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Effect of plant growth regulators and Jeevamrut on yield parameters of pigeonpea

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Abstract
Background: Pigeonpea is one of the major pulse crop cultivated in India. India is the largest producer and consumer of pigeonpea in the world. Pigeonpea have excellent source of high quality protein. The objective of the study to determine the responses of plant growth regulators and Jeevamrut on yield and yield parameters of pigeonpea in view to compensate the high degree of flower abscission and increase the yield of pigeonpea.
Methods: The experiments were executed during 2018-19 and 2019-20 kharif planting season. The experiment comprised of single variety of pigeonpea i.e. PKV -TARA laid out in randomized block design with four replications. The eight treatments consist of two growth regulators i.e. GA_3 and NAA at various concentrations i.e. 25, 50 and 75 ppm including Jeevamrut and control.
Results: The results showed that all the treatments has a significant effect on number of pods per plant, number of seeds per pod, 100 seed weight, seed yield and harvest index of pigeonpea. Foliar application of GA_3-75 ppm significantly produced highest seed yield and yield parameters followed by NAA-75 ppm in conventional method and by soil application of Jeevamrut @ 500 l ha^{-1} in Vedic method.

Keywords: Pigeonpea, plant growth regulators, jeevamrut, yield

Introduction
Pigeonpea is one of the major pulse crop cultivated in India. India is the largest producer and consumer of pigeonpea in the world. It is a widely adapted, hardy and drought tolerant crop with a large temporal variation (90-300 days) for maturity. Pigeonpea have excellent source of high quality protein. Pigeonpea is nutritionally important as it contains protein 22.3%, fat 1.7%, calcium 7.3 mg, thiamine 0.45 mg, riboflavin 0.19 mg, niacin 2.9 mg. Besides this they are also the sources of minerals and some vitamins. In India, pigeonpea is grown on 45.22 lakh hectares with production of 38.51 lakh tons with a productivity of 859 kg/ha (Anonymous, 2020) [1]. Pre-mature abscission of flowers is one of the most serious problems in pigeonpea and other legumes. Pigeonpea produces large number of flowers, of which as much as 90% are shed (Wasike *et al*. 2005) [16]. Therefore, the low yield of pigeonpea is due to poor pod set resulting from high flower and pod drops. The low yield in pigeonpea is also due to excessive vegetative growth, indeterminate growth habit, poor source-sink relationship, poor pod set resulting from high flower and pod drops. Therefore, it is very necessary to compensate the high degree of flower abscission in pigeonpea and increase the pod yield. Plant growth regulators (PGR's) are considered as new generation of agro chemicals after fertilizers, pesticides and herbicides to augment seed yield and quality. They are also known to enhance the source sink-relationship and stimulate the translocation of photo assimilates thereby resulting in better retention of flowers and fruits.
Secondly, indiscriminate use of the fertilizer, pesticide has harmful effects on soil health, human health, ground water health and environment. This will caused more dangerous effect for future possibility. Present status of all food grain production is in enough quantity for population of our country so we need to quality of food production, quality of soil, quality of ground water and quality or healthy environment for better livelihood. These qualities are obtained by the replacing inorganic input through organic input which is more vital for present prospect and future outlook. Jeevamrutha is one of the indigenous liquid organic manure. The useful soil microorganisms, earthworms are activated when jeevamrutha given with irrigation water. Desi cow dung and cattle urine are the main base of jeevamrutha. The abundant quantity of cattle excreta consisting of dung and urine has a good manurial value and can be utilized as a bio fertilizer (Khanal *et al*. 2011) [6]. Cattle urine is a good source of nitrogen, phosphate, potassium, calcium, magnesium, chlorite sulphate and plant hormone.

This solution is rich source of useful and effective microorganisms. It acts as growth hormone, antifungal and anti bacterial and prevents many soil borne diseases. Jeevamrutha can also be used through irrigation water and also used as spray after filtering at 5% concentration.
Taking above view into consideration the comparative study was carried out with the objective to study the responses of plant growth regulators and jeevamrut on yield parameters of pigeonpea.

