Effect of Biofertilizer and Phosphorus on Yield and Nutrient Uptake by Black gram (*Vigna mungo* L.)

Abstract

A field experiment was conducted at experimental farm, Department of Agronomy, A field experiment was conducted at experimental farm, Department of Agronomy, Faculty of Agriculture and Veterinary Sciences, Mewar University Gangrar, Chittorgarh (Rajasthan) during Rabi season of 2023-24 to effect of Biofertilizer and Phosphorus yield and nutrient uptake by of black gram variety "Pratap Urd-1" was used in this study. The result revealed that the maximum yield parameter such as number of pods per plant (29.75), number of seed per pod (7.78), grain yield (12.12 q/ha), straw yield (27.02 q/ha) with application of T_{10}-50 kg P_2O_5 ha^{-1} + PSB + VAM. The maximum nitrogen content and uptake in grain and straw (3.64, 1.52 % and 44.12, 41.07 kg/ha), phosphorus content and uptake (0.32, 0.30% and 3.38, 8.11 kg/ha) and potassium content and uptake (1.92, 1.74% and 23.47, 47.01 kg/ha) were recorded with T_{10}-50 kg P_2O T_9-50 kg P_2O_5 ha^{-1} + VAM $_5$ ha^{-1} + PSB + VAM.

Key words: -Biofertilizer; Phosphorus; Nutrient content & uptake

1. Introduction

Black gram [*Vigna mungo* (L.)] also known as urad, mash bean or black gram, belongs to family Fabaceae (Leguminaceae) is an important pulse crop. It is a self-pollinated leguminous crop. The production is not sufficient to meet the per capita requirement. Pulses are the main source of dietary protein particularly for vegetarians and contribute about 14 per cent of the total protein of average Indian diet. Black gram contains about 24 percent protein, 60 percent carbohydrate, 10.9 percent moisture, 1.4 percent fat, 0.9 percent fiber, 3.2 percent minerals and vitamin viz. calcium -154 mg, phosphorus 385mg, iron 9.1 mg and small amount of vitamin B complex (Gajera *et al*. 2014).

Phosphate Solubilizing Bacteria (PSB) plays an important role in solubilization of soil P through secretion of various organic acids (formic, acetic, butyric, propionic, citric, glucomic,

succinic, oxalic, malic, maleic and lactic acids) and make it available to plant. Many fungi, bacteria and actinomycetes are potential solubilizers of bound phosphates in soil. Application of P along with PSB improved phosphorus uptake by plants and yields indicating that the PSB were able to solubilize phosphates and mobilize phosphorus in crop plants. Phosphorus solubilizing bacteria play important role in phosphorus nutrition by enhancing its availability to plants through release from inorganic and organic soil P pools by solubilization and mineralization. Greater efficiency of phosphorus solubilizing bacteria has been shown through co-inoculation with other beneficial bacteria and mycorrhiza (Khan *et al*. 2009).

PSB & VAM inoculum, include some heterotrophic bacteria and fungi, have the ability to solubilizing inorganic phosphorus from insoluble sources, such as, tricalcium phosphate, ferric, aluminum and magnesium phosphate, rock phosphate and bone meal. Vesicular Arbuscular Mycorrhiza (VAM) plays an important role in phosphorus cycling and its uptake by plants (Biswas *et al.* 2006). These symbiotic microorganisms have extensive mycelial network and can increase the transport of other mineral elements such as zinc and copper. VAM fungi can play an important role in enhancing P availability to plants in deficient soils and can save P-fertilizer by 25-30% (Somani *et al*. 2008). It is well known that VAM fungi improve plant growth through increased uptake of relatively immobile nutrients such as P, Zn, Cu). VAM fungi infect the plants, spread inside the root and produce highly branched hyphal structure, known as vesicles and arbuscules, within the host cell (Patel *et al.* 2017).

The present study was conducted to evaluate the beneficial effect of phosphorus and in combination with PSB and VAM inoculums to determine the nitrogen and phosphorus concentration in roots, shoots and grains and their uptake by black gram plant. In most of the pulses, number of branches, number of pods, seed weight and seeds per pod are the major yield components.

