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Effect of Foliar Application of Different Chemicals on Yield and Yield Attributes of Black gram [*Vigna mungo* (L.) Hepper] under Rainfed Condition

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

A field experiment was performed at the "TCA., research farm of Dholi (Muzaffarpur), which is a unit of the Dr. Rajendra Prasad Central Agricultural University, Pusa (Samastipur), Bihar, during the *Kharif* season of 2021" to investigate the "Effect of foliar application of different chemicals on yield

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attributes and yield of Black gram [*Vigna mungo* (L.) Hepper] under rainfed condition". The design used for making layout of experimental unit was RBD, that was replicated three times, with ten treatments in each replication for a total of 30 plots. The experiment conducted with 10 treatments *viz.,* Absolute Control (T_1), Water Spray (T_2), $ZnSO_4$ @ 0.5% Spray (T_3), NPK (19-19-19) @ 2% Spray (T_4), Urea @ 2% Spray (T_5), DAP @ 2% Spray (T_6), Salicylic acid @ 100 ppm Spray (T_7), Potassium Nitrate @ 2% Spray (T_8), Boron 0.25 % Spray (T_9), Potassium Chloride @ 0.2% Spray(T_{10}). The foliar spray of different treatments applied had a significant impact on the number of pod number plant^{-1}, seed count pod^{-1} and the length of the pod. However, foliar chemicals had no appreciable impact on the weight of 100 seeds. At pre-flowering and pod-initiation stage, foliar treatment of "NPK (19-19-19) @ 2 % spray (T_4)" resulted in significantly greater seed production and stover output. Different chemical administration to the foliage had no significant effect on harvest index.

Keywords: Black gram foliar application of nutrients; rainfed; yield; yield attributes.

1. INTRODUCTION

Pulses are marvellous gift of the mother nature with distinctive capability of biological nitrogen fixation (BNF). The overall requirement of protein content in a balanced diet of vegetarian population of the world is mainly fulfilled by pulses. Pulses also supply nutritive fodder, especially for milch cattle and maintain fertility of soil either through BNF or as a green manure crop and accordingly, play a key role in promoting sustainable agriculture. One of the most coveted pulse crops growing in rainfed areas across the nation is the Black gram or Urd bean [*Vigna mungo* (L.) Hepper]. Urd bean belongs to the "Leguminosae" family and "Papilionaceae" sub-family having chromosome number 2n=22. It is also known as "Mash bean and Urd bean". Urd bean seeds are perfect blend of all nutrients that includes approximately 23-27 % protein, 60-65 % carbohydrates, 1-1.4 % oil, 3.5-5 % fiber, 4-5.5 % ash on dry weight basis and minerals, amino acids, and vitamins [1].

The Urd bean is mostly grown in rainfed conditions under poor management strategies, as well as due to various physiological, bio-chemical, and genetic factors of crop itself, which ultimately contribute to its relatively low yield potential. In addition to genetic make-up, physiological factors such as insufficient assimilate partitioning, poor pod setting as a direct consequence of flower abscission, and a lack of nutrients during or after a crucial time of crop growth, including a number of diseases and pests, constitute the major factors limiting the yield of Urd bean [2].

Application of fertilizers to soil and due to formation of certain soil complexes, the uptake of necessary elements becomes difficult for the plants. The applied fertilizers are not fully utilized by the plants. One of them is the foliar administration of various nutrients to optimise the crop's genetic potential. Because less fertilizers are needed for foliar application than for soil application, therefore foliar application of nutrients seems to be preferable. Because fertilizer costs are rising daily, it is essential to boost the productivity of legume crops through lowering fertiliser costs by applying nutrients as foliar spray.

The most effective treatment for increasing the Black gram's LAI, LAD, specific leaf weight (g), overall dry matter accumulation, and seed yield was foliar spray of nutrients mixed with salicylic acid at a concentration of 100 ppm at 20, 30, and 40 DAS [3]. The slow growth & development of nodule senescence may be addressed by applying N to the leaves at specific stages, which ultimately led to greater growth and production of Black gram without involvement of root absorption at pivotal stages [4].

