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Effect of nutrient and pest management practices on growth and yield attributes; and yield of long duration pigeonpea (*Cajanus cajan* (L.) Mill Sp.)

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Abstract
An experiment was organized at Oilseed Research Farm in C.S.A. University of agriculture and Technology, Kanpur (Uttar Pradesh) during *karif* season in 2017-18 to study the Effect of nutrient and pest management practices on growth and yield attributes; and yield of long duration pigeonpea (*Cajanus cajan* (L.) Mill Sp.). The experiment was laid out in Randomized Block Design in three replications. In the all treatments, recommended dose of fertilizer (N:P:K:S:Zn::20:50:20:20:20 kg ha^{-1}) was applied commonly. Experimental results were revealed that the application of T6 (RDF + 2% urea + 0.5% B + 0.5% Zn spray at 50% flowering) + Indoxacarb at flowering + one systemic insecticide 15 days after first spray was produced (2820 kg ha^{-1}) grain yield and Gross income (1,26,900 $Rs.ha^{-1}$); and B:C cost ratio (3.08), grain yield and B:C ratio was recorded 29.65% and 26.74% higher than the application of RDF. Therefore, on the basis of experimental data we may conclude that the application of RDF + 2% urea + 0.5% B + 0.5% Zn spray at 50% flowering + Indoxacarb 14.5% SC at flowering + one systemic insecticide 15 days after first spray was found appropriate to achieve the higher grain yield and economic return.

Keywords: growth and yield attributes, nutrient management, pest management and yield

Introduction
Pigeonpea (*Cajanus cajan* (L.) Millsp.) is one of the important Kharif season pulse crop in India, it is called by many other names i.e. Red gram, Arhar or Tur. Among all the pulses, it is 2nd most important crop after the gram among all the pulses in the country. India ranks 1st in area and production in the world, with 80% and 67% of world's acreage and production respectively (Ahlawat *et al*., 2005) [2].

Pigeonpea is predominantly a crop of tropical areas mainly cultivated in semi-arid regions of India. This crop is very sensitive to low temperature at flower and pod development stage, therefore during flowering and podding stage cloudy weather, fog and low temperature, leads to poor pod formation, resulted low yield. It is suitable for rainfed situation with an area of 4.4 m ha, production 4.2 mt and productivity 954 kg/ha in the country (Anonymous, 2017-18) [3]. However, Area of pigeonpea in Uttar Pradesh in 2018-19 was 2.51 lakh ha and production 2.72 lakh tonnes with average productivity 1084 kg/ha (Kharif Pulses Prospects, 2020-21 DPD, Bhopal pp.2). Among the pulses, the pigeonpea is an important dietary component of human beings (Gopalan *et al*., 1971) [11], especially to the people which are vegetarians. Being a pulse, it also plays an important role in improving the soil fertility and consequently it improves the productivity of succeeding crops (Kumar Rao, 1990) [12]. Besides the major sources of dietary protein, pigeonpea also plays an important role in sustaining nutrient level in soil productivity by fixing atmospheric nitrogen (Kumar Rao and Dart, 1987) [13] for crop productivity.

Low and imbalanced use of fertilizers is one of the major reasons for its low productivity. It has been recognized that N, P and K fertilizers alone are not always sufficient to provide balanced nutrition for optimal yield and quality of pigeonpea (Jain *et al*., 2007). Pigeonpea flowers profusely during in the month of November-December, a higher per cent of flower drop (70-96%) without setting into the pods was observed. Thus, flower and fruit dropping are considered as a bottleneck in grain production. Flowers retention in crop plant helps to opt the maximum yield. Another major constraint of realization of yield potential of pigeonpea includes, biotic and abiotic stresses which prevalent across all the pulses growing areas. Biotic stresses include the Insects and diseases i.e., phytophthora blight, sterility mosaic, pod fly and

pod borer are damage causing substantial losses. Among abiotic stresses, terminal drought, moisture stress and sudden rise and drop in temperature coupled with frost and foggy weather during the flower and pod initiation and pod development stage, inflicts major yield losses in production.

Materials and Methods

A field experiment was organized during the kharif 2017-18 at Oilseed Research Farm, Kalyanpur, Kanpur Uttar Pradesh (26044'N; 80033'E, 126 m of above mean sea level). The soil of experimental field was well drained and levelled, experimental plots were sandy loam, low in organic carbon (0.45%), 196 kg ha-1 available N, medium in available P2O5 (25.20 kg ha-1), and available K2O (175 kg ha-1). The soil was moderately alkaline in reaction (pH 7.8). This was observed not favourable to make the nutrient availability, because pH range 6-7 seems to favour the availability of nutrients to the plants (Brady 1988). The experiment was laid out in Factorial randomized block design with eight treatments in three replications and variety was Amar. The eight (8) treatments were consisting; (T1) RDF (20:50:20:20:20 kg NPKSZn kg/ha), (T2) RDF + 2% urea spray at 50% flowering, (T3) RDF + 0.5% B spray at 50% flowering, (T4) RDF + 0.5% Zn spray at 50% flowering, (T5) RDF + 2% urea + 0.5% B + 0.5% Zn spray at 50% flowering, (T6) RDF + Multi-micronutrient spray @ 2ml/lts of water, (T7) T1 + Indoxacarb at flowering + one systemic insecticide 15 days after first spray and (T8) T6 + Indoxacarb at flowering + one systemic insecticide 15 days after first spray.

