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Influence of foliar nutrients on yield attributes and yield of greengram

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Abstract
A field experiment was carried out during summer 2021 in field no. B1 at wetland farm, Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore to find out the influence of foliar nutrients on yield and yield attributes of green gram. The experiment field was geographically located in western agro climatic zone of Tamil Nadu at 11ºN latitude and 77ºE longitude and at an altitude of 426.7 meters above the Mean Sea Level (MSL). The texture of the experimental site was clay loam. The experiment was laid out in randomized block design replicated thrice. The treatment consists of T_1: 2% DAP at peak flowering and pod initiation stage. T_2: 2% 19:19:19 at peak flowering and pod initiation stage. T_3: 1% FFW + 1% EAA + 40 ppm NAA + 1% Coconut water at peak flowering and pod initiation stage. T_4: 2% FFW + 2% EAA + 40 ppm NAA + 2% Coconut water at peak flowering and pod initiation stage. T_5: 1% MAP + 0.5% KCl + 0.5% $FeSO_4$ + 0.5% $ZnSO_4$ + 0.5% $CaCl_2$ + 40 ppm NAA at peak flowering and pod initiation stage. T_6: 2% MAP + 1% KCl + 1% $FeSO_4$ + 1% $ZnSO_4$ + 1% $CaCl_2$ + 40 ppm NAA at peak flowering and pod initiation stage. T_7: Control (Water spray + pulse wonder). T_8: Absolute control. The results revealed foliar application of (T_6) - 2% MAP + 1% KCl + 1% $FeSO_4$ + 1% $ZnSO_4$ + 1% $CaCl_2$ + 40 ppm NAA at peak flowering and pod formation stage recorded higher yield and pod setting percentage and it was 24.70% yield increase over absolute control and which was on par with foliar application of (T_4) - 2% Fermented fish waste + 2% Egg amino acid + 2% coconut water + 40 ppm NAA.

Keywords: Green gram, foliar spray, fermented fish waste, egg amino acid

1. Introduction
Green gram (*Vigna radiata* L.) an important pulse crop after chickpea and red gram belonging to Leguminaceae family. It is a short duration crop grown during all the three season of summer, kharif and *rabi*. It can be cultivated in soil having low nutrient content without requiring much need of irrigation and other inputs. It has the ability to fix atmospheric nitrogen into soil with the help of *rhizobium* (Nawange *et al.*, 2011) [13]. Because of its short duration and nitrogen fixing ability, it can be mostly cultivated as intercrop, catch crop and relay crop. In India the total area for green gram production is 4.58 M ha having annual production of 2.5 M T comprising 10.89% of total pulse production (Indiastat, 2020) [8]. To increase the production of greengram, it is necessary to identify the constraints in cultivation of green gram and adopt appropriate measures to reduce the constraints with the help of agriculture technologies. Among several constraints which affect the yield of green gram, flower drop is one the important factor which determines the yield of the crop. Greengram crop has the ability to produce large number of flowers, but most of them were abscise (Sinha, 1974) [16]. In green gram crop about 70% of flowers were failed to develop into pods (Mondal *et al.*, 2011) [12]. Kaul *et al.* (1976) [9] indicated the similar findings that flower drop in green gram, black gram and cowpea were 46%, 39.7% and 53.7%. Thus it indicates that green gram crop has the capability to produce more yield than it actually produced. In pulses usually the extent of flower shed will determine the yield and retention of flowers increases the actual yield of greengram (Bhavya *et al.*, 2020) [2]. This constraint can be tackled either by breeding methods or by agronomic practices. Chaurasia *et al.* (2005) [4] reported that flower drop can be controlled by foliar application of nutrients. Foliar application of nutrients and plant growth regulators at pre flowering and pod formation stage reduces the flower dropping percentage in pulses (Ganapathy *et al.*, 2008) [6]. Besides controlling flower drop, foliar application of nutrients at critical stages of crop growth also enhances the growth parameters of greengram. Foliar application of nutrients has the advantage of reducing nutrient loss through leeching and fixation and it regulates the uptake of nutrients by quick and efficient absorption of nutrients.

