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IMPACT OF BORON, ZINC AND IAA ON GROWTH, DRY MATTER ACCUMULATION AND SINK POTENTIAL OF PIGEON PEA (*CAJANUS CAJAN* L.)

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ABSTRACT

Field experiments were conducted during *Kharif* 2002 to 2003 to examine the impact of B, Zn and IAA singly and in different treatments combinations at flowering and pod initiation stages of pigeon pea variety Asha and ICPL81-119. The objectives was study the pattern of growth, dry matter distribution, leaf and pod abscission as well as the assimilate partitioning for sink enhancement. IAA irrespective of concentrations in combination with boron and zinc at flowering and podding stages was found most effective in prevention of flower and premature abscission and acceleration of assimilate translocation as well, while foliar application of the same at flowering or pod initiation, individually, seems to alter the growth parameters or yield contributing traits partially.

Key words : Boron, Zinc, IAA, Dry matter accumulation, Sink potential.

INTRODUCTION

The low productivity of pigeon pea in the country may be ascribed to many reasons. However, inadequate and imbalanced fertilization, flower drop and dry matter partitioning are noted to be important. Application of bio-regulators is reported to improve photosynthetic activity and its assimilation leading to modification of various metabolic and physiological processes in plants and improving source-sink relationship which ultimately improved flowering, fruit setting, grain filling and test weight in different crops (Deotale *et al*., 1998). Boron is known to be directly linked with the process of fertilization as it is required for seed and grain production, besides its role in stabilizing certain constituents of cell wall and plasma membrane enhancement of cell division and tissue differentiation, translocation of photoassimilates towards pod sink etc (Marschner, 1986). Zinc also plays an important role in the formation of tryptophan, precursor of IAA (Kocchar, 1976). Very scanty work has been done on foliar application of plant growth regulators individually or combination with B and Zn at specific critical growth stages with respect to pigeon pea in Chhattisgarh plains. Keeping all these in view, this work was carried out to study the impact of boron, zinc and IAA on growth, dry matter accumulation and sink potential of pigeon pea.

MATERIAL AND METHODS

The field experiment was conducted during the *kharif* season of 2002-2003 at the Instructional farm, IGKVV, Raipur (C. G.). The soil was clayey in nature (vertisol) and neutral in reaction. It had low nitrogen, medium phosphorus and high potash contents. Seven treatment combinations consisting of T_1 (control), T_2 (IAA + B + Zn at flower initiation, FL), T_3 (IAA + B + Zn at pod initiation, PI), T_4 (IAA + B + Zn at both FL and PI stages), T_5 (IAA only at FL and PI stages), T_6 (B + Zn at FL and PI stages) and T_7 (IAA at FL and B + Zn at PI) were tested in RBD with three replications. For B and Zn, boric acid and zinc sulphate sources were used respectively. The fertilizers were applied @ 20: 30: 50 NPK kg ha^{-1} in the form of urea, SSP and MOP as basal dose. The different treatments were given at specific critical growth stages. The observations regarding the morphological and yield components were recorded by taking five plants from each plot for phenological observations.The seed index was determined by weighing 100 seed weight (in gram).

RESULT AND DISCUSSION

(a) Effects on morphological and physiological characters : In pigeon pea, plant height (Table 1) is the most influencing morphological trait. The data revealed that plant height increased vigorously upto 90 days and then slowed upto maturity. The differences amongst treatments were significant at all the stages except S_1 stage. The treatment T_4 was at par with other treatments. Further, it was emphasized that the importance of appropriate time of application (i.e. flowering and panicle initiation) of IAA, B and Zn, could alter the physiological events when given at proper stage of crop. Increase in plant height was mainly attributed due to higher shoot growth through cell elongation, cell differentiation and apical dominance promoted by IAA. Boron and Zinc were also supposed to be involved in the hormone synthesis, hence indirectly related to translocation and metabolism of carbohydrate finally contributing to additional growth compared to control (Padma *et al*. 1989 and Deotale *et al*. 1998).

The data related to number of branches plant^{-1} (Table 1) revealed that treatment T_4 (18.32 and 21.27 at 50% podding and maturity stages respectively) gave the maximum value as compared to other treatments. These might be due to promotion of bud and branch development by the auxins whereas B and Zn application ultimately increased the availability of other nutrients and accelerated the translocation of photoassimilates as well (Guhey, 1999, Barclary and Madavid, 1988).

