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Effect of organic formulations on growth and yield of summer greengram (*Vigna radiata* L.)

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Abstract
A field experiment was conducted to study the effect of organic formulations on growth and yield of summer greengram (*Vigna radiata* L.) during the year 2021 at Department of Seed Technology, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar. Twelve treatments combinations comprising of 75% RDF with foliar spray of vermiwash, matka khad, cow urine each @ 10% and *panchgavya* @ 4% at 30 and 45 DAS, foliar spray of *panchgavya* @ 4% either with vermiwash, cow urine or matka khad @ 10% at 30 DAS, foliar spray of vermiwash either with matka khad or cow urine, all @ 10% at 30 DAS, foliar spray of cow urine and matka khad each @ 10% at 30 DAS, foliar spray of water at 30 and 45 DAS as well as 100% RDF were tested in Randomized Block Design replications on loamy sand soil. RDF (75%) with foliar spray of *panchgavya* @ 4% and cow urine @ 10% at 30 DAS resulted in significantly higher growth attributes *viz.*, plant height (69.90 cm), root nodules/plant (12.26) and days to 80% maturity (68.33) as well as yield attributes *viz.*, pods/plant (29.2), seeds/pod (12.34), seed (1987 kg/ha) and stover (4437 kg/ha) yield. Considering the growth and yield parameter, it is concluded that should be applied with 75% RDF (15:30:00 kg/ha N:P_2O_5:K_2O) and foliar spray of *panchgavya* @ 4% along with either cow urine or vermiwash each @ 10% at 30 days after sowing.

Keywords: Greengram, *Panchgavya*, vermiwash, cow urine, matka khad, organic foliar spray

Introduction
Pulses are considered as life blood of agriculture because they occupy unique position almost in all cropping systems as main, catch, cover, green manure, intercrop and its inclusion in crop rotation. They are annual leguminous crops yielding between one and twelve grains or seeds of variable size, shape and colour within a pod, used for both food and feed. They keep the soil alive and productive as well as enrich the soil fertility in terms of addition of organic matter and nitrogen through biological nitrogen fixation through *Rhizobia*. Besides, serving as an important source of protein for a large portion of the global population, pulses contribute to healthy soils and climate change mitigation through their nitrogen-fixing properties. Pulses are rich source of protein (20 to 25%) having ability of fixing atmospheric nitrogen in soil i.e. 30-150 kg/ha and consistent source of income and employment to small and marginal farmers. Considering their importance, 2016 was declared as "International Year of Pulses" by United Nations with the objectives of increasing production and consumption of pulses and creating awareness of benefits of pulses by utilizing social media.

Pulses are the wonderful gift of nature to us as when they are in combination with cereals, a balanced diet is formed for relatively a large number of vegetarian Indians. Greengram (*Vigna radiata* L.) is an important popular pulse crop of India. Greengram is a rich source of protein (24.5%) with high quality of tryptophan (60 mg/g) and lysine (460 mg/g). It also contains riboflavin (0.21 mg/100 g) with good amount of minerals and has a significant quantity of ascorbic acid when sprouted (Gopalan *et al*., 1995) [4]. Being a short duration crop, it can grow well in multiple and intercropping systems. The plants may be used as green manure or fodder purpose after picking of pods. Split seeds can be changed into dal in the same way as lentils or blackgram. The seeds can be processed to make starch noodles (bean thread noodles, vermicelli) or soup. The sprouted seeds are served raw or cooked throughout the world. The sprouted seeds of greengram are rich in thiamine, riboflavin and ascorbic acid (Khangarot *et al*., 2023) [6].

The young leaves and immature pods are eaten as a vegetable. Numerous greengram products are very useful for livestock feeding. Greengram bran (churi) is used for the manufacturing of greengram vermicelli which is the byproduct of dehulling for making dal.