Thus foliar application of plant growth regulators and water soluble fertilizers containing both macro and micro nutrients at critical stage of crop growth helps to boost up the productivity of green gram. Keeping this point the study was conducted with the objective of foliar application of nutrients to increase the yield parameters and yield of green gram.

2. Materials and Methods

A field experiment was carried out during summer 2021 in field no. B1 at wetland farm, Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore to find out the influence of foliar nutrients on yield and yield attributes of green gram. The experiment field was geographically located in western agro climatic zone of Tamil Nadu at 11ºN latitude and 77ºE longitude and at an altitude of 426.7 meters above the Mean Sea Level (MSL). The soil of the experimental field was clay loam having pH and EC of 8.4 and 0.84 dS m^{-1}. Green gram variety of CO 8 was sown with the spacing of 30 x 10 cm. The recommended dose of fertilizer 25, 50, 25 and 40 kg NPKS ha^{-1} were applied. The experiment was laid out in randomized block design replicated thrice. The treatment consists of T_1: 2% DAP at peak flowering and pod initiation stage. T_2: 2% 19:19:19 at peak flowering and pod initiation stage.T_3: 1% FFW + 1% EAA + 40 ppm NAA + 1% Coconut water at peak flowering and pod initiation stage.T_4: 2% FFW + 2% EAA + 40 ppm NAA + 2% Coconut water at peak flowering and pod initiation stage. T_5: 1% MAP + 0.5% KCl + 0.5% $FeSO_4$ + 0.5% $ZnSO_4$ + 0.5% $CaCl_2$ + 40 ppm NAA at peak flowering and pod initiation stage.T_6: 2% MAP + 1% KCl + 1% $FeSO_4$ + 1% $ZnSO_4$ + 1% $CaCl_2$ + 40 ppm NAA at peak flowering and pod initiation stage.T_7: Control (Water spray + pulse wonder). T_8: Absolute control The results revealed foliar application of (T_6) - 2% MAP + 1% KCl + 1% $FeSO_4$ + 1% $ZnSO_4$ + 1% $CaCl_2$ + 40 ppm NAA at peak flowering and pod formation stage. Fermented fish waste was prepared as per the procedure described by Vincent *et al.* (2014) [18].

Fermented fish waste was prepared in a plastic container. The fish waste was collected from nearby fish market for free of cost. 1 Kg of Fish Waste was cut down into small piece and they were mixed with finely powdered brown sugar. Then 5 litres of water were added and incubated at room temperature. The pH of the fish waste product was measured daily until it reaches the pH 4. The product was then filtered using gauze of 1 mm^2 pore size, and then it is used for application of foliar spray.

Preparation of Egg amino acid, the egg and brown sugar were taken in the ratio of (1:25 g). The eggs were taken in the container and adequate amount of lemon juice were poured. The juice should were taken enough, so that the eggs should be immersed in the juice. The containers were covered to prevent aeration and they were kept away from direct sunlight. After 20 days the eggs appeared as rubber and the product were mixed thoroughly. Then after two weeks, the product was filtered and taken for foliar spray application (Winnie and Scaria, 2018) [19].

The spray solutions of 2% DAP was prepared by soaking 20 g of DAP in water overnight and the supernent solution was made up to one litre of water and for 2% 19:19:19 mix 20 g of 19:19:19 in 1 litre of water.

For preparation of treatment T_5 foliar spray solution, 10 g of MAP, 5 g of KCl, 5 g of $FeSO_4$, 5 g of $ZnSO_4$, 5 g of $CaCl_2$ was taken and mixed it with 1 liter water. T_6- foliar spray solution preparation, 20 g of MAP, 10 g of KCl, 10 g of $FeSO_4$, 10 g of $ZnSO_4$ 10 g of $CaCl_2$ was taken and mixed it with 1 liter of water. For preparation of 40 ppm NAA solution it was taken 0.9 ml of Planofix was make up to 1 liter with water. Five plants were tagged from each plot and number of flowers and pods were recorded at 3 days interval after foliar spray. The counted flowers and pods were marked by using permanent marker to avoid counting of same flower again. The yield attributes were recorded at harvest stage of green gram. The data were analysed and interpreted by using the AGRESS software at 5% analysis of variance.