2. Materials and Methods

A field experiment was conducted during Rabi season of 2023-24 at experimental farm, Department of Agronomy, Faculty of Agriculture and Veterinary Sciences, Mewar University Gangrar, Chittorgarh (Rajasthan). Soil of the experimental field was sandy loam intexture, saline in reaction with a pH value of 7.6, poor in organic carbon (0.32%), deficient inavailable zinc (0.48 ppm) and iron (1.2 ppm) low in available nitrogen (176 kg/ha) and phosphorus (20.2 kg/ha) but medium in available potassium (320 kg/ha). The experiment was laid out in randomized block design with three replications consisting of ten treatments *viz.* The experiment was laid out in randomized block design with three replications and ten treatments *i.e.* T_1-Control, T_2-PSB, T_3-VAM, T_4-PSB + VAM, T_5-25 kg P_2O_5 ha^{-1} + PSB, T_7-25 kg P_2O_5

ha^{-1} + PSB + VAM, T_8-50 kg P_2O_5 ha^{-1} + PSB, T_9-50 kg P_2O_5 ha^{-1} + VAM and T_{10}-50 kg P_2O_5 ha^{-1} + PSB + VAM. The required quantities of fertilizers as per treatments were applied. The doses of NPK were applied in the form of urea, diammonium phosphate, murate of potash respectively. The half dose of nitrogen gives basal dose and remain two split doses after irrigation and full dose of phosphorus and potassium at basal dose.

3. Results and Discussion

3.1 Yield attributes and yield

Data presented in Table 1.0 that reveals that the maximum number of pods per plant recorded with T_{10}-50 kg P_2O_5 ha^{-1} + PSB + VAM (29.75), it was found at par with T_9-50 kg P_2O_5 ha^{-1} + VAM and T_8-50 kg P_2O_5 ha^{-1} + PSB (28.78 and 28.15), respectively. The minimum number of pods per plant recorded with control treatment (28.15). Data reveals that the maximum number of seed per pod recorded with T_{10}-50 kg P_2O_5 ha^{-1} + PSB + VAM (7.78), it was found at par with T_9-50 kg P_2O_5 ha^{-1} + VAM and T_8-50 kg P_2O_5 ha^{-1} + PSB (7.65 and 7.25), respectively. The minimum number of seed per pod recorded with control treatment (5.25). Data reveals that the maximum grain yield recorded with T_{10}-50 kg P_2O_5 ha^{-1} + PSB + VAM (12.12 q/ha), it was found at par with T_9-50 kg P_2O_5 ha^{-1} + VAM and T_8-50 kg P_2O_5 ha^{-1} + PSB (11.65 and 11.15 q/ha), respectively. The minimum grain yield recorded with control treatment (8.15 q/ha). Data reveals that the maximum straw yield recorded with T_{10}-50 kg P_2O_5 ha^{-1} + PSB + VAM (27.02 q/ha), it was found at par with T_9-50 kg P_2O_5 ha^{-1} + VAM and T_8-50 kg P_2O_5 ha^{-1} + PSB (26.45 and 25.75 q/ha), respectively. The minimum straw yield recorded with control treatment (20.33 q/ha). Similar concluded also observed by Hakeem *et al*. (2008), Mehta *et al*. (2010), Mir *et al*. (2013), Singh and Singh (2013), Singh *et al*. (2016), Yadav *et al*. (2017) and Kachave *et al*. (2018).

3.2 Nutrient content and uptake

3.2.1 Nutrient content (%)

Data revealed (Table 2.0) the maximum nitrogen content in grain was recorded with treatment was recorded T_{10}-50 kg P_2O T_9-50 kg P_2O_5 ha^{-1} + VAM $_5$ ha^{-1} + PSB + VAM (3.64 %). The minimum nitrogen content in grain was recorded with control treatment (3.28 %). Data revealed the maximum nitrogen content in straw was recorded with treatment was recorded T_{10}-50 kg P_2O T_9-50 kg P_2O_5 ha^{-1} + VAM $_5$ ha^{-1} + PSB + VAM (1.52 %). The minimum nitrogen content in straw was recorded with control treatment (1.18 %). Data revealed the maximum phosphorus content in grain was recorded with treatment was recorded T_{10}-50 kg P_2O T_9-50 kg P_2O_5 ha^{-1} + VAM $_5$ ha^{-1} + PSB + VAM (0.32 %). The minimum phosphorus content in grain was recorded with control treatment (0.20 %). Data revealed the maximum phosphorus content in straw was recorded with treatment was recorded T_{10}-50 kg P_2O T_9-50 kg P_2O_5 ha^{-1} + VAM $_5$ ha^{-1}