Two irrigations were applied to the crop, 1st at flowering and 2nd at pod formation stage. Pre-emergence application of pendimethalin 30 EC @ 3.3 lt/ha was applied one day after sowing. A knapsack sprayer was used to spray the herbicides using a spray volume of 600 lts/ha. Two hand weeding operations were done at 20 and 45 DAS with the help of Khurpi in all the treatments. Sowing was done on ridges manually on hills with the help of Khurpi, rows and plant spacing at 60x25 cm was maintained with average depth of 5 cm and seed rate was 18 kg/ha. All the plant protection measures were adopted as per treatments. At maturity stage, after leaving one row on each side as well as 50 cm along the width of each side, a net plot area of 5.0m x 4.0m (4 m long 6 rows at 75 cm) was harvested separately, when two third to three fourth pods at maturity judged by changing their colour to brown. Data about the growth, yield attributes and yields were recorded.

The plants are usually cut with the help of sickle within 25 cm above the ground. Harvested plants should be left in the field for sun drying for 3-6 days depending on climatic conditions. Threshing is done by beating the pods with stick, seeds were cleaned by winnower and clean seeds should be sun dried for 3-4 days to bring their moisture content at 9-10% and yield was recorded. All the observations were statistically analyzed for their test of significance using the F-test (Gomez and Gomez, 1984) [9]. The significant of difference between treatment means were compared with t critical difference at 5% level of probability.

Result and Discussion

1. Effect on growth attributes

Result revealed that plant height was influenced by different treatments and the highest number of branches (11.33 cm) was recorded with the application of (T8) T6 + Indoxacarb at flowering + one systemic insecticide 15 days after first spray followed by (T6) RDF + Multi-micronutrient spray @ 2ml/lts of water (10.67) and (T7) RDF + Indoxacarb at flowering (@0.55ml/lt of water) + one systemic insecticide 15 days after first spray and (T4) RDF + 0.5% Zn spray at 50% flowering (10); which was found higher by 25.88%, 18.55% and 11.11% to RDF application (9) Table-1. These finding are well supported by Kaur G. *et al* (2015) [16], Muthul (2016), and Kumar and Sharma (2020) [20]. The applications of 2% urea recorded maximum plant height and number of branches plant^{-1}. This might be due to more availability of nitrogen, which plays a vital role in cell division. Foliar application of nutrients increased plant height it might be readily due to absorption of nutrients through foliar application. Increased plant height is due to internodes elongation and vigorous root system. Multi-micronutrient spray also improves the root, flower growth and development thus improve overall health of the crop.

Table 1: Effect of Nutrients and Pest Management on Growth Attributes of Pigeonpea

	Treatments	Plant height (cm)	Branch plant^{-1}
1	RDF	220.00	9.00
2	T_1+ 2% urea spray at 50% flowering	205.00	9.67
3	T_1+ 0.5% B spray at 50% flowering	218.33	9.00
4	T_1+ 0.5% Zn spray at 50% flowering	203.33	10.00
5	T_1+ 2% urea + 0.5% B +0.5% Zn spray at 50% flowering	208.33	9.33
6	T_1+ Multi-micronutrient spray @ 2ml/lts of water	206.33	10.67
7	T_1+ Indoxacarb at flowering + one systemic insecticide 15 days after first spray	208.33	10.00
8	T_6+ Indoxacarb at flowering + one systemic insecticide 15 days after first spray	201.67	11.33
	SE (m)	6.294	1.117
	CD (P=0.05)	N/A	N/A

2. Effect on yield attributes, yield and economics

Result showed that significantly highest number of pods plant^{-1} was recorded with the application of T6 + Indoxacarb at flowering + one systemic insecticide 15 days after first spray (232.33) followed by, RDF + Multi-micronutrient spray @ 2ml/lts of water (216.67), which was 18.33% and 10.18% more than application of RDF (196.33) respectively, and the grain pod^{-1} was recorded highest with T6 + Indoxacarb at flowering + one systemic insecticide 15 days after first spray (4.67) followed by other treatments, which was 27.24% more than the application of RDF (3.67), the number of pods plant^{-1} and grains pod^{-1} increased by the application of micronutrients i.e. Zn and B. Similar findings were also reported by Gowda *et al*., (2015) [10], Thamke (2017) [22] and Archana Verma (2020) [4]. As number of pods per plants is considered to be the major determinants in pulses, foliar feeding of micronutrient through multi micronutrient was able to enhanced number of seed per pod. It was also reported by Barrik and Rout (1990) [5] and Elumle *et al*., (2019) [6] where foliar application of nutrients at flowering and pod

development stage might have been easily absorbed and better translocated in the plant and maintained constant requirement of nutrients at the reproductive stage of the crop.