2. MATERIALS AND METHODS

The field research was performed at the "TCA*.,* research farm of Dholi (Muzaffarpur), which is a unit of the Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar", during the *Kharif* season of 2021. For this, a field with a consistent textural make-up and homogeneous fertility was chosen. Soil in the research plot was alluvial & found to be calcareous in nature which developed due to the sedimentation of the river "*Burhi Gandak*" over the time. The soil on the experimental plot had low levels of accessible organic carbon (0.395), nitrogen (190.35 kg/ha), P_2O_5 (21.34 kg/ha), and K_2O (135.68 kg/ha), all of which suggested low

fertility. The pH and EC of the soil was 8.44 and 0.31 dSm^{-1} respectively. Data pertaining to the Physico-chemical properties of the soil is given in Table 1. The mean maximum temperature ranged during crop season was in between 27.9 ^0C to 33.4 ^0C. The mean minimum temperature ranged during crop season was in between 14.1 ^0C to 27.0 ^0C. The Relative Humidity (RH) observed during crop season varied from 98.0% - 100% at 7 AM whereas, at 2 PM it ranged between 73.7% - 94.7%. The total amount of rainfall (675.63 mm) was received during the crop season (August- November 2021). There were ten treatments and they replicated thrice. Under replications, the treatments were allocated randomly. RDF "20 kg/ha N, 20 kg/ha P_2O_5, 20 kg/ha K_2O" is applied as basal dose in all the treatments "except in Absolute control (T_1)". According to experimental treatments in each plot, the appropriate amount of foliar nutrients/chemicals and water was measured and then prepared a uniform solution and same solution was uniformly sprayed using conical-shaped nozzles with knapsack sprayer. As per treatments, first foliar administration (Fig. 1) of nutrients was applied at 33 DAS *i.e.,* at pre flowering stage and again it was applied at pod initiation stage of plant, which was coincided at 53 DAS of crop under study. Collected data at various growth stages and upon harvest were analysed statistically in accordance with Gomez and Gomez's recommendations [5].The "F" test's significance threshold was set at *p=0.05*.

Fig. 1. Foliar spray of various nutrients

3. RESULTS AND DISCUSSION

3.1 Yield Attributes

A crop's yield is a collective function of multiple yield-attributing factors *viz.,* "number of pods $plant^{-1}$, number of seeds pod^{-1}, length of pod and seed index". The results of the current investigation after harvest on yield attributes are reported in Table 2.

3.1.1 Number of pods $plant^{-1}$

Per plant seed yield and productivity is directly corelated with number of pods $plant^{-1}$. Foliar application of treatment at two critical growth stages *i.e.,* pre-flowering and pod initiation has significant effect on pod number $plant^{-1}$. The data presented in table 2 revealed that pod number $plant^{-1}$ after harvest were significantly higher in "NPK (19-19-19) @ 2% Spray (T_4)" *i.e.,* 25.31 as compared to all the remaining treatments applied besides that it was *at par* with following treatments *i.e.,* Urea @ 2% Spray (T_5), DAP @ 2% Spray (T_6) and Potassium Nitrate @ 2% Spray (T_8). Pod number $plant^{-1}$ recorded were lowest in absolute control (T_1) *i.e.,* 16.58 after harvest. Increased pod number was due to decrease in flower drop caused by prolonged assimilatory activity of the leaves. Furthermore, the nitrogen and phosphorus given to the foliage during the pre-flowering and pod-initiation stage may have been easily absorbed and readily translocated to the pods, resulting in a greater pod number. Solaiappan et al. [10] reported similar findings in red gram.

3.1.2 Number of seeds pod^{-1}

Foliar spray of different chemicals at two critical growth stages, first at 33 DAS (Pre-flowering stage) and second at 53 DAS (Pod-initiation stage) increased seed number pod^{-1} significantly in "NPK (19-19-19) @ 2% Spray (T_4)" *i.e.,* 5.99 as compared to all other treatments applied besides that it was *at par* with following treatments *i.e.,* Urea @ 2% Spray (T_5), DAP @ 2% Spray (T_6) and Potassium Nitrate @ 2% Spray (T_8) and it is revealed by the data tabulated in Table 2. Lowest seed number pod^{-1} were noted down in Absolute control (T_1) *i.e.,* 4.01 after harvest (Fig. 2).

