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Effect of GA3 and Bio fertilizers on growth and yield of Lentil (*Lens culinaris* L.)

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Abstract
A field experiment was conducted during *Rabi* season (2021) at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P.). The soil of experimental plot was sandy loam in texture, nearly natural in soil reaction (pH 7.1), low in organic carbon (0.28%), available N (225 kg/ha), available P (19.50 kg/ha) and available K (213.7 kg/ha). The Treatments consisted of 3 levels of GA3(40 ppm, 50 ppm and 60 ppm) and Bio fertilizers *(Rhizobium*, *PSB* and *VAM).* The experiment was laid out in Randomized Block Design with 9 treatments and replicated thrice. The results reported that significantly maximum plant height em), dry weight (8.38 g/plant) and a greater number of nodules (6.70) were found higher with application of treatment GA3 at 60ppm + *Rhizobium* 20gm!Kg of seeds. Whereas, maximum No. pods/plant (91.00), seeds/pod (2.00), test weight (24.64 g), grain yield (1853.47 kg/ha) and stover yield (2880.53 kg/ha) were recorded in (treatment-7) that is GA3 at 60ppm + Rhizobium 20gm/Kg of seeds, then all other treatments.

Keywords: GA3, Economics, *PSB*, *Rhizobium*, *VAM*, yield

Introduction
India is largest pulse-growing country which accounts for nearly one-third of the total world area under pulses and one-fourth of the total world production. In spite of being the largest producer in the world, India has to import about 25 million tonnes of pulses every year to meet its domestic requirements, largely due to the fact that pulses are inseparable ingredients and also, one of the cheaper and easily available sources of dietary protein of vegetarian diet in the country. Pulses are an important group of crops which provide high quality protein for the predominantly vegetarian population of India. Pulses are the integral component of a cropping system in India as these crops fit well in crop rotation and mixed or inter cropping system followed under different agro-ecological regions.

Lentil (*Lens culinaris Medikus*) is an important cool season grain legume crop in India, which is second major winter sown legume after chickpea. It belongs to the sub-family Papilionaceae under the family Fabaceae (Leguminosae). Lentil *(Lens culinaris M.)* Medik a name given by the German botanist medikus in 1778 (Cubero, 1981). It is locally known as Masoor. It is one of the oldest cultivated legume crops and predominantly grown in Asia which accounts for 80 percent of global area and 75% of world production. It is one of the important pulse crops of India which can adapt well to a wide range of climate and soil condition. It can tolerate frost & severe winter. India ranked first in area and second in the production with 39.79% and 22.79% of world area and production respectively. Canada rank first in production (41.16%) due to very high level of productivity (1633 kglha) as compared to India (611 kglha). (FAO STAT., 2014).

Lentil is an important food legume grown during winter season throughout Indian continent under varied agro-ecological conditions, soil types and cropping system, in areas where winters are extremely cold. It is considered as poor man's meat as well as cheapest source of protein for under privileged group of people who cannot afford to buy animal protein (Gowda and Kaul, 1982). The primary product of the cultivated lentil is the seed, which is a valuable human food product containing a high amount of protein (22.0-34.5%), carbohydrates (65%) and other minerals and vitamins (Yadav *et al.*, 2007) [7] since, 2008. In many countries lentils are used as a meat substitute (Duke, 1981) [3]. The seeds are mostly eaten as dal in soups and the flour can be mixed with cereal flour and used in cakes, breads and some baby food (Muehlbauer *et al.*, 1995) [6].

Plant growth regulators are known as to be change the growth and development pattern of growth in plants Physiological and biochemical process and thereby increase in the yield of the crop. The localized application of some plant growth regulators is reported to have profound effects on assimilate partitioning, enhancing the crop productivity. Plant growth regulators are effective on several crop plants to balance the source sink relationship and thereby increasing them, they are used as an aid to enhance yield in many crops. Indole Acetic acid (IAA), Gibberellic acid (GA3) can manipulate a variety of growth and development It also increases the flowering, fruit set, total dry matter of crop likewise GA3 stimulated stem elongation increased dry matter accumulation and enhance total yield. Application of growth regulators significantly increased the total dry matter accumulation irrespective of varieties due to increase in cell division and other physiological activities, due to increase in leaf area more photosynthates are produced and total dry matter of plant was increased. The increase of dry matter might be due to the accumulation of building units that are accompanied by greater saccharides and protein content which is linked with the photosynthetic operator increasing in protein content may be due to the increase in formation of rough endoplasmic reticulum that provide appropriate medium for increasing the poly ribosomes and RNA (Kokare *et al.*, 2006). Application of growth regulators also enhance cell division and cell elongation.

