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Effect of foliar nutrition of water soluble fertilizer and growth regulator on growth attributing characters of black gram (*Vigna mungo* L. Hepper)

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Abstract
A field experiment was conducted to study the **"**Effect of water soluble fertilizer with growth regulator on growth, yield and quality of black gram grown on Vertisol" at the farm of Department of Soil Science and Agril. Chemistry, College of Agriculture, Badnapur during *kharif* 2019-2020. The experiment comprised of ten treatments with three replication which included the foliar spray of water soluble fertilizer and growth regulator and RDF application through soil at the time of sowing. The experimental soil was clay texture, moderately calcareous in nature and slightly alkaline in reaction and normal in salt content. The results emerged out clearly indicated that the significantly higher plant height (12.2 cm) at 20 DAS, (34.26 cm) at 40 DAS and at harvest (38.80 cm) with treatment T_9 (RDF + 00:52:34 @ 0.5%+ GA + SA @ 50 ppm each 27 DAS) foliar spray among all treatments. The significantly higher number of nodules at flowering stage (30-35 DAS) (58.3) were recorded in treatment T_{10} (RDF + 13:00:45 @ 0.5%+ GA + SA @ 50 ppm each 45 DAS). The significantly higher number of pods plant^{-1} (28.00) was also recorded in treatment T_9 (RDF + 00:52:34 @ 0.5% + GA + SA @ 50 ppm each 27 DAS).

Keywords: Black gram, water soluble fertilizer, growth regulator, vertisol

Introduction
Black gram (*Vigna mungo* L. Hepper) is probably native of India as is seen from the Vedic literature; there is a mention of Urd bean in Vedic texts such as Kautilya's "Arthasasthra" and "Charaksamhita", belongs to the family *Leguminosae* and sub-family *Papilionaceae*. Black gram is third important pulse crop of India which is cultivated all over a wide range of agro-climatic zones of the country. It is mainly a day neutral warm season crop commonly grown in semi-arid to sub-humid low land tropics and sub- tropics. In India, black gram traditionally grown in *Kharif* season, but in south it also grown as *Rabi* crop. Black gram producing major states in India are Madhya Pradesh, Rajasthan, Uttar Pradesh, Andhra Pradesh, Tamilnadu and Maharashtra (Anonymous, 2017) [2]. The area under Maharashtra was 4.84 lakh ha with the production of 1.77 lakh tones and productivity is 385 Kg ha^{-1}. (Anonymous, 2017) [2]. Throughout the India, black gram is used for different purpose. The major portion is utilized in making dal, soup, curries, sweet, snacks, idli and dosa. The food values of black gram in its high and easily digestible protein. Its seed contain approximately 25-28 percent protein, 1-1.5 percent oil, 3.5-4.5 percent fiber, 4.5-5 percent ash and 62-65 percent carbohydrates on dry weight basis (Anonymous, 2017) [2]. Black gram protein content is more than twice that of cereals reported by Thesiya *et al.* 2013 [10]. The crop also improves soil fertility by symbiotic fixation of atmospheric nitrogen in root nodules Kshirsagar *et al*. (2022) [6].
Foliar application is regarded as preferred solution when quick supply of nutrient is hindered or the soil condition is not conductive for the absorption of nutrient (Salisbury and Ross (1985) [9]. Foliar spray technique helps the nutrient to reach the site of food synthesis directly leading to no wastage and quick supply of food and therefore reduce the requirement of fertilizer. Foliar nutrient can hasten the growth of crop suddenly. Presently black gram yield is very low because the fact that the crop is mainly grown in rain fed condition with poor management practices and also due to various physiological, biochemical as well as inherent factors associated with the crop. Apart from the genetic makeup, the physiological factor *viz*., insufficient portioning assimilates, poor pod setting due to the flower abscission and lack of nutrients during critical stage of crop growth, coupled with a number of disease and pest constitute the major constraints for the poor yield. The productivity of black gram in our country is very low. Hence, there is need for enhancement of the productivity of black gram by proper agronomic and nutrient management practices.

One among them is foliar application of organic and inorganic sources of nutrients for exploiting genetic potential of the crop. This is considered to be an efficient and economic method of supplementing part of nutrients requirements at critical stages. Foliar application is credited with the advantage of quick and efficient utilization of nutrients, elimination of losses through leaching, fixation and regulating the uptake of nutrients by plant (Manonmani and Srimathi 2009) [8]. Foliar application of nutrient and growth regulator at pre flowering and post flowering stage was seen on reduction in flower drop percentage in black gram. Foliar spray of nutrients mixture with salicylic acid 100 ppm at 20, 30 and 40 DAS proved to be the best treatment to improve Leaf area index, Leaf area duration, specific leaf weight, total dry matter accumulation and seed yield of urd bean. (Amutha and Kumar 2012) [1] Also reported by Kshirsagar *et al*. (2022) [6] for chickpea.