Table 1. Physico-chemical properties of the soil

Sl. No.	Detail	Value determined	Procedure followed	References
1	Sand (%)	49.75	International pipette Method	[6]
2	Silt (%)	38.65	,,	,,
3	Clay (%)	11.60	,,	,,
4	Textural class	Sandy loam	Triangular diagram	,,
5.	EC (dSm^{-1} at 25^0C)	0.31	Conductivity bridge	[7]
6	pH	8.44	Glass electrode pH meter	,,
7	Organic Carbon (%)	0.39	Walkley and Black	[8]
8	Available N (kg/ha)	190.35	Alkaline permanganate	[9]
9	Available P_2O_5 (kg/ha)	21.34	Olsen's Method	Olsen et al, 1954
10	Available K_2O (kg/ha)	135.68	Flame photometer	[7]

Fig. 2. Counting of number of seed per pod

3.1.3 Length of Pod (cm.)

This yield parameter is directly corelated with seed number pod^{-1} and indirectly influenced economic yield of crop. The data shown in Table 2 revealed that different chemicals were applied as foliar spray at two critical growth stages, first at 33 DAS (Pre-flowering stage) and second at 53 DAS (Pod-initiation stage) increased pod length significantly in "NPK (19-19-19) @ 2% Spray (T_4)" *i.e.,* 4.98 cm as compared to all the remaining treatments applied besides that it was *at par* with following treatments *i.e.,* Urea @ 2% Spray (T_5), DAP @ 2% Spray (T_6) and Potassium Nitrate @ 2% Spray (T_8). Lowest pod length was noted down in Absolute control (T_1) *i.e.,* 3.93 cm after harvest. It is due to the administration of nutrients during the reproductive phase, which aided to the transfer of photosynthates from the source to developing pods, resulting in an increase in pod length (4.98 cm). Thakur et al*.* [11] reported similar result.

3.1.4 Seed index (g)

100- seed weight data shown in Table 2 shows that there was no significant difference observed between various treatments applied at two critical growth stages, first at 33 DAS (Pre-flowering stage) and second at 53 DAS (Pod-initiation stage). Maximum seed index was found in NPK (19-19-19) @ 2% Spray -T_4 (4.54 g) and lowest seed index was found in Absolute control -T_1 (3.81 g). The findings confirmed that the foliar spray of various treatments had no significant effect on hundred seed weight (Seed Index). Although seed index was mostly controlled by the genetic characteristics of the cultivar, as no significant differences between treatments were observed.

3.2 Yield Studies

3.2.1 Seed yield (kg ha^{-1})

The data tabulated in Table 3 revealed that foliar spray of different chemicals at two critical growth stages, first at 33 DAS (Pre-flowering stage) and second at 53 DAS (Pod-initiation stage) increased seed yield significantly in "NPK (19-19-19) @ 2% Spray (T_4)" *i.e.,* 1120 kg ha^{-1} as compared to all other treatments applied besides that it was *at par* with following treatments *i.e.,* Urea @ 2% Spray (T_5), DAP @ 2% Spray(T_6) and Potassium Nitrate @ 2% Spray (T_8).

Table 2. Influence of different chemicals as foliar spray on Yield attributing characters of Black gram

Treatments		Yield Attributes			
		Pods plant^{-1}	Seeds pod^{-1}	Pod length(cm)	Seed index (g)
T_1-	Absolute Control	16.58	4.01	3.93	3.81
T_2-	Water Spray	18.90	4.93	4.01	4.12
T_3-	$ZnSO_4$ @ 0.5% Spray	22.11	5.45	4.29	4.39
T_4-	NPK (19-19-19) @ 2% Spray	25.31	5.99	4.98	4.54
T_5-	Urea @ 2% Spray	23.60	5.71	4.61	4.49
T_6-	DAP @ 2% Spray	24.01	5.79	4.80	4.45
T_7-	Salicylic acid @ 100 ppm Spray	22.01	5.32	4.26	4.37
T_8-	Potassium Nitrate @ 2% Spray	23.12	5.50	4.44	4.45
T_9-	Boron 0.25 % Spray	21.12	5.11	4.21	4.25
T_{10}-	Potassium Chloride @ 0.2% Spray	20.32	4.99	4.12	4.20
SEm (±)		1.06	0.26	0.21	0.22
LSD (p=0.05)		3.14	0.77	0.64	NS

