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Effect of foliar spray of nutrients and plant growth regulators (PGRs) for yield maximization in blackgram

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Abstract : An experiment was conducted during 2002 to study the morphological physiological and biochemical effects of foliar spray of nutrients and plant growth regulators on yield and productivity of blackgram. The treatments include foliar spray of 2% DAP, 0.2% Boric acid, 0.5% $FeSO_4$, 0.5% $ZnSO_4$, 0.5% sodium molybdate, 2% urea, 0.1% humic acid, 1% KC1, Salicylic acid 100 ppm, Brassinolide 0.1 ppm and humic acid 20 kg basal application. Among these treatments, foliar spray of 2% urea recorded the highest yield of 955.2 kg/ha followed by foliar spray of KC1 1% along with soil application of humic acid @ 20 kg/ha (926.2 kg/ha). The yield enhancement may be due to improved morphological, physiological and biochemical parameters. The tested chemicals particularly 2% urea were found effective towards yield maximization in black gram.

Introduction

Hormones play an important role on the vegetative and reproductive growth of any plant. At present, several synthetic hormones are employed by the farmers to boost the growth in the vegetative phase and subsequently to increase the yield. Several efforts have been made to increase the yield potential through breeding for high yielding varieties incorporating efficient irrigating methods and application of fertilizers, biocides and hormones. Nutrients such as DAP, N as urea, $FeSO_4$, $ZnSO_4$ are known to significantly influence the yield of pulses (Sujatha, 2001). Salicylic acid, BR and humic acid proved their efficiency in increasing germination (Senthilkumar, 2001) and seed yield in groundnut (Amal, 2001). In grain legumes including blackgram, the application of PGRs and nutrients decreases the leaf senescence by retaining more leaf nitrogen and chlorophyll. Accordingly, it was aimed to study the influence of PGRs and nutrients on the productivity of blackgram.

Materials and Methods

The field experiment was conducted during the *kharif* season *2002* at Coimbatore. Experiment was conducted in Completely Randomized Block Resign involving CO.6 variety. Seeds were sown in rows 30 cm apart with plant to plant spacing of 10 cm and the population was maintained by thinning. The recommended package of practices were followed. The spraying of 2% DAP (T_2), 100 ppm salicylic acid + 2% DAP + 1% KC1 (T_3), 100 ppm salicylic acid + DAP 2% + 0.2% Boric acid + 0.5% $FeSO_4$ + 0.5% $ZnSO_4$, 0.05% Na_2MoO_4 (T_4), 2% urea (T_5), urea foliar spray (equivalent N content as in DAP) (T_6), humic acid 20 kg soil application + 0.1% humic acid foliar spray (T_7), 1% KC1 + humic acid 20 kg/ha as soil application + 0.1% foliar spray (T_8), 1% KC1 + humic acid 20 kg/ha as soil application (T_9), 0.1 ppm Brassinosteroid (T_{10}) and control (T_1) were done at first flowering (40 DAS) and 15 days after first spray. Nutrients and PGRs were sprayed @

Table 1. Effect of nutrients and PGRs on growth attributes in blackgram

Treatments	Plant height (cm)			LA/plant (cm^2)			TDMP/plant (g)		
	Vegetative	Flowering	Pod filling	Vegetative	Flowering	Pod filling	Vegetative	Flowering	Pod filling
T_1	17.1	43.1	52.5	308.65	594.03	529.10	5.99	7.67	6.82
T_2	20.2	57.1	63.5	508.24	772.69	798.24	7.53	14.05	16.25
T_3	21.5	58.2	61.5	393.05	672.04	721.49	7.34	9.23	12.94
T_4	17.2	60.6	66.0	354.49	679.91	726.20	6.66	10.31	11.31
T_5	24.4	62.3	68.0	573.69	924.7	966.50	9.21	12.01	24.84
T_6	18.7	59.4	67.3	405.96	664.7	766.50	6.26	15.52	15.71
T_7	17.7	56.4	62.7	444.53	666.11	890.81	6.79	8.58	21.22
T_8	21.4	55.2	62.6	521.01	644.43	896.63	7.61	10.90	16.55
T_9	22.1	59.6	65.5	557.52	863.73	899.41	6.67	16.42	23.65
T_{10}	18.4	61.3	65.8	463.54	655.03	765.25	6.99	11.71	15.56
Mean	19.55	56.23	63.05	455.82	753.17	836.47	6.95	11.73	16.95
CD (P=0.05)	0.1671	0.1662	NS	2.29	4.02	4.83	0.0647	0.0967	6.23