+ PSB + VAM (0.30 %). The minimum phosphorus content in straw was recorded with control treatment (0.14 %). Data revealed the maximum potassium content in grain was recorded with treatment was recorded T_{10}-50 kg P_2O T_9-50 kg P_2O_5 ha^{-1} + VAM $_5$ ha^{-1} + PSB + VAM (1.92 %). The minimum potassium content in grain was recorded with control treatment (1.70 %). Data revealed the maximum potassium content in straw was recorded with treatment was recorded T_{10}-50 kg P_2O T_9-50 kg P_2O_5 ha^{-1} + VAM $_5$ ha^{-1} + PSB + VAM (1.74 %). The minimum potassium content in straw was recorded with control treatment (1.42 %). Similar result also presented by Khan *et al.* (2009), Ali *et al.* (2012), Das *et al*. (2013), Yadav (2013), Rathour *et al*. (2015), Rani *et al.* (2016), Chaudhary *et al.* (2017) and Dhewa *et al.* (2017).

3.2.2 Nutrient uptake (kg/ha)

Data revealed (Table 3.0 and Figure 1.0) the maximum nitrogen uptake in grain was recorded with treatment was recorded T_{10}-50 kg P_2O T_9-50 kg P_2O_5 ha^{-1} + VAM $_5$ ha^{-1} + PSB + VAM (44.12 kg/ha). The minimum nitrogen uptake in grain was recorded with control treatment (26.73 kg/ha). Data revealed the maximum nitrogen uptake in straw was recorded with treatment was recorded T_{10}-50 kg P_2O T_9-50 kg P_2O_5 ha^{-1} + VAM $_5$ ha^{-1} + PSB + VAM (41.07 kg/ha). The minimum nitrogen uptake in straw was recorded with control treatment (23.99 kg/ha). Data revealed the maximum phosphorus uptake in grain was recorded with treatment was recorded T_{10}-50 kg P_2O T_9-50 kg P_2O_5 ha^{-1} + VAM $_5$ ha^{-1} + PSB + VAM (3.88 kg/ha). The minimum phosphorus uptake in grain was recorded with control treatment (1.63 kg/ha). Data revealed the maximum phosphorus uptake in straw was recorded with treatment was recorded T_{10}-50 kg P_2O T_9-50 kg P_2O_5 ha^{-1} + VAM $_5$ ha^{-1} + PSB + VAM (8.11 kg/ha). The minimum phosphorus uptake in straw was recorded with control treatment (2.85 kg/ha). Data revealed the maximum potassium uptake in grain was recorded with treatment was recorded T_{10}-50 kg P_2O T_9-50 kg P_2O_5 ha^{-1} + VAM $_5$ ha^{-1} + PSB + VAM (23.47 kg/ha). The minimum potassium uptake in grain was recorded with control treatment (13.86 kg/ha). Data revealed the maximum potassium uptake in straw was recorded with treatment was recorded T_{10}-50 kg P_2O T_9-50 kg P_2O_5 ha^{-1} + VAM $_5$ ha^{-1} + PSB + VAM (47.01 kg/ha). The minimum potassium uptake in straw was recorded with control treatment (28.87 kg/ha). These findings also supported by Basu *et al.* (2006), Mohammad *et al.* (2017) and Singh *et al.* (2017).

Conclusion

It is concluded from the present investigation that the application of phosphorus @ 50 kg/ha with co-inoculation of Bio-fertilizer (PSB + VAM) to get maximum yield and nutrients uptake of Black gram. However, the treatment 50 kg/ha and inoculation with PSB and VAM superior among all treatments.