100 seed weight, Grain yield, gross income and B:C ratio of pigeon pea (Table 2) were significantly affected by nutrient and pest management. Highest 100 seed wt. was recorded the application of T6 + Indoxacarb at flowering + one systemic insecticide 15 days after first spray (8.67g) followed by T1 + Indoxacarb at flowering + one systemic insecticide 15 days after first spray (8.57g), which was 9.75% and 11.81% higher over RDF application (7.90), Highest significant grain yield was recorded with the experimental treatment T6 + Indoxacarb at flowering + one systemic insecticide 15 days after first spray (2820.00 kg ha^{-1}); followed by RDF + Multi-micronutrient spray @ 2ml/lts of water (2758.00 kg ha^{-1}), which were 29.65% and 26.80% higher than the RDF (2175.00 kg ha^{-1}). Highest gross income was also obtained with treatment T6 + Indoxacarb at flowering + one systemic insecticide 15 days after first spray (126900.00 Rs. ha^{-1}); followed by RDF + Multi-micronutrient spray @ 2ml/lts of water (124110.00 Rs. ha^{-1}) and T1 + Indoxacarb at flowering + one systemic insecticide 15 days after first spray (122564.70 Rs. ha^{-1}), which were 29.65%, 26.80% and 25.22% higher than RDF (97875.00 Rs. ha^{-1}). Similar findings was also reported by Jadhav and Kute (2019) [14] and Kalaichelvi (2020) [17]; Tekale *et al*., (2009) [21]; El-Seifi *et al*., (2013) [7]; Mukund *et al*., (2013) and Gowthami and Rama Rao (2014) [8]. B:C ratio was also recorded in the same manner, it was found highest with the application of T6 + Indoxacarb at flowering + one systemic insecticide 15 days after first spray (3.08); followed by RDF + Multi-micronutrient spray @ 2ml/lts of water (3.04),, which were 26.74% and 25.10% more than RDF (2.43). These results are in accordance with the results reported by Kailas (2019) [5]. Growth, yield attributes and yield correlation also reflects the above findings.

Table 2: Effect of nutrients and pest management on yield attributes, yield and economics

	Treatment	Pods/ Plant	Grain/ pod	100 seed wt.(g)	Yield (kg/ha)	Gross Income (Rs./ha)	B:C ratio
1	RDF	196.33	3.67	7.90	2175.00	97875.00	2.37
2	T_1+2% urea spray at 50% flowering	204.33	4.00	8.20	2533.33	113999.85	2.69
3	T_1+0.5% B spray at 50% flowering	203.00	4.00	7.97	2476.33	111434.85	2.68
4	T_1+0.5% Zn spray at 50% flowering	214.00	4.00	8.33	2508.66	112889.70	2.69
5	T_1+2% urea+0.5% B+0.5% Zn spray at 50% flowering	208.33	3.67	8.47	2681.66	120674.70	2.83
6	T_1+Multi-micronutrient spray @ 2ml/lts of water	216.67	3.67	8.60	2758.00	124110.00	2.87
7	T_1+Indoxacarb at flowering+one systemic insecticide 15 days after first spray	208.33	4.00	8.57	2723.66	122564.70	2.89
8	T_6+Indoxacarb at flowering+one systemic insecticide 15 days after first spray	232.33	4.67	8.67	2820.00	126900.00	3.04
	SE(m)	6.261	0.45	0.152	62.211	2799.508	0.07
	C.D.	19.175	N/A	0.467	190.527	8573.705	0.213

Conclusion

Results revealed that the application of T6 + Indoxacarb at flowering + one systemic insecticide 15 days after first spray recorded highest grain yield (2820.00 kg ha^{-1}), gross income (126900.00 Rs. ha^{-1}) and benefit cost ratio (3.08). Investigation reflect that by the use of T6 (RDF + 2% urea + 0.5% B + 0.5% Zn spray at 50% flowering) + Indoxacarb at flowering + one systemic insecticide 15 days after first spray was recorded 29.65% higher grain yield and Gross income; and 26.74% higher B:C cost ratio over the application of RDF. So, from overall comparison to RDF, particularly on economic point of view, we may have come in conclusion that the application of RDF + 2% urea + 0.5% B + 0.5% Zn spray at 50% flowering + Indoxacarb 14.5% SC at flowering + one systemic insecticide 15 days after first spray can be suggested for nutrient and pest management practice in long duration pigeonpea to achieve the maximum grain yield and economic return.

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