Materials and Methods

Description of experimental site

The experiments were conducted at Experimental field of Department of Agricultural Botany, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, (M.S.) during kharif season 2018-19 and 2019-20. The topography of the field was fairly uniform and levelled. The climate of Akola is subtropical semi-arid characterized by three distinct seasons namely summer becoming hot and dry from March to May. The warm and rainy monsoon from June to October and winter with mild cold from November to Feb. Akola is situated in the subtropical zone at the latitude of 200 42' North and longitude of 770 02' East. Altitude of the place is 307.41 m above the mean sea level. Average annual precipitation is 750 mm and the major amount is received during the period from June to September. Winter rains are few and uncertain. The normal mean monthly maximum temperature during the hottest month (May) is 42^0C while the normal mean monthly minimum temperature in the coldest month (December) is 10.9^0C. The mean daily evaporation reaches as high as 15.5 mm in the month of May and as low as 3.8 mm in the month of August.

Experimental design

The experiment comprised of single variety of pigeonpea i.e. PKV -TARA laid out in randomized block design with four replications. The eight treatments consists of two growth regulators i.e. GA_3 and NAA at various concentrations i.e. 25, 50 and 75 ppm including jeevvmrut and control. Spraying of growth regulators was done at flower initiation stage (stage 1) and pod initiation stage (stage 2) and soil application of jeevamrut was done at 30 60 90 and 120 DAS. Out of eight treatments seven treatments of two plant growth regulators with three concentrations were grown by adopting package of practices of conventional method of sowing and eighth treatment of soil application of jeevamrut was grown by adopting package of practices of Vedic method. The plot size was 4.6m x 4.0m. Seeds of pigeonpea were sown at spacing of 60 cm between rows and 20 cm between plants. After the emergence of seedling, only one healthy seedling was maintained per hill to obtain uniform planting density. N, P and K fertilizers in the form of urea, single super phosphate and murate of potash were applied @ 25 kg N + 50 kg P_2O_5 + 20 kg K_2O ha^{-1} to the gross plots. Half dose of N and a complete dose of P_2O_5 and K_2O were given as a basal dose at sowing while the remaining N was applied at 18 days after sowing. Plant protection measures were adopted as and when needed. Spray of quinalphos 25 EC @ 1000 ml ha-1 was done to reduce the infestation of pod borer for growth regulators treatments and for jeevamrut treatments, spraying of decoction prepared form plant samples and cow urine was done to reduce the infestation of insects. Observations were recorded at different stages i.e. 60, 90, 120DAS and at maturity. Harvesting in all treatments was undertaken after maturity of crop.

Data collection and analysis

In order to record the various observations, five plants were selected randomly to present the population in each net plot, labelled it and observations were recorded on them at harvest stage and after the harvest of crop. The analysis of variance was performed to test the significance of differences between the treatment for all the characters as per the methodology suggested by Panse and Sukhatme (1954) [10].

Results and Discussion

The effect of plant growth regulators and Jeevamrut on number of pods per pigeonpea crop