Lowest seed yield was reported in Absolute control (T_1) *i.e.,* 605 kg ha^{-1} after harvest. This is because of the continuous supply of nutrients from foliar spray during the flowering and pod-initiation stage of the crop, which increased yield parameters such as "number of pods plant^{-1}, number of seeds pod^{-1}, pod length and 100-seed weight", which had a direct impact on seed yield (Shashi Kumar et al. 2013).[12]

3.2.2 Stover yield (kg ha^{-1})

Vegetative growth of the crop is directly corelated with stover yield. Data on stover yield after harvest in response to varied foliar chemicals spray are listed in Table 3. Foliar application of different chemicals at two critical growth stages, first at 33 DAS (Pre-flowering stage) and second at 53 DAS (Pod-initiation stage) increased stover yield significantly in "NPK (19-19-19) @ 2% Spray (T_4)" *i.e.,* 2321 kg ha^{-1} as compared to all the remaining treatments applied besides that it was *at par* with following treatments *i.e.,* Urea @ 2% Spray (T_5), DAP @ 2% Spray (T_6) and Potassium Nitrate @ 2% Spray (T_8). Lowest stover yield were reported in Absolute control (T_1) *i.e.,* 1590 kg ha^{-1} after harvest. Stover yield directly dependent on vegetative growth of the crop. Stover yield follows the same pattern as of seed yield. It is primarily due to increased plant height and dry matter formation.

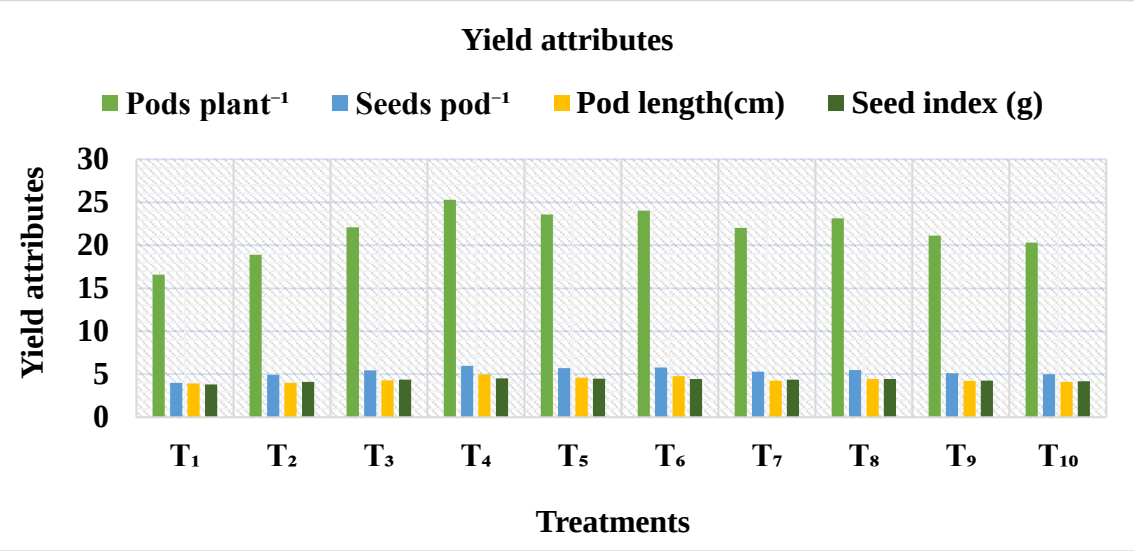

Fig. 3. Influence of different chemicals as foliar spray on yield attributes of black gram