3. Result and Discussion

3.1 Effect of foliar spraying of nutrients on flower production

The total number of flowers produced by the green gram for different treatments were recorded and presented in the Table 1 and illustrated on Fig 1. Even though there is no significant difference between treatments in total number of flowers produced per plant, the treatment T_6 produced more number of flowers (61.73) when compared to other treatments. This might be due high leaf area and number of leaves per plant formed due to higher supply of nutrients enables the plant to maximize the absorption of sunlight, production and translocation of photosynthates from leaves to reproductive parts of plant and thus induces flowering and presence of 40 ppm NAA in that treatment which may influences the floral bud formation. Similar results was observed by Sujatha (2001) [17]. Apart from that, presence of KCl in the foliar spray solution helps to obtain more number of flowers by reducing the stress and enhancing the efficient translocation of photosynthates. Most of the flower production was occurred within 12 days of flowering period. This finding was coincide with statement given by Mondal (2007) [11] that most of the high yielding greengram varieties produce most of the flowers within 10-12 Days after flowering. After that flower production slowed down and completely ended at 18th Days after flowering.

3.2 Effect of foliar spraying of nutrients on pods production and pod setting percentage

The data containing pod production at three days interval, total number of pods $plant^{-1}$, pod setting percentage and flowers dropped were analyzed and presented in the Table 2 and illustrated on Fig 2. Number of pods $plant^{-1}$ is one of the important yield parameter of green gram crop and it was showed that foliar spraying of T_6 produced significantly higher pods per plant (29.32) and it is on par with T_4 (27.57). Pod formation is higher in T_6 at entire reproductive stage of pod formation. This might be due to high pod setting percentage (47.28%) and lower flower drop (32.73) by T_6 and second highest pod setting percentage (45.53%) and second lowest flower drop (32.95) was recorded by T_4. Pod setting and flower drop influences the number of pods $plant^{-1}$ at entire reproductive stage of crop growth. T_6 foliar spray treatment containing 2% MAP + 1% KCl + 1% $FeSo_4$ + 1% $ZnSo_4$ + 1% $CaCl_2$ + 40 ppm NAA reduces the flower drop in greengram. Ca and K ion present in this foliar spray plays a major role in efficient translocation of photosynthates and carbohydrates from source to sink (Cakmak *et al.*, 1994; Nayyar, 2003) [3, 14]. Thus, efficient translocation of assimilates form source to sink increases the pod yield and reduces the flower drop in greengram. Ganapathy *et al.* (2008) [6] reported that foliar spraying of 2% DAP + 40 ppm NAA + Micronutrients increases the pod setting percentage

and decreases the flower shedding in greengram. When compared to treatment T_6, T_5 contains similar nutrients but in lower concentration showed lower pod setting percentage (37.74). T_4 treatment contains 2% FFW + 2% EAA + 2% Coconut water + 40 ppm NAA and recorded on par results with T_6 on number of pods plant^{-1}. The similar findings was recorded by Priyanka *et al.* (2019) [15]. Foliar spray of fermented fish waste and egg amino acid containing nitrogen, phosphorus, potassium and micro nutrients increases the photosynthetic activity which in turn increases the yield and yield attributes (Abbasi *et al.*, 2003) [1]. Higher supply of nutrients at flowering and pod formation of greengram crop might cause efficient photosynthates translocation from source to sink and reduces the flower drop and increases the pod setting percentage (Kumar and Simaiya, 2019) [10].

3.3 Effect of foliar spraying of nutrient on Seed yield, Haulm yield, No of seeds plant^{-1}, No of seeds pod^{-1}, weight of seeds plant^{-1}, weight of pods plant^{-1}, 100 seed weight and HI