As indicated in Table 1, in both year *viz*., kharif 2018-19 and 2019-20 foliar application of GA_3-75ppm (248.40 and 250.58 respectively) at flower and pod initiation stages recorded significantly more number of pods $plant^{-1}$ followed by treatment (T_7) foliar application of NAA-75 ppm (241.26 and 244.20 respectively) and treatment (T_8), soil application of Jeevamrut-@ 500 l ha^{-1} (233.52 and 247.61 respectively).
The pooled mean data revealed that all the treatments recorded significantly more number of pods $plant^{-1}$ as compared to control. Treatment (T_4) foliar application of GA_3-75 ppm (249.69) recorded significantly more number of pods $plant^{-1}$ followed by treatment (T_7), foliar application of NAA-75 ppm (242.73) and T_8 treatment, soil application of Jeevamrut-@ 500 l ha^{-1} (240.56) as compared to control (191.43) and rest of the treatments. The foliar application of GA_3-75 ppm at flower initiation and pod formation stages might have improved the reproductive development of pigeonpea crop and supported efficient translocation of photosynthates from source to sink. This might have significantly increased the number pods/ plant, grain mass and yield/ plant. The increased availability of assimilates might have accelerated the formation of more flower buds, number of pods and subsequently produced higher pod yield. These findings were similar to that obtain by Giri *et al*. (2018) [3] and Kumar and Sharma (2021) [8] reported that two foliar applications of GA_3 -75 ppm at flower and at pod initiation stages recorded significantly higher number of pods/ plant in pigeonpea.
Jondhale *et al*. (2021) [5] revealed that yield contributing attribute number of pods $plant^{-1}$ of pigeonpea was found higher with the application of bioinoculant jeevamrut @ 400 l ha-1 in four equal split at 30, 45, 60 and 75 DAS than rest of the biofertigation treatment.

The effect of plant growth regulators and Jeevamrut on number of seeds per pod of pigeonpea crop

As indicated in Table 1, during both year of experiment (kharif 2018-19 and 2019-20) spraying of GA_3-75ppm (3.85 and 3.86 respectively) at flower and pod initiation stages recorded significantly more number of seeds pod^{-1}. However, treatment (T_7), foliar application of NAA-75 ppm (3.76 and 3.78 respectively) and T_8 treatment, soil application of jeevamrut-@ 500 l ha^{-1} (3.64 and 3.72 respectively) were at par with foliar application of GA_3-75 ppm. Lowest number of seeds pod^{-1} was recorded significantly by control treatment (2.72 and 2.73 respectively).
The pooled mean data revealed that, treatment (T_4) foliar application of GA_3-75ppm (3.89) recorded significantly more

number of seeds pod^{-1} followed by treatment (T_7), foliar application of NAA-75 ppm (3.77) and T_8 treatment, soil application of jeevamrut- @ 500 l ha^{-1} (3.68) as compared to control (2.72) and rest of the treatments. Similar findings were obtain by Kumar and Sharma (2021) [8] reported that seeds/ pod was significantly influenced by foliar application of gibberalic acid and found significantly higher in GA_3 @ 75 ppm at flower initiation and pod initiation stages which was significant over control and water spray in pigeonpea.

The results also corroborate the findings of Janbhare *et al*. (2013) [4] reported that application of FYM @ 2.5tha^{-1} + vermicompost @ 1.0 t ha^{-1} + two times Jeevamrut @ 500 lit^{-1} ha (30 and 45 DAS) was found significantly superior and showed influence on no. of seeds pod^{-1} of pigeonpea than the application of FYM or compost alone and untreated control.

The effect of plant growth regulators and Jeevamrut on 100 seed weight (g) of pigeonpea crop

As indicated in Table 1, the pooled mean data revealed that in present investigation among the treatments tested, treatment (T_4) foliar application of GA_3-75 ppm (9.86 g) recorded significantly highest 100 seed weight plant^{-1} followed by treatment (T_8) soil application of Jeevamrut- @ 500 l ha^{-1} (9.58 g) and by treatment (T_7) foliar application of NAA-75 ppm (9.43 g) as compared to control (9.27 g) and rest of the treatments. Similar findings reported by Giri *et al*. (2018) [3] and Kumar and Sharma (2021) [8] reported that two applications of 75 ppm GA_3 recorded significantly higher seed index in pigeonpea.

Janbhare *et al*. (2013) [4] reported that application of FYM @ 2.5 tha^{-1} + vermicompost @ 1.0 t ha^{-1} + two times Jeevamrut @ 500 lit. ha (30 and 45 DAS) was found significantly superior and showed maximum seed weight plant^{-1} (g) of pigeonpea than the application of FYM or compost alone and untreated control.