Dry matter accumulation in the plant at progressive stages is a justified assessment of growth as a cumulative expression of different growth parameters. Further, it was observed that productivity of pigeon pea was not only dependent on accumulation of total amount of dry matter but its effective partitioning into economic sink seems to be key to increase the yield. The leaf, stem, root and total dry matter plant^{-1} varied significantly at 125 and 180 DAS. Dry matter accumulation in leaf, stem, root and total dry matter was maximum in treatment T_4 (Table 2) followed by T_2 at all crop growth stages.

Figure1 infers that dry matter accumulation in pods was the highest in T_4 (46%) as compared to T_1 (34%) whereas, when B and Zn applied alone again drived the attention for specific need of IAA with these micronutrients. Auxin is known to maintain the higher rate of photosynthesis which contributed to higher dry matter during the later phases, which was an indicator of current photosynthesis (Bangla *et al.* 1983, Puste and Jana, 1988, Shinde *et al*., 1991, Hemantranjan *et al*., 2000 and Upadhyay, 2002).

(b) Effect on yield attributes : Findings of the experiment clearly inferred that growth regulators (IAA) and micronutrients (B + Zn) at flowering and pod initiation could alter the yield attributes resulting

Table 1. Impact of B, Zn and IAA on plant height (cm), total number of branches plant^{-1} and dry weight of leaves plant^{-1}

Treatment	Plant height				Total no. of branches		Dry wt. of leaves			
	S_1	S_2	S_3	S_4	S_3	S_4	S_1	S_2	S_3	S_4
T_1	73.89	113.33	118.44	121.77	9.66	9.81	2.79	6.16	3.89	1.07
T_2	75.0	122.66	138.67	144.83	16.2	19.88	2.67	6.62	5.58	3.47
T_3	75.67	129.11	136.22	136.37	12.99	14.86	2.75	6.22	4.74	2.59
T_4	74.19	128.27	139.05	149.37	18.32	21.27	2.61	8.54	6.80	4.36
T_5	75.47	128.66	135.33	140.98	11.1	14.66	2.72	6.73	4.91	3.19
T_6	75.47	123.33	128.43	134.12	10.1	17.1	2.66	6.86	4.60	1.82
T_7	74.29	125.22	131.99	135.04	11.22	12.21	2.75	7.69	5.37	2.19
SEm±	0.69	5.57	3.27	5.39	0.81	1.36	0.06	.0.82	0.49	0.20
CD 5%	NS	12.13	10.10	16.63	2.48	4.19	NS	NS	1.51	0.63

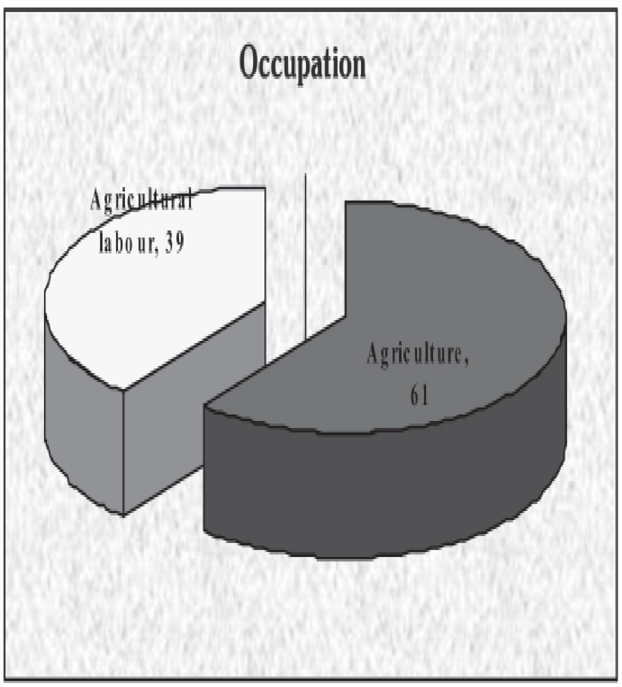
T_1 : control, T_2 : IAA + B + Zn at flowering, T_3 : IAA + B + Zn at pod initiation, T_4 : IAA + B + Zn at both stages, T_5 : IAA at both stages, T_6 : B + Zn at both stages, T_7 : IAA at flowering and B + Zn at pod initiation, S_1 : vegetative stage (45 days), S_2 : 50% flowering (90 days), S_3 : 50% podding (125 days), S_4 : maturity (180 days).

Table 2. Impact of B, Zn and IAA on dry weight of stem, root, total dry matter content and number of pods.