Panchgavya, an organic product has the potential to play the role of promoting growth and providing immunity in plant system. *Panchgavya* consists of eight products *viz.*, cow-dung, cow-urine, cow-milk, curd, cow-jaggery, cow-ghee, banana and water. When properly mixed and used, these have miraculous effect. Physico-chemical properties of *panchgavya* show that they possess almost all the major nutrients, micronutrients and growth hormones (IAA and GA) required for crop growth (Sundararaman *et al.*, 2001) [14]. It contains properties like naturally occurring, beneficial, effective micro-organisms, predominantly lactic acid bacteria, yeast, actinomycetes and photosynthetic bacteria. *Panchgavya* is the eco-friendly organic compounds made from five basic cow products, which have capacity to bring the flow of, consume energy which in turn can revitalize the growth process of plants.

Vermiwash is the spent wash collected at the passage of water through a column of earthworm culture. The spent wash is collected through a drainage pipe provided at the bottom of the vermicompost pit. The wash is a collection of excretory products and excess secretions of earthworms along with micronutrients from soil organic molecules (Yuvaraj, 2007) [18]. Vermiwash obtained from dissolution of organic matter by earthworm is also found as a good liquid manure and significantly affects the growth and productivity of crop during foliar spray (Subasasri, 2003) [12]. Vermiwash contains 0.50 per cent nitrogen, 0.39 per cent phosphorus and 0.46 per cent potassium (Jasmin, 1999) [5]. It is coelomic fluid extraction which contains several enzymes, plant growth stimulating hormones like cytokinins, gibberlines and vitamins along with micro-nutrients and macro-nutrients as nitrogen in the form of mucus and nitrogenous excretory substances (Tripathi and Bhardwaj, 2004) [15]. It also increases the disease resistant power of crop (Yadav *et al.*, 2005) [17]. Vermiwash contains enzymes and secretions of earthworms which ultimately influences the growth of crops. Apart from organic acids, it also contains a rich source of soluble plant nutrients stimulating crop growth (Shivsubramanian and Ganeshkumar, 2004) [13].

Cow urine has very special impact in Indian tradition so, it is said to have a spiritual cleansing produce as well. Cow urine is also mentioned as water of life or “Amrita” and the nectar of the silicon, iron, tartaric, citric and calcium salts, enzymes, vitamins ‘A’, ‘B’, ‘C’, ‘D’, ‘E’, minerals, lactose, creatinine, gold acids and hormones (Pathak and Kumar, 2003) [7]. Cow urine could be an effective source to improve soil fertility, quality and productivity of crops. This can also be a potential substitute for fertigation which is very common in various crops. The use of cow urine in different crops can be considered as a low cost input and beneficial agriculture practice for good crop production.

Matka khad is an organic product used in agricultural crops to enhance the plant growth by supplying growth stimulators and various nutrients. Microbial analysis of the matka khad indicated higher count of microbial population including *Azatobacter*, Actinomycetes and Phosphate solubilizers which resulted in higher growth and yield. Scientific studies on role of matka khad in agriculture are very limited (Chadha *et al.*, 2012) [2].

Material and Methods

The field experiment was conducted at Department of Seed Technology, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during summer 2021. All over climatological data indicated that the weather conditions were observed normal and favourable for the satisfactory growth and development of the greengram crop during summer season of 2021. Total Twelve treatments *viz.*, T_1: 75% RDF with foliar spray of vermiwash @ 10% at 30 and 45 DAS, T_2: 75% RDF with foliar spray of *panchgavya* @ 4% at 30 and 45 DAS, T_3: 75% RDF with foliar spray of matka khad @ 10% at 30 and 45 DAS, T_4: 75% RDF with foliar spray of cow urine @ 10% at 30 and 45 DAS, T_5: 75% RDF with foliar spray of *panchgavya* @ 4% and vermiwash @ 10% at 30 DAS, T_6: 75% RDF with foliar spray of vermiwash @ 10% and matka khad @ 10% at 30 DAS, T_7: 75% RDF with foliar spray of vermiwash @ 10% and cow urine @ 10% at 30 DAS, T_8: 75% RDF with foliar spray of *panchgavya* @ 4% and cow urine @ 10% at 30 DAS, T_9: 75% RDF with foliar spray of cow urine @ 10% and matka khad @ 10% at 30 DAS, T_{10}: 75% RDF with foliar spray of *panchgavya* @ 4% and matka khad @ 10% at 30 DAS, T_{11}: 75% RDF with foliar spray of water at 30 and 45 DAS, T_{12}: RDF 100% (20:40:00, N:P_2O_5:K_2O, kg/ha) were tried in randomized blok design with three replications. Greengram variety Gujarat Mungbean 4 was used as a test crop. The soil of experimental field was loamy sand in texture, low in organic carbon (0.169%), low in available nitrogen (112.90 kg/ha) and medium in available phosphorus (82.07 kg/ha) and high in available potash (181.44 kg/ha).