The effect of plant growth regulators and Jeevamrut on seed yield (q ha^{-1}) of pigeonpea crop

As indicated in Table 1, the pooled mean data revealed that all the treatment was found significantly and statistically superior over control. However among the treatments tested, top ranking treatment (T_4) foliar application of GA_3-75 ppm (21.31q ha^{-1}) recorded significantly highest seed yield ha^{-1} in conventional method followed by T_8 treatment, soil application of jeevamrut-@ 500 l ha^{-1} (19.77q ha^{-1}) in Vedic method and by treatment (T_7) foliar application of NAA-75 ppm (19.53 q ha^{-1}) as compared to control (18.02 q ha^{-1}) and rest of the treatments.

Similarly, mean data obtained from the kharif 2018-19 experiment, treatment (T_4) foliar application of GA_3-75 ppm (20.38 q ha^{-1}) recorded significantly highest seed yield ha^{-1} followed by treatment (T_7), foliar application of NAA-75 ppm (19.07 qt) as compared to control (17.70 q ha^{-1}) and rest of the treatments. While mean data obtained from the kharif 2019-20 experiment, treatment (T_4) spraying of GA_3-75 ppm (22.25 q) recorded significantly highest seed yield ha^{-1} followed by treatment (T_8) soil application of jeevamrut-@ 500 l ha^{-1} (20.92 q ha^{-1}) and treatment (T_7) foliar application of NAA-75ppm (19.99 q ha^{-1}) as compared to control (18.34 q ha^{-1}) and rest of the treatments. Growth regulators in general, are known to influence a wide range of physiological parameters such as alteration of plant architecture, assimilation of partitioning, promotion of photosynthesis, enhancement of nitrogen metabolism, promotion of flowering, increased mobilization of assimilates to defined sinks, induction of floral synchrony and delayed leaf senescence (Sharma *et al*., 2013; Solaimalai *et al*., 2001) [12, 13]. Thus in the present investigation seed yield increased by foliar application of PGRs in conventional method. Giri *et al*. (2018) [3] reported that two foliar applications of 75 ppm GA_3 at flowering and at pod development stages recorded significantly higher grain yield/ plant (1970.16 kg/ha). Many researchers *viz*., Rao and Mahalaxmi (2000) [11], Tekale *et al*. (2009) [15], Chinnathurai *et al*. (2012) [2] also reported increased in seed yield of pigeonpea by application of PGRs.

Jeevamrut application enhances microbial activity in the soil and enhance nutrient availability to crop. It enriches the soil with indigenous microorganisms therefore required for mineraliztion. (Palekar, 2006; Sreenivasa *et al*. 2010) [9, 14]. In the present investigation, seed yield also increased by application of jeevamrut by adopting Vedic method. The positive response of pigeonpea to applied organic formulations was also reported by Jondhale *et al*. (2021) [5] revealed that dry pod weight plant-1, grain yield and stalk yield of pigeonpea was found higher with the application of bioinoculant Jeevamrut @ 400 l ha^{-1} in four equal split at 30, 45, 60 and 75 DAS than rest of the bio fertigation treatment.

The effect of plant growth regulators and Jeevamrut on harvest index (%) of pigeonpea crop

As indicated in Table 1, the mean pooled data obtained varied from 32.09 to 34.25% with general mean 33.03%. The treatment (T_8) soil application of - @ 500 l ha^{-1} (34.25%) recorded significantly highest harvest index followed by treatment (T_4) foliar application of GA_3-75 ppm (33.93%) as compared to control and rest of the treatments.