Rhizobium culture to different legumes is common agronomic practice for enhance pulse production (Bhatt *et al.*, 2014) [1]. Rhizobium inoculation is essential for all the pulse crops to increase the yield of pulses. It is a biofertilizer which increase symbiotic nitrogen fixation and ultimately it increase the yield. Thus, the response of nitrogen to legumes is more important than phosphorus as later is being fixed by the symbiosis. Increasing in the number of such microorganisms accelerates the microbial process to augment to the extent availability of nutrient in the form which can be easily assimilated by the plant. The techniques involving optimization of fertilizer inputs with aim to productivity.

VAM stays with mutual co-operation inside the roots of the plants. The Greek word "Mycorrhiza" means fungus (Mycos) which lives in root (Rhizo). Mycorrhiza which depends on the plants for starch reciprocated by providing several nutrients for the plants. Vesicular Arbuscular Mycorrhizal (VAM) is a fungus which has the ability to dissolve the phosphate found in abundance in the soil. Apart from increasing the availability of phosphorus, VAM provides the plants with the necessary strength to resist disease germs and unfavourable weather conditions. VAM will be active only near the roots of the plants. It can be used by applying on the roots, through nursery grow bags or by mixing in compost. It can be spread throughout the farming area by mixing it when the seeds are put in the granary, or through the roots while re-planting from the grow bags.

Materials and Methods

A field experiment was conducted during *Rabi* season of 2021, at Crop research farm of Department of Agronomy at Sam Higginbottom University of Agriculture, Technology, and Sciences, Prayagraj which is located at 25° 24' 42" N latitude, 81° 50' 56" E longitude and 98 m altitude above the mean sea level (MSL). To assess the effect of GA3 and Bio fertilizers on growth and yield of Lentil. The experiment was laid out in Randomized Block Design comprising of 9 treatments which are replicated thrice. Each treatment net plot size is 3m x 3m. The treatment are categorized as with recommended dose of nitrogen through urea, Phosphorous through DAP and potash through Muriate of Potash, in addition with GA3 and bio fertilizers where applied in combinations as follows, T1: GA3 at 40ppm + Rhizobium 20gm/Kg of seeds, T2: GA3 at 40ppm + PSB 15 gm/Kg of seeds, T3: GA3 at 40ppm + VAM 15gm/Kg of seeds, T4: GA3 at 50ppm +Rhizobium 20gm/Kg of seeds, Ts: GA3 at 50ppm + PSB 15 gm/Kg of seeds, T6: GA3 at 50ppm + VAM 15gm/Kg of seeds, T7: GA3 at 60ppm + Rhizobium 20gm/Kg of seeds, Ts: GA3 at 60ppm + PSB 15 gm/Kg of seeds and Tg: GA3 at 60ppm + VAM 15gm/Kg of seeds. The Lentil crop was harvested treatment wise at harvesting maturity stage. Growth parameters *viz*. plant height (em), no of nodules and dry matter accumulation g planr 1 were recorded manually on five randomly selected representative plants from each plot of each replication separately and after harvesting, seeds were separated from each net plot and were dried under sun for three days. Later winnowed, cleaned and grain yield per ha was computed and expressed in tonnes per hectare. After complete drying under sun for 10 days stover yield from each net plot was recorded and expressed in kgs per hectare. The data was computed and analysed by following statistical method of Gomez and Gomez (1984).

Results and Discussion

Plant height (em)

It is evident from Table-1 that significantly maximum plant height (54.50 em) was recorded with application of GA3 at 60ppm + Rhizobium 20gm/Kg of seeds which was significantly superior over all other treatments and treatment with application of GA 3 at 60ppm + VAM 15gm/Kg of seeds (51.90 em) is statistically at par with treatment application of GA3 at 60ppm + Rhizobium 20gm/Kg.

No. of Nodules/plant

Treatment with GA3 at 60ppm + Rhizobium 20gm/Kg of seeds was recorded maximum number of nodules per plant (6.70) which was significantly superior over all other treatments and treatment with application of GA 3 at 60ppm + VAM 15gm/Kg of seeds (6.40) is statistically at par with treatment application of GA3 at 60ppm + Rhizobium 20gm/Kg of seeds.

Dry matter accumulation

Maximum plant dry weight (8.38 g) was recorded with application GA3 at 60ppm + Rhizobium 20gm/Kg of seeds which was significantly superior over all other treatments and treatment with application of GA 3 at 60ppm + VAM 15gm/Kg of seeds (8.31 g) is statistically at par with treatment application of GA3 at 60ppm + Rhizobium 20gm/Kg of seeds.

Yield and Yield Attributes: Number of Pods/plant

Treatment with application of GA3 60ppm + Rhizobium 20gm/Kg of seeds was recorded maximum number of pods per plant (91.00) which was significantly superior over all other and treatment with application of GA 3 60ppm + VAM 15gm/Kg of seeds (89.88) which was statistically at par with the treatment with application of GA3 60ppm + Rhizobium 20gm/Kg.