The results of the experiments on total number of seed yield, haulm yield, and number of seeds per plant, number of seeds per pod, weight of seeds per plant, weight of pod per plant, 100 seed weight and HI are presented in Table 3 and illustrated in Fig 3 and 4. The seed yield was totally depends on yield attributes of the plant. The yield increases with increase of number of pods plant^{-1}, number of seeds pod^{-1} and 100 seed weight. Treatment T_6 recorded higher grain yield (1283 Kg ha^{-1}). This significant increase in yield is due to higher number of pods plant^{-1} as mentioned above, higher number of seeds pod^{-1} (7.72) and 100 seed weight (3.79 g). There was no significant difference between treatments on 100 seed weight as foliar application of nutrients does not influences the seed size significantly. But the increased 100 seed weight by T_6 is due to increased mobilization and assimilation of nutrients to the reproductive parts. The same finding was given by Dwivedi *et al.* (2014) [5]. Number of seeds plant^{-1} and Number of seed pod^{-1} are relatively proportional to weight of seeds plant^{-1} and weight of pods plant^{-1}. Thus higher number of seeds plant^{-1} (226.5), higher number of seeds pod^{-1} (7.72) relatively increases weight of seeds plant^{-1} (8.56 g) and weight of pods plant^{-1} (13.30 g). Lowest seed yield was recorded by T_8 (966 Kg ha^{-1}). Treatment T_6 recorded highest haulm yield (3551 Kg ha^{-1}) and T_8 shows lowest haulm yield (2114 Kg ha^{-1}). Higher haulm yield is attributed due to higher nutrient supply and uptake by the crop. Similar result of increased haulm yield by higher supply of nutrient as foliar spray has been reported by Ghosh and Joseph (2008) [7] in green gram. Though there was a significant difference between treatments on seed yield of green gram, there is no significant difference between treatments on Harvest Index of greengram indicating that seed yield increases due to increase in dry matter. Hence there would not be any significant difference between treatments on harvest index of green gram.

