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Growth and biomass productivity of pigeonpea [*Cajanus cajan* (L.) Millsp.] as influenced by nutrient and pest management

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Abstract
A field experiment was conducted during *kharif* season of 2017-18 and 2018-19 at Agriculture farm of Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya Chitrakoot, Satna (M.P.) to study the nutrient and pest management on growth and biomass productivity of pigeonpea. Growth parameters *viz*. plant height was recorded numerically higher under RDF + 1% Urea + 0.25% $ZnSO_4$ + 0.25% Borax spray at 50% flowering while, trifoliate leaves per plant was noted markedly more under RDF + 0.5% Borax spray at 50% flowering. Biomass productivity in term of biological yield and stover yield was recorded significant superior and numerically higher primary and secondary branches per plant noted under RDF + 2% Urea spray at 50% flowering. Application of RDF + 2% Urea spray at 50% flowering gave 636 kg/ha (9.8%) more biological yield over control. Significantly maximum seed yield (1071.17 kg/ha) and conspicuous more plant dry weight was recorded under T_8: RDF + Multimicronutrient spray @ 2 ml/lit at 50% flowering + Indoxacarb at flowering + one systemic insecticide 15 days after first spray.

Keywords: RDF, urea, borax, $ZnSO_4$, Multimicronutrient, Indoxacarb, systemic insecticides, Growth, biomass, pigeonpea

Introduction
Pigeonpea [*Cajanus cajan* (L.) *Millsp]* is the most versatile crop cultivated in many countries of tropical and subtropical regions of the world. It is grown worldwide for grain, green manuring, fodder and forage as sole crop, intercrop, mixed crop and in sequential cropping system. India ranks first with about 90% of world area and 85% of production. In India, pigeonpea ranks second in both acreage (5.32 million ha) and production (4.78 million tonnes) among the pulses in India with average productivity of 898 kg/ha (Anonymous, 2017-18).
Nutrient management is the most basic factor and is found to exert a great influence not only on growth and yield attributes of crops but also for obtaining sustained productivity. Among all nutrients N, P, K are most important nutrients which contribute to proper growth and yield of crop plant and it also has direct effect on metabolism of plant. Nutrients play a vital role increasing the seed yield in pulses. Nutrient management mainly aims at the maintenance and or adjustment of soil fertility as a result of nutrients supply to an optimum level for sustaining the desired crop productivity through optimization of the benefits from all possible resources of plant nutrients in an integrated manner (Roy and Ange, 1991) [12]. Optimum plant nutrition helps in early establishment of rainfed crop by developing right crop canopy structure and root system.
Pigeonpea yield have remained stagnant for the past 3 to 4 decades largely due to damage inflicted by insect pest (Basandria *et al.,* 2011 and Sharma *et al.,* 2010) [2, 13]. Alarming past array of more than 250 insect pest is surely on area of concern in pigeonpea pest management (Sharma *et al.,* 2010) [13]. The pigeonpea pod borer complex comprise of gram pod borer, *Helicoverpa armigera* Hubner, Plume moth, *Exelastis atmosa* (Walshingham) and Pod fly, *Melan agromyza obtuse* (Molloch). Considerable loss of grain yield is inflicted on account of their association with fruiting bodies. *Helicoverpa armigera* alone contributes loss upto 50% for management of pod borer complex (Thakare 2001, Dodia *et al.,* 2009) [15, 6]. These losses are more aggregated is short duration pigeonpea. Agrochemicals are still the first choice of farmers. Insecticides are most commonly recommended. Hence, chemical measures are often termed as necessary evil in present pigeonpea pest management scenario. Farmers use chemical pesticides indiscriminately, which leads to increased cost of plant protection resulting in lower profitability on these grounds.

Newer insecticides with noval mode of action were evaluated to find out an effective and economical insecticide at present recommendation for insect pest management of pigeonpea. Hence, an experiment was carried to study the effect of nutrient and pest management on productivity of pigeonpea.