Table 1.0 Effect of biofertilizer and phosphorus yield attributes and yield of black gram

Treatments	Number of pods per plant	Number of seed per pod	Grain yield (q/ha)	Straw yield (q/ha)
T_1-Control	22.80	5.25	8.15	20.33
T_2-PSB	23.10	6.52	9.10	22.36
T_3-VAM	23.96	6.65	9.40	22.85
T_4-PSB + VAM	24.58	6.78	9.58	23.15
T_5-25 kg P_2O_5 ha^{-1} + PSB	25.25	6.96	9.85	23.96
T_6-25 P_2O_5 ha^{-1} + VAM	26.75	7.10	10.36	24.85
T_7-25 kg P_2O_5 ha^{-1} + PSB + VAM	27.63	7.18	10.78	25.25
T_8-50 kg P_2O_5 ha^{-1} + PSB	28.15	7.25	11.15	25.75
T_9-50 kg P_2O_5 ha^{-1} + VAM	28.78	7.65	11.65	26.45
T_{10}-50 kg P_2O_5 ha^{-1} + PSB + VAM	29.75	7.78	12.12	27.02
S. Em. ±	0.55	0.18	0.33	0.60
CD (0.05%)	1.62	0.55	1.00	1.80

Table 2.0 Effect of biofertilizer and phosphorus on nitrogen, phosphorus and potassium content in grain and straw

Treatments	Nitrogen content (%)		Phosphorus content (%)		Potassium content (%)	
	Grain	Straw	Grain	Straw	Grain	Straw
T_1-Control	3.28	1.18	0.20	0.14	1.70	1.42
T_2-PSB	3.32	1.22	0.23	0.16	1.75	1.48
T_3-VAM	3.36	1.26	0.22	0.15	1.77	1.55
T_4-PSB + VAM	3.40	1.28	0.24	0.20	1.80	1.60
T_5-25 kg P_2O_5 ha^{-1} + PSB	3.45	1.32	0.27	0.23	1.82	1.65
T_6-25 P_2O_5 ha^{-1} + VAM	3.48	1.36	0.26	0.22	1.85	1.68
T_7-25 kg P_2O_5 ha^{-1} + PSB + VAM	3.52	1.40	0.29	0.25	1.88	1.69
T_8-50 kg P_2O_5 ha^{-1} + PSB	3.56	1.45	0.31	0.28	1.89	1.70
T_9-50 kg P_2O_5 ha^{-1} + VAM	3.60	1.48	0.30	0.26	1.90	1.72
T_{10}-50 kg P_2O_5 ha^{-1} + PSB + VAM	3.64	1.52	0.32	0.30	1.92	1.74
S. Em. ±	0.03	0.02	0.01	0.01	0.01	0.01
CD (0.05%)	0.08	0.07	0.02	0.04	0.03	0.04

Table 3.0 Effect of biofertilizer and phosphorus on nitrogen, phosphorus and potassium uptake in grain and straw

Treatments	Nitrogen uptake (kg/ha)		Phosphorus uptake (kg/ha)		Potassium uptake (kg/ha)	
	Grain	Straw	Grain	Straw	Grain	Straw
T_1-Control	26.73	23.99	1.63	2.85	13.86	28.87
T_2-PSB	30.21	27.28	2.09	3.58	15.93	33.09
T_3-VAM	31.58	28.79	2.07	3.43	16.64	35.42
T_4-PSB + VAM	32.57	29.63	2.30	4.63	17.24	37.04
T_5-25 kg P_2O_5 ha^{-1} + PSB	33.98	31.63	2.66	5.51	17.93	39.53
T_6-25 P_2O_5 ha^{-1} + VAM	36.05	33.80	2.69	5.47	19.17	41.75
T_7-25 kg P_2O_5 ha^{-1} + PSB + VAM	37.95	35.35	3.13	6.31	20.27	42.67
T_8-50 kg P_2O_5 ha^{-1} + PSB	39.69	37.34	3.46	7.21	21.07	43.78
T_9-50 kg P_2O_5 ha^{-1} + VAM	41.94	39.15	3.50	6.88	22.14	45.49
T_{10}-50 kg P_2O_5 ha^{-1} + PSB + VAM	44.12	41.07	3.88	8.11	23.27	47.01
S. Em. ±	1.50	1.26	0.15	0.43	0.75	1.08
CD (0.05%)	4.52	3.75	0.45	1.30	2.26	3.25