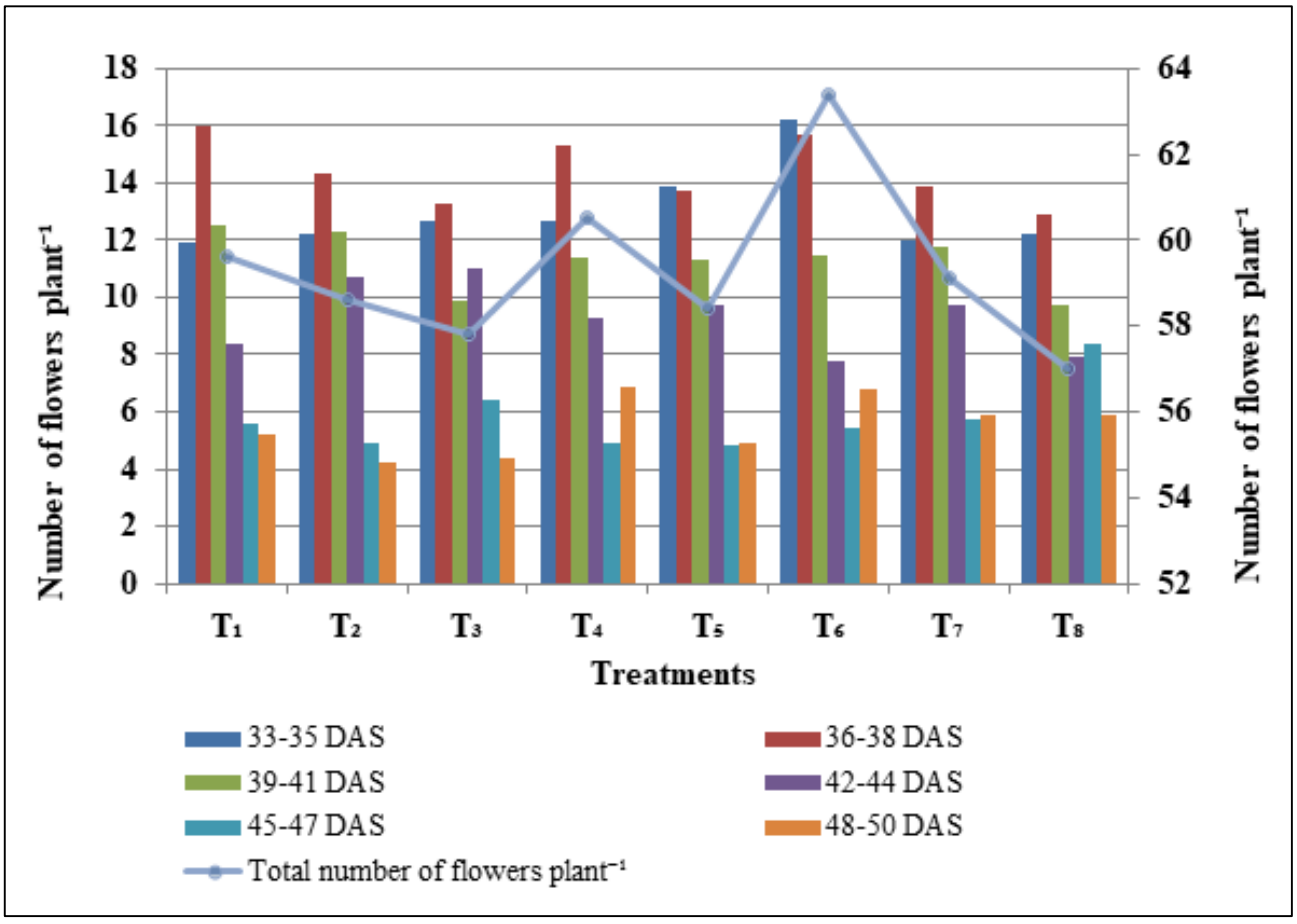

Fig 1: Effect of foliar spraying of nutrients on flower production

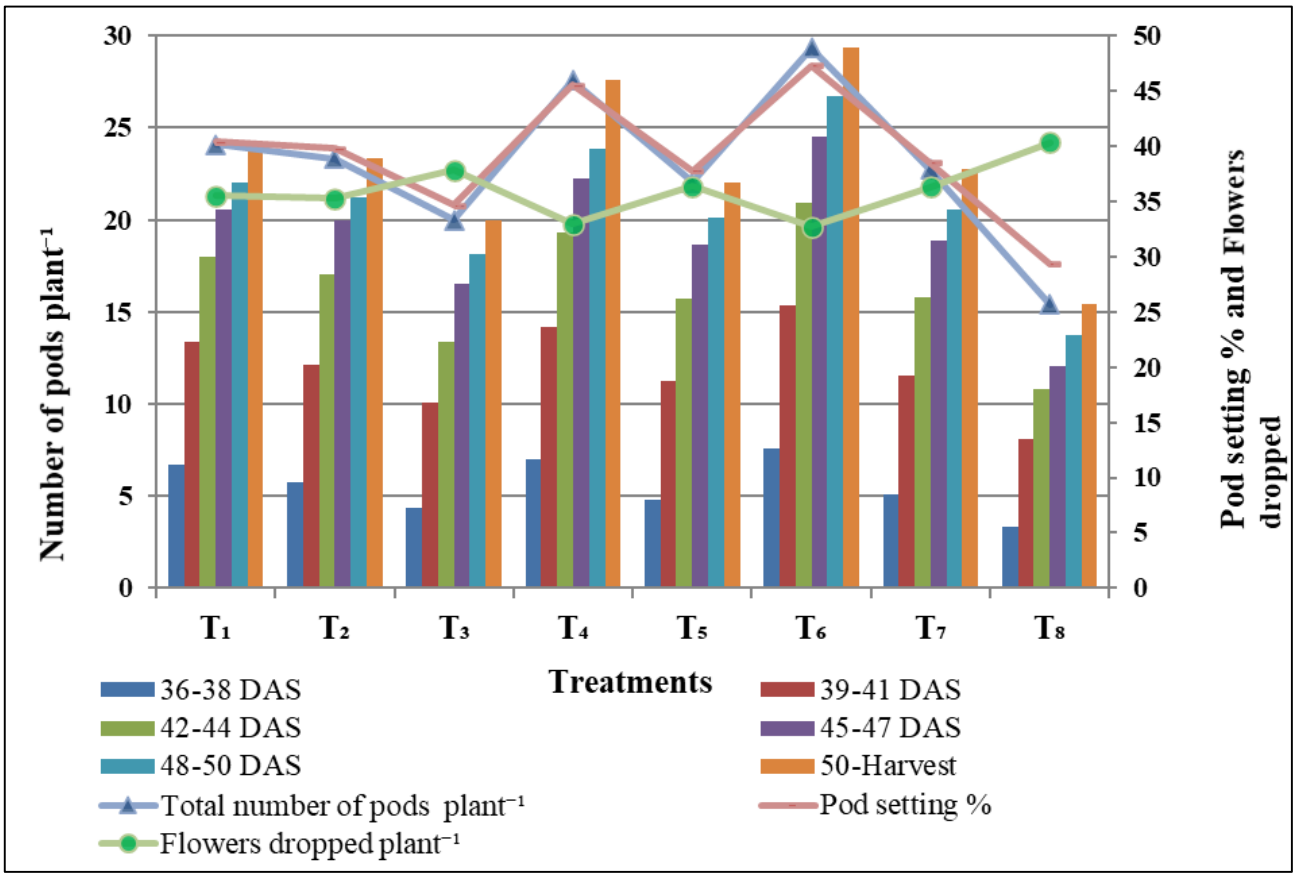

Fig 2: Effect of foliar spraying of nutrients on pods production, Total number of pods