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EFFECT OF VARIETIES AND FERTILITY LEVELS ON FODDER PRODUCTIVITY, NPK CONTENT, UPTAKE AND PROTEIN CONTENT OF SUMMER GREEN GRAM (*VIGNA RADIATA* L.)

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SUMMARY

The present investigation was carried out to study the effects of varieties and fertility levels on growth, fodder yield and nutrients of summer greengram. The experiment was comprised of three varieties viz., V_1- MH-421, V_2- MH-318 and V_3- SML-668 as main plot treatment and four different fertility levels viz., T_1 - Control, T_2 - 100% RDF (20:40:0 kg/ha NPK), T_3 - 75% RDF (inorganic) + 25% N/ha (FYM) + seed treatment (*Rhizobium* + PSB) and T_4 - 50% RDF (inorganic) + 50% N/ha (FYM) + seed treatment (*Rhizobium* + PSB) as sub plot treatments. Experiment was laid out in split plot design with four replications. Summer greengram variety, MH-318 recorded significantly dry matter accumulation (g/plant) over SML-668 and MH-421 at 30 DAS (1.72), 45 DAS (9.01) and at harvest (15.5). MH-318 also exhibited significantly higher nitrogen (3.73, 2.27) and phosphorus (0.40, 0.28) content in grain and straw respectively as compared to SML-668 and MH-421. However, no significant variation was found concerning potassium content in grain as well as straw. NPK uptake in grain and straw was found significantly higher under MH-318 over SML-668 and MH-421. Higher protein content (23.3%) and straw yield (3020 kg ha^{-1}) were recorded under MH-318 in comparison to other two varieties. Among fertility level treatments, 75% RDF (inorganic) + 25% N/ha (FYM) + seed treatment (*Rhizobium* + PSB) recorded significantly higher dry matter accumulation over other treatments. NPK content & uptake, protein content (23.7%) and straw yield (3395 kg ha^{-1}) was also significantly higher with the application of 75% RDF (inorganic) + 25% N/ha (FYM) + seed treatment (*Rhizobium* + PSB) over 50% N/ha (FYM) + seed treatment (*Rhizobium* + PSB), 100% RDF (20:40:0 kg/ha NPK) and control. Thus, the variety MH-318 should be fertilized with 75% RDF (inorganic) + 25% N/ha (FYM) + seed treatment (*Rhizobium* + PSB) to obtain grain & straw yield and economic returns of summer greengram.

Key words : Fertility, fodder, nutrients, variety, protein content

Greengram (*Vigna radiata* L. Wilczek) or “mung” or “moong” is the third mostimportant pulse crop of India both in terms of area and production next to chickpea and pigeonpea (Singh *et al.,* 1994). In India, the area under greengram was 4.75 million hectare area with production of 2.46 million tonnes during 2018-19. In Haryana, greengram is grown in about 0.02 million ha with a production of 0.012 million tonnes (Anonymous, 2021). Its seed contain 23.88% protein (as compared to 10-11% in wheat). The protein is comparatively rich in lysine, which is deficient in cereal grains. Every 100 g of greengram seeds contains 0.67% fat, 92.43 mg calcium, 4.9 mg iron, 198mg magnesium, 416 mg phosphorus, 1268 mg potassium and vitamins like 4.8 mg ascorbic acid, 0.45 mg thiamine, 0.27 mg riboflavin, 2.16 mg niacin, 2.02 mg pantothenic acid and 114IU vitamin A (Longvah *et al.,* 2017).

Despite of significant importance of this crop, the yield is very low in India as well as in Haryana. The main reasons behind low productivity of pulses is problems like suitability to pest and diseases, losses due to shattering, non-availability of high yielding varieties, cultivation on rainfed conditions and in less fertile soils with little or no monetary inputs (Lal *et al.,* 2015). Poor yield is also partly due to lack of suitable and high yielding variety.

Green gram can be used as dual-purpose crop (in early season as a forage crop followed by seed production) during the lean period. The husk of the grain can be feed to cattle by soaking it into water. The fodder contains, on an average, 40-49% nitrogen-free extract, 20-26% crude fiber, 10-15% crude protein, 11-15% ash and 2-2.5% ether extract on dry weight basis. However, the fodder value is generally low on second cut. Hence, green gram can be used as a double purpose (forage + seed), low-cost and low input alternative to summer season fodders. Presently, in countries like Egypt it is being utilised as a fodder cum grain crop (Abd ElSalam *et al.,* 2013).