Materials and Methods

A field experiment was conducted during *Kharif*, 2019-2020 in Vertisol at departmental farm of Soil Science and Agril. Chemistry, College of Agriculture, Badnapur. The experimental soil was clay texture, moderately calcareous in nature and slightly alkaline in reaction and normal in salt content. At sowing of experiment the soil exhibit pH 7.86 (slightly alkaline in reaction), electrical conductance 0.23 dSm^{-1}, organic carbon content 0.75% (moderately high) and free $CaCO_3$ content was 5.22% respectively. The soil sample was low in available nitrogen (180.36 kg ha^{-1}), moderate in available phosphorus (14.36 kg ha^{-1}), high in available potassium (460.59 kg ha^{-1}). The experimental design used was Randomized Block design (RBD) with three replications consisting ten different treatments *viz*. T_1 = Control, T_2 = RDF, T_3 = RDF + 00:52:34 @ 0.5% +GA @ 50 ppm 27 DAS, T_4 = RDF + 00:52:34 @ 0.5% + SA @ 50 ppm 27 DAS, T_5 = RDF + 00:52:34 @ 0.5% + GA @ 50 ppm 45 DAS, T_6 = RDF + 00:52:34 @ 0.5% + SA @ 50 ppm 45 DAS, T_7 = RDF + 13:00:45 @ 0.5% + GA @ 50 ppm 27 DAS, T_8 = RDF + 13:00:45 @ 0.5% + SA @ 50 ppm 27 DAS**,** T_9 = RDF + 00:52:34 @ 0.5%+ GA + SA @ 50 ppm each 27 DAS and treatment T_{10} = RDF + 13:00:45 @ 0.5%+ GA + SA @ 50 ppm each 45 DAS.

Result and Discussion

Plant height

Variations in plant height of black gram crop were non-significant at 20 DAS (varied from 9.3 to 11.8 cm.) due to application of above said ten treatments. The significant difference in plant height was observed at 40 DAS. The highest plant height was observed due to different foliar spray of water soluble fertilizer and growth regulator. The significantly highest plant height (34.26 cm) was observed due to treatment T_9 RDF + 00:52:34 @ 0.5%+ GA + SA @ 50 ppm each 27 DAS. The significant difference in plant height was also observed at harvest stage i.e. 60 DAS due to treatment T_9 (38.80 cm).

At 40 DAS and 60 DAS, treatment T_9 RDF + 00:52:34 @ 0.5%+ GA + SA @ 50 ppm each 27 DAS shows the significant effect on plant growth of black gram. This effect may be due to application of water soluble salicylic acid and mono potassium phosphate, as salicylic acid plays the important role in stress mitigation. The increase in plant height could be partly being attributed due to the beneficial effect of mono potassium phosphate is known to augment cell division and cell expansion resulting in increasing positive effect of growth parameter. The highest plant height may be due to the positive effects of water soluble salicylic acid and mono potassium phosphate on the vegetative growth and accumulation of metabolic materials. The results are also confirmed with the findings of Manjri *et al*. (2018) [7] in black gram. Similar findings were obtained by Islam *et al*. (2010) [4] and Jadhav *et al*. (2017) [5] in black gram, by Kshirsagar *et al*. (2022) [6] for chickpea, by Gaikwad *et al*. (2022) [3] for pigeon pea.

Table 1: Effect of water soluble fertilizer and growth regulator on plant height

Treatments	Plant height (cm)		
	20 DAS	40 DAS	60 DAS
T_1: Control	9.3	21.66	25.76
T_2: RDF	12.2	27.53	33.13
T_3: RDF + 00:52:34 @ 0.5% +GA @ 50 ppm 27 DAS	9.5	33.23	39.73
T_4:RDF + 00:52:34 @ 0.5% + SA @ 50 ppm 27 DAS	11.8	33.16	37.36
T_5: RDF + 00:52:34 @ 0.5% + GA @ 50 ppm 45 DAS	11.0	28.33	34.43
T_6: RDF + 00:52:34 @ 0.5% + SA @ 50 ppm 45 DAS	10.4	28.6	35.36
T_7: RDF + 13:00:45 @ 0.5% + GA @ 50 ppm 27 DAS	11.2	32.00	37.10
T_8: RDF + 13:00:45 @ 0.5% + SA @ 50 ppm 27 DAS	10.8	30.70	35.76
T_9: RDF + 00:52:34 @ 0.5% + GA + SA @ 50 ppm each 27 DAS	10.0	34.26	38.80
T_{10}: RDF + 13:00:45 @ 0.5% + GA + SA @ 50 ppm each 45 DAS	10.6	29.16	35.43
SEm.±	0.44	1.11	0.59
CD at 5%	NS	3.30	1.77

Plant root nodule

The average number of plant root nodules of black gram plants at 30-35 DAS stage was varies from 54.0 to 58.3 and at harvest from 35.1 to 38.6. These variations in plant root nodule were non-significant due to application of above said ten treatments. All the ten treatments contain the RDF with the foliar application of water soluble fertilizer and growth regulator at 27 days after sowing and 45 days after sowing only. So difference observed in plant root nodule was may be due to native soil microbes, biological fertility, water availability and soil management practices, similar results were reported by Kshirsagar *et al*. (2022) [6] for chickpea, by Gaikwad *et al*. (2022) [3] for pigeon pea.