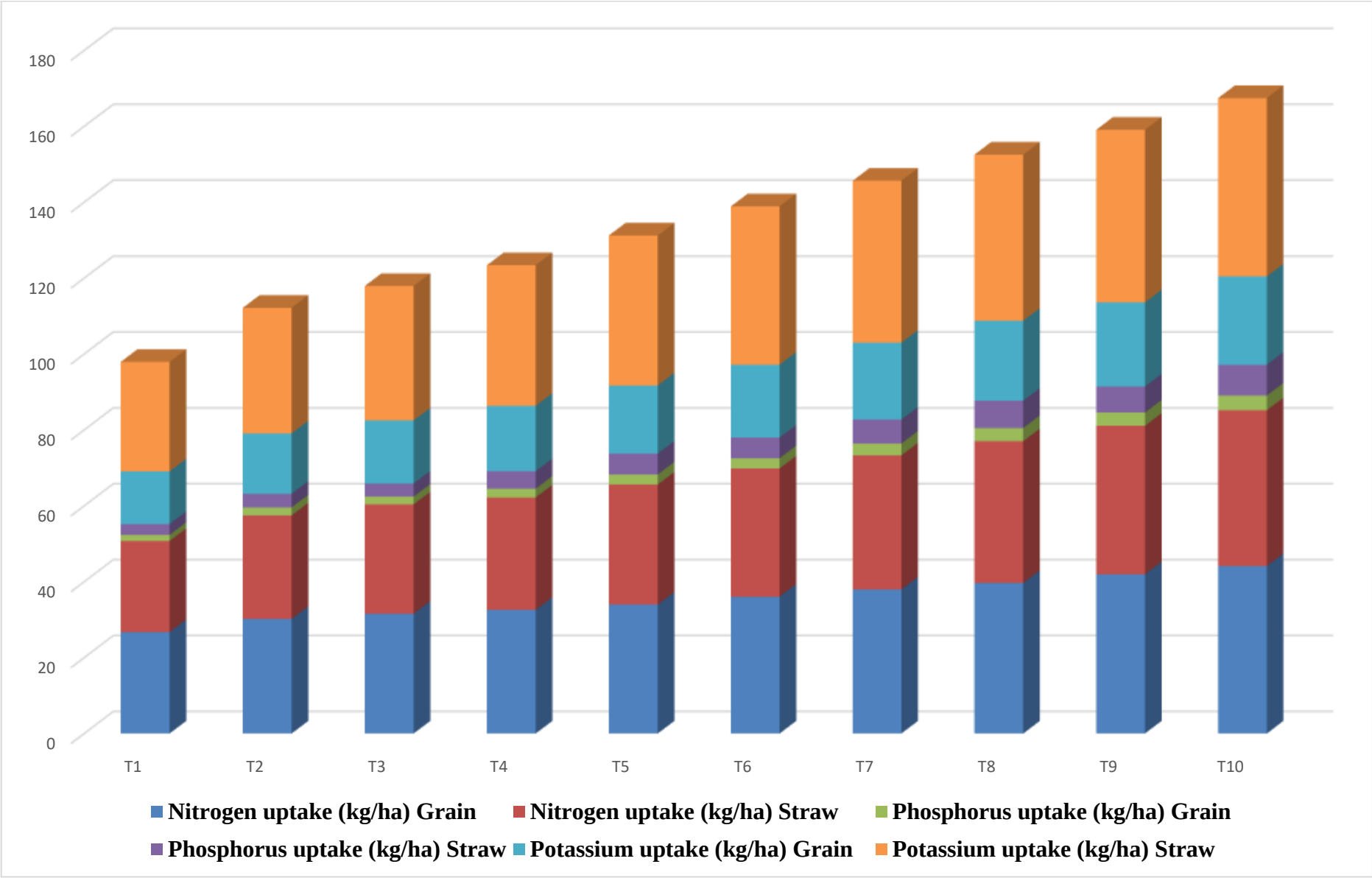

Figure 1.0 Effect of biofertilizer and phosphorus on nitrogen, phosphorus and potassium uptake in grain and straw

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