It is crucial that green gram's growth should not be restricted due to inadequate supply of nutrients especially nitrogen and phosphorus. Since chemical fertilizers are costly and scarce, it is wise to use them economically and in combination with organic fertilizer, as green gram shows high response to organic fertilizer (Bairwa *et al.,* 2009). The aim of investigation was to quantify and qualify forage yield of summer green gram varieties MH-318, SML-668 and MH-421 under different nutrient treatment.

MATERIALS AND METHODS

The experiment was conducted at Research Farm of CCS HAU, Regional Research Station, Bawal, Rewari (Haryana). The soil of the experimental site was loamy sand in texture having pH (1 : 2 soil : H_2O) 8.17, EC 0.16 dS/m and having low organic carbon (0.16%), low available P (11.18 kg/ha) and high available K (149.1 kg/ha) at 0-15 cm soil depth. The experiment was laid out in split plot design. The main plot contained three varieties (i) MH-421, (ii) MH-318 and (iii) SML-668) and four nutrient treatments in sub-plot (i) Control (ii) 100% RDF (20:40:0 kg/ha NPK) (iii) 75% RDF (inorganic) + 25% N/ha (FYM) + seed treatment (*Rhizobium* + PSB) (iv) 50% RDF (inorganic) + 50% N/ha (FYM) + seed treatment (*Rhizobium* + PSB). The size of each plot was 3 x 5m (15 m^2). The crop was sown on 25th April 2020 using pora method at 30 cm row to row spacing at a depth of 5-6 cm using seed rate of 25 kg ha^{-1}. Before sowing, the seeds were treated with *Bavistin* @ 3 g/kg seed to protect them fromseed borne diseases. To control insects, a spray of *Rogor* 30 EC (dimethoate) @ 250 ml was done. Fertilizers, organic matter and biofertilizers were added according to treatments. The harvested produce of each plot was tied up in bundles and properly tagged. After the second picking the produce was allowed to dry in sun on the threshing floor.

Dry matter accumulation from each plot were recorded at 15, 30, 45 DAS and at harvest. Five random plants were uprooted from each plot. After uprooting the whole plant including root portion, were first air dried for some days and then dried in an electric oven at 70 °C till a constant weight was achieved. The weight was recorded and expressed as average dry weight per plant (g).

Nitrogen content (%) was determined by Nessler's reagent methods as described by Jackson (1973). Phosphorous content (%) was determined by Vanedomolybdo phosphoric acid yellow colour method (Koening and Johnson, 1942). Potassium content (%) was determined by Flame photometer method (Richards, 1954). NPK uptake by grain and straw was calculated by using this formula :

$$\text{NPK uptake by grain/straw (kg/ha)} = \frac{\text{NPK content (\%) in grain/straw} \times \text{Grain/straw yield (kg/ha)}}{100}$$

Straw yield (kg/ha) was calculated by subtracting the grain yield from biological yield (kg/ha). The amount of crude protein content in grain was estimated by multiplying the nitrogen content (%) of the grain with a factor of 6.25 (A.O.A.C., 1960). All the experimental data for various growth, yield attributing characters, yield and quality parameters was statistically analysed by the methods of analysis of variance (ANOVA) as described by Panse and Sukhatme (1967).

RESULTS AND DISCUSSION

Dry matter Accumulation (g/plant)

The perusal of data of dry matter accumulation shown in Table 1 unveiled that irrespective of variety and fertility levels, dry matter accumulation (g) per plant increased continuously with the advancement of crop growth up to harvest and the increase in dry matter accumulation was more between 30 to 45 DAS as compared to 45 DAS to harvest. The effect of varieties and fertility levels were found significant at all the observed stages except at 15 DAS. Dry matter accumulation (g per plant) was significantly higher in MH-318 and SML-668 over MH-421.