Method and Materials

The present field experiment was conducted at Agriculture farm of the Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya, Chitrakoot, Satna (M.P.) during *kharif* season of 2017-18 and 2018-19. The farm is situated under Kymore Plateau of Northern Madhya Pradesh (25^0 10´ N latitude, 80^0 32´ E longitude and 190-210 meter above mean sea level). Agro-ecological Chitrakoot is characterised by semi-arid and sub-tropical climate with hot summer and cold winters. The total means annual rainfall of Chitrakoot 950 mm while, the crop was received 800 mm and 670 mm rainfall during crop season (July, 2017 and July 2018 to January, 2019) with 26 and 23 rainy days in two respective years. The soil of experimental field was sandy loam with slightly alkaline p^H 8.29 and 7.8, low in organic carbon (0.24 and 0.27%) and available nitrogen (110.25 and 60.75 kg/ha) and available phosphorus of 8.75 and 13.28 kg/ha and medium in available potash (144 and 160 kg/ha). The experiment consisted 08 treatments replicated three times in Randomized Block Design. The details of treatments were: T_1 - RDF, T_2 - RDF + 2% Urea spray at 50% flowering, T_3 - RDF + 0.5% Borax spray at 50% flowering, T_4 - RDF + 0.5% $ZnSO_4$ spray at 50% flowering, T_5 - RDF + 1% Urea + 0.25% $ZnSO_4$ + 0.25% Borax spray at 50% flowering, T_6 - RDF + Multimicronutrient spray @ 2ml/litre at 50% flowering, T_7 - RDF + Indoxacarb at flowering + one systemic insecticide 15 days after first spray, T_8 - RDF + Multimicronutrient spray @ 2 ml/litre at 50% flowering + Indoxacarb at flowering + one systemic insecticide 15 days after first spray. The recommended dose of fertilizers (RDF) for pigeonpea was 20:60:30 kg N: P_2O_5: K_2O/ha, which supplied through DAP and muriate of potash. The entire quantity of DAP and MOP were applied as basal in the furrows uniformly in all treatments. The seed was treated with thiram @ 2.5 g/kg seed before seed inoculation for protecting fungal infection. Thereafter, it was inoculated with *Rhizobium* culture @ 20 g/kg seed followed by phosphorus solubilizing bacteria (PSB) @ 40 g/kg seed. Pigeonpea was sown in rows 60 cm apart on 19th July 2017 and 17th July 2018 using a seed rate of 20 kg/ha. The plant to plant spacing was maintained 15 cm by thinning at 20 DAS. The crop was grown as per recommended package and practices and harvested on 8th December, 2017 and 03rd Jan., 2019. Important observations were recorded at appropriate time by use of standard procedures. The biomass productivity *viz*., biological yield was calculated on the basis of grain and straw of crop. The experimental data was statistically analysed by Gomez and Gomez (1984). The treatment differences were tested by using "F" test and critical differences at 5% probability.

Results and Discussion

Effect on growth parameters

Growth parameters *viz*., plant height, trifoliate leaves/plant, plant dry weight per plant, primary branches/plant, secondary branches/plant were not significantly affected by nutrient and pest management treatments on the basis of pooled data (Table 1). Plant height was observed numerically higher (153.57 cm) under RDF + 1% Urea + 0.25% $ZnSO_4$ + 0.25% Borax spray at 50% flowering (T_5) followed by T_4 -RDF + 0.5% $ZnSO_4$ spray at 50% flowering (150.77 cm). While, trifoliate leaves/plant was recorded markedly higher in T_3 - RDF + 0.5% Borax spray at 50% flowering (111.53/plant) followed by T_8 -RDF + Multimicronutrient spray @ 2 ml/litre at 50% flowering + Indoxacarb at flowering + one systemic insecticide 15 days after first spray (107.70/ plant). However, plant dry weight was noted conspicuous more under T_8 - RDF + Multimicronutrient spray @ 2 ml/litre at 50% flowering + Indoxacarb at flowering + one systemic insecticide 15 days after first spray (21.97g) followed by T_7 -RDF + Indoxacarb at flowering + one systemic insecticide 15 days after first (21.85 g). Primary and secondary branches were observed numerically superior under T_2 - RDF + 2% Urea spray at 50% flowering (10.67 and 0.97 branches/plant). This could be due to collective application of urea, $ZnSO_4$, borax, multimicronutrient, Indoxacarb and systemic insecticide besides recommended dose of NPK application. Which may accrete the metabolic activities of plant resulted the higher value of their growth parameter. This findings conformity with results obtained by Choudhary *et al.* (2004) [3], Aliloo *et al.* (2012) and Malla Reddy *et al.* (2005) [10].

Table 1: Effect of Nutrient and Pest management on growth on pigeonpea (pooled data of 2 years)

