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Effect of NPK and Bio-fertilizers on Growth and Yield of Chandrasur (*Lapidium sativum* L.)

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ABSTRACT

The present field experiment was conducted at Department of Plantation, Spices, Medicinal and Aromatic Crops, College of Horticulture, RVSKVV, Mandsaur (MP) during the year 2020-2021 using Randomized Block Design in three replications. The experiment was carried out with various bio-fertilizers (PSB and *Azotobacter* @ each 5 kg/ha) and different doses of chemical fertilizers (NPK) along with one control. Result revealed that treatment T_{11} -NPK (40:50:40 kg/ha) + FYM (20 t/ha) + PSB+ *Azotobacter* (each 5 kg/ha) was recorded highest values of plant height (20.97, 101.20 and 114.40 cm plant^{-1}), number of branches at harvest (26.29 plant^{-1}), fresh weight (8.34, 95.57 and 84.17 g plant^{-1}) and dry weight (1.19, 19.11 and 40.40 g plant^{-1}) at 40, 80 and 120 days after sowing respectively. However, days to 50% emergence (6.28), days to 50% flowering (61.32) and days to maturity (114.38) were took lowest days with the same treatment. The maximum seed yield (22.06 q ha^{-1}), biological yield (83.59 q ha^{-1}), test weight (1.89 g) and highest harvest index (26.40) in the same treatment as compared to control. Under the economics of the treatment, the highest net return (Rs 70300) and benefit: Cost ratio (1.75) also found with same treatment.

Keywords Bio-fertilizer, Chemical fertilizer, Nitrogen, Phosphorus, Potassium, Yield.

INTRODUCTION

Chandrasur (*Lapidium sativum* L.) is commonly known as garden cress of Brassicaceae family. It is a fast-growing, erect annual edible herb grows up to a height of 50 to 90 centimeter, basal leaves have long petioles and culinary leaves are pinnate while, the upper leaves are entire in shape. The inflorescence is a dense raceme. The flowers have white or slightly pink petals, measuring two millimeter in length. The fruit, a siliqua measures five to six millimeter long and four millimeter wide, elliptical, is elate form at upper half and is glabrous (Chundawat *et al.* 2017). Seeds, leaves and roots are the economic parts of this crop (Vaishnavi *et al.* 2020). It is hottest drug of Unani medicine and useful in asthma, cough, diarrhea, dysentery, skin disease, blood disorder (Raval 2016). Chandrasur is widely cultivated in temperate

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countries for various culinary and medicinal purposes. In India, it is mainly grown in Madhya Pradesh, Uttar Pradesh, Rajasthan, Gujarat and Maharashtra.

The amount of nitrogen, phosphorus, and potassium in the soil are the most important limiting factors for crop yield. Fertilizers are an important element for achieving the desired yield levels. Bio-fertilizers have developed as an essential component of an integrated nutrient delivery system in recent years, with the potential to boost crop yields and nutrient supplies. The most widely used bio-fertilizers are *Azotobacter*, PSB, and *Azospirillum*, which contribute large amounts of N, P and K to plants while also offering drought tolerance (Mounika *et al.* 2017). Many researchers and producers have been focusing on this trend in order to provide a high-quality and safe product, not only for humans but also for the environment. As a result, using organic and biofertilizers has become necessary.

MATERIALS AND METHODS

The present field experiment was conducted at Department of Plantation, Spices, Medicinal and Aromatic Crops, College of Horticulture, RVSKV-V,Mandsaur (MP) during the year 2020-2021 using Randomized Block Design in three replications. Treatments accompanied as T_1: Control, T_2: FYM (25 t/ha), T_3: NPK (40:40:40 kg/ha) + FYM (10 t/ha), T_4: NPK (40:45:40 kg/ha) + FYM (15 t/ha),T_5: NPK (40:50:40 kg/ha) + FYM (20 t/ha), T_6:NPK (45:40:40 kg/ha) + FYM (10 t/ha), T_7: NPK (45:45:40 kg/ha) + FYM (15 t/ha), T_8: NPK (45:50:40 kg/ha) + FYM (20 t/ha), T_9:NPK (40:40:40 kg/ha) + FYM (10 t/ha) + PSB+ *Azotobacter* (each 5 kg/ha), T_{10}: NPK (40:45:40 kg/ha) + FYM (15 t/ha) + PSB+ *Azotobacter* (each 5 kg/ha), T_{11}: NPK (40:50:40 kg/ha) + FYM (20 t/ha) + PSB+ *Azotobacter* (each 5 kg/ha) assessed for growth and yield attribute under field condition while, the plants in the control plots were shown without any application of supplements. All the parameters were recorded at 40, 80 and 120 days after sowing. The experimental data were subjected to statistical analysis using analysis of variance technique suggested by Panse and Sukhatme (1985). Where the "F" test was found significant at 5% level of significance, the critical differences for the treatment's comparison were worked out.