The maximum dry matter accumulation (g) was recorded in 75% RDF + 25% N/ha (FYM) + *Rhizobium* + PSB at all the growth stages, however,

TABLE 1
Effect of varieties and fertility levels on dry matter accumulation of summer greengram

Treatments	Dry Matter Accumulation (g/plant)			
	15 DAS	30 DAS	45 DAS	At Harvest
Variety				
V_1 - MH-421	0.33	1.63	8.19	14.3
V_2 - MH-318	0.35	1.72	9.01	15.5
V_3 - SML-668	0.34	1.67	8.53	15.1
SEm±	0.01	0.02	0.10	0.26
CD at 5%	NS	0.06	0.36	0.91
Fertility Level				
T_1 - Control	0.32	1.61	7.84	13.6
T_2 - 100% RDF	0.34	1.69	8.78	15.4
T_3 - 75% RDF + 25% N/ha(FYM) + *Rhizobium* + PSB	0.35	1.70	9.16	16.2
T_4 - 50% RDF + 50% N/ha(FYM) + *Rhizobium* + PSB	0.33	1.67	8.51	14.7
SEm±	0.01	0.02	0.13	0.41
CD at 5%	NS	0.06	0.39	1.19

*Significant at p≤ 0.05; NS- Non-significant at p>0.05; PSB- Phosphorus Solubilizing Bacteria.

it was significant at 30 DAS (1.70), 45 DAS (9.16) and at harvest (16.2). At 30, 45 DAS and harvest 75% RDF + 25% N/ha (FYM) + *Rhizobium* + PSB was significantly superior to the rest of the treatments except 100% RDF where it was at par. 75% RDF + 25% N/ha (FYM) + *Rhizobium* + PSB showed an increase of 5.6%, 17%, and 19% in dry matter accumulation over control at 30 DAS, 45 DAS and at harvest, respectively. The increase in different growth attributes due to balanced nutrition in greengram were also reported by Pandey *et al.* (2019) and Ranpariya *et al.* (2017).

Nitrogen content & uptake in grain and straw

Nitrogen content (%) in grain and straw (Table 2) did not differ significantly with different varieties and fertility levels, however, it was recoded maximum under variety MH-318 (3.73, 2.27) as compared to SML-668 (3.63, 2.21) and MH-421 (3.49, 2.11). Nitrogen content (%) in greengram as influenced by different fertility levels ranged from 3.39 to 3.80. The maximum nitrogen content (%) was observed under application of 75% RDF + 25% N/ha (FYM) + *Rhizobium* + PSB (3.80, 2.36) which was statistically at par with 100% RDF (3.67, 2.27). The minimum value of N content (%) was recorded under control (3.39, 2.01).

Nitrogen uptake by grain and straw (kg/ha) was found significantly higher in variety MH-318 (41.9, 69.6) over SML-668 (37.0, 65.0) and MH-421 (33.5, 60.1) by (Table 3). All the fertility levels significantly increased N uptake by grain and straw (kg ha^{-1}) over control. N uptake (kg ha^{-1}) under application of 75% RDF + 25% N/ha (FYM) + *Rhizobium* + PSB (48.2, 80.6) was significantly higher over the rest of the treatments. Minimum nitrogen uptake was recorded under control (23.4, 45.0). Since nutrient uptake in greengram is a function of grain and straw yield and their nutrient content, the improvement in the content

TABLE 2
Effect of varieties and fertility levels on NPK content (%) in grain and straw of summer greengram

Treatments	Nitrogen (%)		Phosphorus (%)		Potassium (%)	
	Grain	Straw	Grain	Straw	Grain	Straw
Variety						
V_1 - MH-421	3.49	2.11	0.32	0.22	1.30	0.66
V_2 - MH-318	3.73	2.27	0.40	0.28	1.40	0.73
V_3 - SML-668	3.63	2.21	0.37	0.25	1.35	0.70
SEm±	0.05	0.03	0.02	0.02	0.02	0.015
CD at 5%	NS	NS	NS	NS	NS	NS
Fertility Level						
T_1 - Control	3.39	2.01	0.31	0.21	1.25	0.66
T_2 - 100% RDF	3.67	2.27	0.38	0.27	1.36	0.71
T_3 - 75% RDF + 25% N/ha(FYM) + *Rhizobium* + PSB	3.80	2.36	0.42	0.28	1.43	0.74
T_4 - 50% RDF + 50% N/ha(FYM) + *Rhizobium* + PSB	3.62	2.16	0.34	0.24	1.34	0.69
SEm±	0.05	0.03	0.02	0.01	0.01	0.009
CD at 5%	0.16	0.10	0.05	0.03	0.042	0.026

*Significant at p≤ 0.05; NS- Non-significant at p>0.05; PSB- Phosphorus Solubilizing Bacteria.