600 lit/ha along with 0.1% Teepol and the control set was sprayed with deionized water and Teepol. Plant height, leaf area and drymatter accumulation was recorded by selecting five random plants from marked rows. The maximum plant height was measured from the base of the stem to the tip of the longest trifoliate leaf. Maximum root length was measured from the base of the stem to the tip of the longest root. Leaf area was measured by using Leaf area meter (LICOR 3000). Drymatter accumulation of various plant parts was estimated by keeping the sample in oven at 80° C for 48 hrs. Total drymatter was quantified by taking the sum of all the plant parts. Growth characteristics namely CGR, NAR, LAD were calculated by adopting the procedure of Watson (1958), Williams (1946), Power *et al.* (1967) and expressed in g/m^2/day, mg/cm^2/day and days respectively.

Biochemical estimates *viz.*, soluble protein (Lowry *et al.*, 1951), nitrate reductase activity (Nicholas *et al*, 1976) and total chlorophyll content (Yoshida *et al.*, 1971) was estimated and the units were expressed as mg/g of fresh weight, μgNO_2/g/ha and mg/g of fresh weight respectively. At harvest pods/plant, 100 seed weight, biological yield and HI were determined from five randomly selected plants. The data were analysed statistically using the 'F test and critical difference (C.D) was calculated (Panse and Sukhatme, 1961).

Results and Discussion

The plant height, leaf area and TDMP increased from vegetative to pod filling stage (Table 1). For plant height, application of 2% urea (T_5) recorded a significant increase (68 cm) over the rest of treatments followed by nutrient mixture with salicylic acid (T_4). The leaf area showed maximum value at pod filling stage when it was sprayed with

Table 2. Effect of nutrients and PGRs on growth indices in blackgram

Treatment	CGR ($g/m^2/day$)		NAR ($mg/cm^2/day$)		LAD (days)	
	35-50 DAS	50-65 DAS	35-50 DAS	50-65 DAS	35-50 DAS	50-65 DAS
T_1	15.7	5.2	0.210	0.230	25.0	20.5
T_2	14.6	6.8	0.240	0.260	33.0	38.5
T_3	18.9	7.5	0.250	0. 340	26.5	27.0
T_4	19.4	8.7	0.280	0.410	23.5	35.0
T_5	24.6	12.8	0.370	0.580	31.0	41.0
T_6	16.7	6.1	0.240	0.370	36.0	48.0
T_7	20.8	9.2	0.300	0.460	29.0	41.5
T_8	21.3	10.8	0.280	0.320	29.5	38.5
T_9	22.5	11.6	0.330	0. 550	40.5	48.5
T_{10}	20.5	9.7	0.300	0.540	29.0	35.5
Mean	19.8	8.84	0.300	0.400	30.61	38.47
CD (5%)	0.4852	0.6492	0.010	0.011	0.1240	0.1827