RESULTS AND DISCUSSION

Effect of NPK and bio-fertilizers on growth parameters

All the growth parameters were significantly influenced with the application of NPK and bio-fertilizers. This variation in growth characteristics was arising due to different doses of NPK and bio-fertilizers combinations. Result confirmed from the Table 1 that, Treatment T_{11} -NPK (40:50:40 kg/ha) + FYM (20 t/ha) + PSB+ *Azotobacter* (each 5 kg/ha) had maximum plant height (20.97, 101.20 and 114.40 cm plant^{-1}), fresh weight (8.34, 95.57 and 84.17 g plant^{-1}) and dry weight (1.19, 19.11 and 40.40 g plant^{-1}) at 40, 80 and 120 days after sowing, respectively while, it was minimum in T_1-control. The bio-fertilizers enhanced the availability of nitrogen in the rhizosphere, which is responsible for higher vegetative growth of plants as well as accumulation of more photosynthets and these might be the reason for highest dry weight (Naidu *et al.* 2016). PSB increases the dry matter is due to the production of some growth promoting substances that are involved in increasing accumulation of food in plant (Singh and Singh 2019). The combination of chemical and bio-fertilizers with farm yard manure ensured readily availability of nutrients for initial requirement through inorganic source and slow pace as long term availability through organic source and resulted in higher plant and dry matter accumulation (Choudhary *et al.* 2011). Similar result was also recorded by Singh and Verma (2002).

Effect of NPK and bio-fertilizers on yield parameters

In the present study, it was found that application of chemical fertilizers and bio-fertilizers were significantly influenced the yield and yield attributing components of chandrasur. At the initial stage, the chemical fertilizers had provided sufficient nutrient to plant followed by bio-fertilizers through biological fixation of nitrogen and solubilization of phosphorus in the rhizosphere. Result revealed that (Table 2) the highest number of racemes (129.56 plant^{-1}), racemes length (27.63 cm), seed yield (22.06 q ha^{-1}), test weight (1.89 g), biological yield (83.59q ha^{-1}) and

Table 1. Effect of NPK and bio-fertilizers on plant height, fresh and dry weight of chandrasur. T_1: Control, T_2: FYM (25 t/ha), T_3: NPK (40:40:40 kg/ha) + FYM (10 t/ha), T_4: NPK (40:45:40 kg/ha) + FYM (15 t/ha),T_5: NPK (40:50:40 kg/ha) + FYM (20 t/ha), T_6:NPK (45:40:40 kg/ha) + FYM (10 t/ha), T_7: NPK (45:45:40 kg/ha) + FYM (15 t/ha), T_8:NPK (45:50:40 kg/ha) + FYM (20 t/ha), T_9:NPK (40:40:40 kg/ha) + FYM (10 t/ha) + PSB+ *Azotobacter* (each 5 kg/ha), T_{10}: NPK (40:45:40 kg/ha) + FYM (15 t/ha) + PSB+ *Azotobacter* (each 5 kg/ha), T_{11}: NPK (40:50:40 kg/ha) + FYM (20 t/ha) + PSB+ *Azotobacter.*

Treatments	Plant height (cm)			Fresh weight (g plant^{-1})			Dry weight (g plant^{-1})		
	40 DAS	80 DAS	120 DAS	40 DAS	80 DAS	120 DAS	40 DAS	80 DAS	120 DAS
T_1	11.77	82.13	92.73	4.87	61.10	52.10	0.70	12.22	16.41
T_2	14.50	85.73	95.43	5.91	65.63	56.23	0.84	13.13	19.08
T_3	16.07	87.07	100.93	6.32	76.63	67.33	0.90	15.33	25.74
T_4	16.83	89.20	102.50	6.57	79.67	70.40	0.93	15.65	27.41
T_5	17.80	92.17	104.17	7.04	82.17	72.53	1.00	16.43	29.56
T_6	16.57	91.23	102.30	6.68	78.43	71.03	0.95	15.82	28.31
T_7	17.53	92.33	105.13	6.95	81.83	72.03	0.99	16.37	29.59
T_8	18.73	95.07	108.03	7.65	88.73	78.87	1.10	17.65	35.88
T_9	18.97	94.17	106.07	7.07	85.10	75.30	1.04	17.02	32.91
T_{10}	20.23	97.20	110.77	8.00	91.47	81.57	1.14	18.29	37.69
T_{11}	20.97	101.50	114.40	8.34	95.57	84.17	1.19	19.11	40.40
SEm±	**0.41**	**1.20**	**1.25**	**0.13**	**1.55**	**1.05**	**0.03**	**0.40**	**0.95**
CD at 5%	**1.22**	**3.53**	**3.67**	**0.39**	**4.56**	**3.10**	**0.07**	**1.17**	**2.81**