TABLE 3
Effect of different varieties and fertility levels on straw yield and protein content of summer greengram

Treatments	Straw Yield (kg/ha)	Protein Content (%)
Variety		
V_1 - MH-421	2818	21.8
V_2 - MH-318	3020	23.3
V_3 - SML-668	2918	22.7
SEm±	44.4	0.31
CD at 5%	153.7	1.1
Fertility Level		
T_1 - Control	2238	21.2
T_2 - 100% RDF	3088	22.9
T_3 - 75% RDF + 25% N/ha (FYM) + *Rhizobium* + PSB	3395	23.7
T_4 - 50% RDF + 50% N/ha (FYM) + *Rhizobium* + PSB	2954	22.6
SEm±	60.5	0.5
CD at 5%	175.6	1.4

*Significant at p≤ 0.05; NS- Non-significant at p>0.05; PSB- Phosphorus Solubilizing Bacteria.

of these nutrients combined with much greater grain and straw yield boosted nutrient uptake dramatically. Similar findings were also recorded by Gorade *et al.* (2014) and Dubey *et al.* (2018).

Phosphorus content & uptake in grain and straw

The data presented in Table 2 showed that phosphorus content (%) in grain and straw, among varieties, was found non-significant, however, variety MH-318 (0.40, 0.28) showed maximum P content followed by SML-668 (0.37, 0.25) and MH-421 (0.32, 0.22). With respect to fertility levels, P content (%) in grain and was recorded significantly higher under application of 75% RDF + 25% N/ha (FYM) + *Rhizobium* + PSB (0.42, 0.28) which was statistically at par with 100% RDF (0.38, 0.27) and significantly higher than control (0.31, 0.21).

A probe into data shown in Table 3 revealed that phosphorus uptake by grain (kg/ha) under variety MH-318 (4.63, 8.78) was significantly higher over SML-668 (3.70, 7.50) and MH-421 (3.22, 6.35). A thorough understanding of data showed that application of 75% RDF + 25% N/ha (FYM) + *Rhizobium* + PSB (5.31, 9.60) recorded significantly higher P uptake (kg ha^{-1}) over rest of the treatments. The lowest phosphorus uptake by grain (kg ha^{-1}) was recorded under control (2.20, 4.86).

Potassium content & uptake in grain and straw

Potassium content (%) in grain and straw was not significantly influenced by varieties (Table 2). However, data exhibited numerical variation. K content (%) was numerically higher in MH-318 (1.40, 0.73) in comparison to SML-668 (1.35, 0.70) and MH-421 (1.30, 0.66). Among various fertility levels, application of 75% RDF + 25% N/ha (FYM) + *Rhizobium* + PSB (1.43, 0.74) was statistically at par with 100% RDF (1.36, 0.71) in grain and straw content while it was observed lowest under control (1.25, 0.66).

The data shown in Table 3 implied that

TABLE 4
Effect of varieties and fertility levels on N, P and K uptake (kg ha-1) by grain and straw of summer greengram

Treatments	Nitrogen (kg/ha)		Phosphorus (kg/ha)		Potassium (kg/ha)	
	Straw	Grain	Straw	Grain	Straw	Grain
Variety						
V_1 - MH-421	33.5	60.1	3.22	6.35	12.4	18.9
V_2 - MH-318	41.9	69.6	4.63	8.78	15.7	22.0
V_3 - SML-668	37.0	65.0	3.70	7.50	13.8	20.8
SEm±	0.85	1.3	0.11	0.12	0.17	0.23
CD at 5%	2.9	4.5	0.40	0.43	0.60	0.80
Fertility Level						
T_1 - Control	23.4	45.0	2.20	4.86	8.6	14.7
T_2 - 100% RDF	41.0	70.3	4.25	8.37	15.4	22.1
T_3 - 75% RDF + 25% N/ha(FYM) + *Rhizobium* + PSB	48.2	80.6	5.31	9.60	18.1	25.1
T_4 - 50% RDF + 50% N/ha(FYM) + *Rhizobium* + PSB	37.3	63.9	3.64	7.33	13.8	20.4
SEm±	1.16	1.7	0.16	0.17	0.28	0.35
CD at 5%	3.4	4.9	0.46	0.50	0.81	1.01