plant^{-1}, Flowers dropped and pod setting percentage.

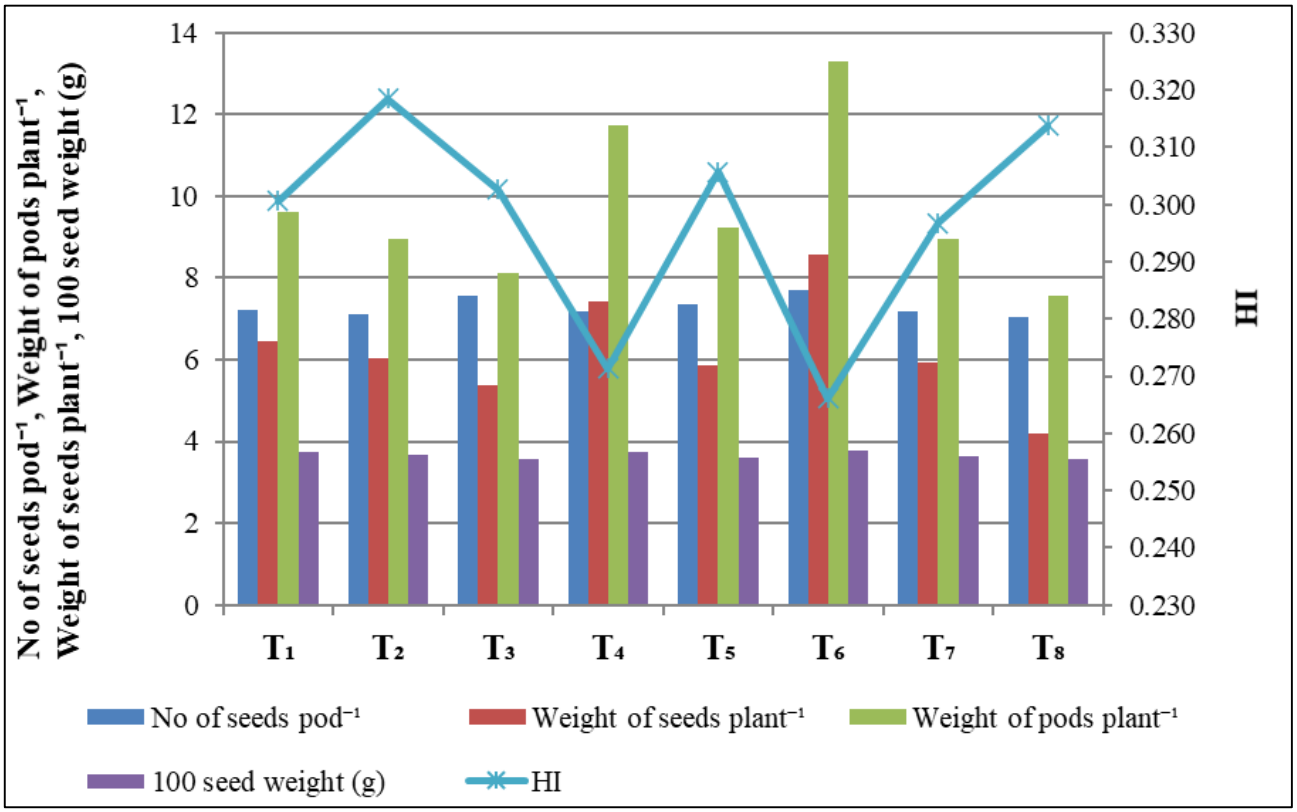

Fig 3: Effect of foliar spraying of nutrients on Number seeds pod^{-1}, Weight of grains plant^{-1}, Weight of pods plant^{-1} and HI.