chemicals and PGRs. Reduction in leaf area was observed at pod filling stage. Maximum photosynthetic surface was recorded in T_5 followed by T_9. TDMP reflects the accumulated carbohydrate in the plant. Urea spray (T_5) had a profound effect in increasing the TDMP at pod filling stage. Application of PGR increased the TDMP from vegetative to pod filling stage. In the present study, the data revealed an increasing in plant height by urea may be attributed by increasing the N status in the plant system. Thus nitrogen containing source (urea) has increased the height substantially compared to the rest of the nutrients (Kalarani, 1991). The maximum LA at peak flowering contributes to better yielding ability in grain legumes (Thandapani, 1985) is a pre-requisite to maximise the photosynthetic activity. In contrast, in control plants the total LA declined at later period due to the onset of senescence phenomenon (Kalarani, 1991 and Sujatha, 2001). The urea sprayed plant maintained comparatively longer LA at different stages, thus aiding in the supply of photosynthates for the development of pods and grains and also intensification of metabolic activity and efficient utilisation of N (Beninger, 1978). From the result, the reduced TDMP might be due to the reducing photosynthetic activity during senescence period. This would have been brought about by the inability of the plant to take up the nutrient from the soil and also due to the depletion of nutrient from leaves to seed. But application of urea increased the TDMP by reducing the leaf senescence (Syverud *et al.* 1980 and Kannan, 1986).

Application of PGR and nutrients increased the growth characters viz., CGR, NAR and LAD (Table 2) at

Table 3. Effect of nutrients and PGRs on biochemical attributes in blackgram

Treatments	Total chlorophyll (mg/g)		Soluble protein (mg/g)		NRase activity (ug NO_2 N/g/ha)	
	Vegetative	Flowering	Vegetative	Flowering	Vegetative	Flowering
T_1	0.4783	2.0687	08.00	10.47	24.33	29.00
T_2	0.6203	2.1031	10.20	13.30	26.60	30.31
T_3	0.8869	2.4236	10.64	13.70	31.00	38.30
T_4	0.9449	2.4826	11.29	14.10	40.34	47.33
T_5	1.8884	2.8623	12.65	15.40	49.62	56.60
T_6	0.8696	2.3839	11.26	13.10	32.02	42.00
T_7	1.0460	2.5165	11.67	13.20	44.33	50.30
T_8	0.8289	2.3435	11.60	13.70	32.51	40.63
T_9	1.0928	2.6850	12.02	15.00	46.31	53.62
T_{10}	0.9304	2.4788	10.73	12.10	46.61	51.30
Mean	0.8773	2.4517	11.005	13.407	37.29	44.50
CD(P=0.05)	0.0045	0.0057	0.0148	0.0160	2.164	2.396

Table 4. Influence of nutrients and PGRs on yield and yield attributes in blackgram

Treat-ments	Number of pods/ plant	Number of clusters/ plant	100 seed weight (g)	Grain yield/ plant(g)	Yield (kg/ha)	HI
T_1	21.31	8.44	3.92	3.74	602.20	0.20
T_2	22.43	10.97	3.97	4.46	690.50	0.27
T_3	26.52	11.86	4.20	4.53	808.80	0.25
T_4	35.60	12.53	4.26	4.65	849.30	0.30
T_5	44.72	15.84	4.48	5.10	955.20	0.32
T_6	24.36	11.76	4.11	45.12	806.00	0.28
T_7	40.93	13.89	4.28	4.77	872.50	0.31
T_8	26.14	11.59	4.02	4.92	752.20	0.27
T_9	43.81	14.91	4.44	5.02	926.20	0.32
T_{10}	30.55	12.08	4.22	4.84	816.30	0.29
Mean	31.64	12.39	4.23	4.62	813.58	0.29
CD(P=0.05)	0.867	0.15	0.03	0.026	2.52	0.009