Treatment	Plant height (cm)	Trifoliate leaves/plant	Plant dry weight (g)	Branches/plant	
				Primary	Secondary
T_1 - RDF	142.50	92.80	18.82	8.07	0.43
T_2 -T_1 + 2% Urea spray at 50% Flowering	144.53	106.43	21.11	10.67	0.97
T_3 -T_1 + 0.5% Borax spray at 50% Flowering	145.00	111.57	21.77	9.70	0.73
T_4 -T_1 + 0.5% $ZnSO_4$ spray at 50% Flowering	150.77	99.60	19.54	9.20	0.70
T_5 -T_1 + 1% Urea + 0.25% $ZnSO_4$ + 0.25% Borax spray at 50% Flowering	153.57	102.43	16.94	10.30	0.80
T_6 - T_1 + Multimicronutrient spray @ 2ml/litre at 50% Flowering	142.17	92.80	18.74	9.83	0.60
T_7 – T_1+ Indoxacarb at flowering + one systemic insecticide 15 days after first spray	141.63	95.80	21.85	10.07	0.77
T_8 – T_6+ Indoxacarb at flowering + one systemic insecticide 15 days after first spray	149.90	107.70	21.97	10.07	0.53
SEm±	6.37	9.26	3.20	1.12	0.17
CD(P=0.05)	NS	NS	NS	NS	NS

Table 2: Effect of Nutrient and Pest management on biomass productivity of pigeonpea

Treatment	Yield (kg/ha)								
	Grain			Stover			Biological		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
T_1 - RDF	837	870	853	6317	4878	5597	7155	5748	6451
T_2 - T_1 + 2% Urea spray at 50% Flowering	940	1035	988	6898	5302	6100	7839	6336	7087

T_3 –T_1 + 0.5% Borax spray at 50% Flowering	838	948	893	6960	5264	6095	7795	6212	6986
T_4 –T_1 + 0.5% $ZnSO_4$ spray at 50% Flowering	936	942	939	6903	4749	5826	7839	5692	6765
T_5 -T_1 + 1% Urea + 0.25% $ZnSO_4$ + 0.25% Borax spray at 50% Flowering	860	898	879	6014	4595	5304	6874	5494	6184
T_6 -T_1 + Multimicronutrient spray @ 2ml/litre at 50% Flowering	878	913	895	5342	4648	4995	6220	5562	5891
T_7 -T_1+ Indoxacarb at flowering + one systemic insecticide 15 days after first spray	1019	1024	1021	4796	4599	4697	5815	5624	5719
T_8 -T_6+ Indoxacarb at flowering + one systemic insecticide 15 days after first spray	1050	1092	1071	5435	5063	5249	6485	6155	6320
SEm±	30.38	42.07	34.12	419.40	168.02	352.90	417.94	162.38	348.93

Effect on Biomass Productivity

The biomass productivity in term of biological yield of pigeonpea was obtained significantly higher under T_2 - RDF + 2% Urea spray at 50% flowering (7078 kg/ha) followed by T_3 - RDF + 0.5% Borax spray at 50% flowering (6986 kg/ha) on the basis of pooled data as well as two years experiment. However, straw yield of pigeonpea was significantly increased under T_2 - RDF + 2% Urea spray at 50% flowering (6100 kg/ha) closely followed by T_3 -RDF + 0.5% Borax spray at 50% flowering (6095 kg/ha). The superior biological yield could be ascribed due to higher growth parameters *viz*. primary and secondary branches, and trifoliate/plant and stover yield. It might be due to continuous supply of nutrient as foliar spray which in turn increased leaf area and dry matter accumulation resulting in higher straw yield. This result are in agreement with the findings of Dash *et al.* (2005) Rathod *et al.* (2014) [11], Dabhi *et al.* (2015) [4], Khamoriya *et al.* (2017) [8], Maha Lakshmi *et al.* (2018) [9] and Phonoglosa *et al.* (2018).

The grain yield of pigeonpea was found superior (1071 kg/ha) under T_8 -RDF + Multimicronutrient spray @ 2 ml/litre at 50% flowering + Indoxacarb at flowering + one systemic insecticide 15 days after first spray followed by T_7 - RDF + Indoxacarb at flowering + one systemic insecticide 15 days after first spray. However, application of RDF + Multimicronutrient spray @ 2 ml/litre at 50% flowering + Indoxacarb at flowering + one systemic insecticide 15 days after first spray T_8 followed by - RDF + Indoxacarb at flowering + one systemic insecticide 15 days after first spray T_7 gave 217kg/ha (25.40%) and 167 kg/ha (19.55%) higher seed yield over control (RDF) on the basis of pooled data. This could be ascribed due to higher value of yield attributes especially pods/plant and 1000-seed weight. Pigeonpea yield also depends upon physiological disorder which could be controlled effective by foliar nutrient spray. It is known that nutrients modify the source sink relationship and increase the translocation, photosynthetic efficient resulting increased flower relation to pod set percent (Ganpathy *et al.*, 2018).

Thus it can be concluded that application of by RDF + 2% Urea spray at 50% flowering was found the best treatment for higher growth and biomass productivity of pigeonpea while, addition RDF + Indoxacarb at flower initiation + one systemic insecticide 15 days after first spray was found superior in term of grain yield for rainfed conditions of Kymore Plateau of Madhya Pradesh.

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