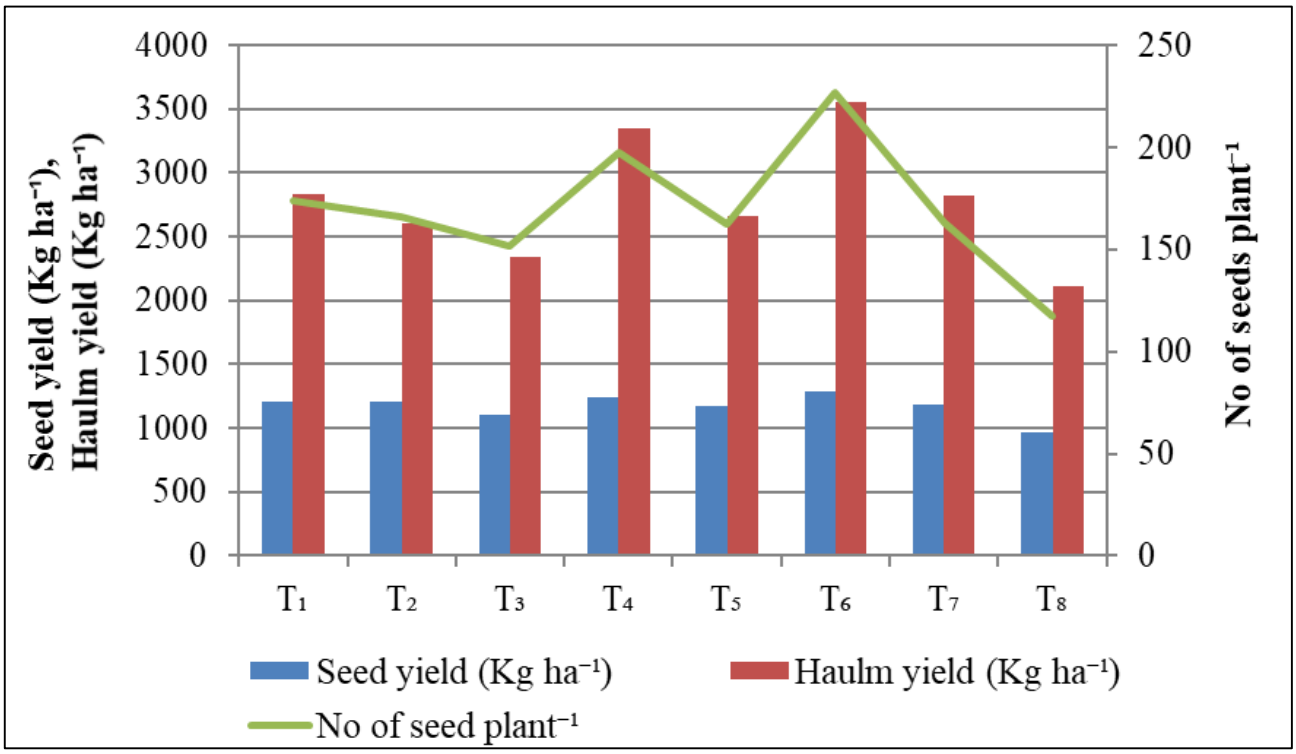

Fig 4: Effect of foliar spraying of nutrients on Seed yield (Kg ha^{-1}), Haulm yield (Kg ha^{-1}) and Number of seeds plant^{-1}.