Harvest index (33.89%) were found with treatment T_{11} -NPK (40:50:40 kg/ha) + FYM (20 t/ha) + PSB+ *Azotobacter* (each 5 kg/ha) over control plots. The higher seed yield was due to more translocation of food materials from source to sink. It was due to biofertilizers inoculation might be due to increase in plant height, higher number of branches and total chlorophyll content and also increased the yield components (number of racemes, racemes length and 1000 seed weight, as well as seed and stalk yield). Finally the yield attributing parameters helped to increase the seed production (Bhat *et al*. 2020). These findings corroborate with the results of Patra *et al.* (2013) in sunflower. Phosphorus solubilizing bacteria enhances the availability of phosphorus to plants and gives rise to better utilization of nutrients by the crop which might have in turn greater root development and plant height (Choudhary *et al.* 2017). These findings are also supported by Pramanik and Bera (2013) and Shambhu *et al.* (2019) in chandrasur.

Table 2. Effect of NPK and bio-fertilizers on yield and yield attributing traits of chandrasur. T_1: Control, T_2: FYM (25 t/ha), T_3: NPK (40:40:40 kg/ha) + FYM (10 t/ha), T_4: NPK (40:45:40 kg/ha) + FYM (15 t/ha),T_5: NPK (40:50:40 kg/ha) + FYM (20 t/ha), T_6: NPK (45:40:40 kg/ha) + FYM (10 t/ha), T_7: NPK (45:45:40 kg/ha) + FYM (15 t/ha), T_8:NPK (45:50:40 kg/ha) + FYM (20 t/ha), T_9:NPK (40:40:40 kg/ha) + FYM (10 t/ha) + PSB+ *Azotobacter* (each 5 kg/ha), T_{10}: NPK (40:45:40 kg/ha) + FYM (15 t/ha) + PSB+ *Azotobacter* (each 5 kg/ha), T_{11}: NPK (40:50:40 kg/ha) + FYM (20 t/ha) + PSB+ *Azotobacter*.

Treatments	Number of racemes (plant^{-1})	Racemes length (cm)	Seed yield (q ha^{-1})	Test weight (g)	Biological yield (q ha^{-1})	Harvest index (%)
T_1	102.05	22.20	11.87	1.71	55.83	21.25
T_2	106.83	23.30	15.17	1.73	65.62	22.58
T_3	116.39	24.57	16.61	1.77	66.17	25.12
T_4	119.88	25.10	17.34	1.80	67.05	25.87
T_5	121.03	26.23	18.34	1.82	72.54	24.94
T_6	118.71	25.53	17.79	1.82	70.98	25.19
T_7	120.84	26.07	18.13	1.84	70.65	25.67
T_8	125.95	26.87	19.15	1.87	74.13	25.83
T_9	123.84	26.47	18.80	1.86	74.09	25.38
T_{10}	127.48	27.20	20.60	1.87	78.53	26.28
T_{11}	129.56	27.63	22.06	1.89	83.59	26.40
SEm±	**1.64**	**0.45**	**0.62**	**0.02**	**1.68**	**0.32**
CD at 5%	**4.83**	**1.33**	**1.81**	**0.06**	**4.96**	**0.95**

Effect of NPK and bio-fertilizers on phenological parameters

In the present study, all the phenophases of chandrasur were significantly influenced by the application of chemical fertilizers in combination with bio-fertilizers (Table 3). However, the investigation revealed that, minimum days to emergence (6.28 days), 50% flowering (61.32 days) and maturity (114.38 days) were

