32.42	0.98	0.98	0.98	2.47	27.68	85.38	12.63	83.81	42.26	39.66	1.93
Pendimethalin 1.25 kg /ha *fb* hoeing at 25 DAS	23.05	9.05	31.83	1.01	0.88	0.94	2.25	30.42	78.44	12.54	72.84	40.57	33.89	1.83
Pendimethalin 1.25 kg /ha *fb* imazethapyr 100 g/ha	24.36	11.55	34.64	1.09	1.14	1.11	2.85	28.06	93.41	13.03	90.65	36.85	46.58	2.26
Pendimethalin 1.25 kg /ha *fb* quizalofop-ethyl 50 g/ha	20.365	10.97	28.19	1.02	0.92	0.97	2.71	26.35	91.63	12.11	87.11	35.95	43.10	2.19
Pendimethalin 1.25 kg/ha *fb* *f*enoxaprop-p-ethyl100 g/ha	19.311	8.45	30.01	0.64	0.77	0.71	2.25	23.99	68.53	11.94	64.57	36.58	37.50	2.02
Weed check	22.36	6.25	22.74	0.50	0.43	0.46	1.23	27.37	45.39	8.84	39.65	31.95	18.32	1.57
Weed free	25.68	11.89	33.9 8	1.20	1.19	1.20	2.75	30.36	98.32	13.91	95.43	45.31	56.04	2.23
LSD (p=0.05)	2.89	1.24	0.97	0.08	0.08	0.08	0.19	1.18	14.35	1.29	10.02			

Conclusion

It can be stated that need based application of nutrient and weed management method should be advocated for greengram. On the basis of experimental finding, application of 100% RD_{PK} +75% RD_N + 25% N (vermicompost) along with pendimethalin 1.25 kg /ha *fb* imazethapyr 100 g/ha become very effective for higher productivity of greengram under new alluvial zone.

REFERENCES

Anonymous. 2020-21. Ministry of Agriculture Department of agriculture and cooperation. Ministry of agriculture Govt. of India New Delhi. pp 84–87.

Burton JD, Gronwald JW, Somers DA, Connelly JA, Gegenbach BG and Wyse DL. 1997. Inhibition of plant acetyl-coenzyme A carboxylase by the herbicides sethoxydim and haloxyfop. Biochemistry and Biophysisc. *Research Communication* **148**: 1039–1044.

Chhodavadia SK, Sagarka BK and Gohil BS. 2014. Integrated management for improved weed suppression in summer greengram (*Vigna radiata* L. Wilczek). *The Bioscan* **45**(2): 137–139.

Chhodavadia SK, Mathukiya RK and Dobariya VK. 2013. Pre- and post-emergence herbicides for integrated weed management in summer greengram. *Indian Journal of Weed Science* **45**(2): 137–139.

Ghosh D, Brahmachari K, Das A, Hassan MM, Mukherjee PK, Sarkar S, Dinda NK, Pramanick B, Moulick D, Maitra S and Hossain A. 2021. Assessment of energy budgeting and Its indicator for sustainable nutrient and weed management in a Rice-Maize-Greengram Cropping System. *Agronomy,* **11**: 166. https://doi.org/10.3390/agronomy11010166.

Gomez KA and Gomez AA. 1984. *Statistical Procedure for Agricultural Research*, 2nd Edn. International Rice Research Institute, Wiley, New York.

Incledon, BJ and Hall JC. 1997. Acetyl-coenzyme A carboxylase: quaternary structure and inhibition by graminicidal herbicides. *Pesticide Biochemistry and Physiology* **57**: 255–271.

Jackson, ML. 1973. *Soil Chemical Analysis*. Prentice Hall of India Private Ltd., New, Delhi, pp. 498.

Meena RS, Dhakal Y, Bohra JS, Singh SP, Singh MK and Sanodiya P. 2015. Influence of bioinorganic combinations on yield, quality and economics of mung bean. *American Journal of Experimental Agriculture* **8**(3): 159–166.

Mukherjee D. 2015. Food security: A worldwide challenge. *Research and Review: Journal of Agriculture and Allied Sciences* **4**(1): 3–5.

Mukherjee D. 2021. Production potential of greengram (*Vigna radiata*) under various sowing dates and weed control measures**.** *Annals of Agricultural Research New Series* **42** (1): 46–53.

Mukherjee D. 2022. New paradigm for higher crop productivity through climate smart strategies. *In: Innovative Approaches for Sustainable Development-Theories and Practices in Agriculture.* (eds. Mahdi, S.S. and Singh Rajbir). Springer Publication, pp. 65–91. https://doi.org/10.1007/978-3-030-90549-1. ISBN 978-3-030-90548-4 ISBN 978-3-030-90549-1 (eBook)

Mukherjee D and Mandal B. 2017. Practice of conservation agriculture for sustaining agro-ecosystem: A Review. *International Journal of Bioresource Science* **4**(2): 89–99.

Singh R and Singh G. 2020.Weed management in greengram: A review. *Indian Journal of Weed Science* **52**(1): 10–20.

Verma SK, Singh SB, Meena RN, Prasad SK, Meena RS and Gaurav. 2015. A review of weed management in India: the need of new directions for sustainable agriculture. *The Bioscan* **10** (1): 253–263.