Table 1: Effect of foliar spraying of nutrients on flower production

Treatments	Flower production						Total number of flowers plant^{-1}
	33-35 DAS	36-38 DAS	39-41 DAS	42-44 DAS	45-47 DAS	48-50 DAS	
T_1	11.97	16.33	12.48	8.41	5.62	5.20	60.01
T_2	12.17	14.33	12.33	10.67	4.93	4.16	58.59
T_3	12.73	13.33	9.89	11.04	6.42	4.42	57.83
T_4	12.70	15.30	11.42	9.29	4.87	6.93	60.51
T_5	13.89	13.69	11.30	9.73	4.84	4.93	58.38
T_6	16.23	15.74	11.49	7.79	5.40	5.08	61.73
T_7	12.04	13.88	11.83	9.71	5.67	5.93	59.06
T_8	12.21	12.95	9.70	7.88	8.40	5.86	57.00
SEd	1.58	1.98	1.72	1.77	1.77	1.94	1.96
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS

Table 2: Effect of foliar spraying of nutrients on pods production and pod setting percentage

Treatments	Pod production						Total number of pods plant^{-1}	Pod setting percentage	Flowers dropped
	36-38 DAS	39-41 DAS	42-44 DAS	45-47 DAS	48-50 DAS	50-Harvest			
T_1	6.67	13.34	18.01	20.53	22.01	24.09	24.09	40.40	35.51
T_2	5.78	12.14	17.05	19.97	21.22	23.34	23.34	39.77	35.25
T_3	4.32	10.07	13.36	16.51	18.15	20.00	20.00	34.64	37.82
T_4	6.99	14.21	19.33	22.21	23.84	27.57	27.57	45.53	32.95
T_5	4.79	11.27	15.7	18.64	20.12	22.03	22.03	37.74	36.36
T_6	7.57	15.37	20.89	24.51	26.72	29.32	29.32	47.28	32.73
T_7	5.1	11.55	15.81	18.85	20.55	22.75	22.75	38.53	36.31
T_8	3.36	8.09	10.77	12.03	13.74	15.39	15.39	29.32	40.33
SEd	0.29	0.79	1.28	1.08	1.16	1.24	1.24	2.68	1.6
CD (P=0.05)	0.63	1.7	2.74	2.31	2.48	2.66	2.66	5.74	3.42

Table 3: Effect of foliar spraying of nutrient on Seed yield, Haulm yield, No of seeds plant, No of seeds pod, weight of seeds plant, weight of pods plant, 100 seed weight and HI

Treatment	Seed yield (Kg ha^{-1})	Haulm yield (Kg ha^{-1})	No of seeds plant^{-1}	No of seeds pod^{-1}	Weight of seeds plant^{-1}	Weight of pods plant^{-1}	100 seed weight (g)	HI
T_1	1210	2828	173.65	7.22	6.46	9.60	3.73	0.301
T_2	1209	2609	166.25	7.12	6.05	8.96	3.66	0.318
T_3	1108	2342	151.41	7.55	5.38	8.11	3.58	0.303
T_4	1240	3345	197.78	7.18	7.44	11.75	3.75	0.271
T_5	1172	2666	162.35	7.37	5.86	9.25	3.61	0.306

T_6	1283	3551	226.54	7.72	8.56	13.3	3.79	0.266
T_7	1188	2817	163.45	7.18	5.94	8.94	3.64	0.297
T_8	966	2114	116.97	7.03	4.19	7.57	3.57	0.314
SEd	60	188	11.81	0.28	0.35	0.5	0.18	0.019
CD (P=0.05)	129	403	25.33	NS	0.75	1.07	NS	NS

4. Conclusion

To increase the productivity, it is necessary to reduce the flower drop of green gram. Application of sufficient quantity of nutrients at flowering and pod formation stage as foliar spray has the merits of higher uptake of nutrients and efficient translocation of assimilates from source to reproductive parts resulting in reduction of flower drop of green gram. The results clearly indicated that 2% MAP + 1% KCl + 1% $FeSO_4$ + 1% $ZnSO_4$ + 1% $CaCl_2$ + 40 ppm NAA foliar spray had recorded better yield when compared to other treatments and which was 24.70% yield increase over absolute control and it was on par with foliar application of (T_4) - 2% Fermented fish waste + 2% Egg amino acid + 2% coconut water + 40 ppm NAA.

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