Table 1: Effect of GA3 and Bio fertilizers on growth parameters of Lentil

S. No	Treatments	Plant height (em)	Nodules/plant	Dry matter (g plant"1)
1.	GA3 40ppm + Rhizobium 20gm/Kg of seeds	48.80	5.20	7.44
2.	GA3 40ppm+PSB 15 gm/Kg of seeds	48.10	5.20	7.30
3.	GA3 40ppm + VAM 15gm/Kg of seeds	46.30	4.80	7.06
4.	GA3 50ppm+ Rhizobium 20gm/Kg of seeds	51.00	5.80	7.56
5.	GA3 50ppm + PSB 15 gm/Kg of seeds	49.30	5.50	7.72
6.	GA3 50ppm + VAM 15gm/Kg of seeds	50.20	5.90	7.88
7.	GA3 60ppm + Rhizobium 20gm/Kg of seeds	54.50	6.70	8.38
8.	GA3 60ppm + PSB 15 gm/Kg of seeds	51.50	6.10	8.15
9.	GA3 60ppm + VAM 15gm/Kg of seeds	51.90	6.40	8.31
	S.Em (±)	0.97	0.12	0.04
	CD (P 0.05)	2.90	0.36	0.14

Number of Seeds/Pod

Treatment with application of GA3 60ppm + Rhizobium 20gm/Kg was recorded maximum number of seeds per pod (2.00) which was significantly superior over all other and treatment with application of GA 3 60ppm + VAM 15gm/Kg of seeds (1.90) which was statistically at par with the treatment with application of GA3 60ppm + Rhizobium 20gm/Kg.

Test weight (g)

Treatment with application of GA3 60ppm + Rhizobium 20gm/Kg was recorded maximum test weight (24.64 g) which was significantly superior over all other and treatment with application of GA 3 60ppm + VAM 15gm/Kg of seeds (2303 g) which was statistically at par with the treatment with application of GA3 60ppm + Rhizobium 20gm/Kg.

Seed yield (kg/ha): Treatment with application of GA3 60ppm + Rhizobium 20gm/Kg was recorded maximum grain yield (1853.47 kglha) which was significantly superior over all other and treatment with application of GA3 60ppm + VAM 15gm/Kg of seeds (1817.30 kglha) which was statistically at par with the treatment with application of GA3 60ppm + Rhizobium 20gm/Kg.

Stover yield (kg/ha)

Treatment with application of GA3 60ppm + Rhizobium 20gm/Kg was recorded maximum stover yield (2880.53 kglha) which was significantly superior over all other and treatment with application of GA3 60ppm + VAM 15gm/Kg of seeds (2759.76 kglha) which was statistically at par with the treatment with application of GA3 60ppm + Rhizobium 20gm/Kg.

Table 2: Effect of GA3 and Bio fertilizers on yield parameters of Lentil.

S. No	Treatments	Pods/plant	Seeds/pod	Test weight	Grain yield (kg/ha)	Stover yield (kg/ha)
1.	GA3 40ppm + Rhizobium 20gm/Kg of seeds	86.30	1.4	21.62	1486.60	2491.40
2.	GA3 40ppm+ PSB 15 gm/Kg of seeds	85.60	1.3	21.17	1422.13	2575.50
3.	GA3 40ppm + VAM 15gm/Kg of seeds	84.40	1.3	20.49	1387.83	2327.16
4.	GA3 50ppm+ Rhizobium 20gm/Kg of seeds	87.80	1.7	22.36	1686.80	2587.63
5.	GA3 50ppm + PSB 15 gm/Kg of seeds	86.60	1.6	21.51	1487.57	2510.00
6.	GA3 50ppm + VAM 15gm/Kg of seeds	87.30	1.6	21.86	1558.23	2541.96
7.	GA3 60ppm + Rhizobium 20gm/Kg of seeds	91.00	2.0	24.64	1853.47	2880.53
8.	GA3 60ppm + PSB 15 gm/Kg of seeds	88.80	1.7	22.67	1723.63	2627.03
9.	GA3 60ppm + VAM 15gm/Kg of seeds	89.88	1.9	23.57	1817.30	2759.76
	S.Em (±)	0.38	0.06	0.36	21.92	49.29
	CD (5°/o)	1.12	0.19	1.09	65.72	147.78

Conclusion

Based on the findings of the investigation it may be concluded that treatment with GA3 at 60ppm + Rhizobium 20gm/Kg of seeds performed exceptionally in all growth and yield parameters and in obtaining maximum grain yield of Lentil. Hence, GA3 at 60ppm + Rhizobium 20gm/Kg of seeds may be more preferable and can be recommended to the farmers.

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