Table 2: Effect of water soluble fertilizer and growth regulator on number of plant root nodules

Treatments	Plant root nodule	
	At flowering	At harvest
T_1: Control	54.0	35.1
T_2: RDF	54.7	36.5
T_3: RDF + 00:52:34 @ 0.5% +GA @ 50 ppm 27 DAS	54.3	37.2
T_4: RDF + 00:52:34 @ 0.5% + SA @ 50 ppm 27 DAS	55.0	36.8
T_5: RDF + 00:52:34 @ 0.5% + GA @ 50 ppm 45 DAS	56.7	37.2
T_6: RDF + 00:52:34 @ 0.5% + SA @ 50 ppm 45 DAS	54.7	37.8
T_7: RDF + 13:00:45 @ 0.5% + GA @ 50 ppm 27 DAS	56.3	38.6
T_8: RDF + 13:00:45 @ 0.5% + SA @ 50 ppm 27 DAS	56.7	38.0
T_9: RDF + 00:52:34 @ 0.5% + GA + SA @ 50 ppm each 27 DAS	56.7	37.6
T_{10}: RDF +13:00:45 @ 0.5% + GA + SA @ 50 ppm each 45 DAS	58.3	38.4
SEm.±	2.25	1.86
CD at 5%	NS	NS

Soil properties

There were no any significant changes observed regarding soil pH, electrical conductivity, soil organic carbon and calcium carbonate at harvest stage**.** Before sowing of experiment the soil exhibit pH 7.86 (slightly alkaline in reaction), electrical conductance 0.23 dSm^{-1}, organic carbon content 0.75% (moderately high) and free $CaCO_3$ content was 5.22% respectively. At harvest of crop, soil pH varies from 7.50 to 7.57, electrical conductivity from 0.25 to 0.27 dSm^{-1}, soil organic carbon from 6.3 to 6.7% and calcium carbonate from 4.58 to 4.69%. It was observe that the primary soil properties like pH, EC, OC and $CaCO_3$ content could not change significantly due to one crop season. During this experiment we apply only recommended dose of fertilizers with foliar application of water soluble fertilizer with growth regulator. Above data concluded to state that, use of foliar application of water soluble fertilizers and growth regulators with recommended dose of fertilizer (RDF) for single experiment year per season did not influence the basic physiochemical properties *viz.* soil pH, EC, soil organic carbon and calcium carbonate.

Table 3: Effect of water soluble fertilizer and growth regulator on soil properties

Treatments	pH	EC (dSm^{-1})	O.C ($g\ kg^{-1}$)	$CaCO_3$ (%)
Before sowing/ Initial soil status	7.86	0.23	0.75	5.22
After harvest				
T_1: Control	7.51	0.26	6.3	4.62
T_2: RDF	7.55	0.25	6.6	4.65
T_3: RDF + 00:52:34 @ 0.5% +GA @ 50 ppm 27 DAS	7.52	0.27	6.6	4.69
T_4: RDF + 00:52:34 @ 0.5% + SA @ 50 ppm 27 DAS	7.54	0.27	6.5	4.61
T_5: RDF + 00:52:34 @ 0.5% + GA @ 50 ppm 45 DAS	7.50	0.25	6.5	4.65
T_6: RDF + 00:52:34 @ 0.5% + SA @ 50 ppm 45 DAS	7.54	0.26	6.7	4.68
T_7: RDF + 13:00:45 @ 0.5% + GA @ 50 ppm 27 DAS	7.57	0.26	6.6	4.58
T_8: RDF + 13:00:45 @ 0.5% + SA @ 50 ppm 27 DAS	7.53	0.26	6.7	4.58
T_9: RDF + 00:52:34 @ 0.5%+ GA + SA @ 50 ppm each 27 DAS	7.51	0.26	6.5	4.61
T_{10}: RDF + 13:00:45 @ 0.5%+ GA + SA @ 50 ppm each 45 DAS	7.52	0.26	6.5	4.63
SEm.±	0.12	0.01	0.01	0.06
CD at 5%	NS	NS	NS	NS

Conclusion

Application of RDF + 00:52:34 @ 0.5% + GA + SA @ 50 ppm each 27 DAS significantly increases growth parameters, such as plant height, leaf area and number of root nodules of black gram. The application of foliar nutrition helps to overcome the specific occurrence of stress and as a result of maximum vegetative growth due to optimized nutrition of the plant.

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