Table 3. Effect of NPK and bio-fertilizers on phenology and economics of chandrasur. T_1: Control, T_2: FYM (25 t/ha), T_3: NPK (40:40:40 kg/ha) + FYM (10 t/ha), T_4: NPK (40:45:40 kg/ha) + FYM (15 t/ha),T_5: NPK (40:50:40 kg/ha) + FYM (20 t/ha), T_6: NPK (45:40:40 kg/ha) + FYM (10 t/ha), T_7: NPK (45:45:40 kg/ha) + FYM (15 t/ha), T_8:NPK (45:50:40 kg/ha) + FYM (20 t/ha), T_9:NPK (40:40:40 kg/ha) + FYM (10 t/ha) + PSB+ *Azotobacter* (each 5 kg/ha), T_{10}: NPK (40:45:40 kg/ha) + FYM (15 t/ha) + PSB+ *Azotobacter* (each 5 kg/ha), T_{11}: NPK (40:50:40 kg/ha) + FYM (20 t/ha) + PSB+ *Azotobacter*.

Treatments	Days to 50% emergence	Days to 50% flowering	Days to maturity	Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	B: C ratio
T_1	7.43	67.03	124.15	59350	31750	1.15
T_2	7.24	66.51	123.12	75850	43850	1.37
T_3	7.11	64.32	121.74	83050	49150	1.44
T_4	6.91	63.11	121.32	86700	50700	1.4
T_5	6.75	62.17	119.47	91700	53700	1.41
T_6	6.85	63.15	120.44	88950	54950	1.61
T_7	6.64	62.19	118.47	90650	54550	1.51
T_8	6.46	61.81	116.32	95750	58650	1.58
T_9	6.59	62.07	117.10	94000	55500	1.44
T_{10}	6.36	61.64	115.80	103000	64000	1.64
T_{11}	6.28	61.32	114.38	110300	70300	1.75
SEm±	**0.10**	**1.23**	**0.86**	--	--	--
CD at 5%	**0.29**	**3.64**	**2.54**	--	--	--

recorded with T_{11}-NPK (40:50:40 kg/ha) + FYM (20 t/ha) + PSB+ *Azotobacter* (each 5 kg/ha) as compared to control plots. This finding is due to the combination of *Azotobacter* and phosphate-solubilizing bacteria which has helped in fixation of atmospheric nitrogen and mobilization of phosphates, improves germination indexes such as percentage, speed of germination, viability, flowering and maturity. Beneficial soil microbes along with recommended NPK led to abundant availability of nutrients in readily available form for the crop uptake (Praneeth *et al.* 2018). The result correlated with the study of Choudhary *et al.* (2006) in cumin, Jat *et al.* (2006) in fenugreek, Mandal and Singh (2002) in Mustard. The reason for obtaining early maturity may be due to increase in cell multiplication, cell elongation and cell expansion throughout the entire period of crop. This might be resulted in higher production of photosynthetics and their translocation to sink (seed), which ultimately increased the plants growth. These findings are supported by Meena *et al.* (2018) in mustard and Nayma *et al.* (2019) in chandrasur.

Economics of the treatments

The perusal of data pertaining to benefit: Cost ratio revealed that (Table 3) maximum B : C ratio (1.75) was obtained with the treatment combination T_{11} -NPK (40:50:40 kg/ha) + FYM (20 t/ha) + PSB+ *Azotobacter* (each 5 kg/ha) followed by T_{10} -NPK (40:45:40 kg/ha) + FYM (15 t/ha) + PSB+ *Azotobacter* (each 5 kg/ha) (1.64), due to higher yield and lower cost of cultivation. Hence, taking into consideration all aspects, treatment T_{11} -NPK (40:50:40 kg/ha) + FYM (20 t/ha) + PSB+ *Azotobacter* (each 5 kg/ha) due to its persistent performance for yield (22.06 q/ha), gross income (Rs 110300/ha), net returns (Rs 70300/ha) and higher benefit: Cost ratio (1.75) along with balanced application of chemical fertilizers and biofertilizers to maintain the soil health was rated as best treatment. Hence, treatment T_{11} -NPK (40:50:40 kg/ha) + FYM (20 t/ha) + PSB+ *Azotobacter* (each 5 kg/ha) can be recommended for commercial cultivation in long run for sustainable production of chandrasur.

CONCLUSION

On the basis of present investigation could be concluded that, out of 11 treatment combinations, Treatment T_{11} -NPK (40:50:40 kg/ha) + FYM (20 t/ha) + PSB+ *Azotobacter* (each 5 kg/ha) is beneficial for obtaining the maximum growth and higher seed yield in Chandrasur.

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