*Significant at p≤ 0.05; NS- Non-significant at p>0.05; PSB- Phosphorus Solubilizing Bacteria.

potassium uptake by grain and straw (kg/ha) was significantly higher in variety MH-318 (15.7, 22.0) over SML-668 (13.8, 20.8) and MH-421 (12.4, 18.9). It is also clear from Table 3 that potassium uptake (kg ha^{-1}) was significantly higher under application of 75% RDF + 25% N/ha (FYM) + *Rhizobium* + PSB (25.1) over rest of the treatments. K uptake by straw (kg ha^{-1}) under various fertility levels ranged from 14.7 kg ha^{-1} (control) to 25.1 kg/ha (75% RDF + 25% N/ha (FYM) + *Rhizobium* + PSB). All the fertility levels *viz.,* 75% RDF + 25% N/ha (FYM) + *Rhizobium* + PSB, 100% RDF and 50% RDF + 50% N/ha (FYM) + *Rhizobium* + PSB increased K uptake by straw over control by 70%, 50% and 38%, respectively. Similar findings were also recorded by Gorade *et al.* (2014) and Tambe *et al.* (2019).

Straw yield (kg/ha)

It is clear from the data presented in Table 4 that both varieties and fertility levels significantly affected the straw yield of greengram. Straw yield (kg/ha) with variety MH-318 (3020 kg/ha) was at par with SML-668 (2918 kg/ha) and significantly higher over MH-421 (2818 kg/ha). The increase in straw yield of variety MH-318 might be due to higher plant height, no. of branches/plant and dry matter accumulation/ plant than SML-668 and MH-421.

Among different fertility levels, the highest straw yield was obtained under application of 75% RDF + 25% N/ha (FYM) + *Rhizobium* + PSB (3395 kg/ha) while the lowest straw yield was recorded under control (2238 kg/ha), thus achieving a significant increase in straw yield of 1157 kg/ha. Straw yield under application of 100% RDF (3088 kg/ha) and 50% RDF + 50% N/ha (FYM) + *Rhizobium* + PSB (2954 kg/ha) were at par among themselves but differ significantly from control (2238 kg/ha). These results are similar to those reported by Tyagi and Upadhyay (2015).

Protein content in grain (%)

Protein content (%) in greengram was significantly influenced by both varieties and fertility levels (Table 4.9). Protein content (%) in grain with variety MH-318 (23.3) was significantly higher over MH-421 (21.8) and at par with SML-668 (22.7). All the different fertility levels gave significantly higher protein content in grain over control. Maximum protein content was recorded with the application of 75% RDF + 25% N/ha (FYM) + *Rhizobium* + PSB (23.7) which was statistically at par with 100% RDF (22.9) and 50% RDF + 50% N/ha (FYM) + *Rhizobium* + PSB (22.6) whereas minimum protein content (%) was observed in control (21.2). Protein content under all fertility levels were at par except control, where it was recorded minimum. Higher protein content in grain may be attributed to high nitrogen fixation ability of greengram in root nodules and efficiently translocated them to grains. Bhardwaj *et al.* (2021) also reported significantly higher protein content with *Rhizobium* + PSB as compared to control in faba bean. Similar observations were also recorded by Patel *et al.* (2019).

CONCLUSION

On the basis of present investigation, it may be concluded that variety MH-318 is significantly better in improving dry matter accumulation, NPK content & uptake, straw yield and protein content of summer greengram (*Vigna radiata*). Similarly, application of 75% RDF (15:30:00 kg $N:P_2O_5:K_2O$/ha) + 25% N/ha (FYM) + seed treatment with *Rhizobium* + PSB was also more effective in imporving these parameters than 50% RDF + 50% N/ha(FYM) + *Rhizobium* + PSB or 100% RDF. Thus summer greengram variety MH-318 along with application of 75% RDF (15:30:00 kg $N:P_2O_5:K_2O$/ha) + 25% N/ha (FYM) + seed treatment with *Rhizobium* + PSB may be recommended to achieve better dry matter accumulation, NPK content & uptake, straw yield and protein content.

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