Results and Discussion

Effect on growth and growth attributes

Plant population per meter row length at 20 DAS and at harvest was not significantly influenced due to foliar application of different organic formulations. Sufficient soil moisture present at the time of germination and during initial growth stage was responsible for maintaining the satisfactory plant population in the experiment. The results show that the maximum plant height at the time of harvest of 69.90 cm was observed with application of 75% RDF with foliar spray of *panchgavya* @ 4% and cow urine @ 10% at 30 DAS. It might be due to the application of *panchgavya* which attributed to increased availability of cytokinin to shoot which played a role in cell elongation process either through cell division or cell elongation and enhanced the growth rate of plant since it contains the favourable macro and micro-nutrients, growth hormones and microbes in liquid formulation. Cow urine consists of uric acid, ammonical nitrogen which may easily absorbed by crop plants. These results were in close vicinity with the findings of Saini *et al.* (2022) [9], Sakpal *et al.* (2022) [10], Bhawariya *et al.* (2022) [1], Pavithra *et al.* (2021) [8] and Vighneshawaran *et al*. (2020) [16].

It is clearly seen from the data presented in Table 1 that days to 80% maturity significantly influenced in treatment T_2 (75% RDF with foliar spray of *panchgavya* @ 4% at 30 and 45 DAS) showed earliness in days to 80% maturity (65.00 days). The very late occurrence of days to 80% maturity (68.33 days) was observed under the treatment T_8 (75% RDF with foliar spray of *panchgavya* @ 4% and cow urine @ 10% at 30 DAS).

Significant difference were observed in number of root nodules per plant due to the application of 75% RDF with foliar spray of *panchgavya* @ 4% and cow urine @ 10% at 30 DAS (T_8) recorded significantly higher number of root nodules per plant (12.26) over rest of the treatments and significantly the lowest number of root nodules per plant (7.06) was recorded with treatment T_{11} (75% RDF with foliar spray of water at 30 and 45 DAS). The increase in number of root nodules per plant might

be due to the application of *panchgavya* contained favourable macro and micro nutrients, growth hormones and microorganism *viz.*, *Azospirillum*, *Azotobacter*, *Phosphobacter* and *Pseudomonas* in formulation which played an important role in root development and proliferation resulting in better nodule formation and nitrogen fixation by supplying assimilates to the roots and better environment in rhizosphere for growth and development. Cow urine provided good source of uric acid, ammonical nitrogen. These results were in close vicinity with the findings of Vighneshawaran *et al*. (2020) [16] and Chaudhari *et al.* (2013) [3].

Effect on yield and yield attributes

The data presented in Table 2 revealed that significantly higher number of pods per plant (29.2) was produced under treatment T_8 (75% RDF with foliar spray of *panchgavya* @ 4% and cow urine @ 10% at 30 DAS). However, it was found statistically at par with treatments T_5 (28.2), T_2 (27.0) and T_{12} (24.9). The lowest number of pods per plant (14.2) was noted with treatment T_{11} (75% RDF with foliar spray of water at 30 and 45 DAS). This might be due to easy transfer of nutrients to plant through foliar spray of *panchgavya* and the quantities of IAA and GA present in *panchgavya* could have created the stimuli in the plant system which in turn increased the production of growth regulators in cell system. Hence, stimulated the necessary growth and development in plants, leading to significant increase in number of pods per plant. These findings were in agreement with those reported by Sakpal *et al.* (2022) [10], Bhawariya *et al.* (2022) [1], Sridhara *et al*. (2022) [11].