Treatment	Dry weight of stem				Dry weight of root				Total dry matter content				No. of pods	
	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4	S_3	S_4
T_1	3.53	14.73	20.01	31.54	1.24	2.34	2.57	2.99	7.61	23.22	49.49	54.76	50.66	63.66
T_2	3.83	15.87	22.58	37.34	1.15	2.76	3.67	4.52	7.64	25.25	59.14	74.23	78.33	93.54
T_3	3.88	14.44	20.53	35.09	1.15	2.08	2.43	4.68	7.70	28.83	55.26	66.93	67.53	89.01
T_4	3.83	18.33	24.12	40.07	1.21	2.44	3.64	4.89	7.71	22.74	63.58	80.53	81.99	106.53
T_5	3.86	17.65	22.23	35.76	1.23	2.64	2.86	3.71	7.63	29.27	51.46	71.01	76.00	90.74
T_6	3.89	14.83	21.26	33.10	1.16	2.81	2.44	3.56	7.74	24.37	53.32	58.57	66.83	78.54
T_7	3.84	15.65	21.61	34.47	1.19	2.41	2.73	3.57	7.78	24.93	54.38	58.65	72.83	85.21
SEm±	0.13	2.11	0.68	0.34	0.02	0.29	0.13	0.09	0.14	3.05	2.67	2.68	1.80	1.48
CD 5%	NS	NS	2.11	1.05	NS	NS	0.40	0.28	NS	NS	8.22	8.27	4.40	4.56

T_1 : control, T_2 : IAA + B + Zn at flowering, T_3 : IAA + B + Zn at pod initiation, T_4 : IAA + B + Zn at both stages, T_5 : IAA at both stages, T_6 : B + Zn at both stages, T_7 : IAA at flowering and B + Zn at pod initiation, S_1 : vegetative stage (45 days), S_2 : 50% flowering (90 days), S_3 : 50% podding (125 days), S_4 : maturity (180 days).

Graph 1. Impact of IAA, boron and zinc on dry matter partitioning at maturity to different plant parts.



remarkable increase in seed yield. Among these yield traits increase in number of pod of the plant shared maximum towards the visible jump in other related yield components *viz.* pod growth, number of seeds plant^{-1},pod weight and seed weight (Table 3).

It was interesting to notice that application of T_4 (IAA + B + Zn at FL and PI stages) showed remarkable improvement in yield attributing traits as compared to T_2 (IAA + B + Zn at FL). Further, suggesting that the application of biomolecules at critical growth stage could specifically accelerate the translocation of photoassimilate from stem to economic sink. T_6 (B and Zn at both the stages) favoured the maximum retention of leaf and flower thus promoted the yield associates.

The data related to seed yield (Table3) shows that the treatments differed significantly. Highest value was noted in T_4 (24.52 gplant^{-1}) whereas T_6 was less effective with value 19.49 gplant^{-1}. Data on harvest index exhibited that all the treatments differed statistically. The maximum value was obtained with T_4(35.78) and the least effect was seen in T_6 (29.18). These might be due to the fact that IAA promotes the prevention of pod abscission and cell elongation at suppression of abscission of pod was the major determining factor of the seed yield. On the other hand, auxin indirectly controled the ethylene activity, which accelerated the abscission. It also suppressed the cellulase activity, cell degrading enzyme which favoured abscission process (Mote *et al.* 1975, Singh,1986). B and Zn also contributed significantly in reducing the pod abscission by preventing abscission layer formation when applied at podding stage. At the same time, it also increased the sink demand as well as the translocation of photosynthates from source to sink. This might be due to unloading of the current photosynthates being accumulated in the leaf and stem (Singh,1986, Setia *et al.* 1993, Guhey, 1999).

Table 3. Impact of B, Zn and IAA on yield attributes.

Treatment	Pod length (cm)	No. of seeds pod^{-1}	No. of seeds $Plant^{-1}$	Pod weight $plant^{-1}$ (g)	Seed yield $plant^{-1}$ (g)	Harvest index	Seed index
T_1	4.96	2.94	165	18.17	16.23	27.70	9.19
T_2	5.26	3.28	240	38.89	22.40	31.01	9.68
T_3	5.30	3.02	230	34.64	22.47	30.00	9.84
T_4	5.40	3.30	250	41.21	24.52	35.78	10.49
T_5	5.16	3.08	226	38.35	22.80	29.66	9.77
T_6	5.10	3.22	206.33	20.09	19.49	29.18	9.03
T_7	5.27	3.10	220	27.42	20.64	29.90	9.38
SEm±	0.05	0.05	4.13	2.64	0.48	2.06	0.22
CD at 5%	0.18	0.16	12.72	8.14	1.48	4.49	0.69

T_1 : control, T_2 : IAA + B + Zn at flowering, T_3 : IAA + B + Zn at pod initiation, T_4 : IAA + B + Zn at both stages, T_5 : IAA at both stages, T_6 : B + Zn at both stages, T_7 : IAA at flowering and B + Zn at pod initiation.

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