all growth stages. Among the treatments, T_5 recorded a maximum CGR value of 24.6 $g/m^2/day$ followed by T_9 (22.5 $g/m^2/day$) at 30 - 50 DAS. Thereafter CGR showed a declining trend. In T_5 and T_9 CGR decreased to a tune of 50% from the critical (35 - 50 DAS) value. More LAD was obtained in T_9 (48.0). It increased from 35-50 DAS to 50 - 65 DAS. The decreasing in LAD in control at lateral period of reproductive phase may be due to decreased number of leaves and leaf surface. All other treatments increased the LAD which is an essential factor for increased the photosynthesis during grain filling period. The increased LAD may be due to increased LAI of urea treated plants. Maximum NAR was recorded at urea treatment (T_5), higher NAR at 50 - 65 DAS may be due to rapid vegetative growth, since the leaf nitrogen is related with NAR during grain filling period which enables the plant to have higher NAR (Calmes *et al.*, 1989, Kalarani, 1991 and Sujatha, 2001). The increase in CGR is due to chemical spray may be attributed to increased LAD. As CGR is a linear function of intercepted irradiation (Shibles and Webber, 1965; 1966) and maintenance of higher LAD has positive effect on higher drymatter production ultimately resulting in higher yield (Gopal Singh and Jainarain Singh, 1982).

The total chlorophyll, soluble protein and NR activity increased from vegetative stage to flowering stage. Among all the treatments, urea had the profound effect in improving the total chlorophyll content, soluble protein content and NR activity followed by the next best treatment T_9 (Table 3). The increased chlorophyll content in urea sprayed plants may be due to the fact that nitrogen is a constituent of chlorophyll molecule which is expected during rapid grain filling leaves (Mitra *et al.*, 1987 and Sujatha, 2001). Martignone *et al.* (1987) reported that soluble proteins are the first nitrogenous compound lost during pod filling and spraying of urea could increase the soluble protein content. This is in conformation with the finding of Manian *et al.* (1987). The NR activity is associated with availability of carbohydrate (Luis and Autonio, 1983). The increased activity is due to urea spray may be attributed by increased enzyme synthesis and high NAR (Mirhatum and Hume, 1976; Akhtar *et al.* 1991).

Foliar spray of 2% urea had profound effect in improving the yield and yield attributes characters *viz.*, number of pods per plant, number of clusters per plant, 100 seed weight, grain yield per plant and yield per hectare (Table 4). The number of pods and clusters per plant were increased due to the application of urea to a tune of 105 per cent and 87 per cent over control followed by T_9. Urea application had the significant yield increase of 58.6 per cent when compared to control followed by the treatment T_9 (53.8%). However, both the treatments (T_5 and T_9) which are on par with each other for harvest index.

As pod number is considered to be the major yield determinant in pulses, foliar feeding of N through urea source was able to increase the pod number in this experiment. This observation is in confirmation with the report of Brevedan *et al.* (1978). The data illustrate the importance of the N nutrition of blackgram plant during reproductive stage. Lathwell and Evans (1951) have reported similar results. The data on 100 seed weight showed that control plants recorded lesser seed weight. The reduction in seed weight may be due to the change in the flux of cytokinin and mineral nutrients from the roots normally declines during pod filling (Nooden, 1984 and Nooden *et al.* 1989) and also by complete deprivation of cytokinin and minerals from this source. Improvement of accumulation of biomass on seed due to other selected chemicals may be attributed due to increased source activity by delaying the senescence during grain filling period. The higher yield noticed in the effective treatments may probably due to longer retention of the effective photoassimilatory surface. Thorne (1973) and Sekhan *et al.* (1987) has suggested that delay in leaf senescence may be achieved agronomically through application of nitrogen fertilizer at flowering. HI and yield are directly correlated with yield in pulses (Kalarani, 1991). In the present study also high yielders had high partitioning efficiency.

Conclusion

The present investigation reveals that the foliar spray of plant growth regulators and chemicals were able to influence the physiological, biochemical and yield components of the crop. In particular, foliar spray of 2% urea was found to be the most effective treatment followed by KCl 1% along with soil application of humic acid @20 kg/ha. Though the selected chemicals were able to increase the yield, 2% urea was found to be the best than others due to efficiency in increasing the yield.

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