The data presented in Table 2 revealed higher number of seeds per pod (12.34) was observed with 75% RDF with foliar spray of *panchgavya* @ 4% and cow urine @ 10% at 30 DAS (T_8) and was found at par with 75% RDF with foliar spray of *panchgavya* @ 4% and vermiwash @ 10% at 30 DAS (T_5), RDF 100% (20:40:00, N:P_2O_5:K_2O kg/ha) (T_{12}) and 75% RDF with foliar spray of *panchgavya* @ 4% at 30 and 45 DAS (T_2). The lowest number of seeds per pod (9.33) was noted with treatment T_{11} (75% RDF with foliar spray of water at 30 and 45 DAS). The foliar applications having beneficial effects on cell elongation and cell division that increased photosynthetic activity and supported efficient translocation of the photosynthates from source to sink. These findings were in agreement with Bhawariya *et al.* (2022) [1], Sakpal *et al.* (2022) [10] and Vighneshawaran *et al*. (2020) [16].

Table 1: Effect of organic formulations on plant population and growth attributes of summer greengram

Treatment	Plant population (per meter row length)		Plant height at harvest (cm)	No. of branches per plant	Days to 50% flowering	Days to 80% maturity	No. of root nodules per plant at flowering	Weight of root nodule per plant (mg)	
	20 DAS	At harvest						Fresh	Dry
T_1: 75% RDF with foliar spray of vermiwash @ 10% at 30 and 45 DAS	10.66	9.29	64.06	3.87	45.97	66.00	9.19	1440.9	312.1
T_2: 75% RDF with foliar spray of *panchgavya* @ 4% at 30 and 45 DAS	11.40	9.73	67.42	4.40	45.27	65.00	10.59	1540.5	333.2
T_3: 75% RDF with foliar spray of matka khad @ 10% at 30 and 45 DAS	10.66	9.79	51.78	3.60	46.63	68.00	7.33	1323.5	262.5
T_4: 75% RDF with foliar spray of cow urine @ 10% at 30 and 45 DAS	10.83	9.46	66.04	3.93	46.30	67.00	9.73	1482.9	312.6
T_5: 75% RDF with foliar spray of *panchgavya* @ 4% and vermiwash @ 10% at 30 DAS	11.80	9.93	67.62	4.47	46.97	67.67	10.93	1602.7	368.2
T_6: 75% RDF with foliar spray of vermiwash @ 10% and matka khad @ 10% at 30 DAS	13.20	8.73	63.16	3.67	45.97	66.00	7.66	1381.3	312.1
T_7: 75% RDF with foliar spray of vermiwash @ 10% and cow urine @ 10% at 30 DAS	10.60	9.23	64.06	3.80	46.97	67.67	8.79	1436.1	295.2
T_8: 75% RDF with foliar spray of *panchgavya* @ 4% and cow urine @ 10% at 30 DAS	12.03	9.96	69.90	4.80	46.97	68.33	12.26	1675.7	387.6
T_9: 75% RDF with foliar spray of cow urine @ 10% and matka khad @ 10% at 30 DAS	11.86	8.59	56.83	3.60	46.63	66.67	7.46	1341.7	220.0
T_{10}: 75% RDF with foliar spray of *panchgavya* @ 4% and matka khad @ 10% at 30 DAS	10.43	8.83	63.86	3.73	46.97	67.33	8.39	1402.4	272.8
T_{11}: 75% RDF with foliar spray of water at 30 and 45 DAS	10.46	8.43	50.49	3.77	45.63	66.00	7.06	1296.8	246.6
T_{12}: RDF 100% (20:40:00, N:P_2O_5:K_2O kg/ha)	11.30	9.63	67.03	4.20	46.63	66.00	8.88	1488.3	309.8
S.Em.±	0.46	0.37	4.06	0.27	2.05	0.66	0.35	86.37	24.02
C.D. (P = 0.05)	NS	NS	12.33	NS	NS	2.00	1.07	NS	NS
C. V. %	7.01	6.95	11.23	11.71	7.65	7.22	6.78	10.31	13.74

Table 2: Effect of organic formulations on yield and yield attributes of summer greengram