Similarly, mean data obtained from the kharif 2018-19 experiment, treatment (T_4) foliar application of GA_3-75 ppm (33.72%) recorded significantly highest harvest index followed by treatment T_8, soil application of jeevamrut-@ 500 l ha^{-1} (33.63%) as compared to control (32.01%). While mean data obtained from the kharif 2019-20 experiment, soil application of jeevamrut-@ 500 l ha^{-1} (34.86%) through Vedic method recorded significantly highest harvest index followed by treatment (T_4) foliar application of GA_3-75 ppm (34.12%) as compared to control (32.17%). The positive response of pigeonpea to applied plant growth regulators and organic formulations was also reported by Giri *et al*. (2018) [3] reported that two applications of 50 ppm GA_3 at flowering and pod development stages recorded the highest harvest index (34.35%), whereas single application of 50 ppm GA_3 at pod development stage recorded the lowest harvest index (32.27%).

Korade *et al*. (2019) [7] recorded significantly maximum harvest index was in treatment 10% cow urine + 25 ppm NAA and minimum in control in pigeonpea. The range of increased harvest index was 51.56% in treatment 10% cow urine + 25 ppm NAA when compared to control 42.43%.

Table 1: Effect of Plant Growth Regulators and Jeevamrut on number of pods plant^{-1}, number of seeds pod^{-1}and 100 seed wt. (g), seed yield q ha^{-1} and harvest index (%) in Pigeonpea

Treatments	2018-19					2019-20					Pooled				
	No. of Pods per Plant	No. of seeds per pod	100 seed wt. (g)	Seed Yield q/ha	Harvest Index	No. of Pods per Plant	No. of seeds per pod	100 seed wt. (g)	Seed Yield q/ha	Harvest Index	No. of Pods per Plant	No. of seeds per pod	100 seed wt. (g)	Seed Yield q/ha	Harvest Index
T_1 (Control)	190.43	2.72	9.23	17.70	32.01	192.43	2.73	9.32	18.34	32.17	191.43	2.72	9.27	18.02	32.09
T_2-GA_3-25PPM	208.23	3.31	9.31	18.48	33.51	230.41	3.41	9.33	19.33	33.45	219.32	3.36	9.32	18.90	33.49
T_3-GA_3 50PPM	233.52	3.34	9.39	18.83	32.38	238.51	3.61	9.43	19.79	32.17	236.02	3.47	9.41	19.31	32.24
T_4-GA_3- 75PPM	248.40	3.85	9.85	20.38	33.72	250.58	3.86	9.86	22.25	34.12	249.69	3.89	9.86	21.31	33.93
T_5-NAA-25PPM	225.40	3.46	9.31	18.85	33.44	228.53	3.59	9.32	19.27	33.48	226.97	3.52	9.31	19.06	33.46
T_6-NAA-50PPM	231.65	3.59	9.38	18.83	32.32	233.65	3.60	9.39	19.57	32.42	232.60	3.59	9.38	19.20	32.37
T_7-NAA-75PPM	241.26	3.76	9.42	19.07	32.36	244.20	3.78	9.44	19.99	32.44	242.73	3.77	9.43	19.53	32.41
T_8-Jeevamruth- @ 500 L ha^{-1}	233.52	3.64	9.53	18.62	33.63	247.61	3.72	9.64	20.92	34.86	240.56	3.68	9.58	19.77	34.25
Mean	226.31	3.46	9.43	18.85	32.92	233.24	3.54	9.47	19.93	33.14	229.78	3.50	9.45	19.39	33.03
SE(m) ±	1.22	0.07	0.08	0.064	0.16	1.37	0.09	0.08	0.209	0.14	0.88	0.06	0.06	0.101	0.12
CD at 5%	3.59	0.21	0.22	0.188	0.48	4.04	0.26	0.23	0.615	0.43	2.58	0.18	0.20	0.297	0.34

Conclusion

In this study, yield parameters of pigeonpea differ according to the plant growth regulators treatments and jeevamrut. The pigeonpea yield components were influenced by GA_3, NAA and jeevamruth. The foliar application of GA_3-75 ppm resulted in higher seed yield and yield components followed by NAA-75 ppm and by soil application of jeevamruth @500 l ha-1. The comparative study of Conventional and Vedic method help to assess economics of cultivation practices and will be useful in crop improvement programme.

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