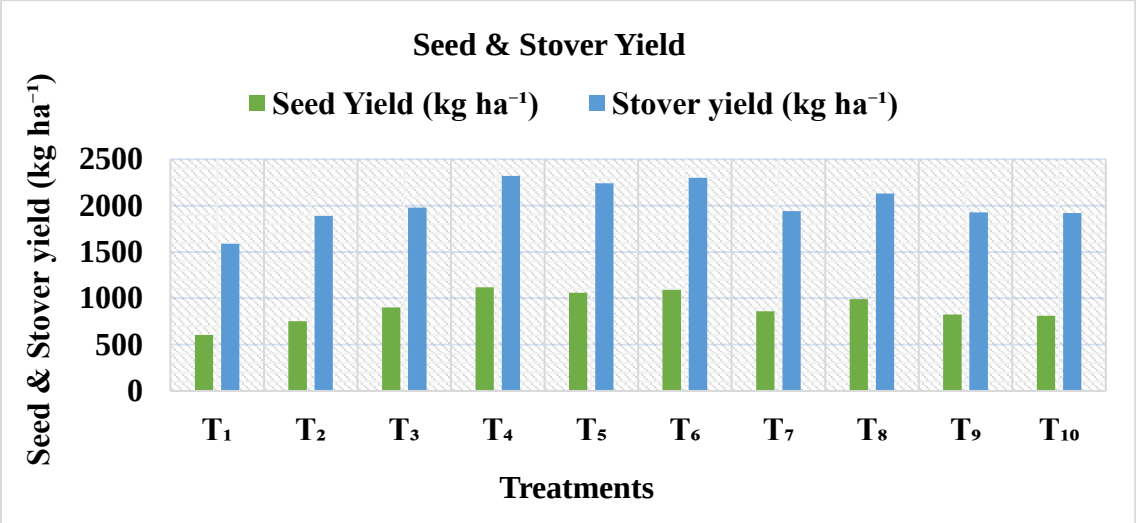

Fig. 4. Influence of different chemicals as foliar spray on yield of black gram

Table 3. Influence of different chemicals as foliar spray on Yield and HI of Black gram

Treatments		Seed Yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Harvest Index (%)
T_1	Absolute Control	605	1590	27.57
T_2	Water Spray	751	1890	28.43
T_3-	$ZnSO_4$ @ 0.5% Spray	900	1980	31.25
T_4-	NPK (19-19-19) @ 2% Spray	1120	2321	32.55
T_5-	Urea @ 2% Spray	1060	2242	32.11
T_6-	DAP @ 2% Spray	1091	2301	32.18
T_7-	Salicylic acid @ 100 ppm Spray	860	1941	30.72
T_8-	Potassium Nitrate @ 2% Spray	991	2131	31.73
T_9-	Boron 0.25 % Spray	825	1928	29.98
T_{10}-	Potassium Chloride @ 0.2% Spray	812	1920	29.73
SEm (±)		45	100	1.54
LSD (p=0.05)		134	297	NS

3.2.3 Harvest index (%)

HI data shown in Table 3 shows that there was no significant difference observed between various treatments applied at two critical growth stages, first at 33 DAS (Pre-flowering stage) and second at 53 DAS (Pod-initiation stage). Maximum Harvest index was found in "NPK (19-19-19) @ 2% Spray -T_4" (32.55 %) and lowest Harvest index was found in Absolute control -T_1 (27.57 %).[13,14]

4. CONCLUSION

Foliar application of "NPK (19-19-19) @ 2% Spray (T_4)" at pre flowering and pod initiation stage significantly increased seed (1120 kg/ha) and stover yield (2321 kg/ha) and yield attributing parameters like pod number plant^{-1} (25.31), seeds pods^{-1} (5.99) and pod length (4.98 cm) as compared to all the remaining treatments except treatments T_5, T_6 and T_6 that were *at par* along with T_4. Based on the aforementioned investigation, it could be concluded that foliar treatment of "NPK (19:19:19) 2 % spray at pre-flowering & pod-initiation stage" may be used to boost the productivity & profitability for Black gram under rainfed conditions.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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