Treatment	No. of pods/plant	Pod length (cm)	No. of seeds/pod	Seed index (g)	Yield (kg/ha)		Harvest index (%)
					Seed	Stover	
T_1: 75% RDF with foliar spray of vermiwash @ 10% at 30 and 45 DAS	22.8	8.99	10.39	4.66	1708	3800	43.15
T_2: 75% RDF with foliar spray of *panchgavya* @ 4% at 30 and 45 DAS	27.0	9.35	11.03	4.86	1831	4205	44.09
T_3: 75% RDF with foliar spray of matka khad @ 10% at 30 and 45 DAS	14.9	8.31	9.42	4.51	1274	3330	38.08
T_4: 75% RDF with foliar spray of cow urine @ 10% at 30 and 45 DAS	23.6	8.94	10.63	4.98	1725	3932	43.57
T_5: 75% RDF with foliar spray of *panchgavya* @ 4% and vermiwash @ 10% at 30 DAS	28.2	9.33	11.36	4.68	1917	4353	44.37
T_6: 75% RDF with foliar spray of vermiwash @ 10% and matka khad @ 10% at 30 DAS	16.9	8.77	9.98	4.62	1551	3522	44.69
T_7: 75% RDF with foliar spray of vermiwash @ 10% and cow urine @ 10% at 30 DAS	21.3	8.88	10.39	4.89	1701	3771	45.27
T_8: 75% RDF with foliar spray of *panchgavya* @ 4% and cow urine @ 10% at 30 DAS	29.2	9.46	12.34	4.64	1987	4437	45.33
T_9: 75% RDF with foliar spray of cow urine @ 10% and matka khad @ 10% at 30 DAS	16.5	8.66	9.50	4.53	1458	3504	42.22
T_{10}: 75% RDF with foliar spray of *panchgavya* @ 4% and matka khad @ 10% at 30 DAS	20.0	8.83	10.31	4.75	1623	3452	46.57
T_{11}: 75% RDF with foliar spray of water at 30 and 45 DAS	14.2	7.15	9.33	4.41	1184	3100	38.69
T_{12}: RDF 100% (20:40:00, N:P_2O_5:K_2O kg/ha)	24.9	9.22	11.05	4.66	1774	4265	42.04
S.Em.±	1.50	0.42	0.44	0.21	104.6	271.9	2.46
C.D. (P = 0.05)	4.56	NS	1.33	NS	318	825	NS
C. V. %	12.04	8.24	7.25	7.76	11.02	12.38	9.86

Effect of different treatments with respect to pod length and seed index was found non-significant. It indicated the uniform pod length and seed index under all the treatments.

Data presented in the table 2, revealed that Spectacular enhancement in seed and stover yields (1987 kg/ha and 4437 kg/ha) respectively was achieved under 75% RDF with foliar spray of *panchgavya* @ 4% and cow urine @ 10% at 30 DAS followed by 75% RDF with foliar spray of *panchgavya* @ 4% and vermiwash @ 10% at 30 DAS and 75% RDF with foliar spray of *panchgavya* @ 4% at 30 and 45 DAS. Significantly, the lowest seed yield (1184 kg/ha) was produced under treatment T_{11} (75% RDF with foliar spray of water at 30 and 45 DAS). Moreover, in present study, organic liquid formulation of cow urine and *panchgavya* which contained naturally occurring beneficial and effective microorganisms, lactic acid bacteria and certain fungi besides beneficial and proven fertilizers such as *Rhizobium* and *Phosphobacterium* which might have helped in uptake of nutrients due to increasing the supply of easily assimilated major nutrients *viz*., N and P by symbiotic nitrogen fixation by *rhizobium* and mobilizing unavailable phosphorus into available form by *Phosphobacterium* and at the same time improved soil physical condition that in turn gave higher seed and stover yield. These findings were in agreement with Sakpal *et al.* (2022) [10], Bhawariya *et al.* (2022) [1], Vighneshawaran *et al*. (2020) [16].

The data indicated that different treatments tried in this experiment did not exert their significance effect on harvest index.

Conclusion

On the basis of present finding, it can be concluded that the application of 75% RDF with foliar spray of *panchgavya* @ 4% and cow urine @ 10% at 30 DAS was found suitable for higher significant growth and yield attributes. Summer greengram crop should be fertilized with 75% RDF (15: 30: 00 kg/ha N:P_2O_5:K_2O) along with foliar spray of *panchgavya* @ 4% and either cow urine or vermiwash each @ 10% at 30 days after sowing.

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